# Package ‘SPSL’

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**Type** Package

**Version** 0.1-8

**Date** 2012-12-29

**Title** Site Percolation on Square Lattice (SPSL)

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**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

**Depends** R (>= 2.14.0)

**Suggests** lattice

**License** GPL-3

**LazyLoad** yes

**URL** http://cran.r-project.org/package=SPSL

**Repository** CRAN

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## R topics documented:

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SPSL-package *Site Percolation on Square Lattice (SPSL)*

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## 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.
`ssa20()` and `ssa30()` functions provide sites labeling of the anisotropic 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.
`ssa2d()` and `ssa3d()` functions provide sites labeling of the anisotropic 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.

## Author(s)

Pavel V. Moskalev <moskalefff@gmail.com>

## References

Moskalev, P.V. and Shitov, V.V. Mathematical modeling of porous structures. Moscow: Fizmatlit, 2007. 120 pp; in Russian.
Moskalev, P.V. (2009), Analysis of the percolation cluster structure. *Technical Physics*, Vol.54, No.6, pp.763-769.
Moskalev, P.V., Grebennikov, K.V. and Shitov, V.V. (2011), Statistical estimation of percolation cluster parameters. *Proceedings of Voronezh State University. Series: Systems Analysis and Information Technologies*, No.1 (January-June), pp.29-35; arXiv:1105.2334v1 [cond-mat.stat-mech]; in Russian.

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`fssa20` *Frequency of Sites on a Square Anisotropic 2D lattice with (1,0)-neighborhood*

---

## 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)&(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\n 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)
```

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`fssa2d` *Frequency of Sites on a Square Anisotropic 2D lattice with (1,d)-neighborhood*

---

## 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)&(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 `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.

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`:

```
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 `rhoMe1=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 <moskalefff@gmail.com>

## See Also

ssa2d, fssa3d, fssa20, fssa30, fssi2d, fssi3d

## Examples

```
x <- y <- seq(33)
image(x, y, rfq <- fssa2d(p0=c(.3,.4,.75,.5)), cex.main=1,
main="Relative frequency distribution of\n anisotropic 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)
```

fssa30 — *Frequency of Sites on a Square Anisotropic 3D lattice with (1,0)-neighborhood*

## Description

fssa30() 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. |
| 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 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 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.

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 3D 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

ssa30, fssa20, fssi20, fssi30, fssa2d, fssa3d

## Examples

```
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

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

## Usage

```
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)&(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, 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`:

```
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` and `e2` subsets with the exponent `d=1` is equal to `rhoMe1=2` and `rhoMe2=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 <moskalefff@gmail.com>

## See Also

ssa3d, fssa2d, fssa20, fssa30, fssi2d, fssi3d

## Examples

```
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

```
fssi20(n=1000, x=33, p=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)&(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

Moskalev, P.V., Grebennikov, K.V. and Shitov, V.V. (2011), Statistical estimation of percolation cluster parameters. *Proceedings of Voronezh State University. Series: Systems Analysis and Information Technologies*, No.1 (January-June), pp.29-35; arXiv:1105.2334v1 [cond-mat.stat-mech]; in Russian.

## See Also

ssi20, fssi30, fssa20, fssa30, fssi2d, fssi3d

## Examples

```
x <- y <- seq(33)
image(x, y, rfq <- fssi20(), cex.main=1,
main="Relative frequency distribution of\n 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)&(p0<1)` of accessible sites (occupation probability) for percolation lattice. |
| `p1` | `p0` value, weighted by non-metrical Minkowski distance: `p1=p0/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 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 `rhoMe1=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 <moskalefff@gmail.com>

### See Also

ssi2d, fssi3d, fssi20, fssi30, fssa2d, fssa3d

### Examples

```
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

```
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 `(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 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 <- fssi30(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)
```

---

fssi3d *Frequency of Sites on a Square Isotropic 3D lattice with (1,d)-neighborhood*

---

## 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(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`:

```
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` and `e2` subsets with the exponent `d=1` is equal to `rhoMe1=2` and `rhoMe2=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 <moskalefff@gmail.com>

### See Also

ssi3d, fssi2d, fssi20, fssi30, fssa2d, fssa3d

## Examples

```
x <- y <- seq(33)
rfq <- fssi3d(p0=.285)
image(x, y, rfq[,,17], cex.main=1,
main="Relative frequency distribution in the z=17 slice\n of isotropic 3D clusters with (1,1)-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)
```

---

ssa20 *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

```
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)&(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, ssa20(), 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),
            p1=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)&(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 `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`:

```
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 `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)
```

---

ssa30 *Site cluster on Square Anisotropic 3D lattice with (1,0)-neighborhood*

---

## 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

### See Also

fssa30, ssa20, ssi20, ssi30, ssa2d, ssa3d

### Examples

```
# Example No.1. Axonometric projection of 3D cluster
require(lattice)
set.seed(20120521)
x <- y <- z <- seq(33)
cls <- which(ssa30(p=.09*c(1,6,1,3,2,1))>1, arr.ind=TRUE)
cloud(cls[,3] ~ cls[,1]*cls[,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\n 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)
cls <- ssa30(p=.09*c(1,6,1,3,2,1))
image(x, y, cls[,,17], zlim=c(0,2), cex.main=1,
main="Z=17 slice of an anisotropic 3D cluster with (1,0)-neighborhood")
abline(h=17, lty=2); abline(v=17, lty=2)
```

---

## 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

```
ssa3d(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

| | |
|---|---|
| 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). |
| 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.

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, e1, or e2 vector; pN is equal to p0, p1, or p2 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(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.mink <- 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 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:<br>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

fssa3d, ssa2d, ssa20, ssa30, ssi2d, ssi3d

## Examples

```
# Example No.1. Axonometric projection of 3D cluster
require(lattice)
set.seed(20120521)
x <- y <- z <- seq(33)
cls <- which(ssa3d(p0=.09*c(1,6,1,3,2,1))>1, arr.ind=TRUE)
cloud(cls[,3] ~ cls[,1]*cls[,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\n an anisotropic 3D cluster with (1,1)-neighborhood")

# Example No.2. Z=17 slice of 3D cluster
set.seed(20120521)
x <- y <- z <- seq(33)
cls <- ssa3d(p0=.09*c(1,6,1,3,2,1))
image(x, y, cls[,,17], zlim=c(0,2), cex.main=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 accessiblity matrix for 2D square percolation lattice:<br>if `acc[e]<p` then `acc[e]` is accessible site;<br>if `acc[e]==1` then `acc[e]` is non-accessible site;<br>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.
Moskalev, P.V. (2009), Analysis of the percolation cluster structure. *Technical Physics*, Vol.54, No.6, pp.763-769.

## 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/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 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 e0 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=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 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` 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 <moskalefff@gmail.com>

### See Also

fssi2d, ssi3d, ssi20, ssi30, ssa2d, ssa3d

### Examples

```
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)
```

---

## ssi30 *Site cluster on Square Isotropic 3D lattice with (1,0)-neighborhood*

---

### Description

`ssi30()` function provides sites labeling of the isotropic cluster on 3D square lattice with von Neumann (1,0)-neighborhood.

### Usage

```
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)&(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 accessiblity matrix for 3D square percolation lattice:<br>if `acc[e]<p` then `acc[e]` is accessible site;<br>if `acc[e]==1` then `acc[e]` is non-accessible site;<br>if `acc[e]==2` then `acc[e]` belongs to a sites cluster. |

## Author(s)

Pavel V. Moskalev

## See Also

fssi30, ssi20, ssa20, ssa30, ssi2d, ssi3d

## Examples

```
# Example No.1. Axonometric projection of 3D cluster
require(lattice)
set.seed(20120507)
x <- y <- z <- seq(33)
cls <- which(ssi30(p=.285)>1, arr.ind=TRUE)
cloud(cls[,3] ~ cls[,1]*cls[,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\n an isotropic 3D cluster with (1,0)-neighborhood")

# Example No.2. Z=17 slice of 3D cluster
set.seed(20120507)
cls <- ssi30(p=.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 (1,0)-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=0.2, 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)&(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 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:

```
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 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]*cls[,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\n 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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