

# Package ‘anchoredDistr’

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**Type** Package

**Title** Post-Processing for the Method of Anchored Distributions

**Version** 1.0.3

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**Description** Supplements the 'MAD#' software (see <<http://mad.codeplex.com/>>, or Osorio-Murillo, et al. (2015) <[doi:10.1016/j.envsoft.2015.01.002](https://doi.org/10.1016/j.envsoft.2015.01.002)>) that implements the Method of Anchored Distributions for inferring geostatistical parameters (see Rubin, et al. (2010) <[doi:10.1029/2009WR008799](https://doi.org/10.1029/2009WR008799)>). Reads 'MAD#' result databases, performs dimension reduction on inversion data, calculates likelihoods and posteriors, and tests for convergence. Also generates plots to summarize results.

**Depends** R (>= 3.1.0)

**License** GPL

**LazyData** TRUE

**Imports** np, RSQLite, DBI, methods, stats, reshape2, Rmisc, ggplot2, plyr, dplyr

**Collate** 'anchoredDistr.R' 'MADproject.R' 'calcLikelihood.R' 'calcPosterior.R' 'data.R' 'plot.R' 'print.R' 'readMAD.R' 'reduceData.R' 'test\_convergence.R'

**RoxygenNote** 6.0.1

**Suggests** knitr, rmarkdown

**VignetteBuilder** knitr

**NeedsCompilation** no

**Repository** CRAN

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anchoredDistr	<i>anchoredDistr: A package for post-processing of the Method of Anchored Distributions.</i>
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## Description

The anchoredDistr package provides functions for post-processing applications of the Method of Anchored Distributions (MAD) such as viewing data, calculating likelihood and posterior distributions, testing convergence of likelihood values, and applying dimension reduction.

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calcLikelihood	<i>Calculate the likelihood for the samples in a MADproject object.</i>
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## Description

calcLikelihood returns an updated MADproject with the likelihood values based on the observation and realization data in the MADproject or, optionally, a subset thereof.

## Usage

```
calcLikelihood(proj, dsubset, num_realz = max(proj@realizations$rid),
  samples = 1:proj@numSamples)

## S4 method for signature 'MADproject,numeric'
calcLikelihood(proj, dsubset,
  num_realz = max(proj@realizations$rid), samples = 1:proj@numSamples)

## S4 method for signature 'MADproject,ANY'
calcLikelihood(proj, num_realz, samples)
```

**Arguments**

proj	The MADproject object with data read from the MAD# databases.
dsubset	The subset of inversion data to use for the likelihood calculations.
num_realz	The number of realizations to use in the likelihood calculation (defaults to all in the realizations slot)
samples	A vector of sample IDs for which to calculate likelihood values (defaults to all available in the realizations slot)

**Details**

The likelihood calculation utilizes the **np** package for non- parametric density estimation with all inversion data as dependent (i.e. multivariate likelihood distributions are estimated).

**Value**

proj The updated MADproject object with a filled likelihood slot.

**Methods (by class)**

- proj = MADproject, dsubset = numeric: Calculates the likelihood using a subset dsubset of inversion data zid
- proj = MADproject, dsubset = ANY: Calculates the likelihood using all inversion data zid

**Examples**

```
data(pumping)
pumping <- calcLikelihood(pumping, 100) #Inversion data as time step 100
```

---

calcPosterior                      *Calculate the posterior for a MADproject object.*

---

**Description**

calcPosterior returns a MADproject object with the posterior values for each sample

**Usage**

```
calcPosterior(proj)

## S4 method for signature 'MADproject'
calcPosterior(proj)
```

**Arguments**

proj                      The MADproject object with the likelihood slot filled.

**Value**

proj An updated MADproject object with the posterior slot filled.

**Methods (by class)**

- MADproject: Calculate the posterior value for each sample

**Examples**

```
data(pumping)
pumping.100 <- calcLikelihood(pumping, 100)
pumping.100 <- calcPosterior(pumping.100)
```

---

MADproject-class      *An S4 class to represent a MAD project*

---

**Description**

An S4 class to represent a MAD project

**Slots**

madname Character string, the name of the MAD# project  
 resultname Character string, the name of the MAD# project's result  
 xpath Character string, the path where to find the MAD# project's result  
 numLocations A numeric value for the number of measurement locations  
 numTimesteps A numeric value for the number of time steps in series  
 numSamples A numeric value for the number of samples  
 numAnchors A numeric value for the number of local parameters to be inferred  
 numTheta A numeric value for the number of global parameters to be inferred  
 truevalues A numeric vector of length numAnchors+numTheta that contains the true values of the parameters being inferred, if known (i.e. for validation)  
 observations A numeric vector containing the observed values of inversion data  
 realizations A data.frame containing the the ensemble of simulated inversion data for each sample  
 priors A data.frame containing the values sampled from the priors for each parameter to be inferred plus estimated marginal density  
 likelihoods A data.frame of likelihood values calculated for each sample  
 posteriors A data.frame containing the posterior values estimated for each sample of each parameter

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`plotMAD`*Plot the data contained in MADproject object slots.*

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### Description

`plot` plots the data contained in various slots of the provided `MADproject`. If no specific slot is specified, all slots that can be plotted will be.

### Usage

```
plotMAD(x, y)

## S4 method for signature 'MADproject,ANY'
plotMAD(x)

## S4 method for signature 'MADproject,character'
plotMAD(x, y)
```

### Arguments

<code>x</code>	The <code>MADproject</code> object
<code>y</code>	character string from the following options: "observations", "realizations", "priors", or "posteriors"

### Details

All plots utilize **ggplot2** plotting functions. The slots that can be plotted are priors, observations, realizations, and posteriors.

### Methods (by class)

- `x = MADproject, y = ANY`: Plots all available slots in the `MADproject` object
- `x = MADproject, y = character`: Plots the `y` slot in the `MADproject` object

### Examples

```
data(pumping)
plotMAD(pumping, "realizations")
plotMAD(pumping, "priors")
plotMAD(pumping, "posteriors")
plotMAD(pumping)
```

---

```
print.MADproject
```

*Print the data contained in MADproject object slots.*

---

### Description

`print.MADproject` plots information on the contents in the slots of the provided `MADproject`.

### Usage

```
## S3 method for class 'MADproject'
print(x, ...)
```

### Arguments

<code>x</code>	The <code>MADproject</code> object
<code>...</code>	Not supported

### Examples

```
data(pumping)
print(pumping)
```

---

```
pumping
```

*anchoredDistr example data*

---

### Description

A dataset containing a `MADproject` object called 'pumping'

### Usage

```
data(pumping)
```

### Format

A `MADproject` object with an observed time series, three prior samples, realizations for each sample, and true values for validation where the parameter to be inferred is the global mean of the natural log conductivity of a 2D aquifer.

**@observations** a time series of drawdown, in meters

**@numSamples** the value 3, [unitless]

**@realizations** the ensemble of simulated drawdown time series

---

readMAD	<i>Read the SQLite databases from MAD# into the MADproject object.</i>
---------	--

---

### Description

readMAD returns an updated MADproject object with data from the MAD# databases.

### Usage

```
readMAD(proj, location)

## S4 method for signature 'MADproject,numeric'
readMAD(proj, location)
```

### Arguments

proj	The MADproject object with the slots madname, resultname, and xpath specified.
location	The measurement ID(s) to be read from the MAD# databases

### Value

proj An updated MADproject object with slots numTimesteps, numLocations, numSamples, numAnchors, numTheta, observations, priors, truevalues (if present), and realizations filled in from the MAD# databases.

### Methods (by class)

- proj = MADproject, location = numeric: Reads the MAD# databases for information related to location

### Examples

```
## Not run:
example <- new("MADproject", madname="Example", resultname="results",
  xpath=getwd())
example <- readMAD(example, 1:3) #Observations 1-3

## End(Not run)
```

---

reduceData	<i>Apply the requested dimension reduction technique to the inversion data for the given MADproject object</i>
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---

### Description

reduceData returns a modified MADproject object where the observations and realizations slots are replaced by a lower-dimensional representation

### Usage

```
reduceData(proj, method, params, ...)

## S4 method for signature 'MADproject`,`function`,`ANY'
reduceData(proj, method)

## S4 method for signature 'MADproject`,`function`,`function`'
reduceData(proj, method, params,
  ...)
```

### Arguments

proj	MADproject object that has been filled by MAD# databases
method	function to apply to data
params	function for estimating the initial values of the parameters of method based on the data, if method has parameters
...	additional arguments as needed for nls to fit method to the data

### Value

proj MADproject object with reduced dimensions for inversion

### Methods (by class)

- proj = MADproject, method = function, params = ANY: Fit method without any parameters (e.g. min)
- proj = MADproject, method = function, params = function: Fit method with parameters and initial guesses for the parameter values

### Examples

```
data(pumping)
pumping.min <- reduceData(pumping, min)
plotMAD(pumping.min, "realizations")
```

---

testConvergence	<i>Test (visually) the convergence of a MADproject object.</i>
-----------------	--

---

### Description

testConvergence returns a plot to help the user visualize if there are enough realizations in the project for converged likelihood values

### Usage

```
testConvergence(proj, dsubset, samples = 1:proj@numSamples, NR = 10,
  NS = 7)
```

```
## S4 method for signature 'MADproject,numeric'
testConvergence(proj, dsubset,
  samples = 1:proj@numSamples, NR = 10, NS = 7)
```

```
## S4 method for signature 'MADproject,ANY'
testConvergence(proj, samples, NR, NS)
```

### Arguments

proj	The MADproject object to be tested.
dsubset	The subset of inversion data to use for the likelihood calculations.
samples	A vector of sample IDs to sample from to calculate likelihood values (defaults to all available in the MADproject object)
NR	The number of different realization totals for which to calculate likelihood values (defaults to 10)
NS	The number of randomly selected samples to test (defaults to 7) out of samples

### Methods (by class)

- proj = MADproject, dsubset = numeric: Tests the convergence using a subset dsubset of inversion data zid
- proj = MADproject, dsubset = ANY: Tests the convergence using all inversion data zid

### Examples

```
## Not run:
data(pumping)
testConvergence(pumping, dsubset=1:3) #Inversion data as time steps 1-3

## End(Not run)
```

---

`tutorial`*anchoredDistr example data*

---

**Description**

A dataset containing a MADproject object called 'tutorial'

**Usage**

```
data(tutorial)
```

**Format**

A MADproject object with an observed head at three wells, 145 prior samples, realizations for each sample, and true values for validation where the parameters to be inferred are four anchors of the local decimal log transmissivity of a 1D aquifer

**@observations** three head measurements, in meters

**@realizations** the ensemble of simulated head measurements

**@numAnchors** the value 4

**@priors** the samples for each anchor's prior distribution based on the kriging mean and variance at the anchor locations

**Source**

<http://www.mad.codeplex.com/releases/>

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