Package 'uniformly'

July 31, 2018

Type Package

Title Uniform Sampling

Version 0.1.0

Date 2018-07-31

Author Stéphane Laurent

Maintainer Stéphane Laurent <laurent_step@yahoo.fr>

Description Uniform sampling on various geometric shapes, such as spheres, ellipsoids, simplices.

License GPL-3

Encoding UTF-8

LazyData true

URL https://github.com/stla/uniformly

BugReports https://github.com/stla/uniformly/issues

RoxygenNote 6.0.1

Imports stats, pgnorm

Suggests knitr, rmarkdown, geometry, rgl, misc3d, scatterplot3d

VignetteBuilder knitr

NeedsCompilation no

Repository CRAN

Date/Publication 2018-07-31 12:10:03 UTC

R topics documented:

`rphong_on_hemisphere` *Sampling on hemisphere*

Description

Sampling on a hemisphere according to the Phong density (dimension 3).

Usage

```
rphong_on_hemisphere(n, alpha = 0, r = 1)
```

Arguments

`n`	number of simulations
`alpha`	parameter of the Phong density, a positive number; `0` for uniform sampling (default)
`r`	radius

Value

The simulations in a `n` times `3` matrix.

Examples

```
## Not run: library(rgl)
sims <- rphong_on_hemisphere(400, alpha=10)
spheres3d(0, 0, 0, color="red", alpha=0.5)
points3d(sims)
## End(Not run)
```

runif_cube *Uniform sampling on/in cube*

Description

Uniform sampling on or in a cube (arbitrary dimension).

Usage

```
runif_in_cube(n, d, O = rep(0, d), r = 1)

runif_on_cube(n, d, O = rep(0, d), r = 1)
```

Arguments

n	number of simulations
d	dimension
O	center of the cube
r	radius (half-side) of the cube

Value

The simulations in a n times d matrix.

Examples

```
sims <- runif_on_cube(60, d=2)
plot(sims, xlim=c(-1,1), ylim=c(-1,1), pch=19, asp=1)
sims <- runif_in_cube(50, d=3)
library(scatterplot3d)
scatterplot3d(sims, pch=19, highlight.3d=TRUE, asp=1)
```

runif_ellipsoid *Uniform sampling on/in ellipsoid*

Description

Uniform sampling on an ellipsoid or in an ellipsoid (arbitrary dimension).

Usage

```
runif_on_ellipsoid(n, A, r)

runif_in_ellipsoid(n, A, r)
```

Arguments

n	number of simulations
A	symmetric positive-definite matrix defining the ellipsoid (see Details)
r	"radius" (see Details)

Details

The ellipsoid is the set of vectors x satisfying `t(x) %*% A %*% x == r^2`.

Value

The simulations in a matrix with n rows.

Examples

```
A <- rbind(c(2,1),c(1,1))
r <- 2
sims <- runif_on_ellipsoid(30, A, r)
plot(sims, xlim=c(-2,2), ylim=c(-3,3), asp=1, pch=19)
sims <- runif_in_ellipsoid(100, A, r)
plot(sims, xlim=c(-2,2), ylim=c(-3,3), asp=1, pch=19)
# 3D example
A <- matrix(c(5,1,1, 1,3,1, 1,1,1), ncol=3)
r <- 2
# draw the ellipsoid
library(misc3d)
x <- seq(-1, 1, len=50)
y <- seq(-1.5, 1.5, len=50)
z <- seq(-2.7, 2.7, len=50)
g <- as.matrix(expand.grid(x=x, y=y, z=z))
voxel <- array(apply(g, 1, function(v) t(v) %*% A %*% v), dim=c(50,50,50))
isosurface <- computeContour3d(voxel, max(voxel), r^2, x=x, y=y, z=z)
drawScene.rgl(makeTriangles(isosurface, alpha=0.3))
# simulate and plot points on ellispoid
library(rgl)
sims <- runif_on_ellipsoid(200, A, r)
points3d(sims)
```

---

runif_in_annulus *Uniform sampling in an annulus*

Description

Uniform sampling in an annulus (dimension 2).

Usage

```
runif_in_annulus(n, O, r1, r2)
```

Arguments

n	number of simulations
O	center of the annulus
r1	inner radius
r2	outer radius

Value

The simulations in a n times 2 matrix.

Examples

```
sims <- runif_in_annulus(100, c(0,0), 1, 2)
plot(sims, xlim = c(-2,2), ylim = c(-2,2), asp = 1, pch = 19)
```

---

runif_in_pball *Uniform sampling in a p-ball*

Description

Uniform sampling in a p-ball (arbitrary dimension).

Usage

```
runif_in_pball(n, d, p, r = 1)
```

Arguments

n	number of simulations
d	dimension
p	exponent in the p-norm, a positive number
r	positive number, the radius

Value

The simulations in a n times d matrix.

Examples

```
sims <- runif_in_pball(500, d=2, p=1)
plot(sims, xlim=c(-1,1), ylim=c(-1,1), asp=1)
```

`runif_in_polygon` *Uniform sampling in a polygon*

Description

Uniform sampling in a polygon (dimension 2).

Usage

```
runif_in_polygon(n, vertices, center = "centroid")
```

Arguments

`n`	number of simulations
`vertices`	two-columns matrix giving the vertices (rows); the vertices must be ordered (clockwise or counterclockwise)
`center`	a point with respect to which the polygon is star-shaped, or `"centroid"` (default) to take the centroid (see Details)

Details

This function works for a star-shaped polygon, that is, a polygon that contains a point from which the entire polygon boundary is visible. This point must be given in the `center` argument. If the polygon is convex, any point inside the polygon is suitable (thus the default option of the `center` argument is appropriate in this case).

Value

The simulations in a `n` times `2` matrix.

Examples

```
vs <- matrix(c(0.951056516295154, 0.309016994374947,
               0.224513988289793, 0.309016994374947,
               -0.951056516295154, 0.309016994374948,
               -0.363271264002681, -0.118033988749895,
               0.587785252292473, -0.809016994374948,
               0.36327126400268, -0.118033988749895,
               0, 1,
               -0.224513988289793, 0.309016994374947,
               -0.587785252292473, -0.809016994374947,
               0, -0.381966011250105),
             ncol=2, byrow=TRUE)
sims <- runif_in_polygon(500, vs)
plot(sims, xlim=c(-1,1), ylim=c(-1,1), pch=19, asp=1)
```

runif_in_simplex *Uniform sampling in a simplex*

Description

Uniform sampling in a simplex (arbitrary dimension).

Usage

```
runif_in_simplex(n, simplex)
```

Arguments

n	number of simulations
simplex	a (d+1) times d matrix giving the vertices of the simplex (rows)

Value

The simulations in a n times d matrix.

Note

In dimension 3, you can use runif_in_tetrahedron instead.

Examples

```
simplex <- rbind(c(0,0,0), c(1,0,0), c(1,1,0), c(1,1,2))
sims <- runif_in_simplex(1000, simplex)
library(rgl)
points3d(sims)
```

runif_in_tetrahedron *Uniform sampling in a tetrahedron*

Description

Uniform sampling in a tetrahedron (in dimension 3).

Usage

```
runif_in_tetrahedron(n, v1, v2, v3, v4)
```

Arguments

n	number of simulations
v1, v2, v3, v4	vertices of the tetrahedron

Value

The simulations in a n times 3 matrix.

See Also

runif_in_simplex for sampling in a simplex in arbitrary dimension.

Examples

```
library(rgl)
tetrahedron <- tetrahedron3d()
shade3d(tetrahedron, color="red", alpha=0.3)
vs <- tetrahedron$vb[1:3,]
sims <- runif_in_tetrahedron(100, vs[,1], vs[,2], vs[,3], vs[,4])
points3d(sims)
```

---

runif_on_spherePatch *Uniform sampling on a spherical patch*

Description

Uniform sampling on a spherical patch (in dimension 3).

Usage

```
runif_on_spherePatch(n, r = 1, phi1, phi2, theta1, theta2)
```

Arguments

n	number of simulations
r	radius
phi1, phi2	numbers defining the latitudinal angle range
theta1, theta2	numbers defining the longitudinal angle range

Details

A sphere patch is the part of the sphere whose polar angles theta and phi satisfy 0 <= theta1 <= theta <= theta2 <= 2*p and 0 <= phi1 <= phi <= phi2 <= pi.

Value

The simulations in a n times 3 matrix.

See Also

runif_on_stri for sampling on a spherical triangle.

Examples

```
# sampling on the first orthant:
sims <- runif_on_spherePatch(100, phi1=0, phi2=pi/2, theta1=0, theta2=pi/2)
## Not run: library(rgl)
spheres3d(0, 0, 0, color="red", alpha=0.5)
points3d(sims)
## End(Not run)
```

`runif_on_stri` *Uniform sampling on a spherical triangle*

Description

Uniform sampling on a spherical triangle (in dimension 3).

Usage

```
runif_on_stri(n, r = 1, v1, v2, v3)
```

Arguments

`n`	number of simulations
`r`	radius
`v1, v2, v3`	vertices

Value

The simulations in a `n` times `3` matrix.

Examples

```
# sampling on the first orthant:
sims <- runif_on_stri(100, v1=c(1,0,0), v2=c(0,1,0), v3=c(0,0,1))
## Not run: library(rgl)
spheres3d(0, 0, 0, color="red", alpha=0.5)
points3d(sims)
## End(Not run)
```

runif_sphere *Uniform sampling on/in sphere*

Description

Uniform sampling on a sphere or in a sphere, in arbitrary dimension.

Usage

```
runif_on_sphere(n, d, r = 1)

runif_in_sphere(n, d, r = 1)
```

Arguments

n	number of simulations
d	dimension of the space
r	radius of the sphere

Value

The simulations in a n times d matrix.

Examples

```
sims <- runif_on_sphere(20, d=2)
plot(sims, xlim=c(-1,1), ylim=c(-1,1), asp=1, pch=19)
sims <- runif_in_sphere(100, d=2)
plot(sims, xlim=c(-1,1), ylim=c(-1,1), asp=1, pch=19)
```

runif_triangle *Uniform sampling on/in a triangle*

Description

Uniform sampling on or in a triangle (dimension 2).

Usage

```
runif_in_triangle(n, v1, v2, v3)

runif_on_triangle(n, v1, v2, v3)
```

Arguments

n	number of simulations
v1, v2, v3	vertices of the triangle

Value

The simulations in a n times 2 matrix.

Examples

```
sims <- runif_on_triangle(30, c(0,0), c(1,0), c(0,1))
plot(sims, xlim=c(0,1), ylim=c(0,1), pch=19)
sims <- runif_in_triangle(100, c(0,0), c(1,0), c(0,1))
plot(sims, xlim=c(0,1), ylim=c(0,1), pch=19)
```

---

runif_unitSimplex *Uniform sampling on/in a unit simplex*

Description

Uniform sampling on or in a unit simplex (arbitrary dimension).

Usage

```
runif_on_unitSimplex(n, d)

runif_in_unitSimplex(n, d)
```

Arguments

n	number of simulations
d	dimension of the space

Value

The simulations in a n times d matrix.

See Also

runif_in_tetrahedron for sampling in an arbitrary tetrahedron in dimension 3; runif_in_simplex for sampling in an arbitrary simplex.

Examples

```
library(rgl)
sims <- runif_on_unitSimplex(300, d=3)
points3d(sims)
```

surface_sphere *Sphere surface*

Description

Surface of a d-dimensional sphere.

Usage

```
surface_sphere(d, r = 1)
```

Arguments

d	dimension of the space
r	radius of the sphere

Value

The surface of the sphere of radius r in the d-dimensional space.

Examples

```
r <- 2
surface_sphere(3, r)
4*pi*r^2
# perimeter of the unit circle:
surface_sphere(2)
```

surface_spherePatch *Sphere patch surface*

Description

Surface of a sphere patch.

Usage

```
surface_spherePatch(r, phi1, phi2, theta1, theta2)
```

Arguments

r	radius
phi1, phi2	numbers defining the latitudinal angle range
theta1, theta2	numbers defining the longitudinal angle range

Details

A sphere patch is the part of the sphere whose polar angles `theta` and `phi` satisfy `0 <= theta1 <= theta <= theta2 <= 2*p` and `0 <= phi1 <= phi <= phi2 <= pi`.

Value

The surface of the sphere patch.

See Also

`surface_stri` for the surface of a spherical triangle.

Examples

```
# surface of the first orthant:
surface_spherePatch(r=1, phi1=0, phi2=pi/2, theta1=0, theta2=pi/2)
surface_stri(r=1, c(1,0,0), c(0,1,0), c(0,0,1))
```

---

surface_stri *Spherical triangle surface*

Description

Surface of a spherical triangle.

Usage

```
surface_stri(r, v1, v2, v3)
```

Arguments

`r`	radius
`v1, v2, v3`	vertices

Value

The surface of the spherical triangle of radius `r` with vertices `v1`, `v2`, `v3`.

Examples

```
# surface of the first orthant:
surface_stri(r=1, c(1,0,0), c(0,1,0), c(0,0,1))
```

surface_triangle *Triangle surface*

Description

Surface of a triangle.

Usage

```
surface_triangle(v1, v2, v3)
```

Arguments

v1, v2, v3	vertices of the triangle

Value

The surface of the triangle with vertices v1, v2, v3.

Examples

```
surface_triangle(c(0,0), c(0,1), c(1,0))
```

volume_ellipsoid *Ellipsoid volume*

Description

Volume of an ellipsoid (arbitrary dimension).

Usage

```
volume_ellipsoid(A, r)
```

Arguments

A	symmetric positive-definite matrix defining the ellipsoid (see Details)
r	"radius" (see Details)

Details

The (boundary of the) ellipsoid is the set of vectors x satisfying `t(x) %*% A %*% x == r^2`.

Value

The volume of the ellipsoid.

Examples

```
# dimension 2 (area), with diagonal matrix A
A <- diag(c(2,3))
r <- 2
volume_ellipsoid(A, r)
pi * r^2 / sqrt(A[1,1]*A[2,2])
```

---

volume_pball *p-ball volume*

Description

Euclidean volume of a p-ball (arbitrary dimension).

Usage

```
volume_pball(d, p, r = 1)
```

Arguments

d	dimension
p	exponent in the p-norm, a positive number
r	radius of the ball

Value

The volume of the p-ball with radius r.

Examples

```
volume_pball(d=4, p=2, r=2)
volume_sphere(d=4, r=2)
```

---

volume_simplex *Simplex volume*

Description

Volume of a simplex (arbitrary dimension).

Usage

```
volume_simplex(simplex)
```

Arguments

simplex	a (d+1) times d matrix giving the vertices of the simplex (rows)

Value

The volume of the simplex.

Examples

```
set.seed(666)
simplex <- matrix(rnorm(4*3), nrow=4, ncol=3)
volume_simplex(simplex)
volume_tetrahedron(simplex[1,], simplex[2,], simplex[3,], simplex[4,])
```

---

volume_sphere *Sphere volume*

Description

Volume of a sphere (arbitrary dimension).

Usage

```
volume_sphere(d, r = 1)
```

Arguments

d	dimension of the space
r	radius of the sphere

Value

The volume of the sphere with radius r in the d-dimensional space.

Examples

```
r <- 2
volume_sphere(3, r)
4/3*pi*r^3
```

volume_tetrahedron *Tetrahedron volume*

Description

Volume of a tetrahedron (dimension 3).

Usage

```
volume_tetrahedron(v1, v2, v3, v4)
```

Arguments

v1, v2, v3, v4	vertices of the tetrahedron

Value

The volume of the tetrahedron.

See Also

volume_simplex for the volume of a simplex in arbitrary dimension.

Examples

```
v1 <- c(0,0,0); v2 <- c(1,0,0); v3 <- c(0,1,0); v4 <- c(0,0,1)
volume_tetrahedron(v1, v2, v3, v4)
volume_unitSimplex(3)
```

volume_unitSimplex *Unit simplex volume*

Description

Volume of the unit simplex (arbitrary dimension).

Usage

```
volume_unitSimplex(d)
```

Arguments

d	dimension of the space

Value

The volume of the unit simplex in the space of dimension d.

See Also

volume_simplex for the volume of an arbitrary simplex.

Index