

# Package ‘queueing’

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**Title** Analysis of Queueing Networks and Models.

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**Depends** R (>= 2.11.1)

## Suggests

**Description** It provides a versatile tool for analysis of birth and death based Markovian Queueing Models and Single and Multiclass Product-Form Queueing Networks. It implements M/M/1, M/M/c, M/M/Infinite, M/M/1/K, M/M/c/K, M/M/c/c, M/M/1/K/K, M/M/c/K/K, M/M/c/K/m, M/M/Infinite/K, Single Channel Open Jackson Networks, Multiple Channel Closed Jackson Networks, Single Channel Multiple Class Open Networks, Single Channel Multiple Class Closed Networks and Single Channel Multiple Class Mixed Networks. Also it provides a B-Erlang, C-Erlang and Engset calculators. This work is dedicated to the memory of D. Sixto Rios Insua.

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queueing-package      *Analysis of Queueing Networks and Models.*

## Description

It provides a versatile tool for analysis of birth and death based Markovian Queueing Models and Single and Multiclass Product-Form Queueing Networks.

It implements the following basic markovian models:

M/M/1,	M/M/c,	M/M/Infinite,
M/M/1/K,	M/M/c/K,	M/M/c/c,
M/M/1/K/K,	M/M/c/K/K,	M/M/c/K/m, M/M/Infinite/K/K

It also solves the following types of networks:

- Multiple Channel Open Jackson Networks.
- Multiple Channel Closed Jackson Networks.
- Single Channel Multiple Class Open Networks.
- Single Channel Multiple Class Closed Networks
- Single Channel Multiple Class Mixed Networks

Also it provides B-Erlang, C-Erlang and Engset calculators.

This work is dedicated to the memory of D. Sixto Rios Insua.

## Details

All models are used in the same way:

1. Create inputs calling the appropriate *NewInput.model*. For example, `x <- NewInput.MM1(lambda=0.25, mu=1, n=10)` for a M/M/1 model. To know the exact acronym model to use for *NewInput* function, you can search the html help or write `help.search("NewInput")` at the command line.
2. Optionally, as a help for creating the inputs, the `CheckInput(x)` function can be called

3. Solve the model calling `y <- QueueingModel(x)`. In this step, the `CheckInput(x)` will be called. That is the reason that the previous step is optional
4. Finally, you can get a performance value as `W(y)`, `Wq(y)` or a report of the principals performance values calling `summary(y)`

See the examples for more detailed information of the use.

### Author(s)

Author, Maintainer and Copyright: Pedro Canadilla <pedro.canadilla@gmail.com>

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

### Examples

```
## M/M/1 model
summary(QueueingModel(NewInput.MM1(lambda=1/4, mu=1/3, n=0)))

## M/M/1/K model
summary(QueueingModel(NewInput.MM1K(lambda=1/4, mu=1/3, k=3)))
```

---

B\_erlang

*Returns the probability that all servers are busy*

---

### Description

Returns the probability that all servers are busy

### Usage

```
B_erlang(c=1, u=0)
```

### Arguments

c	numbers of servers
u	lambda/mu, that is, ratio of rate of arrivals and rate of service

### Details

Returns the probability that all servers are busy

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[C\\_erlang](#)

**Examples**

```
## two servers
B_erlang(2, 0.5/0.7)
```

---

CheckInput	<i>Generic S3 method to check the params of a queueing model (or network)</i>
------------	---

---

**Description**

Generic S3 method to check the params of a queueing model (or network)

**Usage**

```
CheckInput(x, ...)
```

**Arguments**

x	a object of class <code>i_MM1</code> , <code>i_MMC</code> , <code>i_MM1K</code> , <code>i_MMCK</code> , <code>i_MM1KK</code> , <code>i_MMCKK</code> , <code>i_MMCC</code> , <code>i_MMCKM</code> , <code>i_MMInfKK</code> , <code>i_MMInf</code> , <code>i_OJN</code>
...	additional arguments

**Details**

Generic S3 method to check the params of a queueing model (or network)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory.*  
 John Wiley & Sons.

**See Also**

[CheckInput.i\\_MM1](#)  
[CheckInput.i\\_MMC](#)  
[CheckInput.i\\_MM1K](#)  
[CheckInput.i\\_MMCK](#)  
[CheckInput.i\\_MM1KK](#)  
[CheckInput.i\\_MMCKK](#)  
[CheckInput.i\\_MMCC](#)  
[CheckInput.i\\_MMCKM](#)  
[CheckInput.i\\_MMInfKK](#)  
[CheckInput.i\\_MMInf](#)  
[CheckInput.i\\_OJN](#)

**Examples**

```

## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Check the inputs
CheckInput(i_mm1)

```

---

CheckInput.i\_CJN      *Check the input params of a Closed Jackson Network*

---

**Description**

Check the input params of a Closed Jackson Network

**Usage**

```

## S3 method for class 'i_CJN'
CheckInput(x, ...)

```

**Arguments**

x                    a object of class i\_CJN  
...                   additional arguments

**Details**

Check the input params of a Closed Jackson Network. The inputs params are created calling previously the [NewInput.CJN](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.CJN](#)

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

CheckInput(cjn1)
```

---

CheckInput.i\_MCCN

*Check the input params of a MultiClass Closed Network*

---

**Description**

Check the input params of a MultiClass Closed Network

**Usage**

```
## S3 method for class 'i_MCCN'
CheckInput(x, ...)
```

**Arguments**

x                    a object of class i\_MCCN  
...                    additional arguments

**Details**

Check the input params of a MultiClass Closed Network. The inputs params are created calling previously the [NewInput.MCCN](#)

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCCN](#)

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

CheckInput(i_MCCN1)
```

---

CheckInput.i\_MCMN

*Check the input params of a MultiClass Mixed Network*

---

**Description**

Check the input params of a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'i_MCMN'
CheckInput(x, ...)
```

**Arguments**

x	a object of class i_MCMN
...	additional arguments

**Details**

Check the input params of a MultiClass Mixed Network. The inputs params are created calling previously the [NewInput.MCMN](#)

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCMN](#)

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

CheckInput(i_mcmn1)
```

---

CheckInput.i\_MCON

*Check the input params of a MultiClass Open Network*

---

**Description**

Check the input params of a MultiClass Open Network

**Usage**

```
## S3 method for class 'i_MCON'
CheckInput(x, ...)
```

**Arguments**

x	a object of class i_MCON
...	aditional arguments

**Details**

Check the input params of a MultiClass Open Network. The inputs params are created calling previously the [NewInput.MCON](#)

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCON](#)

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

CheckInput(i_mcon1)
```

---

CheckInput.i_MM1	<i>Checks the input params of a M/M/1 queueing model</i>
------------------	--

---

**Description**

Checks the input params of a M/M/1 queueing model

**Usage**

```
## S3 method for class 'i_MM1'
CheckInput(x, ...)
```

**Arguments**

x	a object of class i_MM1
...	additional arguments

**Details**

Checks the input params of a M/M/1 queueing model. The inputs params are created calling previously the [NewInput.MM1](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MM1](#).

**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Check the inputs
CheckInput(i_mm1)
```

---

CheckInput.i_MM1K	<i>Checks the input params of a M/M/1/K queueing model</i>
-------------------	--

---

**Description**

Checks the input params of a M/M/1/K queueing model

**Usage**

```
## S3 method for class 'i_MM1K'
CheckInput(x, ...)
```

**Arguments**

x	a object of class i_MM1K
...	aditional arguments

**Details**

Checks the input params of a M/M/1/K queueing model. The inputs params are created calling previously the [NewInput.MM1K](#)

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[NewInput.MM1K](#).

## Examples

```
## See example 10.7 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)  
  
## check the parameters  
CheckInput(i_mm1k)
```

---

CheckInput.i\_MM1KK      *Checks the input params of a M/M/1/K/K queueing model*

---

## Description

Checks the input params of a M/M/1/K/K queueing model

## Usage

```
## S3 method for class 'i_MM1KK'  
CheckInput(x, ...)
```

## Arguments

x	a object of class i_MM1KK
...	aditional arguments

## Details

Checks the input params of a M/M/1/K/K queueing model. The inputs params are created calling previously the [NewInput.MM1KK](#)

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MM1KK](#).

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## check the parameters
CheckInput(i_mm1kk)
```

---

CheckInput.i_MMC	<i>Checks the input params of a M/M/c queueing model</i>
------------------	--

---

**Description**

Checks the input params of a M/M/c queueing model

**Usage**

```
## S3 method for class 'i_MMC'
CheckInput(x, ...)
```

**Arguments**

x	a object of class i_MMC
...	additional arguments

**Details**

Checks the input params of a M/M/c queueing model. The inputs params are created calling previously the [NewInput.MMC](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMC](#).

## Examples

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## check the parameters
CheckInput(i_mmc)
```

---

CheckInput.i_MMCC	<i>Checks the input params of a M/M/c/c queueing model</i>
-------------------	--

---

## Description

Checks the input params of a M/M/c/c queueing model

## Usage

```
## S3 method for class 'i_MMCC'
CheckInput(x, ...)
```

## Arguments

x	a object of class i_MMCC
...	additional arguments

## Details

Checks the input params of a M/M/c/c queueing model. The inputs params are created calling previously the [NewInput.MMCC](#)

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

## See Also

[NewInput.MMCC](#).

## Examples

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## check the parameters
CheckInput(i_mmcc)
```

---

CheckInput.i_MMCK	<i>Checks the input params of a M/M/c/K queueing model</i>
-------------------	--

---

## Description

Checks the input params of a M/M/c/K queueing model

## Usage

```
## S3 method for class 'i_MMCK'
CheckInput(x, ...)
```

## Arguments

x	a object of class i_MMCK
...	additional arguments

## Details

Checks the input params of a M/M/c/K queueing model. The inputs params are created calling previously the [NewInput.MMCK](#)

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

## See Also

[NewInput.MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Check the inputs
CheckInput(i_mmck)
```

---

CheckInput.i\_MMCKK      *Checks the input params of a M/M/c/K/K queueing model*

---

**Description**

Checks the input params of a M/M/c/K/K queueing model

**Usage**

```
## S3 method for class 'i_MMCKK'
CheckInput(x, ...)
```

**Arguments**

```
x                    a object of class i_MMCKK
...                   additional arguments
```

**Details**

Checks the input params of a M/M/c/K/K queueing model. The inputs params are created calling previously the [NewInput.MMCKK](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMCKK](#).

**Examples**

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## check the parameters
CheckInput(i_mmckk)
```

---

CheckInput.i\_MMCKM      *Checks the input params of a M/M/c/K/m queueing model*

---

### Description

Checks the input params of a M/M/c/K/m queueing model

### Usage

```
## S3 method for class 'i_MMCKM'  
CheckInput(x, ...)
```

### Arguments

x	a object of class i_MMCKM
...	additional arguments

### Details

Checks the input params of a M/M/c/K/m queueing model. The inputs params are created calling previously the [NewInput.MMCKM](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[NewInput.MMCKM](#).

### Examples

```
## create input parameters  
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)  
  
## check the parameters  
CheckInput(i_mmckm)
```

---

CheckInput.i\_MMInf      *Checks the input params of a M/M/Infinite queueing model*

---

### Description

Checks the input params of a M/M/Infinite queueing model

### Usage

```
## S3 method for class 'i_MMInf'  
CheckInput(x, ...)
```

### Arguments

x	a object of class i_MMInf
...	additional arguments

### Details

Checks the input params of a M/M/Infinite queueing model. The inputs params are created calling previously the [NewInput.MMInf](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[NewInput.MMInf](#).

### Examples

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)  
  
## Check the parameters  
CheckInput(i_mminf)
```

---

CheckInput.i\_MMInfKK *Checks the input params of a M/M/Infinite/K/K queueing model*

---

### Description

Checks the input params of a M/M/Infinite/K/K queueing model

### Usage

```
## S3 method for class 'i_MMInfKK'  
CheckInput(x, ...)
```

### Arguments

x	a object of class i_MMInfKK
...	additional arguments

### Details

Checks the input params of a M/M/Infinite/K/K queueing model. The inputs params are created calling previously the [NewInput.MMInfKK](#)

### References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

### See Also

[NewInput.MMInfKK](#).

### Examples

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)  
  
## check the parameters  
CheckInput(i_MMInfKK)
```

---

CheckInput.i_OJN	<i>Check the input params of an Open Jackson Network</i>
------------------	--

---

**Description**

Check the input params of an Open Jackson Network

**Usage**

```
## S3 method for class 'i_OJN'
CheckInput(x, ...)
```

**Arguments**

x	a object of class i_OJN
...	additional arguments

**Details**

Check the input params of an Open Jackson Network. The inputs params are created calling previously the [NewInput.OJN](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.OJN](#)

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

ojn1 <- NewInput.OJN(prob, n1, n2, n3, n4)

CheckInput(ojn1)
```

---

CompareQueueingModels *Compare several queueing models in a tabulated format*

---

### Description

Compare several queueing models in a tabulated format

### Usage

```
CompareQueueingModels(model, ...)
CompareQueueingModels2(models)
```

### Arguments

model	A Queueing Model obtained calling QueueingModel from classes described in the details section
...	a separated by comma list of queueing models obtained calling QueueingModel from classes described in the details section
models	A list of queueing models obtained calling QueueingModel from classes described in the details section

### Details

Compare several queueing models in a tabulated format. By now, only o\_MM1, o\_MMC, o\_MMInf, o\_MM1K, o\_MMCK, o\_MMCC, o\_MM1KK, o\_MMCKK, o\_MMCKM, o\_MMInfKK classes can be compared

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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### See Also

[QueueingModel](#)

### Examples

```
q1 <- QueueingModel(NewInput.MM1(lambda=5, mu=7))
q2 <- QueueingModel(NewInput.MMC(lambda=5, mu=3, c=4))
q3 <- QueueingModel(NewInput.MMInf(lambda=3, mu=4))
q4 <- QueueingModel(NewInput.MMCC(lambda=5, mu=3, c=4))

CompareQueueingModels(q1, q2, q3)
CompareQueueingModels2(list(q1, q2, q3, q4))
```

---

C_erlang	Returns the probability to wait in queue because all servers are busy
----------	---

---

### Description

Returns the probability to wait in queue because all servers are busy

### Usage

```
C_erlang(c=1, r=0)
```

### Arguments

c	numbers of servers
r	lambda/mu, that is, ratio of rate of arrivals and rate of service

### Details

Returns the probability to wait in queue because all servers are busy

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[B\\_erlang](#)

### Examples

```
## two servers  
C_erlang(2, 0.5/0.7)
```

---

Engset *Returns the probability that all servers are busy*

---

### Description

Returns the probability that all servers are busy

### Usage

```
Engset(k=1, c=0, r=0)
```

### Arguments

k	numbers of users
c	numbers of servers
r	lambda/mu, that is, ratio of rate of arrivals and rate of service

### Details

Returns the probability of blocking in a finite source model

### See Also

[B\\_erlang](#)

### Examples

```
## three users, two servers
Engset(3, 2, 0.5/0.7)
```

---

Inputs *Returns the input parameters of a queueing model (or network)*

---

### Description

Returns the inputs parameters of a already built queueing model (or network)

### Usage

```
Inputs(x, ...)
```

### Arguments

x	a object of class o_MM1, o_MMCC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf, o_OJN, o_MCON, o_MCCN, o_MCMN
...	aditional arguments

**Details**

Returns the input parameters of a queueing model (or network)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[Inputs.o\\_MM1](#)  
[Inputs.o\\_MMC](#)  
[Inputs.o\\_MM1K](#)  
[Inputs.o\\_MMCK](#)  
[Inputs.o\\_MM1KK](#)  
[Inputs.o\\_MMCKK](#)  
[Inputs.o\\_MMCC](#)  
[Inputs.o\\_MMCKM](#)  
[Inputs.o\\_MMInfKK](#)  
[Inputs.o\\_MMInf](#)  
[Inputs.o\\_OJN](#)  
[Inputs.o\\_CJN](#)  
[Inputs.o\\_MCON](#)  
[Inputs.o\\_MCCN](#)  
[Inputs.o\\_MCMN](#)

**Examples**

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Inputs
Inputs(o_mm1)
```

---

Inputs.o\_CJN

*Returns the input params of a Closed Jackson Network*

---

**Description**

Returns the input params of a Closed Jackson Network

**Usage**

```
## S3 method for class 'o_CJN'
Inputs(x, ...)
```

**Arguments**

```
x          a object of class o_CJN
...        additional arguments
```

**Details**

Returns the input params of a Closed Jackson Network. The inputs parameters are created calling previously the [NewInput.CJN](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.CJN](#).

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

Inputs(m_cjn1)
```

---

Inputs.o_MCCN	Returns the input params of a MultiClass Closed Network
---------------	---

---

### Description

Returns the input params of a MultiClass Closed Network

### Usage

```
## S3 method for class 'o_MCCN'  
Inputs(x, ...)
```

### Arguments

x	a object of class o_MCCN
...	additional arguments

### Details

Returns the input params of a MultiClass Closed Network. The inputs parameters are created calling previously the [NewInput.MCCN](#)

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[NewInput.MCCN](#).

### Examples

```
## See example in pag 142 in reference [Lazowska84] for more details.  
  
classes <- 2  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)  
  
# Build the model  
o_MCCN1 <- QueueingModel(i_MCCN1)
```

```
Inputs(o_MCMN1)
```

---

Inputs.o_MCMN	<i>Returns the input params of a MultiClass Mixed Network</i>
---------------	---

---

### Description

Returns the input params of a MultiClass Mixed Network

### Usage

```
## S3 method for class 'o_MCMN'
Inputs(x, ...)
```

### Arguments

x	a object of class o_MCMN
...	additional arguments

### Details

Returns the input params of a MultiClass Mixed Network. The inputs parameters are created calling previously the [NewInput.MCMN](#)

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[NewInput.MCMN](#).

### Examples

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)
```

```
i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Inputs(o_mcmn1)
```

---

Inputs.o\_MCON                      *Returns the input params of a MultiClass Open Network*

---

### Description

Returns the input params of a MultiClass Open Network

### Usage

```
## S3 method for class 'o_MCON'
Inputs(x, ...)
```

### Arguments

x	a object of class o_MCON
...	additional arguments

### Details

Returns the input params of a MultiClass Open Network. The inputs parameters are created calling previously the [NewInput.MCON](#)

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[NewInput.MCON](#).

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Inputs(o_mcon1)
```

---

Inputs.o\_MM1

*Returns the input parameters of a M/M/1 queueing model*


---

**Description**

Returns the inputs parameters of a already built M/M/1 queueing model

**Usage**

```
## S3 method for class 'o_MM1'
Inputs(x, ...)
```

**Arguments**

x	a object of class o_MM1
...	aditional arguments

**Details**

Returns the input parameters of a M/M/1 queueing model. The inputs parameters are created calling previously the [NewInput.MM1](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**[NewInput.MM1](#).**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Inputs
Inputs(o_mm1)
```

---

Inputs.o_MM1K	<i>Returns the input parameters of a M/M/1/K queueing model</i>
---------------	---

---

**Description**

Returns the inputs parameters of a already built M/M/1/K queueing model

**Usage**

```
## S3 method for class 'o_MM1K'
Inputs(x, ...)
```

**Arguments**

x	a object of class o_MM1K
...	additional arguments

**Details**

Returns the input parameters of a M/M/1/K queueing model. The inputs parameters are created calling previously the [NewInput.MM1K](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

**See Also**[NewInput.MM1K](#).

### Examples

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mm1k <- QueueingModel(i_mm1k)

## Returns the Inputs
Inputs(o_mm1k)
```

---

Inputs.o_MM1KK	Returns the input parameters of a M/M/1/K/K queueing model
----------------	--

---

### Description

Returns the inputs parameters of a already built M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'
Inputs(x, ...)
```

### Arguments

x	a object of class o_MM1KK
...	aditional arguments

### Details

Returns the input parameters of a M/M/1/K/K queueing model. The inputs parameters are created calling previously the [NewInput.MM1KK](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

### See Also

[NewInput.MM1KK](#).

## Examples

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the Inputs
Inputs(o_mm1kk)
```

---

Inputs.o_MMC	Returns the input parameters of a M/M/c queueing model
--------------	--

---

## Description

Returns the inputs parameters of a already built M/M/c queueing model

## Usage

```
## S3 method for class 'o_MMC'
Inputs(x, ...)
```

## Arguments

x	a object of class o_MMC
...	aditional arguments

## Details

Returns the input parameters of a M/M/c queueing model. The inputs parameters are created calling previously the [NewInput.MMC](#)

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[NewInput.MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMCC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Returns the Inputs
Inputs(o_mmc)
```

---

Inputs.o_MMCC	<i>Returns the input parameters of a M/M/c/c queueing model</i>
---------------	---

---

**Description**

Returns the inputs parameters of a already built M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'
Inputs(x, ...)
```

**Arguments**

x	a object of class o_MMCC
...	aditional arguments

**Details**

Returns the input parameters of a M/M/c/c queueing model. The inputs parameters are created calling previously the [NewInput.MMCC](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMCC](#).

**Examples**

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Returns the Inputs
Inputs(o_mmcc)
```

---

Inputs.o_MMCK	<i>Returns the input parameters of a M/M/c/K queueing model</i>
---------------	---

---

**Description**

Returns the inputs parameters of a already built M/M/c/K queueing model

**Usage**

```
## S3 method for class 'o_MMCK'
Inputs(x, ...)
```

**Arguments**

x	a object of class o_MMCK
...	aditional arguments

**Details**

Returns the input parameters of a M/M/c/K queueing model. The inputs parameters are created calling previously the [NewInput.MMCK](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Returns the Inputs
Inputs(o_mmck)
```

---

Inputs.o_MMCKK	Returns the input parameters of a M/M/c/K/K queueing model
----------------	--

---

**Description**

Returns the inputs parameters of a already built M/M/c/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMCKK'
Inputs(x, ...)
```

**Arguments**

x	a object of class o_MMCKK
...	aditional arguments

**Details**

Returns the input parameters of a M/M/c/K/K queueing model. The inputs parameters are created calling previously the [NewInput.MMCKK](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMCKK](#).

## Examples

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## Build the model
o_mmckk <- QueueingModel(i_mmckk)

## Returns the Inputs
Inputs(o_mmckk)
```

---

Inputs.o_MMCKM	Returns the input parameters of a M/M/c/K/m queueing model
----------------	--

---

## Description

Returns the inputs parameters of a already built M/M/c/K/m queueing model

## Usage

```
## S3 method for class 'o_MMCKM'
Inputs(x, ...)
```

## Arguments

x	a object of class o_MMCKM
...	additional arguments

## Details

Returns the input parameters of a M/M/c/K/m queueing model. The inputs parameters are created calling previously the [NewInput.MMCKM](#)

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[NewInput.MMCKM](#).

**Examples**

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Returns the Inputs
Inputs(o_mmckm)
```

---

Inputs.o_MMInf	<i>Returns the input parameters of a M/M/Infinite queueing model</i>
----------------	--

---

**Description**

Returns the inputs parameters of a already built M/M/Infinite queueing model

**Usage**

```
## S3 method for class 'o_MMInf'
Inputs(x, ...)
```

**Arguments**

x	a object of class o_MMInf
...	additional arguments

**Details**

Returns the input parameters of a M/M/Infinite queueing model. The inputs parameters are created calling previously the [NewInput.MMInf](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMInf](#).

## Examples

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Returns the Inputs
Inputs(o_mminf)
```

---

Inputs.o_MMInfKK	Returns the input parameters of a M/M/Infinite/K/K queueing model
------------------	---

---

## Description

Returns the inputs parameters of a already built M/M/Infinite/K/K queueing model

## Usage

```
## S3 method for class 'o_MMInfKK'
Inputs(x, ...)
```

## Arguments

x	a object of class o_MMInfKK
...	additional arguments

## Details

Returns the input parameters of a M/M/Infinite/K/K queueing model. The inputs parameters are created calling previously the [NewInput.MMInfKK](#)

## References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

## See Also

[NewInput.MMInfKK](#).

**Examples**

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Returns the Inputs
Inputs(o_MMInfKK)
```

---

Inputs.o_OJN	<i>Returns the input params of an Open Jackson Network</i>
--------------	--

---

**Description**

Returns the input params of an Open Jackson Network

**Usage**

```
## S3 method for class 'o_OJN'
Inputs(x, ...)
```

**Arguments**

x	a object of class o_OJN
...	additional arguments

**Details**

Returns the input params of an Open Jackson Network. The inputs parameters are created calling previously the [NewInput.OJN](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.OJN](#).

## Examples

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

i_ojn1 <- NewInput.OJN(prob, n1, n2, n3, n4)

# Build the model
o_ojn1 <- QueueingModel(i_ojn1)

Inputs(o_ojn1)
```

---

L	<i>Returns the mean number of customers in a queueing model (or network)</i>
---	--

---

## Description

Returns the mean number of customers in a queueing model (or network)

## Usage

```
L(x, ...)
```

## Arguments

x	a object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf, o_OJN, o_MCON, o_MCCN, o_MCMN
...	additional arguments

## Details

Returns the mean number of customers in a queueing model (or network)

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[L.o\\_MM1](#)  
[L.o\\_MMC](#)  
[L.o\\_MM1K](#)  
[L.o\\_MMCK](#)  
[L.o\\_MM1KK](#)  
[L.o\\_MMCKK](#)  
[L.o\\_MMCC](#)  
[L.o\\_MMCKM](#)  
[L.o\\_MMInfKK](#)  
[L.o\\_MMInf](#)  
[L.o\\_OJN](#)  
[L.o\\_CJN](#)  
[L.o\\_MCON](#)  
[L.o\\_MCCN](#)  
[L.o\\_MCMN](#)

**Examples**

```

## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the L
L(o_mm1)

```

---

L.o\_CJN

*Returns the mean number of customers of a Closed Jackson Network*


---

**Description**

Returns the mean number of customers of a Closed Jackson Network

**Usage**

```

## S3 method for class 'o_CJN'
L(x, ...)

```

**Arguments**

x                    a object of class o\_CJN  
...                   additional arguments

**Details**

Returns the mean number of customers of a Closed Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_CJN](#).

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

L(m_cjn1)
```

---

L.o\_MCCN

---

*Returns the mean number of customers of a MultiClass Closed Network*


---

**Description**

Returns the mean number of customers of a MultiClass Closed Network

**Usage**

```
## S3 method for class 'o_MCCN'
L(x, ...)
```

**Arguments**

x                    a object of class o\_MCCN  
 ...                  additional arguments

**Details**

Returns the mean number of customers of a MultiClass Closed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCCN](#).

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

L(o_MCCN1)
```

---

L.o\_MCMN

*Returns the mean number of customers of a MultiClass Mixed Network*

---

**Description**

Returns the mean number of customers of a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'  
L(x, ...)
```

**Arguments**

```
x          a object of class o_MCMN  
...       additional arguments
```

**Details**

Returns the mean number of customers of a MultiClass Mixed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.  
  
classes <- 4  
vLambda <- c(1, 1/2)  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=1, nrow=4, ncol=2)  
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)  
  
i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)  
  
# Build the model  
o_mcmn1 <- QueueingModel(i_mcmn1)  
  
L(o_mcmn1)
```

---

L.o\_MCON

*Returns the mean number of customers of a MultiClass Open Network*


---

### Description

Returns the mean number of customers of a MultiClass Open Network

### Usage

```
## S3 method for class 'o_MCON'
L(x, ...)
```

### Arguments

```
x          a object of class o_MCON
...        additional arguments
```

### Details

Returns the mean number of customers of a MultiClass Open Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCON](#).

### Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

L(o_mcon1)
```

---

L.o_MM1	Returns the mean number of customers in the M/M/1 queueing model
---------	--

---

### Description

Returns the mean number of customers in the M/M/1 queueing model

### Usage

```
## S3 method for class 'o_MM1'  
L(x, ...)
```

### Arguments

x	a object of class o_MM1
...	additional arguments

### Details

Returns the mean number of customers in the M/M/1 queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MM1](#).

### Examples

```
## See example 10.3 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)  
  
## Build the model  
o_mm1 <- QueueingModel(i_mm1)  
  
## Returns the L  
L(o_mm1)
```

---

L.o_MM1K	<i>Returns the mean number of customers in the M/M/1/K queueing model</i>
----------	---

---

### Description

Returns the mean number of customers in the M/M/1/K queueing model

### Usage

```
## S3 method for class 'o_MM1K'  
L(x, ...)
```

### Arguments

x	a object of class o_MM1K
...	additional arguments

### Details

Returns the mean number of customers in the M/M/1/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MM1K](#).

### Examples

```
## See example 10.7 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)  
  
## Build the model  
o_mm1k <- QueueingModel(i_mm1k)  
  
## Returns the L  
L(o_mm1k)
```

---

L.o_MM1KK	<i>Returns the mean number of customers in the M/M/1/K/K queueing model</i>
-----------	---

---

### Description

Returns the mean number of customers in the M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'  
L(x, ...)
```

### Arguments

x	a object of class o_MM1KK
...	additional arguments

### Details

Returns the mean number of customers in the M/M/1/K/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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### See Also

[QueueingModel.i\\_MM1K](#).

### Examples

```
## See example 10.13 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)  
  
## Build the model  
o_mm1kk <- QueueingModel(i_mm1kk)  
  
## Returns the L  
L(o_mm1kk)
```

---

`L.o_MMC`*Returns the mean number of customers in the M/M/c queueing model*

---

**Description**

Returns the mean number of customers in the M/M/c queueing model

**Usage**

```
## S3 method for class 'o_MMC'  
L(x, ...)
```

**Arguments**

<code>x</code>	a object of class <code>o_MMC</code>
<code>...</code>	additional arguments

**Details**

Returns the mean number of customers in the M/M/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)  
  
## Build the model  
o_mmc <- QueueingModel(i_mmc)  
  
## Returns the L  
L(o_mmc)
```

---

L.o_MMCC	Returns the mean number of customers in the M/M/c/c queueing model
----------	--

---

### Description

Returns the mean number of customers in the M/M/c/c queueing model

### Usage

```
## S3 method for class 'o_MMCC'  
L(x, ...)
```

### Arguments

x	a object of class o_MMCC
...	additional arguments

### Details

Returns the mean number of customers in the M/M/c/c queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMCC](#).

### Examples

```
## See example 10.12 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)  
  
## Build the model  
o_mmcc <- QueueingModel(i_mmcc)  
  
## Returns the L  
L(o_mmcc)
```

---

L.o_MMCK	<i>Returns the mean number of customers in the M/M/c/K queueing model</i>
----------	---

---

### Description

Returns the mean number of customers in the M/M/c/K queueing model

### Usage

```
## S3 method for class 'o_MMCK'  
L(x, ...)
```

### Arguments

x	a object of class o_MMCK
...	additional arguments

### Details

Returns the mean number of customers in the M/M/c/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMCK](#).

### Examples

```
## See example 10.11 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)  
  
## Build the model  
o_mmck <- QueueingModel(i_mmck)  
  
## Returns the L  
L(o_mmck)
```

---

L.o_MMCKK	<i>Returns the mean number of customers in the M/M/c/K/K queueing model</i>
-----------	---

---

### Description

Returns the mean number of customers in the M/M/c/K/K queueing model

### Usage

```
## S3 method for class 'o_MMCKK'  
L(x, ...)
```

### Arguments

x	a object of class o_MMCKK
...	aditional arguments

### Details

Returns the mean number of customers in the M/M/c/K/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMCKK](#).

### Examples

```
## create input parameters  
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)  
  
## Build the model  
o_mmckk <- QueueingModel(i_mmckk)  
  
## Returns the L  
L(o_mmckk)
```

---

L.o_MMCKM	<i>Returns the mean number of customers in the M/M/c/K/m queueing model</i>
-----------	---

---

### Description

Returns the mean number of customers in the M/M/c/K/m queueing model

### Usage

```
## S3 method for class 'o_MMCKM'  
L(x, ...)
```

### Arguments

x	a object of class o_MMCKM
...	aditional arguments

### Details

Returns the mean number of customers in the M/M/c/K/m queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMCKM](#).

### Examples

```
## create input parameters  
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)  
  
## Build the model  
o_mmckm <- QueueingModel(i_mmckm)  
  
## Returns the L  
L(o_mmckm)
```

---

L.o_MMInf	Returns the mean number of customers in the M/M/Infinite queueing model
-----------	---

---

### Description

Returns the mean number of customers in the M/M/Infinite queueing model

### Usage

```
## S3 method for class 'o_MMInf'  
L(x, ...)
```

### Arguments

x	a object of class o_MMInf
...	aditional arguments

### Details

Returns the mean number of customers in the M/M/Infinite queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMInf](#).

### Examples

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)  
  
## Build the model  
o_mminf <- QueueingModel(i_mminf)  
  
## Returns the L  
L(o_mminf)
```

---

L.o_MMInfKK	<i>Returns the mean number of customers in the M/M/Infinite/K/K queueing model</i>
-------------	--

---

### Description

Returns the mean number of customers in the M/M/Infinite/K/K queueing model

### Usage

```
## S3 method for class 'o_MMInfKK'  
L(x, ...)
```

### Arguments

x	a object of class o_MMInfKK
...	additional arguments

### Details

Returns the mean number of customers in the M/M/Infinite/K/K queueing model

### References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

### See Also

[QueueingModel.i\\_MMInfKK](#).

### Examples

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)  
  
## Build the model  
o_MMInfKK <- QueueingModel(i_MMInfKK)  
  
## Returns the L  
L(o_MMInfKK)
```

---

L.o_OJN	<i>Returns the mean number of customers of an Open Jackson Network</i>
---------	--

---

**Description**

Returns the mean number of customers of an Open Jackson Network

**Usage**

```
## S3 method for class 'o_OJN'
L(x, ...)
```

**Arguments**

x	a object of class o_OJN
...	additional arguments

**Details**

Returns the mean number of customers of an Open Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_OJN](#).

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

i_ojn <- NewInput.OJN(prob, n1, n2, n3, n4)

# Build the model
o_ojn <- QueueingModel(i_ojn)
```

L(o\_ojn)

---

Lc *Returns the vector with the mean number of customers of each class in a multiclass queueing network*

---

### Description

Returns the vector with the mean number of customers of each class in a multiclass queueing network

### Usage

Lc(x, ...)

### Arguments

x            a object of class o\_MCON, o\_MCCN, o\_MCMN  
...           additional arguments

### Details

Returns the vector with the mean number of customers of each class in a multiclass queueing network

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*

Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[Lc.o\\_MCON](#)

[Lc.o\\_MCCN](#)

[Lc.o\\_MCMN](#)

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Lc(o_mcon1)
```

---

Lc.o_MCCN	<i>Returns the vector with the mean number of customers of each class in a MultiClass Closed Network</i>
-----------	--

---

**Description**

Returns the vector with the mean number of customers of each class in a MultiClass Closed Network

**Usage**

```
## S3 method for class 'o_MCCN'
Lc(x, ...)
```

**Arguments**

x	a object of class o_MCCN
...	additional arguments

**Details**

Returns the vector with the mean number of customers of each class in a MultiClass Closed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCCN](#).

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Lc(o_MCCN1)
```

---

Lc.o\_MCMN

*Returns the vector with the mean number of customers of each class in a MultiClass Mixed Network*

---

**Description**

Returns the vector with the mean number of customers of each class in a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'
Lc(x, ...)
```

**Arguments**

x                    a object of class o\_MCMN  
 ...                  additional arguments

**Details**

Returns the vector with the mean number of customers of each class in a MultiClass Mixed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Lc(o_mcmn1)
```

---

Lc.o\_MCON

*Returns the vector with the mean number of customers of each class in a MultiClass Open Network*

---

**Description**

Returns the vector with the mean number of customers of each class in a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
Lc(x, ...)
```

**Arguments**

x                    a object of class o\_MCON  
...                   additional arguments

**Details**

Returns the vector with the mean number of customers of each class in a MultiClass Open Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCON](#).

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Lc(o_mcon1)
```

---

Lck

*Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Network*

---

**Description**

Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Network

**Usage**

Lck(x, ...)

## Arguments

x                    a object of class o\_MCON, o\_MCCN, o\_MCMN  
...                   additional arguments

## Details

Reports a matrix with the mean number of customers of class  $i$  in each node (server)  $j$  in a MultiClass Network

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

## See Also

[Lck.o\\_MCON](#)  
[Lck.o\\_MCCN](#)  
[Lck.o\\_MCMN](#)

## Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.  
  
classes <- 2  
vLambda <- c(3/19, 2/19)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)  
  
# Build the model  
o_mcon1 <- QueueingModel(i_mcon1)  
  
Lck(o_mcon1)
```

---

Lck.o_MCCN	<i>Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Closed Network</i>
------------	---

---

### Description

Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Closed Network

### Usage

```
## S3 method for class 'o_MCCN'
Lck(x, ...)
```

### Arguments

x	a object of class o_MCCN
...	additional arguments

### Details

Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Closed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCCN](#).

### Examples

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)
```

```
# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Lck(o_MCCN1)
```

---

Lck.o_MCMN	<i>Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Mixed Network</i>
------------	--

---

### Description

Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Mixed Network

### Usage

```
## S3 method for class 'o_MCMN'
Lck(x, ...)
```

### Arguments

x	a object of class o_MCMN
...	additional arguments

### Details

Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Mixed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Lck(o_mcmn1)
```

---

Lck.o\_MCON

*Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Open Network*

---

**Description**

Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
Lck(x, ...)
```

**Arguments**

x                    a object of class o\_MCON  
...                    additional arguments

**Details**

Reports a matrix with the mean number of customers of class i in each node (server) j in a MultiClass Open Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCON](#).

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Lck(o_mcon1)
```

---

Lk	<i>Returns the vector with the mean number of customers in each node (server) of a queueing network</i>
----	---

---

**Description**

Returns the vector with the mean number of customers in each node (server) of a queueing network

**Usage**

```
Lk(x, ...)
```

**Arguments**

x	a object of class o_OJN, o_CJN, o_MCON, o_MCCN, o_MCMN
...	additional arguments

**Details**

Returns the vector with the mean number of customers in each node (server) of a queueing network

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*

Prentice-Hall, Inc., Englewood Cliffs, New Jersey

## See Also

[Lk.o\\_OJN](#)

[Lk.o\\_CJN](#)

[Lk.o\\_MCON](#)

[Lk.o\\_MCCN](#)

[Lk.o\\_MCMN](#)

## Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Lk(o_mcon1)
```

---

Lk.o\_CJN

*Returns the vector with the mean number of customers in each node (server) of a Closed Jackson Network*

---

## Description

Returns the vector with the mean number of customers in each node (server) of a Closed Jackson Network

**Usage**

```
## S3 method for class 'o_CJN'
Lk(x, ...)
```

**Arguments**

```
x          a object of class o_CJN
...        additional arguments
```

**Details**

Returns the vector with the mean number of customers in each node (server) of a Closed Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_CJN.](#)

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

Lk(m_cjn1)
```

---

Lk.o_MCCN	<i>Returns a vector with the mean number of customers in each node (server) of a MultiClass Closed Network</i>
-----------	--

---

### Description

Returns a vector with the mean number of customers in each node (server) of a MultiClass Closed Network

### Usage

```
## S3 method for class 'o_MCCN'  
Lk(x, ...)
```

### Arguments

x	a object of class o_MCCN
...	additional arguments

### Details

Returns a vector with the mean number of customers in each node (server) of a MultiClass Closed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCCN](#).

### Examples

```
## See example in pag 142 in reference [Lazowska84] for more details.  
  
classes <- 2  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)
```

```
# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Lk(o_MCCN1)
```

---

Lk.o_MCMN	<i>Returns a vector with the mean number of customers in each node (server) of a MultiClass Mixed Network</i>
-----------	---

---

### Description

Returns a vector with the mean number of customers in each node (server) of a MultiClass Mixed Network

### Usage

```
## S3 method for class 'o_MCMN'
Lk(x, ...)
```

### Arguments

x	a object of class o_MCMN
...	additional arguments

### Details

Returns a vector with the mean number of customers in each node (server) of a MultiClass Mixed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Lk(o_mcmn1)
```

---

Lk.o\_MCON

*Returns a vector with the mean number of customers in each node (server) of a MultiClass Open Network*

---

**Description**

Returns a vector with the mean number of customers in each node (server) of a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
Lk(x, ...)
```

**Arguments**

x                    a object of class o\_MCON  
...                    additional arguments

**Details**

Returns a vector with the mean number of customers in each node (server) of a MultiClass Open Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCON](#).

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Lk(o_mcon1)
```

---

Lk.o\_OJN

*Returns the vector with the mean number of customers in each node (server) of an Open Jackson Network*

---

**Description**

Returns the vector with the mean number of customers in each node (server) of an Open Jackson Network

**Usage**

```
## S3 method for class 'o_OJN'
Lk(x, ...)
```

**Arguments**

x                    a object of class o\_OJN  
 ...                  additional arguments

**Details**

Returns the vector with the mean number of customers in each node (server) of an Open Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_OJN](#).

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

i_ojn <- NewInput.OJN(prob, n1, n2, n3, n4)

# Build the model
o_ojn <- QueueingModel(i_ojn)

Lk(o_ojn)
```

---

Lq	<i>Returns the mean number of customers in the queue in a queueing model</i>
----	--

---

**Description**

Returns the mean number of customers in the queue in a queueing model

**Usage**

```
Lq(x, ...)
```

**Arguments**

x	a object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf
...	aditional arguments

**Details**

Returns the mean number of customers in the queue in a queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[Lq.o\\_MM1](#)  
[Lq.o\\_MMC](#)  
[Lq.o\\_MM1K](#)  
[Lq.o\\_MMCK](#)  
[Lq.o\\_MM1KK](#)  
[Lq.o\\_MMCKK](#)  
[Lq.o\\_MMCC](#)  
[Lq.o\\_MMCKM](#)  
[Lq.o\\_MMInfKK](#)  
[Lq.o\\_MMInf](#)

**Examples**

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Lq
Lq(o_mm1)
```

---

Lq.o\_MM1

*Returns the mean number of customers in the queue in the M/M/1 queueing model*

---

**Description**

Returns the mean number of customers in the queue in the M/M/1 queueing model

**Usage**

```
## S3 method for class 'o_MM1'
Lq(x, ...)
```

**Arguments**

x                    a object of class o\_MM1  
 ...                    additional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/1 queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MM1](#).

**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Lq
Lq(o_mm1)
```

---

Lq.o\_MM1K

*Returns the mean number of customers in the queue in the M/M/1/K queueing model*

---

**Description**

Returns the mean number of customers in the queue in the M/M/1/K queueing model

**Usage**

```
## S3 method for class 'o_MM1K'
Lq(x, ...)
```

**Arguments**

x                    a object of class o\_MM1K  
 ...                    additional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/1/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MM1K](#).

**Examples**

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mm1k <- QueueingModel(i_mm1k)

## Returns the Lq
Lq(o_mm1k)
```

---

Lq.o_MM1KK	<i>Returns the mean number of customers in the queue in the M/M/1/K/K queueing model</i>
------------	--

---

**Description**

Returns the mean number of customers in the queue in the M/M/1/K/K queueing model

**Usage**

```
## S3 method for class 'o_MM1KK'
Lq(x, ...)
```

**Arguments**

x	a object of class o_MM1KK
...	aditional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/1/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MM1KK.](#)

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the Lq
Lq(o_mm1kk)
```

---

Lq.o_MMC	<i>Returns the mean number of customers in the queue in the M/M/c queueing model</i>
----------	--

---

**Description**

Returns the mean number of customers in the queue in the M/M/c queueing model

**Usage**

```
## S3 method for class 'o_MMC'
Lq(x, ...)
```

**Arguments**

x	a object of class o_MMC
...	aditional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Returns the Lq
Lq(o_mmc)
```

---

Lq.o_MMCC	<i>Returns the mean number of customers in the queue in the M/M/c/c queueing model</i>
-----------	--

---

**Description**

Returns the mean number of customers in the queue in the M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'
Lq(x, ...)
```

**Arguments**

x	a object of class o_MMCC
...	aditional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/c/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCC](#).

**Examples**

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Returns the Lq
Lq(o_mmcc)
```

---

Lq.o_MMCK	<i>Returns the mean number of customers in the queue in the M/M/c/K queueing model</i>
-----------	--

---

**Description**

Returns the mean number of customers in the queue in the M/M/c/K queueing model

**Usage**

```
## S3 method for class 'o_MMCK'
Lq(x, ...)
```

**Arguments**

x	a object of class o_MMCK
...	aditional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/c/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Returns the Lq
Lq(o_mmck)
```

---

Lq.o_MMCKK	<i>Returns the mean number of customers in the queue in the M/M/c/K/K queueing model</i>
------------	--

---

**Description**

Returns the mean number of customers in the queue in the M/M/c/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMCKK'
Lq(x, ...)
```

**Arguments**

x	a object of class o_MMCKK
...	additional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/c/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCKK](#).

**Examples**

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## Build the model
o_mmckk <- QueueingModel(i_mmckk)

## Returns the Lq
Lq(o_mmckk)
```

---

Lq.o_MMCKM	<i>Returns the mean number of customers in the queue in the M/M/c/K/m queueing model</i>
------------	--

---

**Description**

Returns the mean number of customers in the queue in the M/M/c/K/m queueing model

**Usage**

```
## S3 method for class 'o_MMCKM'
Lq(x, ...)
```

**Arguments**

x	a object of class o_MMCKM
...	aditional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/c/K/m queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCKM](#).

**Examples**

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Returns the Lq
Lq(o_mmckm)
```

---

Lq.o_MMInf	<i>Returns the mean number of customers in the queue in the M/M/Infinite queueing model</i>
------------	---

---

**Description**

Returns the mean number of customers in the queue in the M/M/Infinite queueing model

**Usage**

```
## S3 method for class 'o_MMInf'
Lq(x, ...)
```

**Arguments**

x	a object of class o_MMInf
...	aditional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/Infinite queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMInf](#).

## Examples

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Returns the Lq
Lq(o_mminf)
```

---

Lq.o_MMInfKK	<i>Returns the mean number of customers in the queue in the M/M/Infinite/K/K queueing model</i>
--------------	---

---

## Description

Returns the mean number of customers in the queue in the M/M/Infinite/K/K queueing model

## Usage

```
## S3 method for class 'o_MMInfKK'
Lq(x, ...)
```

## Arguments

x	a object of class o_MMInfKK
...	additional arguments

## Details

Returns the mean number of customers in the queue in the M/M/Infinite/K/K queueing model

## References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

## See Also

[QueueingModel.i\\_MMInfKK](#).

**Examples**

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Returns the Lq
Lq(o_MMInfKK)
```

---

Lqq	<i>Returns the mean number of customers in queue when there is queue in a queueing model</i>
-----	--

---

**Description**

Returns the mean number of customers in queue when there is queue in a queueing model

**Usage**

```
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf
...	additional arguments

**Details**

Returns the mean number of customers in queue when there is queue in a queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[Lqq.o\\_MM1](#)  
[Lqq.o\\_MMC](#)  
[Lqq.o\\_MM1K](#)  
[Lqq.o\\_MMCK](#)  
[Lqq.o\\_MM1KK](#)  
[Lqq.o\\_MMCKK](#)  
[Lqq.o\\_MMCC](#)

```
Lqq.o_MMCKM
Lqq.o_MMInfKK
Lqq.o_MMInf
```

### Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Lqq
Lqq(o_mm1)
```

---

Lqq.o_MM1	<i>Returns the mean number of customers in queue when there is queue in the M/M/1 queueing model</i>
-----------	--

---

### Description

Returns the mean number of customers in queue when there is queue in the M/M/1 queueing model

### Usage

```
## S3 method for class 'o_MM1'
Lqq(x, ...)
```

### Arguments

x	a object of class o_MM1
...	additional arguments

### Details

Returns the mean number of customers in queue when there is queue in the M/M/1 queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
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### See Also

[QueueingModel.i\\_MM1.](#)

**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Lqq
Lqq(o_mm1)
```

---

Lqq.o_MM1K	<i>Returns the mean number of customers in queue when there is queue in the M/M/1/K queueing model</i>
------------	--

---

**Description**

Returns the mean number of customers in queue when there is queue in the M/M/1/K queueing model

**Usage**

```
## S3 method for class 'o_MM1K'
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MM1K
...	additional arguments

**Details**

Returns the mean number of customers in queue when there is queue in the M/M/1/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MM1K](#).

### Examples

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mm1k <- QueueingModel(i_mm1k)

## Returns the Lq
Lqq(o_mm1k)
```

---

Lqq.o_MM1KK	<i>Returns the mean number of customers in queue when there is queue in the M/M/1/K/K queueing model</i>
-------------	--

---

### Description

Returns the mean number of customers in queue when there is queue in the M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'
Lqq(x, ...)
```

### Arguments

x	a object of class o_MM1KK
...	additional arguments

### Details

Returns the mean number of customers in queue when there is queue in the M/M/1/K/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
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### See Also

[QueueingModel.i\\_MM1KK](#).

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the Lqq
Lqq(o_mm1kk)
```

---

Lqq.o_MMC	<i>Returns the mean number of customers in queue when there is queue in the M/M/c queueing model</i>
-----------	--

---

**Description**

Returns the mean number of customers in queue when there is queue in the M/M/c queueing model

**Usage**

```
## S3 method for class 'o_MMC'
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MMC
...	aditional arguments

**Details**

Returns the mean number of customers in queue when there is queue in the M/M/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Returns the Lqq
Lqq(o_mmc)
```

---

Lqq.o_MMCC	<i>Returns the mean number of customers in queue when there is queue in the M/M/c/c queueing model</i>
------------	--

---

**Description**

Returns the mean number of customers in queue when there is queue in the M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MMCC
...	additional arguments

**Details**

Returns the mean number of customers in queue when there is queue in the M/M/c/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCC](#).

**Examples**

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Returns the Lqq
Lqq(o_mmcc)
```

---

Lqq.o_MMCK	<i>Returns the mean number of customers in queue when there is queue in the M/M/c/K queueing model</i>
------------	--

---

**Description**

Returns the mean number of customers in queue when there is queue in the M/M/c/K queueing model

**Usage**

```
## S3 method for class 'o_MMCK'
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MMCK
...	additional arguments

**Details**

Returns the mean number of customers in queue when there is queue in the M/M/c/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Returns the Lqq
Lqq(o_mmck)
```

---

Lqq.o_MMCKK	<i>Returns the mean number of customers in queue when there is queue in the M/M/c/K/K queueing model</i>
-------------	--

---

**Description**

Returns the mean number of customers in queue when there is queue in the M/M/c/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMCKK'
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MMCKK
...	additional arguments

**Details**

Returns the mean number of customers in queue when there is queue in the M/M/c/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCKK](#).

**Examples**

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## Build the model
o_mmckk <- QueueingModel(i_mmckk)

## Returns the Lqq
Lqq(o_mmckk)
```

---

Lqq.o_MMCKM	<i>Returns the mean number of customers in queue when there is queue in the M/M/c/K/m queueing model</i>
-------------	--

---

**Description**

Returns the mean number of customers in queue when there is queue in the M/M/c/K/m queueing model

**Usage**

```
## S3 method for class 'o_MMCKM'
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MMCKM
...	aditional arguments

**Details**

Returns the mean number of customers in the queue in the M/M/c/K/m queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCKM](#).

**Examples**

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Returns the Lqq
Lqq(o_mmckm)
```

---

Lqq.o_MMInf	<i>Returns the mean number of customers in queue when there is queue in the M/M/Infinite queueing model</i>
-------------	---

---

**Description**

Returns the mean number of customers in queue when there is queue in the M/M/Infinite queueing model

**Usage**

```
## S3 method for class 'o_MMInf'
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MMInf
...	additional arguments

**Details**

Returns the mean number of customers in queue when there is queue in the M/M/Infinite queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMInf.](#)

**Examples**

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Returns the Lqq
Lqq(o_mminf)
```

---

Lqq.o_MMInfKK	<i>Returns the mean number of customers in queue when there is queue in the M/M/Infinite/K/K queueing model</i>
---------------	---

---

**Description**

Returns the mean number of customers in queue when there is queue in the M/M/Infinite/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMInfKK'
Lqq(x, ...)
```

**Arguments**

x	a object of class o_MMInfKK
...	additional arguments

**Details**

Returns the mean number of customers in queue when there is queue in the M/M/Infinite/K/K queueing model

**References**

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
 John Wiley & Sons.

**See Also**

[QueueingModel.i\\_MMInfKK](#).

**Examples**

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Returns the Lqq
Lqq(o_MMInfKK)
```

---

NewInput.CJN

*Define the inputs of a Closed Jackson Network*


---

**Description**

Define the inputs of a Closed Jackson Network

**Usage**

```
NewInput.CJN(prob=NULL, n=0, z=0, operational=FALSE, method=0, tol=0.001, ...)
NewInput2.CJN(prob=NULL, n=0, z=0, operational=FALSE, method=0, tol=0.001, nodes)
NewInput3.CJN(n, z, numNodes, vType, vVisit, vService, vChannel, method=0, tol=0.001)
```

**Arguments**

prob	It is probability transition matrix or visit ratio vector. That is, the prob[i, j] is the transition probability of node i to node j, or prob[i] is the visit ratio (a probability, that is, a value between 0 and 1) to node i. Also, the visit ratio can express the number of times that a client visits the queueing center, in a more operational point of view. See the parameter operational
n	number of customers in the Network
z	think time of the client
operational	If prob is a vector with the visit ratios, operational equal to FALSE gives to the visit ratio a probability meaning, that is, as the stationary values of the imbedded markov chain. If operational is equal to TRUE, the operational point of view is used: it is the number of visits that the same client makes to a node.
method	If method is 0, the exact MVA algorithm is used. If method is 1, the Bard-Schweitzer approximation algorithm is used.
tol	If the parameter method is 1, this is the tolerance parameter of the algorithm.
...	a separated by comma list of nodes of i_MM1, i_MMC or i_MMInf class
nodes	A list of nodes of i_MM1, i_MMC or i_MMInf class
numNodes	The number of nodes of the network
vType	A vector with the type of server: "Q" for a queueing node, "D" for a delay node
vVisit	A vector with the visit ratios. It represent visit counts to a center as if the parameter operational were TRUE

vService	A vector with the services time of each node
vChannel	A vector with the number of channels of the node. The type of the server has to be "Q" to be inspected

### Details

Define the inputs of a Closed Jackson Network. For a operational use, NewInput3.CJN is recommended. For a more academic use, NewInput.CJN or NewInput2.CJN is recommended. Please, note that the different ways to create the inputs for a Closed Jackson Network are equivalent to each other, and no validation is done at this stage. The validation is done calling CheckInput function.

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_CJN](#)

### Examples

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

## think time = 0
z <- 0

## operational value
operational <- FALSE

## definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

## Not run:
cjn1 <- NewInput2.CJN(prob, n, z, operational, 0, 0.001, list(n1, n2))

## End(Not run)
```

```

## using visit ratios and service demands. See [Lazowska84] pag 117.
## E[S] cpu = 0.005, Visit cpu = 121, D cpu = E[S] cpu * Visit cpu = 0.605
cpu <- NewInput.MM1(mu=1/0.005)

## E[S] disk1 = 0.030, Visit disk1 = 70, D disk1 = E[S] disk1 * Visit disk1 = 2.1
disk1 <- NewInput.MM1(mu=1/0.030)

## E[S] disk2 = 0.027, Visit disk2 = 50, D disk2 = E[S] disk2 * Visit disk2 = 1.35
disk2 <- NewInput.MM1(mu=1/0.027)

## The visit ratios.
vVisit <- c(121, 70, 50)

operational <- TRUE

net <- NewInput.CJN(prob=vVisit, n=3, z=15, operational, 0, 0.001, cpu, disk1, disk2)

## Using the operational creation function
n <- 3
think <- 15
numNodes <- 3
vType <- c("Q", "Q", "Q")
vService <- c(0.005, 0.030, 0.027)
vChannel <- c(1, 1, 1)

net2 <- NewInput3.CJN(n, think, numNodes, vType, vVisit, vService, vChannel, method=0, tol=0.001)

```

---

NewInput.MCCN

*Define the inputs of a MultiClass Closed Network*


---

## Description

Define the inputs of a MultiClass Closed Network

## Usage

```

NewInput.MCCN(
  classes, vNumber, vThink, nodes, vType, vVisit, vService, method=1, tol=0.01
)

```

## Arguments

classes	The number of classes
vNumber	A vector with the number of customers of each class
vThink	A vector with the think time of each class
nodes	The number of nodes in the network

vType	A vector with the type of node: "Q" for queueing nodes or "D" for delay nodes
vVisit	A matrix[i, j]. The rows represents the different visit count for each class i to each node j
vService	A matrix[i, j]. The rows represents the different service time for each class i in each node j
method	If method is 0, the exact MVA algorithm is used. If method is 1, the Bard-Schweitzer approximation algorithm is used
tol	If the parameter method is 1, this is the tolerance parameter of the algorithm

### Details

Define the inputs of a MultiClass Closed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCCN](#)

### Examples

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)
```

---

NewInput.MCMN

*Define the inputs of a MultiClass Mixed Network*

---

### Description

Define the inputs of a MultiClass Mixed Network

**Usage**

```
NewInput.MCMN(
  classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService, method=0, tol=0.01
)
```

**Arguments**

classes	The number of classes
vLambda	It is a vector with the rate of arrivals of each class
vNumber	A vector with the number of customers of each class
vThink	A vector with the think time of each class
nodes	The number of nodes in the network
vType	A vector with the type of node: "Q" for queueing nodes or "D" for delay nodes
vVisit	A matrix[i, j]. The rows represents the different visit count for each class i to each node j. Take caution about the orden: open classes are defined first and closed classes are defined second
vService	A matrix[i, j]. The rows represents the different service times for each class i in each node j. Take caution about the orden: open classes are defined first and closed classes are defined second.
method	If method is 0, the exact MVA algorithm is used. If method is 1, the Bard-Schweitzer approximation algorithm is used
tol	If the parameter method is 1, this is the tolerance parameter of the algorithm

**Details**

Define the inputs of a MultiClass Mixed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN](#)

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4 # A and B are open classes and C and D are closed classes.
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
```

```

vType <- c("Q", "Q")

# When the visit ratios and vService are set,
# be sure that the open classes are in the first positions
# and the closed classes after the open classes.
vVisit <- matrix(data=1, nrow=4, ncol=2)

# A and B are open classes:
# with demand service of 1/4 and 1/2 at the node 1 and 1/2 and 1 at the node 2
# C and D are open classes:
# with demand service of 1/4 and 1/2 at the node 1 and 1/2 and 1 at the node 2
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

```

---

NewInput.MCON

*Define the inputs of a MultiClass Open Network*


---

## Description

Define the inputs of a MultiClass Open Network

## Usage

```
NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)
```

## Arguments

classes	The number of classes
vLambda	It is a vector with the rate of arrivals of each class
nodes	The number of nodes in the network
vType	A vector with the type of node: "Q" for queueing nodes or "D" for delay nodes
vVisit	A matrix[i, j]. The rows represents the different visit count for each class i to each node j
vService	A matrix[i, j]. The rows represents the different service times for each class i in each node j

## Details

Define the inputs of a MultiClass Open Network

## References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCON](#)

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)
```

---

NewInput.MM1

*Define the inputs of a new M/M/1 queueing model*

---

**Description**

Define the inputs of a new M/M/1 queueing model

**Usage**

```
NewInput.MM1(lambda=0, mu=0, n=0)
```

**Arguments**

lambda	arrival rate
mu	server service rate
n	number of customers in the system. Put n=0 for a idle probability. With n=-1, no probabilities are computed

**Details**

Define the inputs of a new M/M/1 queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**[CheckInput.i\\_MM1](#)**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)
```

---

NewInput.MM1K	<i>Define the inputs of a new M/M/1/K queueing model</i>
---------------	--

---

**Description**

Define the inputs of a new M/M/1/K queueing model

**Usage**

```
NewInput.MM1K(lambda=0, mu=0, k=1)
```

**Arguments**

lambda	arrival rate
mu	server service rate
k	system capacity

**Details**

Define the inputs of a new M/M/1/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**[CheckInput.i\\_MM1K](#)**Examples**

```
## See example 10.7 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)
```

---

NewInput.MM1KK      *Define the inputs of a new M/M/1/K/K queueing model*

---

### Description

Define the inputs of a new M/M/1/K/K queueing model

### Usage

```
NewInput.MM1KK(lambda=0, mu=0, k=1, method=3)
```

### Arguments

lambda	arrival rate
mu	server service rate
k	system capacity
method	method of computation of the probabilities of k (system capacity) customers down. With method=0, the exact results are calculated using the formal definition. With method=1, approximate results are calculated using Stirling approximation of factorials and logarithms. With method=2, Jain's Method [Jain2007], pag. 26 is used. With method=3, the result that K-n customers up has a truncated poisson distribution is used [Kobayashi2012] pag. 709

### Details

Define the inputs of a new M/M/1/K/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Jain2007] Joti Lal Jain, Sri Gopal Mohanty, Walter Bohm (2007).

*A course on Queueing Models.*  
Chapman-Hall.

[Kobayashi2012] Hisashi Kobayashi, Brian L. Mark, William Turin (2012).

*Probability, Random Processes, and Statistical Analysis: Applications to Communications, Signal Processing, Queueing Theory and Mathematical Finance.*  
Cambridge University Press.

### See Also

[CheckInput.i\\_MM1KK](#)

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)
```

---

NewInput.MMC

*Define the inputs of a new M/M/c queueing model*


---

**Description**

Define the inputs of a new M/M/c queueing model

**Usage**

```
NewInput.MMC(lambda=0, mu=0, c=1, n=0, method=0)
```

**Arguments**

lambda	arrival rate
mu	server service rate
c	number of servers
n	number of customers in the system. Put n=0 for a idle probability. With n=-1, no probabilities are computed
method	method of computation of the probabilities of n number of customers in the system. With method=0, the exact results are calculated using the formal definition. With method=1, approximate results are calculated using Stirling approximation of factorials and logarithms.

**Details**

Define the inputs of a new M/M/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[CheckInput.i\\_MMC](#)

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)
```

---

NewInput.MMCC                      *Define the inputs of a new M/M/c/c queueing model*

---

**Description**

Define the inputs of a new M/M/c/c queueing model

**Usage**

```
NewInput.MMCC(lambda=0, mu=0, c=1, method=1)
```

**Arguments**

lambda	arrival rate
mu	server service rate
c	number of servers
method	with method = 0, the state probabilities are calculated using the formal definition (with overflow problems with factorials; with method = 1 (default), the truncated poisson distribution is used (recomended for professional use)

**Details**

Define the inputs of a new M/M/c/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Kobayashi2012] Hisashi Kobayashi, Brian L. Mark, William Turin (2012).  
*Probability, Random Processes, and Statistical Analysis: Applications to Communications, Signal Processing, Queueing Theory and Mathematical Finance.*  
Cambridge University Press.

**See Also**

[CheckInput.i\\_MMCC](#)

**Examples**

```
## See example 10.12 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)
```

---

NewInput.MMCK	<i>Define the inputs of a new M/M/c/K queueing model</i>
---------------	--

---

**Description**

Define the inputs of a new M/M/c/K queueing model

**Usage**

```
NewInput.MMCK(lambda=0, mu=0, c=1, k=1)
```

**Arguments**

lambda	arrival rate
mu	server service rate
c	number of servers
k	system capacity

**Details**

Define the inputs of a new M/M/c/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[CheckInput.i\\_MMCK](#)

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)
```

---

NewInput.MMCKK      *Define the inputs of a new M/M/c/K/K queueing model*

---

### Description

Define the inputs of a new M/M/c/K/K queueing model

### Usage

```
NewInput.MMCKK(lambda=0, mu=0, c=1, k=1, method=0)
```

### Arguments

lambda	arrival rate
mu	server service rate
c	number of servers
k	system capacity
method	method of computation of the probabilities of k (system capacity) customers down. With method=0, the exact results are calculated using the formal definition. With method=1, approximate results are calculated using Stirling approximation of factorials and logarithms. With method=2, Jain's Method [Jain2007], pag. 26 is used

### Details

Define the inputs of a new M/M/c/K/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Jain2007] Joti Lal Jain, Sri Gopal Mohanty, Walter Bohm (2007).

*A course on Queueing Models.*  
Chapman-Hall.

### See Also

[CheckInput.i\\_MMCKK](#)

### Examples

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)
```

---

NewInput.MMCKM      *Define the inputs of a new M/M/c/K/m queueing model*

---

**Description**

Define the inputs of a new M/M/c/K/m queueing model

**Usage**

```
NewInput.MMCKM(lambda=0, mu=0, c=1, k=1, m=1, method=0)
```

**Arguments**

lambda	arrival rate
mu	server service rate
c	number of servers
k	system capacity
m	population size. Please, observe that should be $m \geq k$
method	method of computation of the probabilities of k (system capacity) customers down. With method=0, the exact results are calculated using the formal definition. With method=1, approximate results are calculated using Stirling approximation of factorials and logarithms.

**Details**

Define the inputs of a new M/M/c/K/m queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[CheckInput.i\\_MMCKM](#)

**Examples**

```
## create input parameters  
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)
```

---

NewInput.MMInf      *Define the inputs of a new M/M/Infinite queueing model*

---

**Description**

Define the inputs of a new M/M/Infinite queueing model

**Usage**

```
NewInput.MMInf(lambda=0, mu=0, n=0)
```

**Arguments**

lambda	arrival rate
mu	server service rate
n	number of customers in the system. Put n=0 for a standard model

**Details**

Define the inputs of a new M/M/Infinite queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[CheckInput.i\\_MMInf](#)

**Examples**

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)
```

---

NewInput.MMInfKK	<i>Define the inputs of a new M/M/Infinite/K/K queueing model</i>
------------------	---

---

### Description

Define the inputs of a new M/M/Infinite/K/K queueing model

### Usage

```
NewInput.MMInfKK(lambda=0, mu=0, k=1)
```

### Arguments

lambda	arrival rate
mu	server service rate
k	system capacity

### Details

Define the inputs of a new M/M/Infinite/K/K queueing model

### References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

### See Also

[CheckInput.i\\_MMInfKK](#)

### Examples

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)
```

NewInput.OJN

*Define the inputs of an Open Jackson Network***Description**

Define the inputs of an Open Jackson Network

**Usage**

NewInput.OJN(prob=NULL, ...)

NewInput2.OJN(prob=NULL, nodes)

NewInput3.OJN(vLambda, numNodes, vType, vVisit, vService, vChannel)

**Arguments**

prob	It is probability transition matrix or visit ratio vector. That is, the prob[i, j] is the transition probability of node i to node j, or prob[i] is the visit ratio to node i (the visit ratio values doesn't need to be probabilities, that is, a value greater than 1 can be used here. See the examples)
...	a separated by comma list of nodes of i_MM1, i_MMC or i_MMInf class
nodes	A list of nodes of i_MM1, i_MMC or i_MMInf class
vLambda	Vector with the arrivals rates to each node
numNodes	Number of nodes
vType	A vector with the type of server: "Q" for a queueing node, "D" for a delay node
vVisit	A vector with the visit ratios
vService	A vector with the services time of each node
vChannel	A vector with the number of channels of the node. The type of the server has to be "Q" to be inspected

**Details**

Define the inputs of an Open Jackson Network. For a operational use, NewInput3.OJN is recommended. For a more academic use, NewInput.OJN or NewInput2.OJN is recommended. Please, note that the different ways to create the inputs for a Open Jackson Network are equivalent to each other, and no validation is done at this stage. The validation is done calling CheckInput function.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*

Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_OJN](#)

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

ojn1 <- NewInput.OJN(prob, n1, n2, n3, n4)

## Using function NewInput2
## Not run:
  ojn1 <- NewInput2.OJN(prob, list(n1, n2, n3, n4))

## End(Not run)

## Using visit ratios. Values taken from [Lazowska84], pag. 113.

## E[S] cpu = 0.005, Visit cpu = 121, D cpu = E[S] cpu * Visit cpu = 0.605
cpu <- NewInput.MM1(lambda=0.2, mu=1/0.005)

## E[S] disk1 = 0.030, Visit disk1 = 70, D disk1 = E[S] disk1 * Visit disk1 = 2.1
disk1 <- NewInput.MM1(lambda=0.2, mu=1/0.030)

## E[S] disk2 = 0.027, Visit disk2 = 50, D disk2 = E[S] disk2 * Visit disk2 = 1.35
disk2 <- NewInput.MM1(lambda=0.2, mu=1/0.027)

## In this example, to have the throughput per node, the visit ratios has to be given in this form.
## Please, don't use in the closed Jackson Network
visit <- c(121, 70, 50)
net <- NewInput.OJN(visit, cpu, disk1, disk2)

## Using NewInput3
vLambda <- c(0.2, 0.2, 0.2)
vService <- c(0.005, 0.030, 0.027)
numNodes <- 3
vType <- c("Q", "Q", "Q")
vChannel <- c(1, 1, 1)
net2 <- NewInput3.OJN(vLambda, numNodes, vType, visit, vService, vChannel)
```

---

Pn *Returns the probabilities of a queueing model (or network)*

---

### Description

Pn returns the probabilities that a queueing model (or network) has n customers.

Qn returns the probabilities that an arrival that enter the system see n customers in it

### Usage

Pn(x, ...)

Qn(x, ...)

### Arguments

x	For Pn, an object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf, o_OJN. For Qn, an object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf
...	additional arguments

### Details

Pn returns the system probabilities of a queueing model (or network). Qn returns the probability that an effective arrival see n customers in the system

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

### See Also

[Pn.o\\_MM1](#)

[Qn.o\\_MM1](#)

[Pn.o\\_MMC](#)

[Qn.o\\_MMC](#)

[Pn.o\\_MM1K](#)

[Qn.o\\_MM1K](#)

[Pn.o\\_MMCK](#)

[Qn.o\\_MMCK](#)

[Pn.o\\_MM1KK](#)

[Qn.o\\_MM1KK](#)

[Pn.o\\_MMCKK](#)

[Qn.o\\_MMCKK](#)

```

Pn.o_MMCC
Qn.o_MMCC
Pn.o_MMCKM
Qn.o_MMCKM
Pn.o_MMInfKK
Qn.o_MMInfKK
Pn.o_MMInf
Qn.o_MMInf
Pn.o_OJN

```

## Examples

```

## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the probabilities
Pn(o_mm1)

```

---

Pn.o\_MM1

*Returns the probabilities of a M/M/1 queueing model*


---

## Description

Pn returns the probabilities that a M/M/1 queueing model has n customers.  
Qn returns the probabilities that an arrival that enter the system see n customers in it.

## Usage

```

## S3 method for class 'o_MM1'
Pn(x, ...)
## S3 method for class 'o_MM1'
Qn(x, ...)

```

## Arguments

x                    a object of class o\_MM1  
...                    additional arguments

## Details

Pn returns the probabilities that a M/M/1/K queueing model has n customers.  
Qn returns the probabilities that an arrival that enter the system see n customers. By the PASTA property, both probabilities has to be the same.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MM1](#).

**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the probabilities
Pn(o_mm1)
Qn(o_mm1)
```

---

Pn.o\_MM1K

*Returns the probabilities of a M/M/1/K queueing model*


---

**Description**

Pn returns the probabilities that a M/M/1/K queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers in it.

**Usage**

```
## S3 method for class 'o_MM1K'
Pn(x, ...)
## S3 method for class 'o_MM1K'
Qn(x, ...)
```

**Arguments**

x                    a object of class o\_MM1K  
 ...                  additional arguments

**Details**

Pn returns the probabilities that a M/M/1/K queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MM1K](#).

**Examples**

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mm1k <- QueueingModel(i_mm1k)

## Returns the probabilities
Pn(o_mm1k)
Qn(o_mm1k)
```

---

Pn.o\_MM1KK

*Returns the probabilities of a M/M/1/K/K queueing model*


---

**Description**

Pn returns the probabilities of a M/M/1/K/K queueing model Qn returns the probabilities that an arrival that enter the system see n customers in it.

**Usage**

```
## S3 method for class 'o_MM1KK'
Pn(x, ...)
## S3 method for class 'o_MM1KK'
Qn(x, ...)
```

**Arguments**

x                    a object of class o\_MM1KK  
 ...                    additional arguments

**Details**

Pn returns the probabilities that a M/M/1/K/K queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MM1KK](#).

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the probabilities
Pn(o_mm1kk)
Qn(o_mm1kk)
```

---

Pn.o\_MMC

*Returns the probabilities of a M/M/c queueing model*


---

**Description**

Pn returns the probabilities that a M/M/c queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers in it.

**Usage**

```
## S3 method for class 'o_MMC'
Pn(x, ...)
## S3 method for class 'o_MMC'
Qn(x, ...)
```

**Arguments**

x                    a object of class o\_MMC  
 ...                  additional arguments

**Details**

Pn returns the probabilities that a M/M/c queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers. By the PASTA property, both probabilities has to be the same.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Returns the probabilities
Pn(o_mmc)
Qn(o_mmc)
```

---

Pn.o\_MMCC

*Returns the probabilities of a M/M/c/c queueing model*

---

**Description**

Pn returns the probabilities that a M/M/c/c queueing model has n customers.

Qn returns the probabilities that an arrival that enter the system see n customers in it.

**Usage**

```
## S3 method for class 'o_MMCC'
Pn(x, ...)
## S3 method for class 'o_MMCC'
Qn(x, ...)
```

**Arguments**

x                    a object of class o\_MMCC  
...                   additional arguments

**Details**

Pn returns the probabilities that a M/M/c/c queueing model has n customers.

Qn returns the probabilities that an arrival that enter the system see n customers.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCC](#).

**Examples**

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Returns the probabilities
Pn(o_mmcc)
Qn(o_mmcc)
```

---

Pn.o\_MMCK

*Returns the probabilities of a M/M/c/K queueing model*


---

**Description**

Pn returns the probabilities that a M/M/c/K queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers in it.

**Usage**

```
## S3 method for class 'o_MMCK'
Pn(x, ...)
## S3 method for class 'o_MMCK'
Qn(x, ...)
```

**Arguments**

x                    a object of class o\_MMCK  
 ...                  additional arguments

**Details**

Pn returns the probabilities that a M/M/c/K queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Returns the probabilities
Pn(o_mmck)
Qn(o_mmck)
```

---

Pn.o\_MMCKK

*Returns the probabilities of a M/M/c/K/K queueing model*


---

**Description**

Pn returns the probabilities that a M/M/c/K/K queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers in it.

**Usage**

```
## S3 method for class 'o_MMCKK'
Pn(x, ...)
## S3 method for class 'o_MMCKK'
Qn(x, ...)
```

**Arguments**

x                    a object of class o\_MMCKK  
 ...                  additional arguments

**Details**

Pn returns the probabilities that a M/M/c/K/K queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MMCKK](#).

**Examples**

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## Build the model
o_mmckk <- QueueingModel(i_mmckk)

## Returns the parameters
Pn(o_mmckk)
Qn(o_mmckk)
```

---

Pn.o\_MMCKM

*Returns the probabilities of a M/M/c/K/m queueing model*

---

**Description**

Pn returns the probabilities that a M/M/c/K/m queueing model has n customers.

Qn returns the probabilities that an arrival that enter the system see n customers in it.

**Usage**

```
## S3 method for class 'o_MMCKM'
Pn(x, ...)
## S3 method for class 'o_MMCKM'
Qn(x, ...)
```

**Arguments**

x                    a object of class o\_MMCKM  
...                    additional arguments

**Details**

Pn returns the probabilities that a M/M/c/K/m queueing model has n customers.

Qn returns the probabilities that an arrival that enter the system see n customers.

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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## See Also

[QueueingModel.i\\_MMCKM](#).

## Examples

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Returns the probabilities
Pn(o_mmckm)
Qn(o_mmckm)
```

---

Pn.o\_MMInf

*Returns the probabilities of a M/M/Infinite queueing model*

---

## Description

Pn returns the probabilities that a M/M/Infinite queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers in it.

## Usage

```
## S3 method for class 'o_MMInf'
Pn(x, ...)
## S3 method for class 'o_MMInf'
Qn(x, ...)
```

## Arguments

x                    a object of class o\_MMInf  
 ...                  additional arguments

## Details

Pn returns the probabilities that a M/M/Infinite queueing model has n customers.  
 Qn returns the probabilities that an arrival that enter the system see n customers. By the PASTA property, both probabilities has to be the same.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMInf.](#)

**Examples**

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Returns the probabilities
Pn(o_mminf)
Qn(o_mminf)
```

---

Pn.o\_MMInfKK

*Returns the probabilities of a M/M/Infinite/K/K queueing model*


---

**Description**

Pn returns the probabilities that a M/M/Infinite/K/K queueing model has n customers.

Qn returns the probabilities that an arrival that enter the system see n customers in it.

**Usage**

```
## S3 method for class 'o_MMInfKK'
Pn(x, ...)
## S3 method for class 'o_MMInfKK'
Qn(x, ...)
```

**Arguments**

x                    a object of class o\_MMInfKK  
...                    additional arguments

**Details**

Pn returns the probabilities that a M/M/Infinite/K/K queueing model has n customers.

Qn returns the probabilities that an arrival that enter the system see n customers.

**References**

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
 John Wiley & Sons.

**See Also**

[QueueingModel.i\\_MMInfKK](#).

**Examples**

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Returns the probabilities
Pn(o_MMInfKK)
Qn(o_MMInfKK)
```

---

Pn.o_OJN	<i>Returns vector of the probabilities of each node (server) of an Open Jackson Network</i>
----------	---

---

**Description**

Returns vector of the probabilities of each node (server) of an Open Jackson Network

**Usage**

```
## S3 method for class 'o_OJN'
Pn(x, ...)
```

**Arguments**

x	a object of class o_OJN
...	aditional arguments

**Details**

Returns vector of the probabilities of each node (server) of an Open Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos*.  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_OJN](#).

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

# Definition of the new input
i_ojn <- NewInput.OJN(prob, n1, n2, n3, n4)

# Build the models
o_ojn <- QueueingModel(i_ojn)

Pn(o_ojn)
```

---

QueueingModel

*Generic S3 method to build a queueing model (or network)*

---

**Description**

Generic S3 method to build a queueing model (or network)

**Usage**

```
QueueingModel(x, ...)
```

**Arguments**

x	a object of class <code>i_MM1</code> , <code>i_MMC</code> , <code>i_MM1K</code> , <code>i_MMCK</code> , <code>i_MM1KK</code> , <code>i_MMCKK</code> , <code>i_MMCC</code> , <code>i_MMCKM</code> , <code>i_MMInfKK</code> , <code>i_MMInf</code> , <code>o_OJN</code> , <code>o_MCON</code>
...	additional arguments

**Details**

Generic S3 method to build a queueing model (or network)

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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## See Also

[QueueingModel.i\\_MM1](#)  
[QueueingModel.i\\_MMC](#)  
[QueueingModel.i\\_MM1K](#)  
[QueueingModel.i\\_MMCK](#)  
[QueueingModel.i\\_MM1KK](#)  
[QueueingModel.i\\_MMCKK](#)  
[QueueingModel.i\\_MMCC](#)  
[QueueingModel.i\\_MMCKM](#)  
[QueueingModel.i\\_MMInfKK](#)  
[QueueingModel.i\\_MMInf](#)  
[QueueingModel.i\\_OJN](#)  
[QueueingModel.i\\_MCON](#)

## Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
QueueingModel(i_mm1)
```

---

QueueingModel.i\_CJN    *Builds one Closed Jackson Network*

---

## Description

Builds one Closed Jackson Network

## Usage

```
## S3 method for class 'i_CJN'
QueueingModel(x, ...)
```

## Arguments

x                    a object of class i\_CJN  
...                   additional arguments

**Details**

Build one Closed Jackson Network. It also checks the input params calling the [CheckInput.i\\_CJN](#)

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[CheckInput.i\\_CJN](#)

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

m_cjn1
```

---

QueueingModel.i\_MCCN *Builds one MultiClass Closed Network*

---

**Description**

Builds one MultiClass Closed Network

**Usage**

```
## S3 method for class 'i_MCCN'  
QueueingModel(x, ...)
```

**Arguments**

x	a object of class i_MCCN
...	additional arguments

**Details**

Build one MultiClass Closed Network. It also checks the input params calling the [CheckInput.i\\_MCCN](#)

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[CheckInput.i\\_MCCN](#)

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.  
  
classes <- 2  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)  
  
# Build the model  
o_MCCN1 <- QueueingModel(i_MCCN1)  
  
o_MCCN1
```

---

QueueingModel.i\_MCMN *Builds one MultiClass Mixed Network*

---

### Description

Builds one MultiClass Mixed Network

### Usage

```
## S3 method for class 'i_MCMN'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MCMN
...	additional arguments

### Details

Build one MultiClass Mixed Network. It also checks the input params calling the [CheckInput.i\\_MCMN](#)

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[CheckInput.i\\_MCMN](#)

### Examples

```
## See example in pag 147 in reference [Lazowska84] for more details.  
  
classes <- 4  
vLambda <- c(1, 1/2)  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=1, nrow=4, ncol=2)  
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)  
  
i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)  
  
# Build the model  
o_mcmn1 <- QueueingModel(i_mcmn1)
```

```
o_mcmn1
```

---

QueueingModel.i\_MCON *Builds one MultiClass Open Network*

---

## Description

Builds one MultiClass Open Network

## Usage

```
## S3 method for class 'i_MCON'  
QueueingModel(x, ...)
```

## Arguments

x	a object of class i_MCON
...	additional arguments

## Details

Build one MultiClass Open Network. It also checks the input params calling the [CheckInput.i\\_MCON](#)

## References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

## See Also

[CheckInput.i\\_MCON](#)

## Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.  
  
classes <- 2  
vLambda <- c(3/19, 2/19)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)
```

```
# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

o_mcon1
```

---

QueueingModel.i\_MM1     *Builds a M/M/1 queueing model*

---

### Description

Builds a M/M/1 queueing model

### Usage

```
## S3 method for class 'i_MM1'
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MM1
...	aditional arguments

### Details

Build a M/M/1 queueing model. It also checks the input params calling the [CheckInput.i\\_MM1](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_MM1](#)

### Examples

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
QueueingModel(i_mm1)
```

---

QueueingModel.i\_MM1K *Builds a M/M/1/K queueing model*

---

### Description

Builds a M/M/1/K queueing model

### Usage

```
## S3 method for class 'i_MM1K'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MM1K
...	additional arguments

### Details

Build a M/M/1/K queueing model. It also checks the input params calling the [CheckInput.i\\_MM1K](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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### See Also

[CheckInput.i\\_MM1K](#).

### Examples

```
## See example 10.7 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)  
  
## Build the model  
QueueingModel(i_mm1k)
```

---

QueueingModel.i\_MM1KK *Builds a M/M/1/K/K queueing model*

---

### Description

Builds a M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'i_MM1KK'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MM1KK
...	additional arguments

### Details

Build a M/M/1/K/K queueing model. It also checks the input params calling the [CheckInput.i\\_MM1KK](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_MM1KK](#).

### Examples

```
## See example 10.13 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)  
  
## Build the model  
QueueingModel(i_mm1kk)
```

---

QueueingModel.i\_MMC    *Builds a M/M/c queueing model*

---

### Description

Builds a M/M/c queueing model

### Usage

```
## S3 method for class 'i_MMC'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MMC
...	additional arguments

### Details

Build a M/M/c/ queueing model. It also checks the input params calling the [CheckInput.i\\_MMC](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_MMC](#)

### Examples

```
## See example 10.9 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)  
  
## Build the model  
QueueingModel(i_mmc)
```

---

QueueingModel.i\_MMCC *Builds a M/M/c/c queueing model*

---

### Description

Builds a M/M/c/c queueing model

### Usage

```
## S3 method for class 'i_MMCC'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MMCC
...	additional arguments

### Details

Build a M/M/c/c queueing model. It also checks the input params calling the [CheckInput.i\\_MMCC](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_MMCC](#).

### Examples

```
## See example 10.12 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)  
  
## Build the model  
QueueingModel(i_mmcc)
```

---

QueueingModel.i\_MMCK *Builds a M/M/c/K queueing model*

---

### Description

Builds a M/M/c/K queueing model

### Usage

```
## S3 method for class 'i_MMCK'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MMCK
...	additional arguments

### Details

Build a M/M/c/K queueing model. It also checks the input params calling the [CheckInput.i\\_MMCK](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_MMCK](#).

### Examples

```
## See example 10.11 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)  
  
## Build the model  
QueueingModel(i_mmck)
```

---

QueueingModel.i\_MMCKK *Builds a M/M/c/K/K queueing model*

---

### Description

Builds a M/M/c/K/K queueing model

### Usage

```
## S3 method for class 'i_MMCKK'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MMCKK
...	additional arguments

### Details

Build a M/M/c/K/K queueing model. It also checks the input params calling the [CheckInput.i\\_MMCKK](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_MMCKK](#).

### Examples

```
## create input parameters  
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)  
  
## Build the model  
QueueingModel(i_mmckk)
```

---

QueueingModel.i\_MMCKM *Builds a M/M/c/K/m queueing model*

---

### Description

Builds a M/M/c/K/m queueing model

### Usage

```
## S3 method for class 'i_MMCKM'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MMCKM
...	additional arguments

### Details

Build a M/M/c/K/m queueing model. It also checks the input params calling the [CheckInput.i\\_MMCKM](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_MMCKM](#)

### Examples

```
## create input parameters  
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)  
  
## Build the model  
QueueingModel(i_mmckm)
```

---

QueueingModel.i\_MMInf *Builds a M/M/Infinite queue model*

---

### Description

Builds a M/M/Infinite queue model

### Usage

```
## S3 method for class 'i_MMInf'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_MMInf
...	additional arguments

### Details

Build a M/M/Infinite model. It also checks the input params calling the [CheckInput.i\\_MMInf](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_MMInf](#)

### Examples

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)  
  
## Build the model  
QueueingModel(i_mminf)
```

---

`QueueingModel.i_MMInfKK`*Builds a M/M/Infinite/K/K queueing model*

---

**Description**

Builds a M/M/Infinite/K/K queueing model

**Usage**

```
## S3 method for class 'i_MMInfKK'  
QueueingModel(x, ...)
```

**Arguments**

x	a object of class i_MMInfKK
...	additional arguments

**Details**

Build a M/M/Infinite/K/K queueing model. It also checks the input params calling the [CheckInput.i\\_MMInfKK](#)

**References**

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

**See Also**

[CheckInput.i\\_MMInfKK](#)

**Examples**

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)  
  
## Build the model  
QueueingModel(i_MMInfKK)
```

---

QueueingModel.i\_OJN *Builds one Open Jackson Network*

---

### Description

Builds one Open Jackson Network

### Usage

```
## S3 method for class 'i_OJN'  
QueueingModel(x, ...)
```

### Arguments

x	a object of class i_OJN
...	additional arguments

### Details

Build one Open Jackson Network. It also checks the input params calling the [CheckInput.i\\_OJN](#)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[CheckInput.i\\_OJN](#)

### Examples

```
## See example 11.11 in reference [Sixto2004] for more details.  
## create the nodes  
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)  
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)  
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)  
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)  
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)  
  
# definition of the transition probabilities  
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)  
  
ojn1 <- NewInput.OJN(prob, n1, n2, n3, n4)  
  
m_ojn1 <- QueueingModel(ojn1)
```

m\_ojn1

---

RO *Reports the server use of a queueing model*

---

### Description

Reports the server use of a queueing model)

### Usage

RO(x, ...)

### Arguments

x a object of class o\_MM1, o\_MMC, o\_MM1K, o\_MMCK, o\_MM1KK, o\_MMCKK, o\_MMCC, o\_MMCKM, o\_MMInfKK, o\_MMInf  
... additional arguments

### Details

Reports the server use of a queueing model (or network)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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### See Also

[RO.o\\_MM1](#)  
[RO.o\\_MMC](#)  
[RO.o\\_MM1K](#)  
[RO.o\\_MMCK](#)  
[RO.o\\_MM1KK](#)  
[RO.o\\_MMCKK](#)  
[RO.o\\_MMCC](#)  
[RO.o\\_MMCKM](#)  
[RO.o\\_MMInfKK](#)  
[RO.o\\_MMInf](#)

## Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Report the use of the server
RO(o_mm1)
```

---

RO.o\_MM1

*Reports the server use of a M/M/1 queueing model*

---

## Description

Reports the server use of a M/M/1 queueing model

## Usage

```
## S3 method for class 'o_MM1'
RO(x, ...)
```

## Arguments

x                    a object of class o\_MM1  
...                   additional arguments

## Details

Reports the server use of a M/M/1 queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MM1](#).

## Examples

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Report the use of the server
RO(o_mm1)
```

---

RO.o\_MM1K

*Reports the server use of a M/M/1/K queueing model*

---

## Description

Reports the server use of a M/M/1/K queueing model

## Usage

```
## S3 method for class 'o_MM1K'
RO(x, ...)
```

## Arguments

x	a object of class o_MM1K
...	additional arguments

## Details

Reports the server use of a M/M/1/K queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MM1K](#).

### Examples

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mm1k <- QueueingModel(i_mm1k)

## Report the use of the server
RO(o_mm1k)
```

---

RO.o\_MM1KK

*Reports the server use of a M/M/1/K/K queueing model*

---

### Description

Reports the server use of a M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'
RO(x, ...)
```

### Arguments

x                    a object of class o\_MM1KK  
...                   additional arguments

### Details

Reports the server use of a M/M/1/K/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MM1KK.](#)

## Examples

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Report the use of the server
RO(o_mm1kk)
```

---

RO.o\_MMC

*Reports the server use of a M/M/c queueing model*

---

## Description

Reports the server use of a M/M/c queueing model

## Usage

```
## S3 method for class 'o_MMC'
RO(x, ...)
```

## Arguments

x	a object of class o_MMC
...	additional arguments

## Details

Reports the server use of a M/M/c queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Report the use of the server
RO(o_mmc)
```

---

RO.o\_MMCC

*Reports the server use of a M/M/c/c queueing model*


---

**Description**

Reports the server use of a M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'
RO(x, ...)
```

**Arguments**

x	a object of class o_MMCC
...	additional arguments

**Details**

Reports the server use of a M/M/c/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCC](#).

## Examples

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Report the use of the server
RO(o_mmcc)
```

---

RO.o_MMCK	<i>Reports the server use of a M/M/c/K queueing model</i>
-----------	---

---

## Description

Reports the server use of a M/M/c/K queueing model

## Usage

```
## S3 method for class 'o_MMCK'
RO(x, ...)
```

## Arguments

x	a object of class o_MMCK
...	additional arguments

## Details

Reports the server use of a M/M/c/K queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Report the use of the server
RO(o_mmck)
```

---

RO.o\_MMCKK

*Reports the server use of a M/M/c/K/K queueing model*


---

**Description**

Reports the server use of a M/M/c/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMCKK'
RO(x, ...)
```

**Arguments**

x	a object of class o_MMCKK
...	additional arguments

**Details**

Reports the server use of a M/M/c/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCKK](#).

## Examples

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## Build the model
o_mmckk <- QueueingModel(i_mmckk)

## Report the use of the server
RO(o_mmckk)
```

---

RO.o\_MMCKM

*Reports the server use of a M/M/c/K/m queueing model*

---

## Description

Reports the server use of a M/M/c/K/m queueing model

## Usage

```
## S3 method for class 'o_MMCKM'
RO(x, ...)
```

## Arguments

x                    a object of class o\_MMCKM  
...                   additional arguments

## Details

Reports the server use of a M/M/c/K/m queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MMCKM](#).

### Examples

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Report the use of the server
RO(o_mmckm)
```

---

RO.o\_MMInf

*Reports the server use of a M/M/Infinite queueing model*

---

### Description

Reports the server use of a M/M/Infinite queueing model

### Usage

```
## S3 method for class 'o_MMInf'
RO(x, ...)
```

### Arguments

x                    a object of class o\_MMInf  
...                   additional arguments

### Details

Reports the server use of a M/M/Infinite queueing model. It should be noted that in this model, the RO parameter has a different meaning, its the traffic intensity and it coincides exactly with the average number of customers in the system (L)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMInf](#)  
[L.o\\_MMInf](#)

## Examples

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Report the use of the server
RO(o_mminf)
```

---

RO.o\_MMInfKK

*Reports the server use of a M/M/Infinite/K/K queueing model*

---

## Description

Reports the server use of a M/M/Infinite/K/K queueing model

## Usage

```
## S3 method for class 'o_MMInfKK'
RO(x, ...)
```

## Arguments

x                    a object of class o\_MMInfKK  
...                   additional arguments

## Details

Reports the server use of a M/M/Infinite/K/K queueing model

## References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

## See Also

[QueueingModel.i\\_MMInfKK](#).

**Examples**

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Report the use of the server
RO(o_MMInfKK)
```

---

ROck	<i>Reports a matrix with the use of class i in each node (server) j in a MultiClass Queueing Network</i>
------	--

---

**Description**

Reports a matrix with the use of class i in each node (server) j in a MultiClass Queueing Network

**Usage**

```
ROck(x, ...)
```

**Arguments**

x	a object of class o_MCON, o_MCCN, o_MCMN
...	aditional arguments

**Details**

Reports a matrix with the use of class i in each node (server) j in a MultiClass Queueing Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos CaballeROk, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial CentROk de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[ROck.o\\_MCON](#)  
[ROck.o\\_MCCN](#)  
[ROck.o\\_MCMN](#)

**Examples**

```

## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

ROck(o_MCCN1)

```

---

ROck.o_MCCN	<i>Reports a matrix with the use of class <math>i</math> in each node (server) <math>j</math> in a MultiClass Closed Network</i>
-------------	--

---

**Description**

Reports a matrix with the use of class  $i$  in each node (server)  $j$  in a MultiClass Closed Network

**Usage**

```

## S3 method for class 'o_MCCN'
ROck(x, ...)

```

**Arguments**

$x$	a object of class o_MCCN
...	aditional arguments

**Details**

Reports a matrix with the use of class  $i$  in each node (server)  $j$  in a MultiClass Closed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCCN](#).

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

ROck(o_MCCN1)
```

---

ROck.o\_MCMN

*Reports a matrix with the use of class i in each node (server) j in a MultiClass Mixed Network*

---

**Description**

Reports a matrix with the use of class i in each node (server) j in a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'
ROck(x, ...)
```

**Arguments**

x                    a object of class o\_MCMN  
 ...                  additional arguments

**Details**

Reports a matrix with the use of class  $i$  in each node (server)  $j$  in a

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

ROck(o_mcmn1)
```

---

ROck.o\_MCON

*Reports a matrix with the use of class  $i$  in each node (server)  $j$  in a MultiClass Open Network*

---

**Description**

Reports a matrix with the use of class  $i$  in each node (server)  $j$  in a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
ROck(x, ...)
```

**Arguments**

x                    a object of class o\_MCON  
 ...                  additional arguments

**Details**

Reports a matrix with the use of class i in each node (server) j in a

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCON](#).

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

ROk(o_mcon1)
```

---

 ROk

*Reports a vector with each node (server) use of a queueing network*

---

**Description**

Reports a vector with each node (server) use of a queueing network

**Usage**

```
ROk(x, ...)
```

**Arguments**

x                    a object of class o\_OJN, o\_CJN, o\_MCON, o\_MCCN, o\_MCMN  
 ...                    additional arguments

**Details**

Reports a vector with each node (server) use of a queueing network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos CaballeROk, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial CentROk de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[ROk.o\\_OJN](#)  
[ROk.o\\_CJN](#)  
[ROk.o\\_MCON](#)  
[ROk.o\\_MCCN](#)  
[ROk.o\\_MCMN](#)

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

ROk(o_MCCN1)
```

---

ROk.o_CJN	<i>Reports a vector with each node (server) use of a Closed Jackson Network</i>
-----------	---

---

**Description**

Reports a vector with each node (server) use of a Closed Jackson Network

**Usage**

```
## S3 method for class 'o_CJN'
ROk(x, ...)
```

**Arguments**

x	a object of class o_CJN
...	aditional arguments

**Details**

Reports a vector with each node (server) use of a Closed Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_CJN.](#)

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)
```

```
# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

ROk(m_cjn1)
```

---

ROk.o_MCCN	<i>Reports a vector with each node (server) use of a MultiClass Closed Network</i>
------------	--

---

### Description

Reports a vector with each node (server) use of a MultiClass Closed Network

### Usage

```
## S3 method for class 'o_MCCN'
ROk(x, ...)
```

### Arguments

x	a object of class o_MCCN
...	additional arguments

### Details

Reports a vector with each node (server) use of a MultiClass Closed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCCN](#).

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

ROk(o_MCCN1)
```

---

ROk.o_MCMN	<i>Reports a vector with each node (server) use of a MultiClass Mixed Network</i>
------------	---

---

**Description**

Reports a vector with each node (server) use of a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'
ROk(x, ...)
```

**Arguments**

x	a object of class o_MCMN
...	aditional arguments

**Details**

Reports a vector with each node (server) use of a MultiClass Mixed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

ROk(o_mcmn1)
```

---

ROk.o_MCON	<i>Reports a vector with each node (server) use of a MultiClass Open Network</i>
------------	--

---

**Description**

Reports a vector with each node (server) use of a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
ROk(x, ...)
```

**Arguments**

x	a object of class o_MCON
...	aditional arguments

**Details**

Reports a vector with each node (server) use of a MultiClass Open Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCON](#).

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

ROk(o_mcon1)
```

---

ROk.o\_OJN

*Reports a vector with each node (server) use of an Open Jackson Network*

---

**Description**

Reports a vector with each node (server) use of an Open Jackson Network

**Usage**

```
## S3 method for class 'o_OJN'
ROk(x, ...)
```

**Arguments**

x                    a object of class o\_OJN  
...                   additional arguments

**Details**

Reports a vector with each node (server) use of an Open Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_OJN](#).

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

# Deinition of the new input
i_ojn <- NewInput.OJN(prob, n1, n2, n3, n4)

# Build the models
o_ojn <- QueueingModel(i_ojn)

R0k(o_ojn)
```

---

 SP

*Returns the saturation point of a queueing model*

---

**Description**

Returns the saturation point of a queueing model

**Usage**

SP(x, ...)

**Arguments**

x                    a object of class o\_MM1KK  
 ...                  additional arguments

**Details**

Returns the saturation point of a queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[SP.o\\_MM1KK](#)

**Examples**

```
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=4, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the saturation point
SP(o_mm1kk)
```

---

SP.o\_MM1KK

*Returns the saturation point of a M/M/1/K/K queueing model*

---

**Description**

Returns the saturation point, or the maximum number of customers that the M/M/1/K/K queueing model can support with no interference or synchronization between themselves

**Usage**

```
## S3 method for class 'o_MM1KK'
SP(x, ...)
```

**Arguments**

x                    a object of class o\_MM1KK  
 ...                  additional arguments

**Details**

The value returned is the optimal number of customers of a M/M/1/K/K queueing model. It coincides with the inverse of the serialization parameter of Amdahl's Law. That is, the value which converges the speedup  $\text{func}(k) = k/(1 + \text{ser} * (k-1))$ . It makes sense, because the saturation point is the maximum value in which no synchronization happens.

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MM1KK](#)

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=4, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the saturation point
SP(o_mm1kk)
```

---

summary.o\_CJN

*Reports the results of a Closed Jackson Network*


---

**Description**

Reports the results of a Closed Jackson Network

**Usage**

```
## S3 method for class 'o_CJN'
summary(object, ...)
```

**Arguments**

```
object      a object of class o_CJN
...         additional arguments
```

**Details**

generates a report of the queueing network received as parameter

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_CJN](#).

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

summary(m_cjn1)
```

---

summary.o\_MCCN

*Reports the results of a MultiClass Closed Network*

---

**Description**

Reports the results of a MultiClass Closed Network

**Usage**

```
## S3 method for class 'o_MCCN'  
summary(object, ...)
```

**Arguments**

object	a object of class o_MCCN
...	additional arguments

**Details**

generates a report of the queueing network received as parameter

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCCN](#).

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.  
  
classes <- 2  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)  
  
# Build the model  
o_MCCN1 <- QueueingModel(i_MCCN1)  
  
summary(o_MCCN1)
```

---

`summary.o_MCMN`*Reports the results of a MultiClass Mixed Network*

---

**Description**

Reports the results of a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'  
summary(object, ...)
```

**Arguments**

<code>object</code>	a object of class <code>o_MCMN</code>
<code>...</code>	additional arguments

**Details**

generates a report of the queueing network received as parameter

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.  
  
classes <- 4  
vLambda <- c(1, 1/2)  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=1, nrow=4, ncol=2)  
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)  
  
i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)  
  
# Build the model  
o_mcmn1 <- QueueingModel(i_mcmn1)
```

```
summary(o_mcmn1)
```

---

summary.o_MCON	<i>Reports the results of a MultiClass Open Network</i>
----------------	---

---

## Description

Reports the results of a MultiClass Open Network

## Usage

```
## S3 method for class 'o_MCON'  
summary(object, ...)
```

## Arguments

object	a object of class o_MCON
...	additional arguments

## Details

generates a report of the queueing network received as parameter

## References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

## See Also

[QueueingModel.i\\_MCON](#).

## Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.  
  
classes <- 2  
vLambda <- c(3/19, 2/19)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)
```

```
# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

summary(o_mcon1)
```

---

summary.o\_MM1

*Reports the results of a M/M/1 queueing model*

---

### Description

Reports the results of a M/M/1 queueing model.

### Usage

```
## S3 method for class 'o_MM1'
summary(object, ...)
```

### Arguments

object	a object of class o_MM1
...	aditional arguments

### Details

generates a report of the queueing model received as parameter

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MM1](#).

### Examples

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Report the results
summary(o_mm1)
```

---

summary.o_MM1K	<i>Reports the results of a M/M/1/K queueing model</i>
----------------	--

---

## Description

Reports the results of a M/M/1/K queueing model.

## Usage

```
## S3 method for class 'o_MM1K'  
summary(object, ...)
```

## Arguments

object	a object of class o_MM1K
...	additional arguments

## Details

generates a report of the queueing model received as parameter

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MM1K](#).

## Examples

```
## See example 10.7 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)  
  
## Build the model  
o_mm1k <- QueueingModel(i_mm1k)  
  
## Report the results  
summary(o_mm1k)
```

---

summary.o_MM1KK	<i>Reports the results of a M/M/1/K/K queueing model</i>
-----------------	--

---

### Description

Reports the results of a M/M/1/K/K queueing model.

### Usage

```
## S3 method for class 'o_MM1KK'  
summary(object, ...)
```

### Arguments

object	a object of class o_MM1KK
...	aditional arguments

### Details

generates a report of the queueing model received as parameter

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MM1KK](#).

### Examples

```
## See example 10.13 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)  
  
## Build the model  
o_mm1kk <- QueueingModel(i_mm1kk)  
  
## Report the results  
summary(o_mm1kk)
```

---

`summary.o_MMC`*Reports the results of a M/M/c queueing model*

---

**Description**

Reports the results of a M/M/c queueing model.

**Usage**

```
## S3 method for class 'o_MMC'  
summary(object, ...)
```

**Arguments**

<code>object</code>	a object of class <code>o_MMC</code>
<code>...</code>	additional arguments

**Details**

generates a report of the queueing model received as parameter

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)  
  
## Build the model  
o_mmc <- QueueingModel(i_mmc)  
  
## Report the results  
summary(o_mmc)
```

---

summary.o_MMCC	<i>Reports the results of a M/M/c/c queueing model</i>
----------------	--

---

### Description

Reports the results of a M/M/c/c queueing model.

### Usage

```
## S3 method for class 'o_MMCC'  
summary(object, ...)
```

### Arguments

object	a object of class o_MMCC
...	additional arguments

### Details

generates a report of the queueing model received as parameter

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMCC](#).

### Examples

```
## See example 10.12 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)  
  
## Build the model  
o_mmcc <- QueueingModel(i_mmcc)  
  
## Report the results  
summary(o_mmcc)
```

---

summary.o_MMCK	<i>Reports the results of a M/M/c/K queueing model</i>
----------------	--

---

## Description

Reports the results of a M/M/c/K queueing model.

## Usage

```
## S3 method for class 'o_MMCK'  
summary(object, ...)
```

## Arguments

object	a object of class o_MMCK
...	additional arguments

## Details

generates a report of the queueing model received as parameter

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MMCK](#).

## Examples

```
## See example 10.11 in reference [Sixto2004] for more details.  
## create input parameters  
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)  
  
## Build the model  
o_mmck <- QueueingModel(i_mmck)  
  
## Report the results  
summary(o_mmck)
```

---

`summary.o_MMCKK`*Reports the results of a M/M/c/K/K queueing model*

---

### Description

Reports the results of a M/M/c/K/K queueing model.

### Usage

```
## S3 method for class 'o_MMCKK'  
summary(object, ...)
```

### Arguments

<code>object</code>	a object of class <code>o_MMCKK</code>
<code>...</code>	additional arguments

### Details

generates a report of the queueing model received as parameter

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMCKK](#).

### Examples

```
## create input parameters  
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)  
  
## Build the model  
o_mmckk <- QueueingModel(i_mmckk)  
  
## Report the results  
summary(o_mmckk)
```

---

summary.o_MMCKM	<i>Reports the results of a M/M/c/K/m queueing model</i>
-----------------	--

---

### Description

Reports the results of a M/M/c/K/m queueing model.

### Usage

```
## S3 method for class 'o_MMCKM'  
summary(object, ...)
```

### Arguments

object	a object of class o_MMCKM
...	additional arguments

### Details

generates a report of the queueing model received as parameter

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMCKM](#).

### Examples

```
## create input parameters  
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)  
  
## Build the model  
o_mmckm <- QueueingModel(i_mmckm)  
  
## Report the results  
summary(o_mmckm)
```

---

summary.o_MMInf	<i>Reports the results of a M/M/Infinite queueing model</i>
-----------------	---

---

### Description

Reports the results of a M/M/Infinite queueing model.

### Usage

```
## S3 method for class 'o_MMInf'  
summary(object, ...)
```

### Arguments

object	a object of class o_MMInf
...	additional arguments

### Details

generates a report of the queueing model received as parameter

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMInf](#).

### Examples

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)  
  
## Build the model  
o_mminf <- QueueingModel(i_mminf)  
  
## Report the results  
summary(o_mminf)
```

---

summary.o\_MMInfKK      *Reports the results of a M/M/Infinite/K/K queueing model*

---

## Description

Reports the results of a M/M/Infinite/K/K queueing model.

## Usage

```
## S3 method for class 'o_MMInfKK'  
summary(object, ...)
```

## Arguments

object	a object of class o_MMInfKK
...	additional arguments

## Details

generates a report of the queueing model received as parameter

## References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

## See Also

[QueueingModel.i\\_MMInfKK](#).

## Examples

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)  
  
## Build the model  
o_MMInfKK <- QueueingModel(i_MMInfKK)  
  
## Report the results  
summary(o_MMInfKK)
```

---

summary.o\_OJN

*Reports the results of an Open Jackson Network*


---

### Description

Reports the results of an Open Jackson Network

### Usage

```
## S3 method for class 'o_OJN'
summary(object, ...)
```

### Arguments

object	a object of class o_OJN
...	aditional arguments

### Details

generates a report of the queueing network received as parameter

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_OJN](#).

### Examples

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

i_ojn <- NewInput.OJN(prob, n1, n2, n3, n4)

o_ojn <- QueueingModel(i_ojn)
```

summary(o\_ojn)

---

Throughput                      *Throughput of a queueing model (or network)*

---

### Description

Returns the throughput of a queueing model (or network)

### Usage

Throughput(x, ...)

### Arguments

x                      a object of class o\_MM1, o\_MMC, o\_MM1K, o\_MMCK, o\_MM1KK, o\_MMCKK, o\_MMCC, o\_MMCKM, o\_MMInfKK, o\_MMInf, o\_OJN, o\_CJN, o\_MCON, o\_MCCN, o\_MCMN

...                    additional arguments

### Details

Returns the throughput of a queueing model (or network)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[Throughput.o\\_MM1](#)  
[Throughput.o\\_MMC](#)  
[Throughput.o\\_MM1K](#)  
[Throughput.o\\_MMCK](#)  
[Throughput.o\\_MM1KK](#)  
[Throughput.o\\_MMCKK](#)  
[Throughput.o\\_MMCC](#)  
[Throughput.o\\_MMCKM](#)  
[Throughput.o\\_MMInfKK](#)

```
Throughput.o_MMInf  
Throughput.o_OJN  
Throughput.o_CJN  
Throughput.o_MCON  
Throughput.o_MCCN  
Throughput.o_MCMN
```

### Examples

```
## create input parameters  
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)  
  
## Build the model  
o_mm1 <- QueueingModel(i_mm1)  
  
## Throughput  
Throughput(o_mm1)
```

---

Throughput.o_CJN	<i>Reports the network throughput of a Closed Jackson Network</i>
------------------	---

---

### Description

Reports the network throughput of a Closed Jackson Network

### Usage

```
## S3 method for class 'o_CJN'  
Throughput(x, ...)
```

### Arguments

x	a object of class o_CJN
...	additional arguments

### Details

Reports the network throughput of a Closed Jackson Network

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.OJN](#), [CheckInput.i\\_CJN](#), [QueueingModel.i\\_CJN](#)

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

Throughput(m_cjn1)
```

---

Throughput.o\_MCCN      *Reports the throughput of a MultiClass Closed Network*

---

**Description**

Reports the throughput of a MultiClass Closed Network

**Usage**

```
## S3 method for class 'o_MCCN'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MCCN  
 ...                  additional arguments

**Details**

Reports the throughput of a MultiClass Closed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCCN](#), [CheckInput.i\\_MCCN](#), [QueueingModel.i\\_MCCN](#)

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Throughput(o_MCCN1)
```

---

Throughput.o\_MCMN      *Reports the throughput of a MultiClass Mixed Network*

---

**Description**

Reports the throughput of a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MCMN  
 ...                  additional arguments

**Details**

Reports the throughput of a MultiClass Mixed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCMN](#), [CheckInput.i\\_MCMN](#), [QueueingModel.i\\_MCMN](#)

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Throughput(o_mcmn1)
```

---

Throughput.o\_MCON      *Reports the throughput of a MultiClass Open Network*

---

**Description**

Reports the throughput of a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MCON  
 ...                additional arguments

**Details**

Reports the throughput of a MultiClass Open Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCON](#), [CheckInput.i\\_MCON](#), [QueueingModel.i\\_MCON](#)

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Throughput(o_mcon1)
```

---

Throughput.o\_MM1

*Throughput of a M/M/1 queueing model*

---

**Description**

Returns the throughput of a M/M/1 queueing model

**Usage**

```
## S3 method for class 'o_MM1'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MM1  
 ...                  additional arguments

**Details**

Returns the throughput of a M/M/1 queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MM1](#), [CheckInput.i\\_MM1](#), [QueueingModel.i\\_MM1](#)

**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Throughput
Throughput(o_mm1)
```

---

Throughput.o\_MM1K      *Throughput of a M/M/1/K queueing model*

---

**Description**

Returns the throughput of a M/M/1/K queueing model

**Usage**

```
## S3 method for class 'o_MM1K'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MM1K  
 ...                  additional arguments

**Details**

Returns the throughput of a M/M/1/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[NewInput.MM1K](#), [CheckInput.i\\_MM1K](#), [QueueingModel.i\\_MM1K](#)

**Examples**

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mmck <- QueueingModel(i_mm1k)

## Throughput
Throughput(o_mmck)
```

---

Throughput.o\_MM1KK      *Throughput of a M/M/1/K/K queueing model*

---

**Description**

Returns the throughput of a M/M/1/K/K queueing model

**Usage**

```
## S3 method for class 'o_MM1KK'
Throughput(x, ...)
```

**Arguments**

x                      a object of class o\_MM1KK  
...                     additional arguments

**Details**

Returns the throughput of a M/M/1/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MM1KK](#), [CheckInput.i\\_MM1KK](#), [QueueingModel.i\\_MM1KK](#)

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_MM1KKk <- QueueingModel(i_mm1kk)

## Throughput
Throughput(o_MM1KKk)
```

---

 Throughput.o\_MMC

*Throughput of a M/M/c queueing model*


---

**Description**

Returns the throughput of a M/M/c queueing model

**Usage**

```
## S3 method for class 'o_MMC'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MMC  
 ...                    additional arguments

**Details**

Returns the throughput of a M/M/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMC](#), [CheckInput.i\\_MMC](#), [QueueingModel.i\\_MMC](#)

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Throughput
Throughput(o_mmc)
```

---

Throughput.o\_MMCC      *Throughput of a M/M/c/c queueing model*

---

**Description**

Returns the throughput of a M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MMCC  
 ...                  additional arguments

**Details**

Returns the throughput of a M/M/c/c queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[NewInput.MMCC](#), [CheckInput.i\\_MMCC](#), [QueueingModel.i\\_MMCC](#)

## Examples

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Throughput
Throughput(o_mmcc)
```

---

Throughput.o\_MMCK      *Throughput of a M/M/c/K queueing model*

---

## Description

Returns the throughput of a M/M/c/K queueing model

## Usage

```
## S3 method for class 'o_MMCK'
Throughput(x, ...)
```

## Arguments

x                    a object of class o\_MMCK  
...                   additional arguments

## Details

Returns the throughput of a M/M/c/K queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[NewInput.MMCK](#), [CheckInput.i\\_MMCK](#), [QueueingModel.i\\_MMCK](#)

## Examples

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Throughput
Throughput(o_mmck)
```

---

Throughput.o\_MMCKK      *Throughput of a M/M/c/K/K queueing model*

---

## Description

Returns the throughput of a M/M/c/K/K queueing model

## Usage

```
## S3 method for class 'o_MMCKK'
Throughput(x, ...)
```

## Arguments

x                    a object of class o\_MMCKK  
...                   additional arguments

## Details

Returns the throughput of a M/M/c/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMCKK](#), [CheckInput.i\\_MMCKK](#), [QueueingModel.i\\_MMCKK](#)

**Examples**

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## build the model
o_mmckk <- QueueingModel(i_mmckk)

## Throughput
Throughput(o_mmckk)
```

---

Throughput.o\_MMCKM      *Throughput of a M/M/c/K/m queueing model*

---

**Description**

Returns the throughput of a M/M/c/K/m queueing model

**Usage**

```
## S3 method for class 'o_MMCKM'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MMCKM  
 ...                  additional arguments

**Details**

Returns the throughput of a M/M/c/K/m queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMCKM](#), [CheckInput.i\\_MMCKM](#), [QueueingModel.i\\_MMCKM](#)

**Examples**

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Throughput
Throughput(o_mmckm)
```

---

Throughput.o\_MMInf      *Throughput of a M/M/Infinite queueing model*

---

**Description**

Returns the throughput of a M/M/Infinite queueing model

**Usage**

```
## S3 method for class 'o_MMInf'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MMInf  
...                   additional arguments

**Details**

Returns the throughput of a M/M/Infinite queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.MMInf](#), [CheckInput.i\\_MMInf](#), [QueueingModel.i\\_MMInf](#)

**Examples**

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Throughput
Throughput(o_mminf)
```

---

Throughput.o\_MMInfKK *Throughput of a M/M/Infinite/K/K queueing model*

---

**Description**

Returns the throughput of a M/M/Infinite/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMInfKK'
Throughput(x, ...)
```

**Arguments**

x                    a object of class o\_MMInfKK  
...                   additional arguments

**Details**

Returns the throughput of a M/M/Infinite/K/K queueing model

**References**

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

**See Also**

[NewInput.MMInfKK](#), [CheckInput.i\\_MMInfKK](#), [QueueingModel.i\\_MMInfKK](#)

## Examples

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Throughput
Throughput(o_MMInfKK)
```

---

Throughput.o_OJN	<i>Reports the throughput of an Open Jackson Network</i>
------------------	--

---

## Description

Reports the throughput of an Open Jackson Network

## Usage

```
## S3 method for class 'o_OJN'
Throughput(x, ...)
```

## Arguments

x	a object of class o_OJN
...	additional arguments

## Details

Reports the throughput of an Open Jackson Network

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[NewInput.OJN](#), [CheckInput.i\\_OJN](#), [QueueingModel.i\\_OJN](#)

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

# Definition of the new input
i_ojn <- NewInput.OJN(prob, n1, n2, n3, n4)

# Build the models
o_ojn <- QueueingModel(i_ojn)

Throughput(o_ojn)
```

---

Throughputc	<i>Reports a vector with each class throughput in a multiclass queueing network</i>
-------------	---

---

**Description**

Reports a vector with each class throughput in a multiclass queueing network

**Usage**

```
Throughputc(x, ...)
```

**Arguments**

x	a object of class o_MCON, o_MCCN, o_MCMN
...	additional arguments

**Details**

Reports a vector with each class throughput in a multiclass queueing network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.* Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[Throughputc.o\\_MCON](#)  
[Throughputc.o\\_MCCN](#)  
[Throughputc.o\\_MCCN](#)

### Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Throughputc(o_mcon1)
```

---

Throughputc.o_MCCN	<i>Reports a vector with each class throughput in a MultiClass Closed Network</i>
--------------------	---

---

### Description

Reports a vector with each class throughput in a MultiClass Closed Network

### Usage

```
## S3 method for class 'o_MCCN'
Throughputc(x, ...)
```

### Arguments

x	a object of class o_MCCN
...	additional arguments

**Details**

Reports a vector with each class throughput in a MultiClass Closed Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCCN](#), [CheckInput.i\\_MCCN](#), [QueueingModel.i\\_MCCN](#)

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Throughputc(o_MCCN1)
```

---

Throughputc.o_MCMN	<i>Reports a vector with each class throughput in a MultiClass Mixed Network</i>
--------------------	--

---

**Description**

Reports a vector with each class throughput in a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'
Throughputc(x, ...)
```

**Arguments**

```
x          a object of class o_MCMN
...        additional arguments
```

**Details**

Reports a vector with each class throughput in a MultiClass Mixed Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCMN](#), [CheckInput.i\\_MCMN](#), [QueueingModel.i\\_MCMN](#)

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Throughputc(o_mcmn1)
```

---

Throughputc.o_MCON	<i>Reports a vector with each class throughput in a MultiClass Open Network</i>
--------------------	---

---

### Description

Reports a vector with each class throughput in a MultiClass Open Network

### Usage

```
## S3 method for class 'o_MCON'  
Throughputc(x, ...)
```

### Arguments

x	a object of class o_MCON
...	additional arguments

### Details

Reports a vector with each class throughput in a MultiClass Open Network

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[NewInput.MCON](#), [CheckInput.i\\_MCON](#), [QueueingModel.i\\_MCON](#)

### Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.
```

```
classes <- 2  
vLambda <- c(3/19, 2/19)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)
```

```

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Throughputc(o_mcon1)

```

---

Throughputck	<i>Reports a matrix with the throughput of class i in each node (server) j in a MultiClass Network</i>
--------------	--

---

### Description

Reports a matrix with the throughput of class i in each node (server) j in a MultiClass Network

### Usage

```
Throughputck(x, ...)
```

### Arguments

x	a object of class o_MCON, o_MCCN
...	additional arguments

### Details

Reports a matrix with the throughput of class i in each node (server) j in a MultiClass Network

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[Throughputck.o\\_MCON](#)

[Throughputck.o\\_MCCN](#)

[Throughputck.o\\_MCMN](#)

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Throughputck(o_mcon1)
```

---

Throughputck.o\_MCCN    *Reports a matrix with the throughput of class i in each node (server) j in a MultiClass Closed Network*

---

**Description**

Reports a matrix with the throughput of class i in each node (server) j in a MultiClass Closed Network

**Usage**

```
## S3 method for class 'o_MCCN'
Throughputck(x, ...)
```

**Arguments**

x                    a object of class o\_MCCN  
 ...                  additional arguments

**Details**

Reports a matrix with the throughput of class i in each node (server) j in a MultiClass Closed Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.* Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[NewInput.MCCN](#), [CheckInput.i\\_MCCN](#), [QueueingModel.i\\_MCCN](#)

### Examples

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Throughputck(o_MCCN1)
```

---

Throughputck.o_MCMN	<i>Reports a matrix with the throughput of class i in each node (server) j in a MultiClass Mixed Network</i>
---------------------	--

---

### Description

Reports a matrix with the throughput of class i in each node (server) j in a MultiClass Mixed Network

### Usage

```
## S3 method for class 'o_MCMN'
Throughputck(x, ...)
```

### Arguments

x	a object of class o_MCMN
...	additional arguments

**Details**

Reports a matrix with the throughput of class  $i$  in each node (server)  $j$  in a MultiClass Mixed Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*

Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCMN](#), [CheckInput.i\\_MCMN](#), [QueueingModel.i\\_MCMN](#)

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Throughputck(o_mcmn1)
```

---

Throughputck.o_MCON	<i>Reports a matrix with the throughput of class <math>i</math> in each node (server) <math>j</math> in a MultiClass Open Network</i>
---------------------	---

---

**Description**

Reports a matrix with the throughput of class  $i$  in each node (server)  $j$  in a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
Throughputck(x, ...)
```

**Arguments**

```
x          a object of class o_MCON
...        additional arguments
```

**Details**

Reports a matrix with the throughput of class  $i$  in each node (server)  $j$  in a MultiClass Open Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*

Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCON](#), [CheckInput.i\\_MCON](#), [QueueingModel.i\\_MCON](#)

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Throughputck(o_mcon1)
```

---

Throughputcn	<i>Returns a matrix with the Throughput from each class and every population of a Multi Class Closed Network</i>
--------------	--

---

### Description

Returns a matrix with the Throughput from each class and every population of a Multi Class Closed Network

### Usage

```
Throughputcn(x, ...)
```

### Arguments

x	a object of class o_MCCN
...	additional arguments

### Details

Returns a matrix with the Throughput from each class and every population of a Multi Class Closed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[Throughputcn.o\\_MCCN](#)

### Examples

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)
```

```
# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Throughputcn(o_MCCN1)
```

---

Throughputcn.o\_MCCN     *Returns a matrix with the Throughput from each class and every population of a Multi Class Closed Network*

---

### Description

Returns a matrix with the Throughput from each class and every population of a Multi Class Closed Network

### Usage

```
## S3 method for class 'o_MCCN'
Throughputcn(x, ...)
```

### Arguments

x                    a object of class o\_MCCN  
...                   additional arguments

### Details

Returns a matrix with the Throughput from each class and every population of a Multi Class Closed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[NewInput.MCCN](#), [CheckInput.i\\_MCCN](#), [QueueingModel.i\\_MCCN](#)

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Throughputcn(o_MCCN1)
```

---

Throughputk	<i>Reports a vector with each node (server) throughput of a queueing network</i>
-------------	--

---

**Description**

Reports a vector with each node (server) throughput of a queueing network

**Usage**

```
Throughputk(x, ...)
```

**Arguments**

x	a object of class o_OJN, o_CJN, o_MCON, o_MCCN, o_MCMN
...	additional arguments

**Details**

Reports a vector with each node (server) throughput of a queueing network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik

(1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[Throughputk.o\\_OJN](#)  
[Throughputk.o\\_CJN](#)  
[Throughputk.o\\_MCON](#)  
[Throughputk.o\\_MCCN](#)  
[Throughputk.o\\_MCMN](#)

### Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Throughputk(o_mcon1)
```

---

Throughputk.o_CJN	<i>Reports a vector with each node (server) throughput of a Closed Jackson Network</i>
-------------------	--

---

### Description

Reports a vector with each node (server) throughput of a Closed Jackson Network

### Usage

```
## S3 method for class 'o_CJN'
Throughputk(x, ...)
```

### Arguments

x	a object of class o_CJN
...	additional arguments

**Details**

Reports a vector with each node (server) throughput of a Closed Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.CJN](#), [CheckInput.i\\_CJN](#), [QueueingModel.i\\_CJN](#)

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

Throughputk(m_cjn1)
```

---

Throughputk.o_MCCN	<i>Reports a vector with each node (server) throughput of a MultiClass Closed Network</i>
--------------------	---

---

**Description**

Reports a vector with each node (server) throughput of a MultiClass Closed Network

**Usage**

```
## S3 method for class 'o_MCCN'
Throughputk(x, ...)
```

**Arguments**

```
x          a object of class o_MCCN
...        additional arguments
```

**Details**

Reports a vector with each node (server) throughput of a MultiClass Closed Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[NewInput.MCCN](#), [CheckInput.i\\_MCCN](#), [QueueingModel.i\\_MCCN](#)

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Throughputk(o_MCCN1)
```

---

Throughputk.o_MCMN	<i>Reports a vector with each node (server) throughput of a MultiClass Mixed Network</i>
--------------------	--

---

### Description

Reports a vector with each node (server) throughput of a MultiClass Mixed Network

### Usage

```
## S3 method for class 'o_MCMN'  
Throughputk(x, ...)
```

### Arguments

x	a object of class o_MCMN
...	additional arguments

### Details

Reports a vector with each node (server) throughput of a MultiClass Mixed Network

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[NewInput.MCMN](#), [CheckInput.i\\_MCMN](#), [QueueingModel.i\\_MCMN](#)

### Examples

```
## See example in pag 147 in reference [Lazowska84] for more details.
```

```
classes <- 4  
vLambda <- c(1, 1/2)  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")
```

```

vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Throughputk(o_mcmn1)

```

---

Throughputk.o_MCON	<i>Reports a vector with each node (server) throughput of a MultiClass Open Network</i>
--------------------	---

---

### Description

Reports a vector with each node (server) throughput of a MultiClass Open Network

### Usage

```

## S3 method for class 'o_MCON'
Throughputk(x, ...)

```

### Arguments

x	a object of class o_MCON
...	additional arguments

### Details

Reports a vector with each node (server) throughput of a MultiClass Open Network

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[NewInput.MCON](#), [CheckInput.i\\_MCON](#), [QueueingModel.i\\_MCON](#)

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Throughputk(o_mcon1)
```

---

Throughputk.o_OJN	<i>Reports a vector with each node (server) throughput of an Open Jackson Network</i>
-------------------	---

---

**Description**

Reports a vector with each node (server) throughput of an Open Jackson Network

**Usage**

```
## S3 method for class 'o_OJN'
Throughputk(x, ...)
```

**Arguments**

x	a object of class o_OJN
...	aditional arguments

**Details**

Reports a vector with each node (server) throughput of an Open Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[NewInput.OJN](#), [CheckInput.i\\_OJN](#), [QueueingModel.i\\_OJN](#)

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

# Definition of the new input
i_ojn <- NewInput.OJN(prob, n1, n2, n3, n4)

# Build the models
o_ojn <- QueueingModel(i_ojn)

Throughputk(o_ojn)
```

---

Throughputn	<i>Returns a vector with the each Throughput from 1 to the parameter n (population passed as input) of a Closed Network</i>
-------------	---

---

**Description**

Returns a vector with the each Throughput from 1 to the parameter n (population passed as input) of a Closed Network

**Usage**

```
Throughputn(x, ...)
```

**Arguments**

x	a object of class o_CJN
...	aditional arguments

**Details**

Returns a vector with the each Throughput from 1 to the parameter n (population passed as input) of a Closed Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[Throughputn.o\\_CJN](#)

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

Throughputn(m_cjn1)
```

---

Throughputn.o_CJN	<i>Returns a vector with the each Throughput from 1 to the parameter n (population passed as input) of a Closed Jackson Network</i>
-------------------	---

---

**Description**

Returns a vector with the each Throughput from 1 to the parameter n (population passed as input) of a Closed Jackson Network

**Usage**

```
## S3 method for class 'o_CJN'
Throughputn(x, ...)
```

### Arguments

x                    a object of class o\_CJN  
...                   additional arguments

### Details

Returns a vector with the each Throughput from 1 to the parameter n (population passed as input) of a Closed Jackson Network

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[NewInput.CJN](#), [CheckInput.i\\_CJN](#), [QueueingModel.i\\_CJN](#)

### Examples

```
## See example 11.13 in reference [Sixto2004] for more details.  
## create the nodes  
n <- 2  
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)  
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)  
  
# think time = 0  
z <- 0  
  
# operational value  
operational <- FALSE  
  
# definition of the transition probabilities  
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)  
  
# Define a new input  
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)  
  
# Check the inputs and build the model  
m_cjn1 <- QueueingModel(cjn1)  
  
Throughputn(m_cjn1)
```

---

VN	<i>Returns the variance of the number of customers in a queueing model (or network)</i>
----	---

---

### Description

Returns the variance of the number of customers in a queueing model (or network)

### Usage

```
VN(x, ...)
```

### Arguments

x	a object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf
...	additional arguments

### Details

Returns the variance of the number of customers in a queueing model (or network)

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[VN.o\\_MM1](#)  
[VN.o\\_MMC](#)  
[VN.o\\_MMCC](#)  
[VN.o\\_MMInf](#)  
[VN.o\\_MMInfKK](#)  
[VN.o\\_MM1K](#)  
[VN.o\\_MMCK](#)  
[VN.o\\_MM1KK](#)  
[VN.o\\_MMCKK](#)  
[VN.o\\_MMCKM](#)

### Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)
```

```
## Returns the variance
VN(o_mm1)
```

---

VN.o_MM1	<i>Returns the variance of the number of customers in the M/M/1 queueing model</i>
----------	--

---

### Description

Returns the variance of the number of customers in the M/M/1 queueing model

### Usage

```
## S3 method for class 'o_MM1'
VN(x, ...)
```

### Arguments

x	a object of class o_MM1
...	additional arguments

### Details

Returns the variance of the number of customers in the M/M/1 queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
 University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1](#).

### Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the variance
VN(o_mm1)
```

---

VN.o_MM1K	<i>Returns the variance of the number of customers in the M/M/1/K queueing model</i>
-----------	--

---

### Description

Returns the variance of the number of customers in the M/M/1/K queueing model

### Usage

```
## S3 method for class 'o_MM1K'  
VN(x, ...)
```

### Arguments

x	a object of class o_MM1K
...	aditional arguments

### Details

Returns the variance of the number of customers in the M/M/1/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1K](#).

### Examples

```
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)  
  
## Build the model  
o_mm1k <- QueueingModel(i_mm1k)  
  
## Returns the variance  
VN(o_mm1k)
```

---

VN.o_MM1KK	<i>Returns the variance of the number of customers in the M/M/1/K/K queueing model</i>
------------	--

---

### Description

Returns the variance of the number of customers in the M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'  
VN(x, ...)
```

### Arguments

x	a object of class o_MM1KK
...	aditional arguments

### Details

Returns the variance of the number of customers in the M/M/1/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1K](#).

### Examples

```
## create input parameters  
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)  
  
## Build the model  
o_mm1kk <- QueueingModel(i_mm1kk)  
  
## Returns the variance  
VN(o_mm1kk)
```

---

VN.o_MMC	<i>Returns the variance of the number of customers in the M/M/c queueing model</i>
----------	--

---

### Description

Returns the variance of the number of customers in the M/M/c queueing model

### Usage

```
## S3 method for class 'o_MMC'  
VN(x, ...)
```

### Arguments

x	a object of class o_MMC
...	aditional arguments

### Details

Returns the variance of the number of customers in the M/M/c queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMC](#).

### Examples

```
## create input parameters  
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)  
  
## Build the model  
o_mmc <- QueueingModel(i_mmc)  
  
## Returns the variance  
VN(o_mmc)
```

---

VN.o_MMCC	<i>Returns the variance of the number of customers in the M/M/c/c queueing model</i>
-----------	--

---

### Description

Returns the variance of the number of customers in the M/M/c/c queueing model

### Usage

```
## S3 method for class 'o_MMCC'  
VN(x, ...)
```

### Arguments

x	a object of class o_MMCC
...	additional arguments

### Details

Returns the variance of the number of customers in the M/M/c/c queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCC](#).

### Examples

```
## create input parameters  
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)  
  
## Build the model  
o_mmcc <- QueueingModel(i_mmcc)  
  
## Returns the variance  
VN(o_mmcc)
```

---

VN.o_MMCK	<i>Returns the variance of the number of customers in the M/M/c/K queueing model</i>
-----------	--

---

### Description

Returns the variance of the number of customers in the M/M/c/K queueing model

### Usage

```
## S3 method for class 'o_MMCK'  
VN(x, ...)
```

### Arguments

x	a object of class o_MMCK
...	aditional arguments

### Details

Returns the variance of the number of customers in the M/M/c/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCK](#).

### Examples

```
## create input parameters  
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)  
  
## Build the model  
o_mmck <- QueueingModel(i_mmck)  
  
## Returns the variance  
VN(o_mmck)
```

---

VN.o_MMCKK	<i>Returns the variance of the number of customers in the M/M/c/K/K queueing model</i>
------------	--

---

### Description

Returns the variance of the number of customers in the M/M/c/K/K queueing model

### Usage

```
## S3 method for class 'o_MMCKK'  
VN(x, ...)
```

### Arguments

x	a object of class o_MMCKK
...	aditional arguments

### Details

Returns the variance of the number of customers in the M/M/c/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCKK](#).

### Examples

```
## create input parameters  
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)  
  
## Build the model  
o_mmckk <- QueueingModel(i_mmckk)  
  
## Returns the variance  
VN(o_mmckk)
```

---

VN.o_MMCKM	<i>Returns the variance of the number of customers in the M/M/c/K/m queueing model</i>
------------	--

---

### Description

Returns the variance of the number of customers in the M/M/c/K/m queueing model

### Usage

```
## S3 method for class 'o_MMCKM'  
VN(x, ...)
```

### Arguments

x	a object of class o_MMCKM
...	additional arguments

### Details

Returns the variance of the number of customers in the M/M/c/K/m queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCKM](#).

### Examples

```
## create input parameters  
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)  
  
## Build the model  
o_mmckm <- QueueingModel(i_mmckm)  
  
## Returns the variance  
VN(o_mmckm)
```

---

VN.o_MMInf	<i>Returns the variance of the number of customers in the M/M/Infinite queueing model</i>
------------	---

---

### Description

Returns the variance of the number of customers in the M/M/Infinite queueing model

### Usage

```
## S3 method for class 'o_MMInf'  
VN(x, ...)
```

### Arguments

x	a object of class o_MMInf
...	additional arguments

### Details

Returns the variance of the number of customers in the M/M/Infinite queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMInf](#).

### Examples

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)  
  
## Build the model  
o_mminf <- QueueingModel(i_mminf)  
  
## Returns the variance  
VN(o_mminf)
```

---

VN.o_MMInfKK	<i>Returns the variance of the number of customers in the M/M/Infinite/K/K queueing model</i>
--------------	---

---

### Description

Returns the variance of the number of customers in the M/M/Infinite/K/K queueing model

### Usage

```
## S3 method for class 'o_MMInfKK'  
VN(x, ...)
```

### Arguments

x	a object of class o_MMInfKK
...	additional arguments

### Details

Returns the variance of the number of customers in the M/M/Infinite/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMInfKK](#).

### Examples

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)  
  
## Build the model  
o_MMInfKK <- QueueingModel(i_MMInfKK)  
  
## Returns the variance  
VN(o_MMInfKK)
```

---

VNq	<i>Returns the variance of the number of customers in the queue in a queueing model</i>
-----	---

---

### Description

Returns the variance of the number of customers in the queue in a queueing model

### Usage

```
VNq(x, ...)
```

### Arguments

x	a object of class o_MM1, o_MMCC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf
...	additional arguments

### Details

Returns the variance of the number of customers in the queue in a queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[VNq.o\\_MM1](#)  
[VNq.o\\_MM1](#)  
[VNq.o\\_MMCC](#)  
[VNq.o\\_MMInf](#)  
[VNq.o\\_MMInfKK](#)  
[VNq.o\\_MM1K](#)  
[VNq.o\\_MMCK](#)  
[VNq.o\\_MM1KK](#)  
[VNq.o\\_MMCKK](#)  
[VNq.o\\_MMCKM](#)

### Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)
```

```
## Returns the variance
VNq(o_mm1)
```

---

VNq.o_MM1	<i>Returns the variance of the number of customers in the queue in the M/M/1 queueing model</i>
-----------	---

---

### Description

Returns the variance of the number of customers in the queue in the M/M/1 queueing model

### Usage

```
## S3 method for class 'o_MM1'
VNq(x, ...)
```

### Arguments

x	a object of class o_MM1
...	additional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/1 queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
 University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1](#).

### Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the variance
VNq(o_mm1)
```

---

VNq.o_MM1K	<i>Returns the variance of the number of customers in the queue in the M/M/1/K queueing model</i>
------------	---

---

### Description

Returns the variance of the number of customers in the queue in the M/M/1/K queueing model

### Usage

```
## S3 method for class 'o_MM1K'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MM1K
...	aditional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/1/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1K](#).

### Examples

```
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)  
  
## Build the model  
o_mm1k <- QueueingModel(i_mm1k)  
  
## Returns the variance  
VNq(o_mm1k)
```

---

VNq.o_MM1KK	<i>Returns the variance of the number of customers in the queue in the M/M/1/K/K queueing model</i>
-------------	---

---

### Description

Returns the variance of the number of customers in the queue in the M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MM1KK
...	aditional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/1/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1KK](#).

### Examples

```
## create input parameters  
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)  
  
## Build the model  
o_mm1kk <- QueueingModel(i_mm1kk)  
  
## Returns the variance  
VNq(o_mm1kk)
```

---

VNq.o_MMC	<i>Returns the variance of the number of customers in the queue in the M/M/c queueing model</i>
-----------	---

---

### Description

Returns the variance of the number of customers in the queue in the M/M/c queueing model

### Usage

```
## S3 method for class 'o_MMC'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MMC
...	aditional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/c queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMC](#).

### Examples

```
## create input parameters  
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)  
  
## Build the model  
o_mmc <- QueueingModel(i_mmc)  
  
## Returns the variance  
VNq(o_mmc)
```

---

VNq.o_MMCC	<i>Returns the variance of the number of customers in the queue in the M/M/c/c queueing model</i>
------------	---

---

### Description

Returns the variance of the number of customers in the queue in the M/M/c/c queueing model

### Usage

```
## S3 method for class 'o_MMCC'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MMCC
...	aditional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/c/c queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCC](#).

### Examples

```
## create input parameters  
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)  
  
## Build the model  
o_mmcc <- QueueingModel(i_mmcc)  
  
## Returns the variance  
VNq(o_mmcc)
```

---

VNq.o_MMCK	<i>Returns the variance of the number of customers in the queue in the M/M/c/K queueing model</i>
------------	---

---

### Description

Returns the variance of the number of customers in the queue in the M/M/c/K queueing model

### Usage

```
## S3 method for class 'o_MMCK'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MMCK
...	aditional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/c/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCK](#).

### Examples

```
## create input parameters  
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)  
  
## Build the model  
o_mmck <- QueueingModel(i_mmck)  
  
## Returns the variance  
VNq(o_mmck)
```

---

VNq.o_MMCKK	<i>Returns the variance of the number of customers in the queue in the M/M/c/K/K queueing model</i>
-------------	---

---

### Description

Returns the variance of the number of customers in the queue in the M/M/c/K/K queueing model

### Usage

```
## S3 method for class 'o_MMCKK'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MMCKK
...	aditional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/c/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCKK](#).

### Examples

```
## create input parameters  
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)  
  
## Build the model  
o_mmckk <- QueueingModel(i_mmckk)  
  
## Returns the variance  
VNq(o_mmckk)
```

---

VNq.o_MMCKM	<i>Returns the variance of the number of customers in the queue in the M/M/c/K/m queueing model</i>
-------------	---

---

### Description

Returns the variance of the number of customers in the queue in the M/M/c/K/m queueing model

### Usage

```
## S3 method for class 'o_MMCKM'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MMCKM
...	additional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/c/K/m queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCKM](#).

### Examples

```
## create input parameters  
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)  
  
## Build the model  
o_mmckm <- QueueingModel(i_mmckm)  
  
## Returns the variance  
VNq(o_mmckm)
```

---

VNq.o_MMInf	<i>Returns the variance of the number of customers in the queue in the M/M/Infinite queueing model</i>
-------------	--

---

### Description

Returns the variance of the number of customers in the queue in the M/M/Infinite queueing model

### Usage

```
## S3 method for class 'o_MMInf'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MMInf
...	additional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/Infinite queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMInf](#).

### Examples

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)  
  
## Build the model  
o_mminf <- QueueingModel(i_mminf)  
  
## Returns the variance  
VNq(o_mminf)
```

---

VNq.o_MMInfKK	<i>Returns the variance of the number of customers in the queue in the M/M/Infinite/K/K queueing model</i>
---------------	--

---

### Description

Returns the variance of the number of customers in the queue in the M/M/Infinite/K/K queueing model

### Usage

```
## S3 method for class 'o_MMInfKK'  
VNq(x, ...)
```

### Arguments

x	a object of class o_MMInfKK
...	aditional arguments

### Details

Returns the variance of the number of customers in the queue in the M/M/Infinite/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMInfKK](#).

### Examples

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)  
  
## Build the model  
o_MMInfKK <- QueueingModel(i_MMInfKK)  
  
## Returns the VNq  
VNq(o_MMInfKK)
```

---

VT	Returns the variance of the time spend in a queueing model (or network)
----	---

---

### Description

Returns the variance of the time spend in a queueing model (or network)

### Usage

```
VT(x, ...)
```

### Arguments

x	a object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf
...	additional arguments

### Details

Returns the variance of the time spend in a queueing model (or network)

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[VT.o\\_MM1](#)  
[VT.o\\_MMC](#)  
[VT.o\\_MMCC](#)  
[VT.o\\_MMInf](#)  
[VT.o\\_MMInfKK](#)  
[VT.o\\_MM1K](#)  
[VT.o\\_MM1KK](#)

### Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the variance of the time spend in the system
VT(o_mm1)
```

---

`VT.o_MM1`*Returns the variance of the time spend in the M/M/1 queueing model*

---

**Description**

Returns the variance of the time spend in the M/M/1 queueing model

**Usage**

```
## S3 method for class 'o_MM1'  
VT(x, ...)
```

**Arguments**

<code>x</code>	a object of class <code>o_MM1</code>
<code>...</code>	aditional arguments

**Details**

Returns the variance of the time spend in the M/M/1 queueing model

**References**

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

**See Also**

[QueueingModel.i\\_MM1](#).

**Examples**

```
## create input parameters  
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)  
  
## Build the model  
o_mm1 <- QueueingModel(i_mm1)  
  
## Returns the variance of the time spend in the system  
VT(o_mm1)
```

---

VT.o\_MM1K                      *Returns the variance of the time spend in the M/M/1/K queueing model*

---

### Description

Returns the variance of the time spend in the M/M/1/K queueing model

### Usage

```
## S3 method for class 'o_MM1K'  
VT(x, ...)
```

### Arguments

x                      a object of class o\_MM1K  
...                    additional arguments

### Details

Returns the variance of the time spend in the M/M/1/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1K](#).

### Examples

```
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)  
  
## Build the model  
o_mm1k <- QueueingModel(i_mm1k)  
  
## Returns the variance  
VT(o_mm1k)
```

---

VT.o_MM1KK	<i>Returns the variance of the time spend in the M/M/1/K/K queueing model</i>
------------	---

---

### Description

Returns the variance of the time spend in the M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'  
VT(x, ...)
```

### Arguments

x	a object of class o_MM1KK
...	aditional arguments

### Details

Returns the variance of the time spend in the M/M/1/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1KK](#).

### Examples

```
## create input parameters  
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)  
  
## Build the model  
o_mm1kk <- QueueingModel(i_mm1kk)  
  
## Returns the variance  
VT(o_mm1kk)
```

---

VT.o\_MMC *Returns the variance of the time spend in the M/M/c queueing model*

---

### Description

Returns the variance of the time spend in the M/M/c queueing model

### Usage

```
## S3 method for class 'o_MMC'  
VT(x, ...)
```

### Arguments

x                    a object of class o\_MMC  
...                   additional arguments

### Details

Returns the variance of the time spend in the M/M/c queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMC](#).

### Examples

```
## create input parameters  
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)  
  
## Build the model  
o_mmc <- QueueingModel(i_mmc)  
  
## Returns the variance of the time spend in the system  
VT(o_mmc)
```

---

`VT.o_MMCC`*Returns the variance of the time spend in the M/M/c/c queueing model*

---

**Description**

Returns the variance of the time spend in the M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'  
VT(x, ...)
```

**Arguments**

`x`                    a object of class o\_MMCC  
`...`                additional arguments

**Details**

Returns the variance of the time spend in the M/M/c/c queueing model

**References**

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

**See Also**

[QueueingModel.i\\_MMCC](#).

**Examples**

```
## create input parameters  
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)  
  
## Build the model  
o_mmcc <- QueueingModel(i_mmcc)  
  
## Returns the variance  
VT(o_mmcc)
```

---

VT.o_MMInf	<i>Returns the variance of the time spend in the M/M/Infinite queueing model</i>
------------	--

---

### Description

Returns the variance of the time spend in the M/M/Infinite queueing model

### Usage

```
## S3 method for class 'o_MMInf'  
VT(x, ...)
```

### Arguments

x	a object of class o_MMInf
...	aditional arguments

### Details

Returns the the variance of the time spend in the M/M/Infinite queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMInf](#).

### Examples

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)  
  
## Build the model  
o_mminf <- QueueingModel(i_mminf)  
  
## Returns the variance  
VT(o_mminf)
```

---

VT.o_MMInfKK	<i>Returns the variance of the time spend in the M/M/Infinite/K/K queueing model</i>
--------------	--

---

### Description

Returns the variance of the time spend in the M/M/Infinite/K/K queueing model

### Usage

```
## S3 method for class 'o_MMInfKK'  
VT(x, ...)
```

### Arguments

x	a object of class o_MMInfKK
...	aditional arguments

### Details

Returns the variance of the time spend in the M/M/Infinite/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMInfKK](#).

### Examples

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)  
  
## Build the model  
o_MMInfKK <- QueueingModel(i_MMInfKK)  
  
## Returns the variance  
VT(o_MMInfKK)
```

---

VTq	<i>Returns the variance of the time spend in queue in a queueing model</i>
-----	--

---

**Description**

Returns the variance of the time spend in queue in a queueing model

**Usage**

```
VTq(x, ...)
```

**Arguments**

x	a object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMIInfKK, o_MMIInf
...	additional arguments

**Details**

Returns the variance of the time spend in queue in a queueing model

**References**

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
 University of Debrecen, Faculty of Informatics.

**See Also**

[VTq.o\\_MM1](#)  
[VTq.o\\_MMC](#)  
[VTq.o\\_MMCC](#)  
[VTq.o\\_MMIInf](#)  
[VTq.o\\_MMIInfKK](#)  
[VTq.o\\_MM1K](#)  
[VTq.o\\_MMCK](#)  
[VTq.o\\_MM1KK](#)  
[VTq.o\\_MMCKK](#)

**Examples**

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the variance of the time spend in queue
VTq(o_mm1)
```

---

VTq.o_MM1	<i>Returns the variance of the time spend in queue in the M/M/1 queueing model</i>
-----------	--

---

### Description

Returns the variance of the time spend in queue in the M/M/1 queueing model

### Usage

```
## S3 method for class 'o_MM1'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MM1
...	aditional arguments

### Details

Returns the variance of the time spend in queue in the M/M/1 queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1](#).

### Examples

```
## create input parameters  
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)  
  
## Build the model  
o_mm1 <- QueueingModel(i_mm1)  
  
## Returns the variance of the time spend in queue  
VTq(o_mm1)
```

---

VTq.o_MM1K	<i>Returns the variance of the time spend in queue in the M/M/1/K queueing model</i>
------------	--

---

### Description

Returns the variance of the time spend in queue in the M/M/1/K queueing model

### Usage

```
## S3 method for class 'o_MM1K'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MM1K
...	aditional arguments

### Details

Returns the variance of the time spend in queue in the M/M/1/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1K](#).

### Examples

```
## create input parameters  
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)  
  
## Build the model  
o_mm1k <- QueueingModel(i_mm1k)  
  
## Returns the variance  
VTq(o_mm1k)
```

---

VTq.o_MM1KK	<i>Returns the variance of the time spend in queue in the M/M/1/K/K queueing model</i>
-------------	--

---

### Description

Returns the variance of the time spend in queue in the M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MM1KK
...	aditional arguments

### Details

Returns the variance of the time spend in queue in the M/M/1/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MM1KK](#).

### Examples

```
## See example 10.13 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)  
  
## Build the model  
o_mm1kk <- QueueingModel(i_mm1kk)  
  
## Returns the VTq  
VTq(o_mm1kk)
```

---

VTq.o_MMC	<i>Returns the variance of the time spend in queue in the M/M/c queueing model</i>
-----------	--

---

### Description

Returns the variance of the time spend in queue in the M/M/c queueing model

### Usage

```
## S3 method for class 'o_MMC'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MMC
...	aditional arguments

### Details

Returns the variance of the time spend in queue in the M/M/c queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMC](#).

### Examples

```
## create input parameters  
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)  
  
## Build the model  
o_mmc <- QueueingModel(i_mmc)  
  
## Returns the variance of the time spend in queue  
VTq(o_mmc)
```

---

VTq.o_MMCC	<i>Returns the variance of the time spend in queue in the M/M/c/c queueing model</i>
------------	--

---

### Description

Returns the variance of the time spend in queue in the M/M/c/c queueing model

### Usage

```
## S3 method for class 'o_MMCC'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MMCC
...	aditional arguments

### Details

Returns the variance of the time spend in queue in the M/M/c/c queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCC](#).

### Examples

```
## create input parameters  
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)  
  
## Build the model  
o_mmcc <- QueueingModel(i_mmcc)  
  
## Returns the variance  
VTq(o_mmcc)
```

---

VTq.o_MMCK	<i>Returns the variance of the time spend in queue in the M/M/c/K queueing model</i>
------------	--

---

### Description

Returns the variance of the time spend in queue in the M/M/c/K queueing model

### Usage

```
## S3 method for class 'o_MMCK'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MMCK
...	aditional arguments

### Details

Returns the variance of the time spend in queue in the M/M/c/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCK](#).

### Examples

```
## create input parameters  
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)  
  
## Build the model  
o_mmck <- QueueingModel(i_mmck)  
  
## Returns the variance  
VTq(o_mmck)
```

---

VTq.o_MMCKK	<i>Returns the variance of the time spend in queue in the M/M/c/K/K queueing model</i>
-------------	--

---

### Description

Returns the variance of the time spend in queue in the M/M/c/K/K queueing model

### Usage

```
## S3 method for class 'o_MMCKK'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MMCKK
...	aditional arguments

### Details

Returns the variance of the time spend in queue in the M/M/c/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMCKK](#).

### Examples

```
## create input parameters  
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)  
  
## Build the model  
o_mmckk <- QueueingModel(i_mmckk)  
  
## Returns the variance  
VTq(o_mmckk)
```

---

VTq.o_MMInf	<i>Returns the variance of the time spend in queue in the M/M/Infinite queueing model</i>
-------------	---

---

### Description

Returns the variance of the time spend in queue in the M/M/Infinite queueing model

### Usage

```
## S3 method for class 'o_MMInf'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MMInf
...	additional arguments

### Details

Returns the variance of the time spend in queue in the M/M/Infinite queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMInf](#).

### Examples

```
## create input parameters  
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)  
  
## Build the model  
o_mminf <- QueueingModel(i_mminf)  
  
## Returns the variance  
VTq(o_mminf)
```

---

VTq.o_MMInfKK	<i>Returns the variance of the time spend in queue in the M/M/Infinite/K/K queueing model</i>
---------------	---

---

### Description

Returns the variance of the time spend in queue in the M/M/Infinite/K/K queueing model

### Usage

```
## S3 method for class 'o_MMInfKK'  
VTq(x, ...)
```

### Arguments

x	a object of class o_MMInfKK
...	aditional arguments

### Details

Returns the variance of the time spend in queue in the M/M/Infinite/K/K queueing model

### References

[Sztrik2012] Dr. Janos Sztrik (2012).  
*Basic Queueing Theory*.  
University of Debrecen, Faculty of Informatics.

### See Also

[QueueingModel.i\\_MMInfKK](#).

### Examples

```
## create input parameters  
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)  
  
## Build the model  
o_MMInfKK <- QueueingModel(i_MMInfKK)  
  
## Returns the variance  
VTq(o_MMInfKK)
```

---

W *Returns the mean time spend in a queueing model (or network)*

---

### Description

Returns the mean time spend in a queueing model (or network)

### Usage

$W(x, \dots)$

### Arguments

x a object of class o\_MM1, o\_MMC, o\_MM1K, o\_MMCK, o\_MM1KK, o\_MMCKK, o\_MMCC, o\_MMCKM, o\_MMInfKK, o\_MMInf, o\_OJN, o\_MCON, o\_MCCN, o\_MCMN  
... additional arguments

### Details

Returns the mean time spend in a queueing model (or network)

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[W.o\\_MM1](#)  
[W.o\\_MMC](#)  
[W.o\\_MM1K](#)  
[W.o\\_MMCK](#)  
[W.o\\_MM1KK](#)  
[W.o\\_MMCKK](#)  
[W.o\\_MMCC](#)  
[W.o\\_MMCKM](#)  
[W.o\\_MMInfKK](#)  
[W.o\\_MMInf](#)  
[W.o\\_OJN](#)  
[W.o\\_MCON](#)  
[W.o\\_MCCN](#)  
[W.o\\_MCMN](#)

## Examples

```
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the W
W(o_mm1)
```

---

W.o\_CJN

*Returns the mean time spend in a Closed Jackson Network*

---

## Description

Returns the mean time spend in a Closed Jackson Network

## Usage

```
## S3 method for class 'o_CJN'
W(x, ...)
```

## Arguments

x                    a object of class o\_CJN  
...                   additional arguments

## Details

Returns the mean time spend in a Closed Jackson Network

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_CJN](#).

**Examples**

```

## See example 11.13 in reference [Sixto2004] for more details.
## create the nodes
n <- 2
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)

# think time = 0
z <- 0

# operational value
operational <- FALSE

# definition of the transition probabilities
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)

# Define a new input
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)

# Check the inputs and build the model
m_cjn1 <- QueueingModel(cjn1)

W(m_cjn1)

```

---

W.o\_MCCN

*Returns the mean time spend in a MultiClass Closed Network*


---

**Description**

Returns the mean time spend in a MultiClass Closed Network

**Usage**

```

## S3 method for class 'o_MCCN'
W(x, ...)

```

**Arguments**

x	a object of class o_MCCN
...	additional arguments

**Details**

Returns the mean time spend in a MultiClass Closed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCCN](#).

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

W(o_MCCN1)
```

---

W.o\_MCMN

*Returns the mean time spend in a MultiClass Mixed Network*

---

**Description**

Returns the mean time spend in a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'
W(x, ...)
```

**Arguments**

x                    a object of class o\_MCMN  
 ...                  additional arguments

**Details**

Returns the mean time spend in a MultiClass Mixed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

W(o_mcmn1)
```

---

W.o\_MCON

*Returns the mean time spend in a MultiClass Open Network*


---

**Description**

Returns the mean time spend in a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
W(x, ...)
```

**Arguments**

x                    a object of class o\_MCON  
 ...                 additional arguments

**Details**

Returns the mean time spend in a MultiClass Open Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCON.](#)

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

W(o_mcon1)
```

---

W.o\_MM1

*Returns the mean time spend in the M/M/1 queueing model*

---

**Description**

Returns the mean time spend in the M/M/1 queueing model

**Usage**

```
## S3 method for class 'o_MM1'
W(x, ...)
```

**Arguments**

x                    a object of class o\_MM1  
 ...                  additional arguments

**Details**

Returns the mean time spend in the M/M/1 queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MM1](#).

**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the W
W(o_mm1)
```

---

W.o\_MM1K

---

*Returns the mean time spend in the M/M/1/K queueing model*


---

**Description**

Returns the mean time spend in the M/M/1/K queueing model

**Usage**

```
## S3 method for class 'o_MM1K'
W(x, ...)
```

**Arguments**

x                    a object of class o\_MM1K  
 ...                  additional arguments

**Details**

Returns the mean time spend in the M/M/1/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MM1K](#).

**Examples**

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mm1k <- QueueingModel(i_mm1k)

## Returns the W
W(o_mm1k)
```

---

W.o\_MM1KK

*Returns the mean time spend in the M/M/1/K/K queueing model*

---

**Description**

Returns the mean time spend in the M/M/1/K/K queueing model

**Usage**

```
## S3 method for class 'o_MM1KK'
W(x, ...)
```

**Arguments**

x                    a object of class o\_MM1KK  
 ...                  additional arguments

**Details**

Returns the mean time spend in the M/M/1/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MM1KK.](#)

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the W
W(o_mm1kk)
```

---

W.o\_MMC

*Returns the mean time spend in the M/M/c queueing model*


---

**Description**

Returns the mean time spend in the M/M/c queueing model

**Usage**

```
## S3 method for class 'o_MMC'
W(x, ...)
```

**Arguments**

x                    a object of class o\_MMC  
 ...                    additional arguments

**Details**

Returns the mean time spend in the M/M/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Returns the W
W(o_mmc)
```

---

W.o\_MMCC

*Returns the mean time spend in the M/M/c/c queueing model*

---

**Description**

Returns the mean time spend in the M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'
W(x, ...)
```

**Arguments**

x	a object of class o_MMCC
...	aditional arguments

**Details**

Returns the mean time spend in the M/M/c/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCC](#).

**Examples**

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Returns the W
W(o_mmcc)
```

---

W.o\_MMCK

*Returns the mean time spend in the M/M/c/K queueing model*


---

**Description**

Returns the mean time spend in the M/M/c/K queueing model

**Usage**

```
## S3 method for class 'o_MMCK'
W(x, ...)
```

**Arguments**

x                    a object of class o\_MMCK  
...                    additional arguments

**Details**

Returns the mean time spend in the M/M/c/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Returns the W
W(o_mmck)
```

---

W.o\_MMCKK

*Returns the mean time spend in the M/M/c/K/K queueing model*


---

**Description**

Returns the mean time spend in the M/M/c/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMCKK'
W(x, ...)
```

**Arguments**

x                    a object of class o\_MMCKK  
...                    additional arguments

**Details**

Returns the mean time spend in the M/M/c/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCKK](#).

## Examples

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## Build the model
o_mmckk <- QueueingModel(i_mmckk)

## Returns the W
W(o_mmckk)
```

---

W.o\_MMCKM

*Returns the mean time spend in the M/M/c/K/m queueing model*

---

## Description

Returns the mean time spend in the M/M/c/K/m queueing model

## Usage

```
## S3 method for class 'o_MMCKM'
W(x, ...)
```

## Arguments

x                    a object of class o\_MMCKM  
...                   additional arguments

## Details

Returns the mean time spend in the M/M/c/K/m queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MMCKM](#).

### Examples

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Returns the W
W(o_mmckm)
```

---

W.o\_MMInf

*Returns the time spend in the M/M/Infinite queueing model*

---

### Description

Returns the mean time spend in the M/M/Infinite queueing model

### Usage

```
## S3 method for class 'o_MMInf'
W(x, ...)
```

### Arguments

x                    a object of class o\_MMInf  
...                   additional arguments

### Details

Returns the mean time spend in the M/M/Infinite queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MMInf.](#)

## Examples

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Returns the W
W(o_mminf)
```

---

W.o_MMInfKK	<i>Returns the mean time spend in the M/M/Infinite/K/K queueing model</i>
-------------	---

---

## Description

Returns the mean time spend in the M/M/Infinite/K/K queueing model

## Usage

```
## S3 method for class 'o_MMInfKK'
W(x, ...)
```

## Arguments

x	a object of class o_MMInfKK
...	aditional arguments

## Details

Returns the mean time spend in the M/M/Infinite/K/K queueing model

## References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

## See Also

[QueueingModel.i\\_MMInfKK](#).

## Examples

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Returns the W
W(o_MMInfKK)
```

---

W.o\_OJN

*Returns the mean time spend in an Open Jackson Network*

---

## Description

Returns the mean time spend in an Open Jackson Network

## Usage

```
## S3 method for class 'o_OJN'
W(x, ...)
```

## Arguments

x                    a object of class o\_OJN  
...                   additional arguments

## Details

Returns the mean time spend in an Open Jackson Network

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_OJN](#).

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

# Definition of the new input
i_ojn <- NewInput.OJN(prob, n1, n2, n3, n4)

# Build the models
o_ojn <- QueueingModel(i_ojn)

W(o_ojn)
```

---

Wc	<i>Returns the vector with each class mean time spend on a multiclass queueing network</i>
----	--

---

**Description**

Returns the vector with each class mean time spend on a multiclass queueing network

**Usage**

```
Wc(x, ...)
```

**Arguments**

x	a object of class o_MCON, o_MCCN, o_MCMN
...	additional arguments

**Details**

Returns the vector with each class mean time spend on a multiclass queueing network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[Wc.o\\_MCON](#)  
[Wc.o\\_MCCN](#)  
[Wc.o\\_MCMN](#)

### Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Wc(o_mcon1)
```

---

Wc.o\_MCCN

*Returns the vector with each class mean time spend on a MultiClass Closed Network*

---

### Description

Returns the vector with each class mean time spend on a MultiClass Closed Network

### Usage

```
## S3 method for class 'o_MCCN'
Wc(x, ...)
```

### Arguments

x                    a object of class o\_MCCN  
...                    additional arguments

**Details**

Returns the vector with each class mean time spend on a MultiClass Closed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCCN](#).

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Wc(o_MCCN1)
```

---

Wc.o\_MCMN

*Returns the vector with each class mean time spend on a MultiClass Mixed Network*

---

**Description**

Returns the vector with each class mean time spend on a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'
Wc(x, ...)
```

**Arguments**

x                    a object of class o\_MCMN  
 ...                  additional arguments

**Details**

Returns the vector with each class mean time spend on a MultiClass Mixed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN.](#)

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Wc(o_mcmn1)
```

---

Wc.o\_MCON

*Returns the vector with each class mean time spend on a MultiClass Open Network*

---

**Description**

Returns the vector with each class mean time spend on a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'  
Wc(x, ...)
```

**Arguments**

```
x          a object of class o_MCON  
...       additional arguments
```

**Details**

Returns the vector with each class mean time spend on a MultiClass Open Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCON](#).

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.  
  
classes <- 2  
vLambda <- c(3/19, 2/19)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)  
  
# Build the model  
o_mcon1 <- QueueingModel(i_mcon1)  
  
Wc(o_mcon1)
```

---

Wck	<i>Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Queueing Network</i>
-----	--

---

### Description

Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Queueing Network

### Usage

```
Wck(x, ...)
```

### Arguments

x	a object of class o_MCON, o_MCCN, o_MCMN
...	additional arguments

### Details

Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Queueing Network

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[Wck.o\\_MCON](#)  
[Wck.o\\_MCCN](#)  
[Wck.o\\_MCMN](#)

### Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.  
  
classes <- 2  
vLambda <- c(3/19, 2/19)  
nodes <- 2  
vType <- c("Q", "Q")
```

```

vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Wck(o_mcon1)

```

---

Wck.o_MCCN	<i>Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Closed Network</i>
------------	--

---

## Description

Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Closed Network

## Usage

```

## S3 method for class 'o_MCCN'
Wck(x, ...)

```

## Arguments

x	a object of class o_MCCN
...	additional arguments

## Details

Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Closed Network

## References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

## See Also

[QueueingModel.i\\_MCCN](#).

**Examples**

```
## See example in pag 142 in reference [Lazowska84] for more details.

classes <- 2
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_MCCN1 <- QueueingModel(i_MCCN1)

Wck(o_MCCN1)
```

---

Wck.o_MCMN	<i>Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Mixed Network</i>
------------	---

---

**Description**

Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Mixed Network

**Usage**

```
## S3 method for class 'o_MCMN'
Wck(x, ...)
```

**Arguments**

x	a object of class o_MCMN
...	additional arguments

**Details**

Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Mixed Network

**References**

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

**See Also**

[QueueingModel.i\\_MCMN](#).

**Examples**

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)

i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Wck(o_mcmn1)
```

---

Wck.o_MCON	<i>Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Open Network</i>
------------	--

---

**Description**

Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Open Network

**Usage**

```
## S3 method for class 'o_MCON'
Wck(x, ...)
```

**Arguments**

x	a object of class o_MCON
...	additional arguments

**Details**

Reports a matrix with the mean time of class i in each node (server) j in a MultiClass Open Network

## References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).

*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.* Prentice-Hall, Inc., Englewood Cliffs, New Jersey

## See Also

[QueueingModel.i\\_MCON](#).

## Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Wck(o_mcon1)
```

---

Wk	<i>Generic S3 method to return the mean time spend in each node (or server) of a network</i>
----	--

---

## Description

Generic S3 method to return the mean time spend in each node (or server) of a network

## Usage

```
Wk(x, ...)
```

## Arguments

x	a object of class o_OJN, o_CJN, o_MCON, o_MCCN, o_MCMN
...	aditional arguments

## Details

Generic S3 method to return the mean time spend in each node (or server) of a network

## References

- [Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.
- [Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984).  
*Quantitative System Performance: Computer System Analysis Using Queueing Network Models.*  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey

## See Also

[Wk.o\\_OJN](#)  
[Wk.o\\_CJN](#)  
[Wk.o\\_MCON](#)  
[Wk.o\\_MCCN](#)  
[Wk.o\\_MCMN](#)

## Examples

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Wk(o_mcon1)
```

---

Wk.o_CJN	<i>Returns the vector with the mean time spend in each node (server) of a Closed Jackson Network</i>
----------	--

---

## Description

Returns the vector with the mean time spend in each node (server) of a Closed Jackson Network

## Usage

```
## S3 method for class 'o_CJN'
Wk(x, ...)
```

**Arguments**

x                    a object of class o\_CJN  
...                   additional arguments

**Details**

Returns the vector with the mean time spend in each node (server) of a Closed Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_CJN.](#)

**Examples**

```
## See example 11.13 in reference [Sixto2004] for more details.  
## create the nodes  
n <- 2  
n1 <- NewInput.MM1(lambda=0, mu=1/0.2, n=0)  
n2 <- NewInput.MM1(lambda=0, mu=1/0.4, n=0)  
  
# think time = 0  
z <- 0  
  
# operational value  
operational <- FALSE  
  
# definition of the transition probabilities  
prob <- matrix(data=c(0.5, 0.5, 0.5, 0.5), nrow=2, ncol=2, byrow=TRUE)  
  
# Define a new input  
cjn1 <- NewInput.CJN(prob, n, z, operational, 0, 0.001, n1, n2)  
  
# Check the inputs and build the model  
m_cjn1 <- QueueingModel(cjn1)  
  
Wk(m_cjn1)
```

---

Wk.o_MCCN	<i>Returns a vector with the mean time spend in each node (server) of a MultiClass Closed Network</i>
-----------	---

---

### Description

Returns a vector with the mean time spend in each node (server) of a MultiClass Closed Network

### Usage

```
## S3 method for class 'o_MCCN'  
Wk(x, ...)
```

### Arguments

x	a object of class o_MCCN
...	additional arguments

### Details

Returns a vector with the mean time spend in each node (server) of a MultiClass Closed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCCN](#).

### Examples

```
## See example in pag 142 in reference [Lazowska84] for more details.  
  
classes <- 2  
vNumber <- c(1, 1)  
vThink <- c(0, 0)  
nodes <- 2  
vType <- c("Q", "Q")  
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)  
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)  
  
i_MCCN1 <- NewInput.MCCN(classes, vNumber, vThink, nodes, vType, vVisit, vService)  
  
# Build the model  
o_MCCN1 <- QueueingModel(i_MCCN1)
```

```
Wk(o_MCMN1)
```

---

Wk.o_MCMN	<i>Returns a matrix with the mean time spend in each node (server) of a MultiClass Mixed Network</i>
-----------	--

---

### Description

Returns a matrix with the mean time spend in each node (server) of a MultiClass Mixed Network

### Usage

```
## S3 method for class 'o_MCMN'
Wk(x, ...)
```

### Arguments

x	a object of class o_MCMN
...	additional arguments

### Details

Returns a matrix with the mean time spend in each node (server) of a MultiClass Mixed Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCMN](#).

### Examples

```
## See example in pag 147 in reference [Lazowska84] for more details.

classes <- 4
vLambda <- c(1, 1/2)
vNumber <- c(1, 1)
vThink <- c(0, 0)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=1, nrow=4, ncol=2)
vService <- matrix(data=c(1/4, 1/2, 1/2, 1, 1/6, 1, 1, 4/3), nrow=4, ncol=2)
```

```
i_mcmn1 <- NewInput.MCMN(classes, vLambda, vNumber, vThink, nodes, vType, vVisit, vService)

# Build the model
o_mcmn1 <- QueueingModel(i_mcmn1)

Wk(o_mcmn1)
```

---

Wk.o_MCON	<i>Returns a matrix with the mean time spend in each node (server) of a MultiClass Open Network</i>
-----------	---

---

### Description

Returns a matrix with the mean time spend in each node (server) of a MultiClass Open Network

### Usage

```
## S3 method for class 'o_MCON'
Wk(x, ...)
```

### Arguments

x	a object of class o_MCON
...	additional arguments

### Details

Returns a matrix with the mean time spend in each node (server) of a MultiClass Open Network

### References

[Lazowska84] Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik (1984). *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey

### See Also

[QueueingModel.i\\_MCON](#).

**Examples**

```
## See example in pag 138 in reference [Lazowska84] for more details.

classes <- 2
vLambda <- c(3/19, 2/19)
nodes <- 2
vType <- c("Q", "Q")
vVisit <- matrix(data=c(10, 9, 5, 4), nrow=2, ncol=2, byrow=TRUE)
vService <- matrix(data=c(1/10, 1/3, 2/5, 1), nrow=2, ncol=2, byrow=TRUE)

i_mcon1 <- NewInput.MCON(classes, vLambda, nodes, vType, vVisit, vService)

# Build the model
o_mcon1 <- QueueingModel(i_mcon1)

Wk(o_mcon1)
```

---

Wk.o\_OJN

---

*Returns the vector with the mean time spend in each node (server) of an Open Jackson Network*


---

**Description**

Returns the vector with the mean time spend in each node (server) of an Open Jackson Network

**Usage**

```
## S3 method for class 'o_OJN'
Wk(x, ...)
```

**Arguments**

x                    a object of class o\_OJN  
...                    additional arguments

**Details**

Returns the vector with the mean time spend in each node (server) of an Open Jackson Network

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_OJN](#).

**Examples**

```
## See example 11.11 in reference [Sixto2004] for more details.
## create the nodes
n1 <- NewInput.MM1(lambda=8, mu=14, n=0)
n2 <- NewInput.MM1(lambda=0, mu=9, n=0)
n3 <- NewInput.MM1(lambda=6, mu=17, n=0)
n4 <- NewInput.MM1(lambda=0, mu=7, n=0)
m <- c(0, 0.2, 0.56, 0.24, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

# definition of the transition probabilities
prob <- matrix(data=m, nrow=4, ncol=4, byrow=TRUE)

ojn1 <- NewInput.OJN(prob, n1, n2, n3, n4)

m_ojn1 <- QueueingModel(ojn1)

Wk(m_ojn1)
```

---

Wq

---

*Returns the mean time spend in queue in a queueing model*


---

**Description**

Returns the mean time spend in queue in a queueing model

**Usage**

Wq(x, ...)

**Arguments**

x                    a object of class o\_MM1, o\_MMC, o\_MM1K, o\_MMCK, o\_MM1KK, o\_MMCKK,  
o\_MMCC, o\_MMCKM, o\_MMInfKK, o\_MMInf  
...                    additional arguments

**Details**

Returns the mean time spend in queue in a queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[Wq.o\\_MM1](#)  
[Wq.o\\_MM2](#)  
[Wq.o\\_MM1K](#)  
[Wq.o\\_MMCK](#)  
[Wq.o\\_MM1KK](#)  
[Wq.o\\_MMCKK](#)  
[Wq.o\\_MMCC](#)  
[Wq.o\\_MMCKM](#)  
[Wq.o\\_MMInfKK](#)  
[Wq.o\\_MMInf](#)

**Examples**

```

## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Wq
Wq(o_mm1)

```

---

Wq.o\_MM1

*Returns the mean time spend in queue in the M/M/1 queueing model*


---

**Description**

Returns the mean time spend in queue in the M/M/1 queueing model

**Usage**

```

## S3 method for class 'o_MM1'
Wq(x, ...)

```

**Arguments**

x                    a object of class o\_MM1  
...                   additional arguments

**Details**

Returns the mean time spend in queue in the M/M/1 queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MM1](#).

**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Wq
Wq(o_mm1)
```

---

Wq.o\_MM1K

*Returns the mean time spend in queue in the M/M/1/K queueing model*


---

**Description**

Returns the mean time spend in queue in the M/M/1/K queueing model

**Usage**

```
## S3 method for class 'o_MM1K'
Wq(x, ...)
```

**Arguments**

x                    a object of class o\_MM1K  
 ...                    additional arguments

**Details**

Returns the mean time spend in queue in the M/M/1/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
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**See Also**

[QueueingModel.i\\_MM1K](#).

**Examples**

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mm1k <- QueueingModel(i_mm1k)

## Returns the Wq
Wq(o_mm1k)
```

---

Wq.o_MM1KK	<i>Returns the mean time spend in queue in the M/M/1/K/K queueing model</i>
------------	---

---

**Description**

Returns the mean time spend in queue in the M/M/1/K/K queueing model

**Usage**

```
## S3 method for class 'o_MM1KK'
Wq(x, ...)
```

**Arguments**

x	a object of class o_MM1KK
...	additional arguments

**Details**

Returns the mean time spend in queue in the M/M/1/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).

*Investigacion Operativa. Modelos deterministicos y estocasticos.*

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**See Also**

[QueueingModel.i\\_MM1KK](#).

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the Wq
Wq(o_mm1kk)
```

---

Wq.o\_MMC

*Returns the mean time spend in queue in the M/M/c queueing model*


---

**Description**

Returns the mean time spend in queue in the M/M/c queueing model

**Usage**

```
## S3 method for class 'o_MMC'
Wq(x, ...)
```

**Arguments**

x	a object of class o_MMC
...	additional arguments

**Details**

Returns the mean time spend in queue in the M/M/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Returns the Wq
Wq(o_mmc)
```

---

Wq.o\_MMCC

*Returns the mean time spend in queue in the M/M/c/c queueing model*


---

**Description**

Returns the mean time spend in queue in the M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'
Wq(x, ...)
```

**Arguments**

x	a object of class o_MMCC
...	additional arguments

**Details**

Returns the mean time spend in queue in the M/M/c/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCC](#).

**Examples**

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Returns the Wq
Wq(o_mmcc)
```

---

Wq.o_MMCK	<i>Returns the mean time spend in queue in the M/M/c/K queueing model</i>
-----------	---

---

**Description**

Returns the mean time spend in queue in the M/M/c/K queueing model

**Usage**

```
## S3 method for class 'o_MMCK'
Wq(x, ...)
```

**Arguments**

x	a object of class o_MMCK
...	aditional arguments

**Details**

Returns the mean time spend in queue in the M/M/c/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Returns the Wq
Wq(o_mmck)
```

---

Wq.o_MMCKK	<i>Returns the mean time spend in queue in the M/M/c/K/K queueing model</i>
------------	---

---

**Description**

Returns the mean time spend in queue in the M/M/c/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMCKK'
Wq(x, ...)
```

**Arguments**

x	a object of class o_MMCKK
...	aditional arguments

**Details**

Returns the mean time spend in queue in the M/M/c/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCKK](#).

## Examples

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## Build the model
o_mmckk <- QueueingModel(i_mmckk)

## Returns the Wq
Wq(o_mmckk)
```

---

Wq.o_MMCKM	<i>Returns the mean time spend in queue in the M/M/c/K/m queueing model</i>
------------	---

---

## Description

Returns the mean time spend in queue in the M/M/c/K/m queueing model

## Usage

```
## S3 method for class 'o_MMCKM'
Wq(x, ...)
```

## Arguments

x	a object of class o_MMCKM
...	additional arguments

## Details

Returns the mean time spend in queue in the M/M/c/K/m queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MMCKM](#).

**Examples**

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Returns the Wq
Wq(o_mmckm)
```

---

Wq.o_MMInf	<i>Returns the mean time spend in queue in the M/M/Infinite queueing model</i>
------------	--

---

**Description**

Returns the mean time spend in queue in the M/M/Infinite queueing model

**Usage**

```
## S3 method for class 'o_MMInf'
Wq(x, ...)
```

**Arguments**

x	a object of class o_MMInf
...	additional arguments

**Details**

Returns the mean time spend in queue in the M/M/Infinite queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMInf](#).

## Examples

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Returns the Wq
Wq(o_mminf)
```

---

Wq.o_MMInfKK	<i>Returns the mean time spend in queue in the M/M/Infinite/K/K queueing model</i>
--------------	--

---

## Description

Returns the mean time spend in queue in the M/M/Infinite/K/K queueing model

## Usage

```
## S3 method for class 'o_MMInfKK'
Wq(x, ...)
```

## Arguments

x	a object of class o_MMInfKK
...	additional arguments

## Details

Returns the mean time spend in queue in the M/M/Infinite/K/K queueing model

## References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

## See Also

[QueueingModel.i\\_MMInfKK](#).

**Examples**

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Returns the Wq
Wq(o_MMInfKK)
```

---

Wq <sub>q</sub>	<i>Returns the mean time spend in queue when there is queue in a queueing model</i>
-----------------	---

---

**Description**

Returns the mean time spend in queue when there is queue in a queueing model

**Usage**

```
Wqq(x, ...)
```

**Arguments**

x	a object of class o_MM1, o_MMC, o_MM1K, o_MMCK, o_MM1KK, o_MMCKK, o_MMCC, o_MMCKM, o_MMInfKK, o_MMInf
...	additional arguments

**Details**

Returns the mean time spend in queue when there is queue in a queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[Wq<sub>q</sub>.o\\_MM1](#)  
[Wq<sub>q</sub>.o\\_MMC](#)  
[Wq<sub>q</sub>.o\\_MM1K](#)  
[Wq<sub>q</sub>.o\\_MMCK](#)  
[Wq<sub>q</sub>.o\\_MM1KK](#)  
[Wq<sub>q</sub>.o\\_MMCKK](#)  
[Wq<sub>q</sub>.o\\_MMCC](#)

```

Wqq.o_MMCKM
Wqq.o_MMInfKK
Wqq.o_MMInf

```

### Examples

```

## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Wqq
Wqq(o_mm1)

```

---

Wqq.o_MM1	<i>Returns the mean time spend in queue when there is queue in the M/M/1 queueing model</i>
-----------	---

---

### Description

Returns the mean time spend in queue when there is queue in the M/M/1 queueing model

### Usage

```

## S3 method for class 'o_MM1'
Wqq(x, ...)

```

### Arguments

x	a object of class o_MM1
...	additional arguments

### Details

Returns the mean time spend in queue when there is queue in the M/M/1 queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MM1](#).

**Examples**

```
## See example 10.3 in reference [Sixto2004] for more details.
## create input parameters
i_mm1 <- NewInput.MM1(lambda=1/4, mu=1/3, n=0)

## Build the model
o_mm1 <- QueueingModel(i_mm1)

## Returns the Wqq
Wqq(o_mm1)
```

---

Wqq.o_MM1K	<i>Returns the mean time spend in queue when there is queue in the M/M/1/K queueing model</i>
------------	---

---

**Description**

Returns the mean time spend in queue when there is queue in the M/M/1/K queueing model

**Usage**

```
## S3 method for class 'o_MM1K'
Wqq(x, ...)
```

**Arguments**

x	a object of class o_MM1K
...	aditional arguments

**Details**

Returns the mean time spend in queue when there is queue in the M/M/1/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MM1K](#).

## Examples

```
## See example 10.7 in reference [Sixto2004] for more details.
## create input parameters
i_mm1k <- NewInput.MM1K(lambda=5, mu=5.714, k=15)

## Build the model
o_mm1k <- QueueingModel(i_mm1k)

## Returns the Wqq
Wqq(o_mm1k)
```

---

Wqq.o_MM1KK	<i>Returns the mean time spend in queue when there is queue in the M/M/1/K/K queueing model</i>
-------------	---

---

## Description

Returns the mean time spend in queue when there is queue in the M/M/1/K/K queueing model

## Usage

```
## S3 method for class 'o_MM1KK'
Wqq(x, ...)
```

## Arguments

x	a object of class o_MM1KK
...	aditional arguments

## Details

Returns the mean time spend in queue when there is queue in the M/M/1/K/K queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MM1KK.](#)

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the Wqq
Wqq(o_mm1kk)
```

---

Wqq.o_MMC	<i>Returns the mean time spend in queue when there is queue in the M/M/c queueing model</i>
-----------	---

---

**Description**

Returns the mean time spend in queue when there is queue in the M/M/c queueing model

**Usage**

```
## S3 method for class 'o_MMC'
Wqq(x, ...)
```

**Arguments**

x	a object of class o_MMC
...	aditional arguments

**Details**

Returns the mean time spend in queue when there is queue in the M/M/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMC](#).

**Examples**

```
## See example 10.9 in reference [Sixto2004] for more details.
## create input parameters
i_mmc <- NewInput.MMC(lambda=5, mu=10, c=2, n=0, method=0)

## Build the model
o_mmc <- QueueingModel(i_mmc)

## Returns the Wqq
Wqq(o_mmc)
```

---

Wqq.o_MMCC	<i>Returns the mean time spend in queue when there is queue in the M/M/c/c queueing model</i>
------------	---

---

**Description**

Returns the mean time spend in queue when there is queue in the M/M/c/c queueing model

**Usage**

```
## S3 method for class 'o_MMCC'
Wqq(x, ...)
```

**Arguments**

x	a object of class o_MMCC
...	aditional arguments

**Details**

Returns the mean time spend in queue when there is queue in the M/M/c/c queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCC](#).

**Examples**

```
## See example 10.12 in reference [Sixto2004] for more details.
## create input parameters
i_mmcc <- NewInput.MMCC(lambda=3, mu=0.25, c=15)

## Build the model
o_mmcc <- QueueingModel(i_mmcc)

## Returns the Wqq
Wqq(o_mmcc)
```

---

Wqq.o_MMCK	<i>Returns the mean time spend in queue when there is queue in the M/M/c/K queueing model</i>
------------	---

---

**Description**

Returns the mean time spend in queue when there is queue in the M/M/c/K queueing model

**Usage**

```
## S3 method for class 'o_MMCK'
Wqq(x, ...)
```

**Arguments**

x	a object of class o_MMCK
...	aditional arguments

**Details**

Returns the mean time spend in queue when there is queue in the M/M/c/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCK](#).

**Examples**

```
## See example 10.11 in reference [Sixto2004] for more details.
## create input parameters
i_mmck <- NewInput.MMCK(lambda=8, mu=4, c=5, k=12)

## Build the model
o_mmck <- QueueingModel(i_mmck)

## Returns the Wqq
Wqq(o_mmck)
```

---

Wqq.o_MMCKK	<i>Returns the mean time spend in queue when there is queue in the M/M/c/K/K queueing model</i>
-------------	---

---

**Description**

Returns the mean time spend in queue when there is queue in the M/M/c/K/K queueing model

**Usage**

```
## S3 method for class 'o_MMCKK'
Wqq(x, ...)
```

**Arguments**

x	a object of class o_MMCKK
...	aditional arguments

**Details**

Returns the mean time spend in queue when there is queue in the M/M/c/K/K queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
 Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCKK](#).

**Examples**

```
## create input parameters
i_mmckk <- NewInput.MMCKK(lambda=8, mu=2, c=5, k=12, method=0)

## Build the model
o_mmckk <- QueueingModel(i_mmckk)

## Returns the Wqq
Wqq(o_mmckk)
```

---

Wqq.o_MMCKM	<i>Returns the mean time spend in queue when there is queue in the M/M/c/K/m queueing model</i>
-------------	---

---

**Description**

Returns the mean time spend in queue when there is queue in the M/M/c/K/m queueing model

**Usage**

```
## S3 method for class 'o_MMCKM'
Wqq(x, ...)
```

**Arguments**

x	a object of class o_MMCKM
...	additional arguments

**Details**

Returns the mean time spend in queue when there is queue in the M/M/c/K/m queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

**See Also**

[QueueingModel.i\\_MMCKM](#).

## Examples

```
## create input parameters
i_mmckm <- NewInput.MMCKM(lambda=0.25, mu=4, c=2, k=4, m=8, method=0)

## Build the model
o_mmckm <- QueueingModel(i_mmckm)

## Returns the Wq
Wq(o_mmckm)
```

---

Wq.o_MMInf	<i>Returns the mean time spend in queue when there is queue in the M/M/Infinite queueing model</i>
------------	--

---

## Description

Returns the mean time spend in queue when there is queue in the M/M/Infinite queueing model

## Usage

```
## S3 method for class 'o_MMInf'
Wq(x, ...)
```

## Arguments

x	a object of class o_MMInf
...	additional arguments

## Details

Returns the mean time spend in queue when there is queue in the M/M/Infinite queueing model

## References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

## See Also

[QueueingModel.i\\_MMInf](#).

### Examples

```
## create input parameters
i_mminf <- NewInput.MMInf(lambda=0.25, mu=4, n=0)

## Build the model
o_mminf <- QueueingModel(i_mminf)

## Returns the Wq
Wq(o_mminf)
```

---

Wq.o_MMInfKK	<i>Returns the mean time spend in queue when there is queue in the M/M/Infinite/K/K queueing model</i>
--------------	--

---

### Description

Returns the mean time spend in queue when there is queue in the M/M/Infinite/K/K queueing model

### Usage

```
## S3 method for class 'o_MMInfKK'
Wq(x, ...)
```

### Arguments

x	a object of class o_MMInfKK
...	additional arguments

### Details

Returns the mean time spend in queue when there is queue in the M/M/Infinite/K/K queueing model

### References

[Kleinrock1975] Leonard Kleinrock (1975).  
*Queueing Systems Vol 1: Theory*.  
John Wiley & Sons.

### See Also

[QueueingModel.i\\_MMInfKK](#).

**Examples**

```
## create input parameters
i_MMInfKK <- NewInput.MMInfKK(lambda=0.25, mu=4, k=4)

## Build the model
o_MMInfKK <- QueueingModel(i_MMInfKK)

## Returns the Wqq
Wqq(o_MMInfKK)
```

---

WVs

*Returns the normalized mean response time in a queueing model*

---

**Description**

Returns the normalized mean response time in a queueing model

**Usage**

```
WVs(x, ...)
```

**Arguments**

x            a object of class o\_MM1KK  
...           additional arguments

**Details**

Returns the normalized mean response time in a queueing model

**References**

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004).  
*Investigacion Operativa. Modelos deterministicos y estocasticos.*  
Editorial Centro de Estudios Ramon Areces.

**See Also**

[WVs.o\\_MM1KK](#).

### Examples

```
## create input parameters
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)

## Build the model
o_mm1kk <- QueueingModel(i_mm1kk)

## Returns the Wws
Wws(o_mm1kk)
```

---

Wws.o_MM1KK	<i>Returns the normalized mean response time in the M/M/1/K/K queueing model</i>
-------------	--

---

### Description

Returns the normalized mean response time in the M/M/1/K/K queueing model

### Usage

```
## S3 method for class 'o_MM1KK'
Wws(x, ...)
```

### Arguments

x	a object of class o_MM1KK
...	additional arguments

### Details

Returns the normalized mean response time in the M/M/1/K/K queueing model

### References

[Sixto2004] Sixto Rios Insua, Alfonso Mateos Caballero, M Concepcion Bielza Lozoya, Antonio Jimenez Martin (2004). *Investigacion Operativa. Modelos deterministicos y estocasticos*. Editorial Centro de Estudios Ramon Areces.

### See Also

[QueueingModel.i\\_MM1KK](#).

**Examples**

```
## See example 10.13 in reference [Sixto2004] for more details.  
## create input parameters  
i_mm1kk <- NewInput.MM1KK(lambda=0.25, mu=4, k=2, method=3)  
  
## Build the model  
o_mm1kk <- QueueingModel(i_mm1kk)  
  
## Returns the WVs  
WVs(o_mm1kk)
```

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