Qhull examples

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This document presents examples of the `geometry` package functions which implement functions using the Qhull library.

1 Convex hulls in 2D

1.1 Calling `convhulln` with one argument

With one argument, convhulln returns the indices of the points of the convex hull.

```
> library(geometry)
> ps <-matrix(rnorm(30), , 2)
> ch <- convhulln(ps)
> head(ch)
```

```
     [,1] [,2]
[1,]    7   15
[2,]   14   15
[3,]   11    6
[4,]   11    7
[5,]   13    6
[6,]   13   14
```

1.2 Calling `convhulln` with `options`

We can supply Qhull options to `convhulln`; in this case it returns an object of class `convhulln` which is also a list. For example `FA` returns the generalised `area` and

`volume`. Confusingly in 2D the generalised area is the length of the perimeter, and the generalised volume is the area.

```
> ps <-matrix(rnorm(30), , 2)
> ch <- convhulln(ps, options="FA")
> print(ch$area)
```

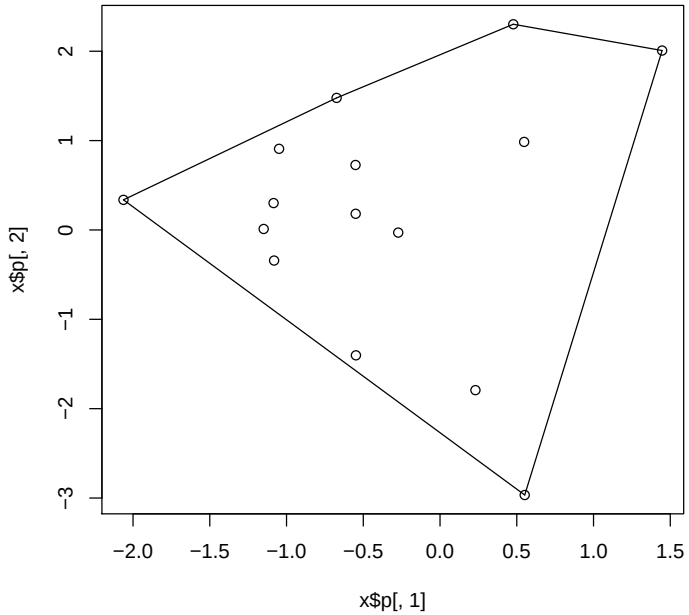
```
[1] 13.49196
```

```
> print(ch$vol)
```

```
[1] 9.389812
```

A `convhulln` object can also be plotted.

```
> plot(ch)
```



We can also find the normals to the "facets" of the convex hull:

```
> ch <- convhulln(ps, options="n")
> head(ch$normals)
```

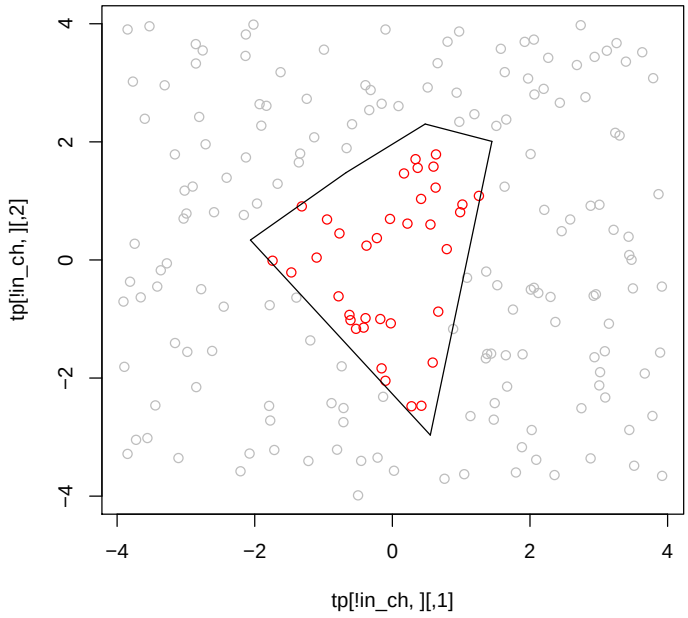
```
           [,1]       [,2]      [,3]
[1,] -0.7841531 -0.6205675 -1.407990
[2,]  0.9841861 -0.1771377 -1.068412
[3,]  0.2902411  0.9569535 -2.341298
[4,] -0.6348369  0.7726462 -1.569560
[5,] -0.5821727  0.8130652 -1.593810
```

Here the first two columns and the x and y direction of the normal, and the third column defines the position at which the face intersects that normal.

1.3 Testing if points are inside a convex hull with `inhulln`

The function `inhulln` can be used to test if points are inside a convex hull. Here the function `rbox` is a handy way to create points at random locations.

```
> tp <- rbox(n=200, D=2, B=4)
> in_ch <- inhulln(ch, tp)
> plot(tp[!in_ch,], col="gray")
> points(tp[in_ch,], col="red")
> plot(ch, add=TRUE)
```



2 Delaunay triangulation in 2D

2.1 Calling `delaunayn` with one argument

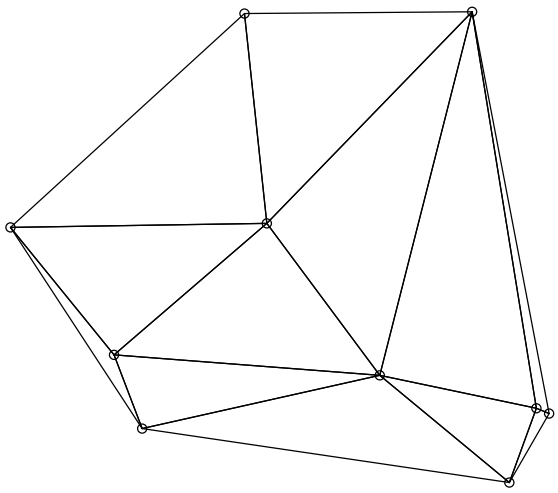
With one argument, a set of points, `delaunayn` returns the indices of the points at each vertex of each triangle in the triangulation.

```
> ps <- rbox(n=10, D=2)
> dt <- delaunayn(ps)
> head(dt)
```

```
     [,1] [,2] [,3]
[1,]    4    7   10
```

```
[2,]    4    7    5
[3,]    3    7   10
[4,]    3    1   10
[5,]    9    7    5
[6,]    9    3    7
```

```
> trimesh(dt, ps)
> points(ps)
```



2.2 Calling `delaunayn` with `options`

We can supply Qhull options to `delaunayn`; in this case it returns an object of class `delaunayn` which is also a list. For example `Fa` returns the generalised `area` of each triangle. In 2D the generalised area is the actual area; in 3D it would be the volume.

```
> dt2 <- delaunayn(ps, options="Fa")
> print(dt2$areas)
```

```
 [1] 0.094983849 0.084280224 0.058328041 0.007140705 0.057067978 0.067100078
 [7] 0.033513186 0.097113988 0.001922239 0.022078453 0.008318539 0.105728194
```

```
> dt2 <- delaunayn(ps, options="Fn")
> print(dt2$neighbours)
```

```
[[1]]
[1]   3 -13   2

[[2]]
[1]   8 -13   1

[[3]]
[1] 1 4 6

[[4]]
[1] -10   3   7

[[5]]
[1] -10   7  10

[[6]]
[1] 3 8 7

[[7]]
[1] 4 5 6

[[8]]
[1]  2 12  6

[[9]]
[1] -9 11 10

[[10]]
[1]  5  9 12

[[11]]
[1] -9  9 12

[[12]]
[1]  8 11 10
```