Package 'RIFS'

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Title Random Iterated Function System (RIFS)

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Description RIFS package provides functionality for generating & plotting prefractals in R^n with various protofractal sets and partition coefficient for iterative segments

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RIFS-package *Random Iterated Function System (RIFS)*

Description

RIFS package provides functionality for generating & plotting prefractal sets in R^n with various protofractal sets, probability distribution, and partition coefficient for iterative segments.

Details

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`plotR2pre()` function draws a prefractal set in R^2.
`preRIFS()` function generates a sample of fractal points (a prefractal points) in R^n with a random iterated function system (RIFS).
`preRSum0()` function generates a sample of fractal points (a prefractal points) in R^n with a matrix of random sums of a numerical series.
`R2ngon()` function generates a regular polygonal set in R^2.

Author(s)

Pavel V. Moskalev, Alexey G. Bukhovets and Tatyana Ya. Biruchinskay

plotR2pre *Plot a prefractal set in R^2*

Description

`plotR2pre()` function draws a prefractal set in R^2.

Usage

```
plotR2pre(l=preRIFS(),
          s="Prefractal points for 3-gon: k=3; p=1/3; mu=1")
```

Arguments

l	a list with prefractal (`$pre`) and protofractal (`$proto`) points & indexes (`$index`).
s	a string for the main title.

Details

A regular polygon is a convex polygon in which all edges and all angles are equal.

A protofractal set `Z` is a discrete or continuous set, which in the iterative process generates a sample of the fractal set (a prefractal set) `X`.

Author(s)

Pavel V. Moskalev and Alexey G. Bukhovets

See Also

preRIFS,

Examples

```
# Example 1. Sierpinski triangle, 1st order, p=const, mu=var
for (m in seq(-4,0)) {
  plotR2pre(preRIFS(M=2^rnorm(n=3, mean=m, sd=-m/4)),
            s="Prefractal points for 1st order 3-gon")
  Sys.sleep(0.5)
}

# Example 2. Uniform distribution, 1st order, p=const, mu=var
for (m in seq(-4,0)) {
  plotR2pre(preRIFS(Z=R2ngon(4,1),
                    M=2^rnorm(n=4, mean=m, sd=-m/4)),
            s="Prefractal points for 1st order 4-gon")
  Sys.sleep(0.5)
}

# Example 3. Sierpinski triangle, 2nd order, p=const, mu=var
for (m in seq(-3,1)) {
  plotR2pre(preRIFS(Z=R2ngon(3,2),
                    M=2^rnorm(n=6, mean=m, sd=-(m-1)/4)),
            s="Prefractal points for 2nd order 3-gon")
  Sys.sleep(0.5)
}

# Example 4. Sierpinski square, 2nd order, p=const, mu=var
for (m in seq(-3,1)) {
  plotR2pre(preRIFS(Z=R2ngon(4,2),
                    M=2^rnorm(n=8, mean=m, sd=-(m-1)/4)),
            s="Prefractal points for 2nd order 4-gon")
  Sys.sleep(0.5)
}
```

preRIFS *Prefractal points in R^n generated with a RIFS*

Description

preRIFS() function generates a sample of fractal (prefractal) points in R^n with a random iterated function system (RIFS).

Usage

```
preRIFS(n=10000, Z=R2ngon(),
       P=rep(1/nrow(Z), times=nrow(Z)),
       M=rep(1, times=nrow(Z)))
```

Arguments

n	a number of prefractal points.
Z	a set of protofractal points.
P	a probability distribution of protofractal points.
M	a partition coefficients distribution of protofractal points.

Details

A protofractal set Z is a discrete or continuous set, which in the iterative process generates a prefractal set X.

A prefractal set X is a sample of an attractor (fractal) of a random iterated function system:
X[i,] <- (X[i-1,] + M[z[i]]*Z[z[i],])/(1 + M[z[i]]),
where the index i in seq(n); the index z corresponds to a random points sample of a protofractal set Z.

Value

A list with the prefractal ($pre) and protofractal points ($proto); distributions of probabilities & coefficients ($distr); sample of protofractal indexes ($index).

Author(s)

Pavel V. Moskalev and Alexey G. Bukhovets

References

Bukhovets, A.G. and Bukhovets, E.A. (2012), Modeling of fractal data structures. *Automation and Remote Control*, Vol.73, No.2, pp.381-385.

See Also

R2ngon, plotR2pre, preRSum0

Examples

```
# Example 1a. Sierpinski triangle, 1st order, p=const, mu=const
l <- preRIFS()
r <- rainbow(n=nrow(l$proto), v=0.9)
plot(l$proto, asp=1, col=r,
     main="Prefractal points for 3-gon: k=3; p=1/3; mu=1")
points(l$pre, pch=46, col=r[l$index])

# Example 1b. Sierpinski triangle, 1st order, p=var, mu=const
l <- preRIFS(P=c(2,2,5)/9)
r <- rainbow(n=nrow(l$proto), v=0.9)
plot(l$proto, asp=1, col=r,
     main="Prefractal points for 3-gon: k=3; p=(2,2,5)/9; mu=1")
points(l$pre, pch=46, col=r[l$index])

# Example 1c. Sierpinski triangle, 1st order, p=const, mu=var
l <- preRIFS(M=c(4,4,6)/5)
r <- rainbow(n=nrow(l$proto), v=0.9)
plot(l$proto, asp=1, col=r,
     main="Prefractal points for 3-gon: k=3; p=1/3; mu=(4,4,6)/5")
points(l$pre, pch=46, col=r[l$index])

# Example 2a. Sierpinski square, 2nd order, p=const, mu=const
l <- preRIFS(Z=R2ngon(4,2), M=rep(2,8))
r <- rainbow(n=nrow(l$proto), v=0.9)
plot(l$proto, asp=1, col=r,
     main="Prefractal points for 4-gon: k=8, p=1/8, mu=2")
points(l$pre, pch=46, col=r[l$index])

# Example 2b. Sierpinski square, 2nd order, p=var, mu=const
l <- preRIFS(Z=R2ngon(4,2), P=2^abs(seq(-3,4))/45, M=rep(2,8))
r <- rainbow(n=nrow(l$proto), v=0.9)
plot(l$proto, col=r, asp=1,
     main="Prefractal points for 4-gon: k=8, p=2^|-3:4|/45, mu=2")
points(l$pre, pch=46, col=r[l$index])

# Example 2c. Sierpinski square, 2nd order, p=const, mu=var
l <- preRIFS(Z=R2ngon(4,2), M=1.2^abs(seq(-3,4))+0.5)
r <- rainbow(n=nrow(l$proto), v=0.9)
plot(l$proto, col=r, asp=1,
     main="Prefractal points for 4-gon: k=8, p=1/8, mu=0.5+1.2^|-3:4|")
points(l$pre, pch=46, col=r[l$index])
```

`preRSum0` *Prefractal points in R^n generated with a matrix of random sums*

Description

`preRSum0()` function generates a sample of fractal (prefractal) points in R^n with a matrix of random sums of a numerical series.

Usage

```
preRSum0(n=10000, mu=1, eps=1e-9, Z=R2ngon(),
         P=rep(1/nrow(Z), times=nrow(Z)))
```

Arguments

n	a number of prefractal points.
mu	a partition coefficient for iterative segments.
eps	an error of a random sum of a numerical series.
Z	a set of protofractal points.
P	a probability distribution of protofractal points.

Details

A protofractal set Z is a discrete or continuous set, which in the iterative process generates a prefractal set X.

A prefractal set S%*%Z is a sample of a fractal set generates with a matrix of random sums S of a numerical series: S[i,j] <- sum(X[l==j]),
where i in seq(n); j in seq(k); k <- nrow(Z); X <- mu/(mu+1)^seq(m); m <- 1-log(eps*mu)/log(1+mu);
l <- sample.int(k, size=m, prob=P, replace=TRUE).

Value

A list with the prefractal ($pre) and protofractal points ($proto); distributions of probabilities & coefficients ($distr).

Author(s)

Pavel V. Moskalev, Alexey G. Bukhovets and Tatyana Ya. Biruchinskay

References

Bukhovets, A.G. and Bukhovets, E.A. (2012), Modeling of fractal data structures. *Automation and Remote Control*, Vol.73, No.2, pp.381-385.
Bukhovetc, A.G. and Biruchinskay, T.Y. (2011), Modelling fractal's properties of system objects. *Proceedings of Voronezh State University. Series: Systems Analysis and Information Technologies*, No.2 (July-December), pp.22-26; in Russian.

See Also

R2ngon, preRIFS, plotR2pre

Examples

```
# Example 1a. Sierpinski triangle, 1st order, p=const, mu=const
l <- preRSum0()
plot(l$proto, asp=1, col="red",
     main="Prefractal points for 3-gon: k=3; p=1/3; mu=1")
points(l$pre, pch=46, col="red")

# Example 1b. Sierpinski triangle, 1st order, p=var, mu=const
l <- preRSum0(P=c(2,2,5)/9)
plot(l$proto, asp=1, col="red",
     main="Prefractal points for 3-gon: k=3; p=(2,2,5)/9; mu=1")
points(l$pre, pch=46, col="red")

# Example 2a. Sierpinski square, 2nd order, p=const, mu=const
l <- preRSum0(Z=R2ngon(4,2), mu=2)
plot(l$proto, asp=1, col="red",
     main="Prefractal points for 4-gon: k=8, p=1/8, mu=2")
points(l$pre, pch=46, col="red")

# Example 2b. Sierpinski square, 2nd order, p=var, mu=const
l <- preRSum0(Z=R2ngon(4,2), P=2^abs(seq(-3,4))/45, mu=2)
plot(l$proto, asp=1, col="red",
     main="Prefractal points for 4-gon: k=8, p=2^|-3:4|/45, mu=2")
points(l$pre, pch=46, col="red")
```

R2ngon *Regular polygonal protofractal set in R^2*

Description

`R2ngon()` function generates a regular polygonal protofractal set in R^2.

Usage

```
R2ngon(n1=3, n2=1, r=1, o=c(0,0), cycle=FALSE)
```

Arguments

`n1`	a number of vertices of a regular polygon.
`n2`	a number of partition points for the edges of a regular polygon.
`r`	a radius of the circumscribed circle.
`o`	a center of the circumscribed circle.
`cycle`	logical; if `cycle=FALSE`, first & last points are not equal.

Details

A regular polygon is a convex polygon in which all edges and all angles are equal.

A protofractal set `Z` is a discrete or continuous set, which in the iterative process generates a sample `X` of a fractal set.

Value

A matrix of points coordinates of a protofractal set in R^2.

Author(s)

Pavel V. Moskalev

See Also

preRIFS

Examples

```
plot(R2ngon(n1=90, cycle=TRUE), type="l", asp=1, col="gray",
     main="Regular {3,4,5,7,11}-gonal sets in R^2")
for (n in c(3,4,5,7,11))
  lines(R2ngon(n1=n, cycle=TRUE),
        type="b", pch=16, col=hsv(h=(n-2)/9,v=0.9))
```

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