Experiment 1: Problem set

The assignment is worth **20 marks**.
The final submission should be a PDF file uploaded in Moodle. No email submissions.
Unless otherwise specified there is no need to include the source code.
Submission deadline: August 26, 2021 (Thursday), 12 pm

Plotting etiquette: Some pointers for a good plot. Make sure that you provide a title and label the axes (with units). The minimum readable font size is 24, with either Times New Roman or Arial font throughout (uniformity is important). You can use figure 3 in the notes as an example for the fonts and plots style. I have used Times New Roman as the font with a minimum size of 28.

1. (5 marks) Consider the rolling of 3 unbiased dice. The sum of the rolled dice can range from 3-18. Choose a number in this range and show analytically the probability of obtaining that number when the 3 dice are rolled. Write a program in MATLAB (or equivalent) to evaluate the same (following the same protocol as the coin toss experiment). Make a plot of the probability vs. the number of iterations in the range of 500-10000 iterations (with a step size of 500 iterations). In the second part of this question, choose five specific iterations: 500, 1000, 2500, 5000, 7500, and 10000. For each of these iterations, repeat the 'experiment' five times and record the probability. Output your result as a table and calculate the mean and standard deviation for each iteration. Explain your conclusions from the results.

2. (5 marks) Consider a bag containing 50 white and 50 black socks. A person randomly draws two socks from the bag, one after the other and in quick succession, and wears them without noticing the color. The process is repeated by 49 other people until the bag is completely empty. Now, if all these 50 people are assembled in a room, what is the

probability that 25 of them will be wearing socks of the same color?[1]

3. (10 marks) **Random networks and information pathways:** Consider a network of 100 people, where each person is in contact with four other persons. It will help if you imagine a 10×10 grid occupied by individuals, with each individual having four nearest neighbours. For persons at the edges and corners you can assume the appropriate number of connections. An 'information' originates randomly from a person located on the left edge of the grid (remember there are 10 people in the left edge). Trace the path taken by this 'information' to reach a person located in the right edge (it can be any one of the 10 persons on the right edge). The following are the constraints

   (a) Information can only flow from left to right, i.e. unidirectional flow.

   (b) Information flow can happen either up or down. If information 'leaves' from the top it 'enters' from the bottom in the same column. This is called a *periodic boundary condition*.

   (c) A person receiving the information can do one of three things: Not transmit at all (in which case the simulation stops), transfer to the person on their right, or transfer to the person above or below. You have to use random numbers to assign probabilities for these events, with the stipulation that their sum must be 1. Also, the probabilities should change from person to person.

   (d) The simulation stops when you either reach a person on the right edge or a person who does not transmit.

   Run enough simulations and output at least **five** paths and represent your results **visually**. In your output, a maximum of two paths can terminate within the grid but at least three should go all way to the right edge. [2]
   What sort of real-life situation(s) do you think this model would be suited for? Suggest suitable variations/modifications for achieving this. Keep your answer brief, approximately half-a-page.

[1] I could not solve this problem analytically and had to use MC simulations. Please note that you need at least 10000 iterations to get reasonable data.

[2] This question is inspired by the book *The Premonition* by Michael Lewis.