Tasks labeled by the 🏵 sign are optional and are worth extra credits.

General information

Contact: zsolt.lazar@ubbcluj.ro
Course website: MS Teams
Assignment: Submitted assignment should be archived folder with its name containing the assignment number and title of the assignment, e.g., `02_Random_walk_part_1`. The folder should be uploaded as a compressed archive containing the student's name, e.g., `Smith_John_02_Random_walk_part_1.zip`.

Requirements

Reports should include:

1. Students name
2. Title
3. Statement of the problem
4. Hypotheses
5. Strategy/method
6. Conclusions
7. Complete compilation/installation/execution instructions. Specifying dependencies are appreciated.
8. Results from demo runs including screen captures of charts, etc. - where it applies - should be included.
9. Detail the parameters used for the demonstrated runs (on the Figures)
10. Describe the environment(s) where the testing was successful (compilers, libraries, environments,...)
11. Have a list of source files attached.

Source code should be readable:

12. properly segmented, consistently indented
13. generously commented (including the description of the approach)
14. self-explanatory naming of variables

All programing tasks have to be implemented in C/C++. Some of the tasks are to be implemented ALSO in a language with vector/matrix operation capabilities like Python or Matlab. These are marked with a P/M sign.
In these cases emphasis is on employing builtin functions of the language and avoiding loops. The algorithms do not have to be fully equivalent to their C variant but rather focusing on simplicity as primary goal.
Difference between the two approaches (C vs. Python/Matlab), if any, together with benefits, drawbacks and limitations should be discussed.
Submission beyond deadline is possible but penalized.

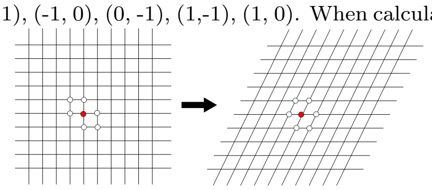
Week 02 - Random walk

Deadline: 20.03

1. Study the probability of getting lost(probability of not getting back to the starting position) in 1D, 2D and 3D (P/M)
   (a) Estimate and plot the probability distribution of the number of steps before returning "home" (P/M)
   (b) Prove that in 1D and 2D the probability is zero and in 3D it is 2/3 (P/M)
   Hint: Generate an ensemble of large walks and using cumulative summation estimate the dependence of return probability on walk length. Represent on a log-log scale the difference between the hypothetical and estimated probability. Draw your conclusions based on the observed trend.

2. (+15%) Repeat the experiments from last week's assignment's task 4a and 4b for a 2D triangular lattice (six first neighbors) (P/M)

   Hint: You can "create" a triangular lattice by using a regular square lattice that is imagined as if skewed horizontally by $\pi/6$ ($\square \rightarrow$ ▱), the six first neighbors are (0, 1), (-1, 1), (-1, 0), (0, -1), (1,-1), (1, 0). When calculating the distance use $x' = x+y/2, y' = y\sqrt{3}/2$.



3. Study the self-avoiding random walk in one and two dimensions (lattice sites can be visited only once)
   (a) $\langle d^2(N) \rangle$ dependence
   (b) probability distribution of the number of steps before getting blocked
   (c) probability of getting blocked

4. Study the cell size distribution for the Voronoi tessellation
   (a) 1D: show that it is of xe^{-x} type (P/M)
   (b) 2D: show that it is of $x^{5/2}e^{-x}$ type (P/M)