(Re)Construction Based on Simulated Annealing

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The R program `Construction.R` is a small example program which demonstrates the use of simulated annealing for the purpose of simulating point patterns with certain specific summary characteristics. For more general information on the (re)construction method see the papers Tscheschel and Stoyan (2006), Pommerening and Stoyan (2008) and Nothdurft *et al.* (2010).

For demonstration purposes I have selected the aggregation index by Clark and Evans (1954). This summary characteristic can, of course, be replaced by others. Also multiple summary characteristics are possible. The program `Construction.R` starts with a sample of a Poisson process. The user can specify the observation window (`xmax`, `ymax`) and the point density λ (`density`). Also, the user can assign an arbitrary target value of the aggregation index by Clark and Evans (1954) to the variable `CEtarget`.

Simulated annealing settings include `energyAim`, `maxSimSteps`, `coolingFactor` and `Te` (Temperature). If `Te` is set to `0` `Construction.R` performs the improvements-only algorithm. For details see the aforementioned papers.

Three options of modifying the initial Poisson point pattern have been implemented. They are distinguished by the variable `tz`:

Value of `tz`	Modification process
1	A randomly selected point is deleted.
2	A new point with random coordinates is added.
3	An existing randomly selected point is assigned to new random coordinates.

In each simulation iteration, a value of `tz`, either 1, 2 or 3, is randomly selected and the process described in the above table is carried out. The modified, new pattern is, however, only accepted if there is an energy gain or if a random number is smaller than the Metropolis probability. If the user wishes to exclude the modification processes 1 and 2 it is possible to replace the line `tz <- round(runif(1, min = 1, max = 3), 0)` by `tz <- 3`.

The simulation uses periodic boundary conditions.

The simulation stops, when `CEtarget` is achieved or when the maximum number of iterations is exceeded. Using the `spatstat` package `Construction.R` finally shows a map of the initial Poisson pattern and of the simulated point pattern which is a realisation of `CEtarget`.

`Construction.R` can be used to simulate patterns with a specific value of a given summary characteristic and to assess how difficult it is to establish the corresponding pattern if at all realisable.

References

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