Package ‘SPSL’

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Site Percolation on Square Lattice (SPSL)

Description

SPSL package provides functionality for labeling of percolation clusters on 2D & 3D square lattice with various lattice size, relative fraction of accessible sites (occupation probability), iso- & anisotropy, von Neumann & Moore (1,d)-neighborhood.

Details

Package: SPSL
Type: Package
Version: 0.1-8
Date: 2012-12-29
License: GPL-3
LazyLoad: yes

ssi20() and ssi30() functions provide sites labeling of the isotropic cluster on 2D & 3D square lattice with von Neumann (1,0)-neighborhood.
ssi2d() and ssi3d() functions provide sites labeling of the isotropic cluster on 2D & 3D square lattice with Moore (1,d)-neighborhood.

fssi20() and fssi30() functions calculates the relative frequency distribution of isotropic clusters on 2D & 3D square lattice with von Neumann (1,0)-neighborhood.
fssa20() and fssa30() functions calculates the relative frequency distribution of anisotropic clusters on 2D & 3D square lattice with von Neumann (1,0)-neighborhood.
fssi2d() and fssi3d() functions calculates the relative frequency distribution of isotropic clusters on 2D & 3D square lattice with Moore (1,d)-neighborhood.
fssa2d() and fssa3d() functions calculates the relative frequency distribution of anisotropic clusters on 2D & 3D square lattice with Moore (1,d)-neighborhood.
fssa20

Description

fssa20() function calculates the relative frequency distribution of anisotropic clusters on 2D square lattice with von Neumann (1,0)-neighborhood.

Usage

fssa20(n=1000, x=33, p=runif(4, max=0.9), set=(x^2+1)/2, all=TRUE)

Arguments

n a sample size.

x a linear dimension of 2D square percolation lattice.

p a vector of relative fractions (0<p<1) of accessible sites (occupation probability) for lattice directions: (-x, +x, -y, +y).

set a vector containing the linear indexes of sites from initial subset.

all logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

Details

The percolation is simulated on 2D square lattice with uniformly weighted sites and the vector p, distributed over the lattice directions.

The anisotropic cluster is formed from the accessible sites connected with the initial subset set, and depends on the direction in 2D square lattice.

Von Neumann (1,0)-neighborhood on 2D square lattice consists of sites, only one coordinate of which is different from the current site by one: e=c(-1, 1, -x, x).

Each element of the matrix frq is equal to the relative frequency with which the 2D square lattice site belongs to a cluster sample of size n.
Value

rfq  
a 2D matrix of relative sampling frequencies for sites of the percolation lattice.

Author(s)

Pavel V. Moskalev <moskalefff@gmail.com>

See Also

ssa20, fssa30, fssi20, fssi30, fssa2d, fssa3d

Examples

x <- y <- seq(33)
image(x, y, rfq <- fssa20(p=c(.3, .4, .75, .5)), cex.main=1,
main="Relative frequency distribution of anisotropic 2D clusters with (1,0)-neighborhood")
contour(x, y, rfq, levels=seq(.2, .3, .05), add=TRUE)
abline(h=17, lty=2); abline(v=17, lty=2)

Description

fssa2d() function calculates the relative frequency distribution of anisotropic clusters on 2D square lattice with Moore (1,d)-neighborhood.

Usage

fssa2d(n=1000, x=33,
p0=runif(4, max=0.8),
p1=colMeans(matrix(p0[c(1,3, 2,3, 1,4, 2,4)], nrow=2))/2,
set=(x^2+1)/2, all=TRUE)

Arguments

n  
a sample size.

x  
a linear dimension of 2D square percolation lattice.

p0  
a vector of relative fractions (0<p0<1) of accessible sites (occupation probability) for lattice directions: (-x,+x,-y,+y).

p1  
averaged double combinations of p0-components weighted by non-metrical Minkowski distance: p1=colMeans(matrix(p0[c(1,3,...)], nrow=2))/rhoMe1.

set  
a vector of linear indexes of initial sites subset.

all  
logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.
Details

The percolation is simulated on 2D square lattice with uniformly weighted sites and the vectors \( \mathbf{p}_0 \) and \( \mathbf{p}_1 \), distributed over the lattice directions, and their combinations.

The anisotropic cluster is formed from the accessible sites connected with the initial subset set, and depends on the direction in 2D square lattice.

Moore (1,d)-neighborhood on 2D square lattice consists of sites, at least one coordinate of which is different from the current site by one: \( e=c(e_0, e_1) \), where \( e_0=c(-1, 1, -x, x) \); \( e_1=\text{colSums}(\text{matrix}(e_0[(c(1, 3, 2, 3, 1, 4, 2, 4)], nrow=2)) \).

Minkowski non-metrical distance between sites \( a \) and \( b \) depends on the exponent \( d \):

\[
\rho_\text{M} = \begin{cases} 
\text{function}(a, b, d=1) \\
\text{if (is.infinite(d)) return(apply(abs(b-a), 2, max))} \\
\text{else return(apply(abs(b-a)^d, 2, sum)^{(1/d)})} 
\end{cases}
\]

Minkowski non-metrical distance for sites from \( e_1 \) subset with the exponent \( d=1 \) is equal to \( \rho_\text{M}e_1=2 \).

Each element of the matrix \( \text{frq} \) is equal to the relative frequency with which the 2D square lattice site belongs to a cluster sample of size \( n \).

Value

\( \text{rfq} \)  

a 2D matrix of relative sampling frequencies for sites of the percolation lattice.

Author(s)

Pavel V. Moskalev <moskaleff@gmail.com>

See Also

ssa2d, fssa3d, fssa20, fssa30, fssi2d, fssi3d

Examples

\[
x <- y <- \text{seq}(33) \\
\text{image}(x, y, \text{rfq} <- \text{fssa2d}(p0=c(.3, .4, .75, .5)), \text{cex.main}=1, \\
\text{main="Relative frequency distribution of anisotropic 2D clusters with (1,1)-neighborhood"}) \\
\text{contour}(x, y, \text{rfq}, \text{levels=seq(.2, .3, .05), add=TRUE}) \\
\text{abline(h=17, lty=2); abline(v=17, lty=2)}
\]

Description

\text{fssa30()} \text{ function calculates the relative frequency distribution of anisotropic clusters on 3D square lattice with von Neumann (1,0)-neighborhood.}
Usage

fssa30(n=1000, x=33, p=runif(6, max=0.6), set=(x^3+1)/2, all=TRUE)

Arguments

n  a sample size.
  a linear dimension of 3D square percolation lattice.
  a vector of relative fractions (0<p<1) of accessible sites (occupation probability) for lattice directions: (-x,+x,-y,+y,-z,+z).
  a vector containing the linear indexes of sites from initial subset.
  logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

Details

The percolation is simulated on 3D square lattice with uniformly weighted sites and the vector \( p \), distributed over the lattice directions.

The anisotropic cluster is formed from the accessible sites connected with the initial subset \( \text{set} \), and depends on the direction in 3D square lattice.

Von Neumann \((1,0)-\text{neighborhood}\) on 3D square lattice consists of sites, only one coordinate of which is different from the current site by one: \( e=c(-1, 1, -x, x, -x^2, x^2) \).

Each element of the 3D matrix \( \text{frq} \) is equal to the relative frequency with which the 3D square lattice site belongs to a cluster sample of size \( n \).

Value

\( \text{rfq} \)  a 3D matrix of relative sampling frequencies for sites of the percolation lattice.

Author(s)

Pavel V. Moskalev <moskaleff@gmail.com>

See Also

\( \text{ssa30, fssa20, fssi20, fssi30, fssa2d, fssa3d} \)

Examples

```r
x <- y <- seq(33)
rfq <- fssa30(p=.17*c(.5,3,.5,1.5,1,.5))
image(x, y, rfq[,17], cex.main=1,
main="Relative frequency distribution in the z=17 slice\n of anisotropic 3D clusters with \( (1,0)\)-neighborhood")
contour(x, y, rfq[,17], levels=seq(.05,.3,.05), add=TRUE)
abline(h=17, lty=2); abline(v=17, lty=2)
```
**fssa3d**

*Frequency of Sites on a Square Anisotropic 3D lattice with (1,d)-neighborhood*

---

**Description**

The `fssa3d()` function calculates the relative frequency distribution of anisotropic clusters on 3D square lattice with Moore (1,d)-neighborhood.

**Usage**

```r
fssa3d(n=1000, x=33,
      p0=runif(6, max=0.4),
      p1=colMeans(matrix(p0[c(1,3,2,3,1,4,2,4, 1,5,2,5,1,6,2,6, 3,5,4,5,3,6,4,6)], nrow=2))/2,
      p2=colMeans(matrix(p0[c(1,3,5,2,3,5,1,4,5,2,4,5, 1,3,6,2,3,6,1,4,6,2,4,6)], nrow=3))/3,
      set=(x^3+1)/2, all=TRUE)
```

**Arguments**

- `n` a sample size.
- `x` a linear dimension of 2D square percolation lattice.
- `p0` a vector of relative fractions (0<p0<1) of accessible sites (occupation probability) for lattice directions: (-x, +x, -y, +y, -z, +z).
- `p1` averaged double combinations of p0-components weighted by non-metrical Minkowski distance: p1=colMeans(matrix(p0[c(1,3,...)], nrow=2))/rhoMe1.
- `p2` averaged triple combinations of p0-components weighted by non-metrical Minkowski distance: p2=colMeans(matrix(p0[c(1,3,5,...)], nrow=3))/rhoMe2.
- `set` a vector of linear indexes of initial sites subset.
- `all` logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

**Details**

The percolation is simulated on 3D square lattice with uniformly weighted sites acc and the vectors p0, p1, and p2, distributed over the lattice directions, and their combinations. The anisotropic cluster is formed from the accessible sites connected with the initial subset set, and depends on the direction in 3D square lattice.

Moore (1,d)-neighborhood on 3D square lattice consists of sites, at least one coordinate of which is different from the current site by one: e=c(e0,e1,e2), where e0=c(-1, 1, -x, x, -x^2, x^2); e1=colSums(matrix(e0[c(1,3,2,3,1,4,2,4,1,5,2,5,1,6,2,6,3,5,4,5,3,6]], nrow=3))/rhoMe2.
Minkowski non-metrical distance between sites $a$ and $b$ depends on the exponent $d$:

```r
rhom <- function(a, b, d=1)
if (is.infinite(d)) return(apply(abs(b-a), 2, max))
else return(apply(abs(b-a)^d, 2, sum)^(1/d)).
```

Minkowski non-metrical distance for sites from $e_1$ and $e_2$ subsets with the exponent $d=1$ is equal to $\rho_{Me1}=2$ and $\rho_{Me2}=3$.

Each element of the matrix `frq` is equal to the relative frequency with which the 3D square lattice site belongs to a cluster sample of size $n$.

**Value**

`rfq`  
A 3D matrix of relative sampling frequencies for sites of the percolation lattice.

**Author(s)**

Pavel V. Moskalev <moskaleff@gmail.com>

**See Also**

`ssa3d, fssa2d, fssa20, fssa30, fssi2d, fssi3d`

**Examples**

```r
x <- y <- seq(33)
rfq <- fssa3d(p0=.17*c(.5,.3,.5,1.5,1.5))
image(x, y, rfq[,17], cex.main=1,
main="Relative frequency distribution in the z=17 slice\n of anisotropic 3D clusters with (1,1)-neighborhood")
contour(x, y, rfq[,17], levels=seq(.05,.3,.05), add=TRUE)
abline(h=17, lty=2); abline(v=17, lty=2)
```

---

**fssi20**  
*Frequency of Sites on a Square Isotropic 2D lattice with (1,0)-neighborhood*

**Description**

`fssi20()` function calculates the relative frequency distribution of isotropic clusters on 2D square lattice with von Neumann (1,0)-neighborhood.

**Usage**

```r
fssi20(n=1000, x=33, p0=0.592746, set=(x^2+1)/2, all=TRUE)
```
Arguments

- `n` a sample size.
- `x` a linear dimension of 2D square percolation lattice.
- `p` the relative fractions \((0<p<1)\) of accessible sites (occupation probability) for percolation lattice.
- `set` a vector containing the linear indexes of sites from initial subset.
- `all` logical; if `all=TRUE`, mark all sites from initial subset; if `all=FALSE`, mark accessible sites from initial subset.

Details

The percolation is simulated on 2D square lattice with uniformly weighted sites and the constant parameter \(p\).

The isotropic cluster is formed from the accessible sites connected with initial sites subset `set`.

Von Neumann \((1,0)\)-neighborhood on 2D square lattice consists of sites, only one coordinate of which is different from the current site by one: \(e=c(-1, 1, -x, x)\).

Each element of the matrix `frq` is equal to the relative frequency with which the 2D square lattice site belongs to a cluster sample of size \(n\).

Value

- `rfq` a 2D matrix of relative sampling frequencies for sites of the percolation lattice.

Author(s)

Pavel V. Moskalev

References


See Also

- `ssi20`, `fssi30`, `fssa20`, `fssa30`, `fssi2d`, `fssi3d`

Examples

```r
x <- y <- seq(33)
image(x, y, rfq <- fssi20(), cex.main=1,
main="Relative frequency distribution of isotropic 2D clusters with \((1,0)\)-neighborhood")
contour(x, y, rfq, levels=seq(.2,.3,.05), add=TRUE)
abline(h=17, lty=2); abline(v=17, lty=2)
```
fssi2d

Frequency of Sites on a Square Isotropic 2D lattice with (1,d)-neighborhood

Description

fssi2d() function calculates the relative frequency distribution of isotropic clusters on 2D square lattice with Moore (1,d)-neighborhood.

Usage

fssi2d(n=1000, x=33, p0=0.5, p1=p0/2, set=(x^2+1)/2, all=TRUE)

Arguments

n       a sample size.

x       a linear dimension of 2D square percolation lattice.

p0      a relative fraction (0<p0<1) of accessible sites (occupation probability) for percolation lattice.

p1      p0 value, weighted by non-metrical Minkowski distance: p1=p0/rh0me1.

set     a vector of linear indexes of initial sites subset.

all     logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

Details

The percolation is simulated on 2D square lattice with uniformly weighted sites and the constant parameters p0 and p1.

The isotropic cluster is formed from the accessible sites connected with initial sites subset set.

Moore (1,d)-neighborhood on 2D square lattice consists of sites, at least one coordinate of which is different from the current site by one: e=c(e0,e1), where e0=c(-1, 1, -x, x, -x^2, x^2); e1=colSums(matrix(e0[c(1,3,2,3,1,4,2,4)], nrow=2)).

Minkowski non-metrical distance between sites a and b depends on the exponent d:

rhom <- function(a, b, d=1)
if (is.infinite(d)) return(apply(abs(b-a), 2, max))
else return(apply(abs(b-a)^d, 2, sum)^(1/d)).

Minkowski non-metrical distance for sites from e1 subset with the exponent d=1 is equal to rh0me1=2.

Each element of the matrix frq is equal to the relative frequency with which the 2D square lattice site belongs to a cluster sample of size n.

Value

rfq       a 2D matrix of relative sampling frequencies for sites of the percolation lattice.
Author(s)

Pavel V. Moskalev <moskaleff@gmail.com>

See Also

ssi2d, fssi3d, fssi20, fssi30, fssa2d, fssa3d

Examples

```r
x <- y <- seq(33)
image(x, y, rfq <- fssi2d(), cex.main=1,
main="Relative frequency distribution of \n isotropic 2D clusters with (1,1)-neighborhood")
contour(x, y, rfq, levels=seq(.2,.3,.05), add=TRUE)
abline(h=17, lty=2); abline(v=17, lty=2)
```

---

**fssi30**

*Frequency of Sites on a Square Isotropic 3D lattice with (1,0)-neighborhood*

Description

fssi30() function calculates the relative frequency distribution of isotropic clusters on 3D square lattice with von Neumann (1,0)-neighborhood.

Usage

```r
fssi30(n=1000, x=33, p=0.311608, set=(x^3+1)/2, all=TRUE)
```

Arguments

- `n` a sample size.
- `x` a linear dimension of 3D square percolation lattice.
- `p` the relative fractions of accessible sites (occupation probability) for percolation lattice.
- `set` a vector containing the linear indexes of sites from initial subset.
- `all` logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

Details

The percolation is simulated on 3D square lattice with uniformly weighted sites and the constant parameter p.

The isotropic cluster is formed from the accessible sites connected with initial sites subset `set`.

Von Neumann (1,0)-neighborhood on 3D square lattice consists of sites, only one coordinate of which is different from the current site by one: `e=c(-1, 1, -x, x, -x^2, x^2)`.

Each element of the matrix `frq` is equal to the relative frequency with which the 3D square lattice site belongs to a cluster sample of size n.
Value

rfq

a 3D matrix of relative sampling frequencies for sites of the percolation lattice.

Author(s)

Pavel V. Moskalev <moskalefff@gmail.com>

See Also

ssi30, fssi20, fssa20, fssa30, fssi2d, fssi3d

Examples

x <- y <- seq(33)
rfq <- fssi3d(p=0.37)
image(x, y, rfq[,17], cex.main=1,
main="Relative frequency distribution in the z=17 slice\n of isotropic 3D clusters with (1,0)-neighborhood")
contour(x, y, rfq[,17], levels=c(0.2,0.25,0.3), add=TRUE)
abline(h=17, lty=2); abline(v=17, lty=2)

Description

fssi3d() function calculates the relative frequency distribution of isotropic clusters on 3D square lattice with Moore (1,d)-neighborhood.

Usage

fssi3d(n=1000, x=33, p0=0.2, p1=p0/2, p2=p0/3, set=(x^3+1)/2, all=TRUE)

Arguments

n

a sample size.

x

a linear dimension of 3D square percolation lattice.

p0

a relative fraction (0<p0)&(p0<1) of accessible sites (occupation probability) for percolation lattice.

p1

p0 value, weighted by non-metrical Minkowski distance: p1=p0/rhoMe1.

p2

p0 value, weighted by non-metrical Minkowski distance: p2=p0/rhoMe2.

set

a vector of linear indexes of initial sites subset.

all

logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.
Details

The percolation is simulated on 3D square lattice with uniformly weighted sites and the constant parameters \( p0, p1, \) and \( p2 \).

The isotropic cluster is formed from the accessible sites connected with initial sites subset set.

Moore \((1,d)\)-neighborhood on 3D square lattice consists of sites, at least one coordinate of which is different from the current site by one: \( e^c(ePLe1Le1LeRI, e2) \), where \( e^0=c(-1, 1, -x, x, -x^2, x^2) \):

\[
e^0 = \text{colSums(matrix}(e^0[c(1,3, 2,3, 1,4, 2,4, 1,5, 2,5, 1,6, 2,6, 3,5, 4,5, 3,6, 4,6), \text{nrow}=2]e0) = \text{colMeans(matrix}(p0[c(1,3,5, 2,3,5, 1,4,5, 2,4,5, 1,3,6, 2,3,6, 1,4,6, 2,4,6]), \text{nrow}=3)\).
\]

Minkowski non-metrical distance between sites \( a \) and \( b \) depends on the exponent \( d \):

\[
rhom = \text{function}(a, b, d=1)
if (\text{is.infinite}(d)) \text{return(apply(abs(b-a), 2, max))}
else \text{return(apply(abs(b-a)^d, 2, sum)^((1/d)))}.
\]

Minkowski non-metrical distance for sites from \( e1 \) and \( e2 \) subsets with the exponent \( d=1 \) is equal to \( \text{rhom1} = 2 \) and \( \text{rhom2} = 3 \).

Each element of the matrix \( \text{frq} \) is equal to the relative frequency with which the 3D square lattice site belongs to a cluster sample of size \( n \).

Value

\( rfq \) a 3D matrix of relative sampling frequencies for sites of the percolation lattice.

Author(s)

Pavel V. Moskalev <moskaleff@gmail.com>

See Also

\( ssi3d, fssi2d, fssi20, fssi30, fssa2d, fssa3d \)

Examples

\( x <- y <- \text{seq}(33) \)
\( rfq <- \text{fssi3d}(p0=.285) \)
\( \text{image}(x, y, rfq[,17], \text{cex.main}=1, \text{main}="\text{Relative frequency distribution in the z=17 slice of isotropic 3D clusters with (1,1)-neighborhood}\)"
\( \text{contour}(x, y, rfq[,17], \text{levels}=c(0.2,0.25,0.3), \text{add=}FALSE) \)
\( \text{abline}(h=17, \text{lty}=2); \text{abline}(v=17, \text{lty}=2) \)
**Site cluster on Square Anisotropic 2D lattice with (1,0)-neighborhood**

**Description**

`ssa20()` function provides sites labeling of the anisotropic cluster on 2D square lattice with von Neumann (1,0)-neighborhood.

**Usage**

```plaintext
ssa20(x=33, p=runif(4, max=0.9), set=(x^2+1)/2, all=TRUE)
```

**Arguments**

- `x` a linear dimension of 2D square percolation lattice.
- `p` a vector of relative fractions \((0<p<1)\) of accessible sites (occupation probability) for lattice directions: \((-x, +x, -y, +y)\).
- `set` a vector of linear indexes of initial sites subset.
- `all` logical; if `all=TRUE`, mark all sites from initial subset; if `all=FALSE`, mark accessible sites from initial subset.

**Details**

The percolation is simulated on 2D square lattice with uniformly weighted sites `acc` and the vector `p`, distributed over the lattice directions.

The anisotropic cluster is formed from the accessible sites connected with the initial subset, and depends on the direction in 2D square lattice.

To form the cluster the condition `acc[set+e[n]]<p[n]` is iteratively tested for sites of the von Neumann (1,0)-neighborhood `e` for the current cluster perimeter `set`, where `n` is equal to direction in 2D square lattice.

Von Neumann (1,0)-neighborhood on 2D square lattice consists of sites, only one coordinate of which is different from the current site by one: \(e=c(-1, 1, -x, x)\).

Forming cluster ends with the exhaustion of accessible sites in von Neumann (1,0)-neighborhood of the current cluster perimeter.

**Value**

- `acc` an accessibility matrix for 2D square percolation lattice:
  - if `acc[e]<p[n]` then `acc[e]` is accessible site;
  - if `acc[e]==1` then `acc[e]` is non-accessible site;
  - if `acc[e]==2` then `acc[e]` belongs to a sites cluster.

**Author(s)**

Pavel V. Moskalev
References

Moskalev, P.V. and Shitov, V.V. Mathematical modeling of porous structures. Moscow: Fizmatlit, 2007. 120 pp; in Russian.

See Also

fssa20, ssa30, ssi20, ssi30, ssa2d, ssa3d

Examples

```
set.seed(20120507)
x <- y <- seq(33)
image(x, y, ssa2d(), zlim=c(0,2),
main="Anisotropic 2D cluster with (1,0)-neighborhood")
abline(h=17, lty=2); abline(v=17, lty=2)
```

ssa2d

**Site cluster on Square Anisotropic 2D lattice with (1,d)-neighborhood**

Description

ssa2d() function provides sites labeling of the anisotropic cluster on 2D square lattice with Moore (1,d)-neighborhood.

Usage

```
ssa2d(x=33, p0=runif(4, max=0.8),
    pl=colMeans(matrix(p0[c(1,3,2,3,1,4,2,4)], nrow=2))/2,
    set=(x^2+1)/2, all=TRUE)
```

Arguments

- `x` a linear dimension of 2D square percolation lattice.
- `p0` a vector of relative fractions (0<p0<1) of accessible sites (occupation probability) for lattice directions: (-x, +x, -y, +y).
- `pl` averaged double combinations of p0-components weighted by non-metrical Minkowski distance: pl=colMeans(matrix(p0[c(1,3,1,3)], nrow=2))/rhoMe1.
- `set` a vector of linear indexes of initial sites subset.
- `all` logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.
Details

The percolation is simulated on 2D square lattice with uniformly weighted sites acc and the vectors p0 and p1, distributed over the lattice directions, and their combinations.

The anisotropic cluster is formed from the accessible sites connected with the initial subset set, and depends on the direction in 2D square lattice.

To form the cluster the condition acc[set+eN[n]]<pN[n] is iteratively tested for sites of the Moore (1,d)-neighborhood eN for the current cluster perimeter set, where eN is equal to e0 or e1 vector; pN is equal to p0 or p1 vector; n is equal to direction in 2D square lattice.

Moore (1,d)-neighborhood on 2D square lattice consists of sites, at least one coordinate of which is different from the current site by one: e=c(e0,e1), where e0=c(-1,1,-x,x); e1=colSums(matrix(e0[c(1,3,2,3,1,4,2,4), nrow=2]).

Minkowski non-metrical distance between sites a and b depends on the exponent d:

\[
\text{rhoM} \leftarrow \text{function}(a, b, d=1) \\
\text{if } (\text{is.infinite}(d)) \text{ return(apply(abs(b-a), 2, max))} \\
\text{else return(apply(abs(b-a)^d, 2, sum)^((1/d)))}.
\]

Minkowski non-metrical distance for sites from e1 subset with the exponent d=1 is equal to rhoMe1=2.

Forming cluster ends with the exhaustion of accessible sites in Moore (1,d)-neighborhood of the current cluster perimeter.

Value

acc an accessibility matrix for 2D square percolation lattice:

- if acc[e]<pN[n] then acc[e] is accessible site;
- if acc[e]==1 then acc[e] is non-accessible site;
- if acc[e]==2 then acc[e] belongs to a sites cluster.

Author(s)

Pavel V. Moskalev

See Also

fssa2d, ssa3d, ssa20, ssa30, ssi2d, ssi3d

Examples

set.seed(20120507)
x <- y <- seq(33)
image(x, y, ssa2d(), zlim=c(0,2),
main="Anisotropic 2D cluster with (1,1)-neighborhood")
abline(h=17, lty=2); abline(v=17, lty=2)
Description

ssa30() function provides sites labeling of the anisotropic cluster on 3D square lattice with von Neumann (1,0)-neighborhood.

Usage

ssa30(x=33, p=runif(6, max=0.6), set=(x^3+1)/2, all=TRUE)

Arguments

x
a linear dimension of 3D square percolation lattice.
p
a vector of relative fractions (0<p)<(p<1) of accessible sites (occupation probability) for lattice directions: (-x, +x, -y, +y, -z, +z).
set
a vector of linear indexes of initial sites subset.
all
logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

Details

The percolation is simulated on 3D square lattice with uniformly weighted sites acc and the vector p, distributed over the lattice directions.

The anisotropic cluster is formed from the accessible sites connected with the initial subset set, and depends on the direction in 3D square lattice.

To form the cluster the condition acc[set+e[n]]<p[n] is iteratively tested for sites of the von Neumann (1,0)-neighborhood e for the current cluster perimeter set, where n is equal to direction in 3D square lattice.

Von Neumann (1,0)-neighborhood on 3D square lattice consists of sites, only one coordinate of which is different from the current site by one: e=c(-1, 1, -x, x, -x^2, x^2).

Forming cluster ends with the exhaustion of accessible sites in von Neumann (1,0)-neighborhood of the current cluster perimeter.

Value

acc
an accessibility matrix for 3D square percolation lattice:
if acc[e]<p[n] then acc[e] is accessible site;
if acc[e]==1 then acc[e] is non-accessible site;
if acc[e]==2 then acc[e] belongs to a sites cluster.

Author(s)

Pavel V. Moskalev
ssa3d

**Site cluster on Square Anisotropic 3D lattice with (1,d)-neighborhood**

**Description**

ssa3d() function provides sites labeling of the anisotropic cluster on 3D square lattice with Moore (1,d)-neighborhood.

**Usage**

```r
ssa3d(x=33, p0=runif(6, max=0.4),
   pl=colMeans(matrix(p0[c(1,3, 2, 3, 1, 4, 2, 4,
                              1, 5, 2, 5, 1, 6, 2, 6,
                              3, 5, 4, 5, 3, 6, 4, 6)], nrow=2))/2,
   p2=colMeans(matrix(p0[c(1,3,5, 2,3,5, 1,4,5, 2,4,5,
                          1,3,6, 2,3,6, 1,4,6, 2,4,6)], nrow=3))/3,
   set=(x^3+1)/2, all=TRUE)
```

**Arguments**

- `x` a linear dimension of 3D square percolation lattice.
- `p0` a vector of relative fractions (0<p0)&(p0<1) of accessible sites (occupation probability) for lattice directions: (-x,+x,-y,+y,-z,+z).

**Examples**

```r
# Example No.1. Axonometric projection of 3D cluster
require(lattice)
set.seed(20120521)
x <- y <- z <- seq(33)
c1 = which(ssa3d(p=.09*c(1,6,1,3,2,1))>1, arr.ind=TRUE)
cloud(c1) + c2 + c3, zlim=range(z),
col=rgb(1,0,0,0.4), xlab="x", ylab="y", zlab="z", main.cex=1,
main="Axonometric projection of an anisotropic 3D cluster with (1,0)-neighborhood")

# Example No.2. Z=17 slice of 3D cluster
set.seed(20120521)
x <- y <- z <- seq(33)
c1 = ssa3d(p=.09*c(1,6,1,3,2,1))
image(x, y, c1[1:17], zlim=c(0,2), main.cex=1,
main="Z=17 slice of an anisotropic 3D cluster with (1,0)-neighborhood")
```

**See Also**

fssa30, ssa20, ssi20, ssi30, ssa2d, ssa3d
p1 averaged double combinations of \( p \)-components weighted by non-metrical Minkowski distance: 
\[
p_1 = \text{colMeans}(\text{matrix}(p_0[c(1,3,\ldots)], nrow=2)) / \rho_{\text{ho}1}.
\]

p2 averaged triple combinations of \( p \)-components weighted by non-metrical Minkowski distance: 
\[
p_2 = \text{colMeans}(\text{matrix}(p_0[c(1,3,5,\ldots)], nrow=3)) / \rho_{\text{ho}2}.
\]

set a vector of linear indexes of initial sites subset.

all logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

Details

The percolation is simulated on 3D square lattice with uniformly weighted sites \( \text{acc} \) and the vectors \( p_0, p_1, \) and \( p_2 \), distributed over the lattice directions, and their combinations.

The anisotropic cluster is formed from the accessible sites connected with the initial subset \( \text{set} \), and depends on the direction in 3D square lattice.

To form the cluster the condition \( \text{acc}[\text{set}+\text{en}[n]]<p_*[n] \) is iteratively tested for sites of the Moore (1,d)-neighborhood \( \text{en} \) for the current cluster perimeter \( \text{set} \), where \( \text{en} \) is equal to \( e_0, e_1, \) or \( e_2 \) vector; \( p_* \) is equal to \( p_0, p_1, \) or \( p_2 \) vector; \( n \) is equal to direction in 3D square lattice.

Moore (1,d)-neighborhood on 3D square lattice consists of sites, at least one coordinate of which is different from the current site by one: 
\[
e = c(e_0, e_1, e_2), \text{ where } e_0 = c(-1, 1, -x, x, -x^2, x^2); e_1 = \text{colSums}(\text{matrix}(e_0[c(1,3,2,3,1,4,2,4,1,5,2,5,1,6,2,6,3,5,4,5,3,6,4,6)], nrow=2)); e_2 = \text{colMeans}(\text{matrix}(p_0[c(1,3,5,2,3,5,1,4,5,2,4,5,1,3,6,2,3,6,1,4,6,2,4,6)], nrow=3)).
\]

Minkowski non-metrical distance between sites \( a \) and \( b \) depends on the exponent \( d \): 
\[
rho_{\text{mink}} \leftarrow \text{function}(a, b, d=1)
\]
if (is.infinite(d)) return(apply(abs(b-a), 2, max))
else return(apply(abs(b-a)^d, 2, sum)^(1/d)).

Minkowski non-metrical distance for sites from \( e_1 \) and \( e_2 \) subsets with the exponent \( d=1 \) is equal to \( \rho_{\text{ho}1}=2 \) and \( \rho_{\text{ho}2}=3 \).

Forming cluster ends with the exhaustion of accessible sites in Moore (1,d)-neighborhood of the current cluster perimeter.

Value

\( \text{acc} \) an accessibility matrix for 3D square percolation lattice:

- if \( \text{acc}[e]<p_*[n] \) then \( \text{acc}[e] \) is accessible site;
- if \( \text{acc}[e]=1 \) then \( \text{acc}[e] \) is non-accessible site;
- if \( \text{acc}[e]=2 \) then \( \text{acc}[e] \) belongs to a sites cluster.

Author(s)

Pavel V. Moskalev

See Also

\( \text{fssa3d, ssa2d, ssa20, ssa30, ssi2d, ssi3d} \)
Examples

# Example No.1. Axonometric projection of 3D cluster
require(cluster)
sset.seed(RP1RPUR1)
x <- y <- z <- seq(33)
class <- which(ssa3d(p=0.9*c(1,6,1,3,2,1))>1, arr.ind=TRUE)
cloud(class[,3] ~ class[,1]*class[,2],
xlim=range(x), ylim=range(y), zlim=range(z),
col=rgb(1,0,0,0.4), xlab="x", ylab="y", zlab="z", main.cex=1,
main="Axonometric projection of an anisotropic 3D cluster with (1,1)-neighborhood")

# Example No.2. Z=17 slice of 3D cluster
set.seed(RP1RPUR1)
x <- y <- z <- seq(33)
class <- ssa3d(p=0.9*c(1,6,1,3,2,1))
image(x, y, class[,17], zlim=c(0,2), main.cex=1,
main="Z=17 slice of an anisotropic 3D cluster with (1,1)-neighborhood")
abline(h=17, lty=2); abline(v=17, lty=2)

ssi20

Site cluster on Square Isotropic 2D lattice with (1,0)-neighborhood

Description

ssi20() function provides sites labeling of the isotropic cluster on 2D square lattice with von Neumann (1,0)-neighborhood.

Usage

ssi20(x=33, p=0.592746, set=(x^2+1)/2, all=TRUE)

Arguments

x a linear dimension of 2D square percolation lattice.
p the relative fractions (0<p)<(p<1) of accessible sites (occupation probability) for percolation lattice.
set a vector containing the linear indexes of sites from initial subset.
all logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

Details

The percolation is simulated on 2D square lattice with uniformly weighted sites acc and the constant parameter p.
The isotropic cluster is formed from the accessible sites connected with initial sites subset.
To form the cluster the condition acc[set+e]<p is iteratively tested for sites of the von Neumann (1,0)-neighborhood e for the current cluster perimeter set.
Von Neumann (1,0)-neighborhood on 2D square lattice consists of sites, only one coordinate of which is different from the current site by one: e=c(-1, 1, -x, x).

Forming cluster ends with the exhaustion of accessible sites in von Neumann (1,0)-neighborhood of the current cluster perimeter.

Value

acc an accessibility matrix for 2D square percolation lattice:
if acc[e]<p then acc[e] is accessible site;
if acc[e]==1 then acc[e] is non-accessible site;
if acc[e]==2 then acc[e] belongs to a sites cluster.

Author(s)

Pavel V. Moskalev

References

Moskalev, P.V. and Shitiv, V.V. Mathematical modeling of porous structures. Moscow: Fizmatlit, 2007. 120 pp; in Russian.

See Also

fssi20, ssi30, ssa20, ssa30, ssi2d, ssi3d

Examples

set.seed(20120507)
x <- y <- seq(33)
image(x, y, ssi20(), zlim=c(0,2), main="Isotropic 2D cluster with (1,0)-neighborhood")
abline(h=17, lty=2); abline(v=17, lty=2)

ssi2d

Site cluster on Square Isotropic 2D lattice with (1,d)-neighborhood

Description

ssi2d() function provides sites labeling of the isotropic cluster on 2D square lattice with Moore (1,d)-neighborhood.

Usage

ssi2d(x=33, p0=0.5, p1=p0/2, set=(x^2+1)/2, all=TRUE)
Arguments

x  a linear dimension of 2D square percolation lattice.

\( p0 \)  a relative fraction \((0 < p0)\&\&(p0 < 1)\) of accessible sites (occupation probability) for percolation lattice.

\( p1 \)  \( p0 \) value, weighted by non-metrical Minkowski distance: \( p1 = p0 / \text{rhoM} e1 \).

set  a vector of linear indexes of initial sites subset.

all  logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.

Details

The percolation is simulated on 2D square lattice with uniformly weighted sites \( acc \) and the constant parameters \( p0 \) and \( p1 \).

The isotropic cluster is formed from the accessible sites connected with initial sites subset \( set \).

To form the cluster the condition \( acc[set+en] < pN \) is iteratively tested for sites of the Moore \((1,d)\)-neighborhood \( en \) for the current cluster perimeter \( set \), where \( en \) is equal to \( eP \) or \( e1 \) vector; \( pN \) is equal to \( p0 \) or \( p1 \) value.

Moore \((1,d)\)-neighborhood on 2D square lattice consists of sites, at least one coordinate of which is different from the current site by one: \( e = c(e0,e1) \), where \( e0 = c(-1, 1, -x, x, -x^2, x^2) \); \( e1 = \text{colSums(matrix}(e0[c(1,3,2,3,1,4,2,4)), nrow=2)) \).

Minkowski non-metrical distance between sites a and b depends on the exponent d:

\[
\text{rhoM} \leftarrow \begin{cases} 
\text{function}(a, b, d = 1) \\
\text{if (is.infinite(d)) return(apply(abs(b-a), 2, max))} \\
\text{else return(apply(abs(b-a)^d, 2, sum)^(1/d))}.
\end{cases}
\]

Minkowski non-metrical distance for sites from \( e1 \) subset with the exponent \( d = 1 \) is equal to \( \text{rhoM} e1 = 2 \).

Forming cluster ends with the exhaustion of accessible sites in Moore \((1,d)\)-neighborhood of the current cluster perimeter.

Value

\( acc \)  an accessibility matrix for 2D square percolation lattice:

- if \( acc[e] < pN \) then \( acc[e] \) is accessible site;
- if \( acc[e] = 1 \) then \( acc[e] \) is non-accessible site;
- if \( acc[e] = 2 \) then \( acc[e] \) belongs to a sites cluster.

Author(s)

Pavel V. Moskalev <moskaleff@gmail.com>

See Also

\( fssi2d, ssi3d, ssi20, ssi30, ssa2d, ssa3d \)
Examples

```r
set.seed(20120507)
x <- y <- seq(33)
image(x, y, ssi2d(), zlim=c(0,2),
main="Isotropic 2D cluster with (1,1)-neighborhood")
abline(h=17, lty=2); abline(v=17, lty=2)
```

---

### Description

SSI3() function provides sites labeling of the isotropic cluster on 3D square lattice with von Neumann (1,0)-neighborhood.

### Usage

```r
ssi30(x=33, p=0.311608, set=(x^3+1)/2, all=TRUE)
```

### Arguments

- **x**: a linear dimension of 3D square percolation lattice.
- **p**: the relative fractions \(0<p<1\) of accessible sites (occupation probability) for percolation lattice.
- **set**: a vector containing the linear indexes of sites from initial subset.
- **all**: logical; if `all=TRUE`, mark all sites from initial subset; if `all=FALSE`, mark accessible sites from initial subset.

### Details

The percolation is simulated on 3D square lattice with uniformly weighted sites acc and the constant parameter p.

The isotropic cluster is formed from the accessible sites connected with initial sites subset set.

To form the cluster the condition acc[set+e]<p is iteratively tested for sites of the von Neumann (1,0)-neighborhood e for the current cluster perimeter set.

Von Neumann (1,0)-neighborhood on 3D square lattice consists of sites, only one coordinate of which is different from the current site by one: \(e=c(-1, 1, -x, x, -x^2, x^2)\).

Forming cluster ends with the exhaustion of accessible sites in von Neumann (1,0)-neighborhood of the current cluster perimeter.

### Value

- **acc**: an accessibility matrix for 3D square percolation lattice:
  - if acc[e]<p then acc[e] is accessible site;
  - if acc[e]==1 then acc[e] is non-accessible site;
  - if acc[e]==2 then acc[e] belongs to a sites cluster.
Author(s)

Pavel V. Moskalev

See Also

fssi30, ssi20, ssa30, ssi2d, ssi3d

Examples

# Example No.1. Axonometric projection of 3D cluster
require(lattice)
set.seed(20120507)
x <- y <- z <- seq(33)
c1s <- which(ssi30(p=.285)>1, arr.ind=TRUE)
cloud(c1s[,3]-c1s[,1], c1s[,2],
xlim=range(x), ylim=range(y), zlim=range(z),
col=rgb(1,0,0,0.4), xlab="x", ylab="y", zlab="z", main.cex=1,
main="Axonometric projection of an isotropic 3D cluster with (1,0)-neighborhood")

# Example No.2. Z=17 slice of 3D cluster
set.seed(20120507)
c1s <- ssi30(p=.285)
x <- y <- z <- seq(33)
image(x, y, c1s[,17], zlim=c(0,2), cex.main=1,
main="Z=17 slice of an isotropic 3D cluster with (1,0)-neighborhood")
abline(h=17, lty=2); abline(v=17, lty=2)

ssi3d

Site cluster on Square Isotropic 3D lattice with (1,d)-neighborhood

Description

ssi3d() function provides sites labeling of the isotropic cluster on 3D square lattice with Moore (1,d)-neighborhood.

Usage

ssi3d(x=33, p0=.2, p1=p0/2, p2=p0/3, set=(x^3+1)/2, all=TRUE)

Arguments

x

a linear dimension of 3D square percolation lattice.
p0

a relative fraction (0<p0)<(0<p0<1) of accessible sites (occupation probability) for percolation lattice.
p1

p0 value, weighted by non-metrical Minkowski distance: p1=p0/rhoM1.
p2

p0 value, weighted by non-metrical Minkowski distance: p2=p0/rhoM2.
set

a vector of linear indexes of initial sites subset.
all

logical; if all=TRUE, mark all sites from initial subset; if all=FALSE, mark accessible sites from initial subset.
Details

The percolation is simulated on 3D square lattice with uniformly weighted sites acc and the constant parameters p0, p1, and p2.

The isotropic cluster is formed from the accessible sites connected with initial sites subset set.

To form the cluster the condition acc[set+en]<pN is iteratively tested for sites of the Moore (1,d)-neighborhood en for the current cluster perimeter set, where en is equal to e0, e1 or e2 vector; pN is equal to p0, p1 or p2 value.

Moore (1,d)-neighborhood on 3D square lattice consists of sites, at least one coordinate of which is different from the current site by one: e=c(e0,e1,e2), where e0=c(-1, 1, -x, x, -x^2, x^2); e1=colSums(matrix(e0[c(1,3,2,3,1,4,2,4,1,5,2,5,1,6,2,6,3,5,4,5,3,6,4,6)], nrow=2)); e2=colMeans(matrix(p0[c(1,3,5,2,3,5,1,4,5,2,4,5,1,3,6,2,3,6,1,4,6,2,4,6)], nrow=3)).

Minkowski non-metrical distance between sites a and b depends on the exponent d:

\[
\rho_m \left( \begin{array}{l}
\text{if } (\text{is.infinite}(d)) \text{ return(apply(abs(b-a), 2, max))} \\
\text{else return(apply(abs(b-a)^d, 2, sum)^((1/d)))}
\end{array} \right).
\]

Minkowski non-metrical distance for sites from e1 and e2 subsets with the exponent d=1 is equal to rhoMe1=2 and rhoMe2=3.

Forming cluster ends with the exhaustion of accessible sites in Moore (1,d)-neighborhood of the current cluster perimeter.

Value

acc an accessibility matrix for 3D square percolation lattice:

- if acc[e]<pN then acc[e] is accessible site;
- if acc[e]==1 then acc[e] is non-accessible site;
- if acc[e]==2 then acc[e] belongs to a sites cluster.

Author(s)

Pavel V. Moskalev

See Also

fssi3d, ssi2d, ssi20, ssi30, ssa2d, ssa3d

Examples

# Example No.1. Axonometric projection of 3D cluster
require(lattice)
set.seed(20120507)
x <- y <- z <- seq(33)
cls <- which(ssi3d(p0=.285)>1, arr.ind=TRUE)
cloud(cls[,3] ~ cls[,1]xcls[,2],
xlim=range(x), ylim=range(y), zlim=range(z),
col=rgb(1,0,0,0.4), xlab="x", ylab="y", zlab="z", main.cex=1,
main="Axonometric projection of an isotropic 3D cluster with (1,1)-neighborhood")
# Example No.2. Z=17 slice of 3D cluster
set.seed(20120507)
cls <- ssi3d(p0=.285)
x <- y <- z <- seq(33)
image(x, y, cls[,17], zlim=c(0,2), cex.main=1,
main="Z=17 slice of an isotropic 3D cluster with (1,1)-neighborhood")
abline(h=17, lty=2); abline(v=17, lty=2)
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