MM3110 Assignment 1

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1 Problem 1

I chose the sum of the rolled dice to be 10. The table below shows the possible combinations that sum to 10 and the number of ways in which each combination can be obtained.

(1,3,6)	$3! = 6$
(1,4,5)	$3! = 6$
(2,2,6)	$\frac{3!}{2!} = 3$
(2,3,5)	$3! = 6$
(2,4,4)	$\frac{3!}{2!} = 3$
(3,4,3)	$\frac{3!}{2!} = 3$

Therefore, the total number of possible combinations that sum to 10 is 27.
The total number of possible outcomes on rolling three dice is $6^3 = 216$.
Therefore, the probability of obtaining 10 when three dice are rolled is $\frac{27}{216} = 0.125$

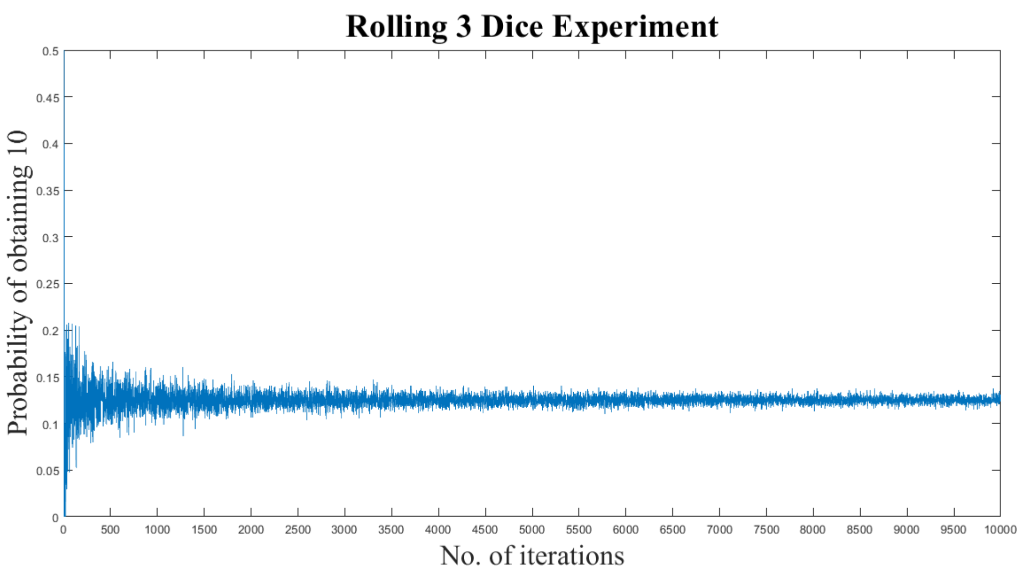

Figure 1: Plot of the probability vs. the number of iterations

The probability obtained from Monte Carlo simulations tends towards 0.125, clearly matching our known result that the probability of obtaining 10 as the sum of the rolled dice is 0.125.
On repeating the experiment five times for 500, 1000, 2500, 5000, 7500, and 10000 iterations, the table below (Figure 2) is obtained. I have included the mean and standard deviation for each iteration in it.

2 Problem 2

In order to randomly draw two socks from a bag of 50 black and 50 white socks, I generated a vector of dimension two using rand, and assumed that two black socks were drawn if both the entries of the vector

iters_heading	Round1_Probability	Round2_Probability	Round3_Probability	Round4_Probability	Round5_Probability	means	stds
{'500' }	0.106	0.114	0.132	0.13	0.13	0.1224	0.011696
{'1000' }	0.125	0.141	0.129	0.125	0.13	0.13	0.0065574
{'2500' }	0.1188	0.1168	0.1212	0.1336	0.1308	0.12424	0.0074972
{'5000' }	0.1252	0.1332	0.1178	0.1288	0.1274	0.12648	0.005665
{'7500' }	0.12107	0.13173	0.12627	0.12813	0.1196	0.12536	0.0050185
{'10000'}	0.124	0.1243	0.1249	0.1244	0.1254	0.1246	0.00055227

Figure 2: Table for the second part

were greater than or equal to 0.5, two white socks were drawn if both the entries of the vector were less than 0.5 and a white and a black sock in all other cases.
If we ignore the total sum of white socks and the total sum of black socks finally worn by all 50 people, the probability that 25 of them will be wearing socks of the same color is approximately 0.115.

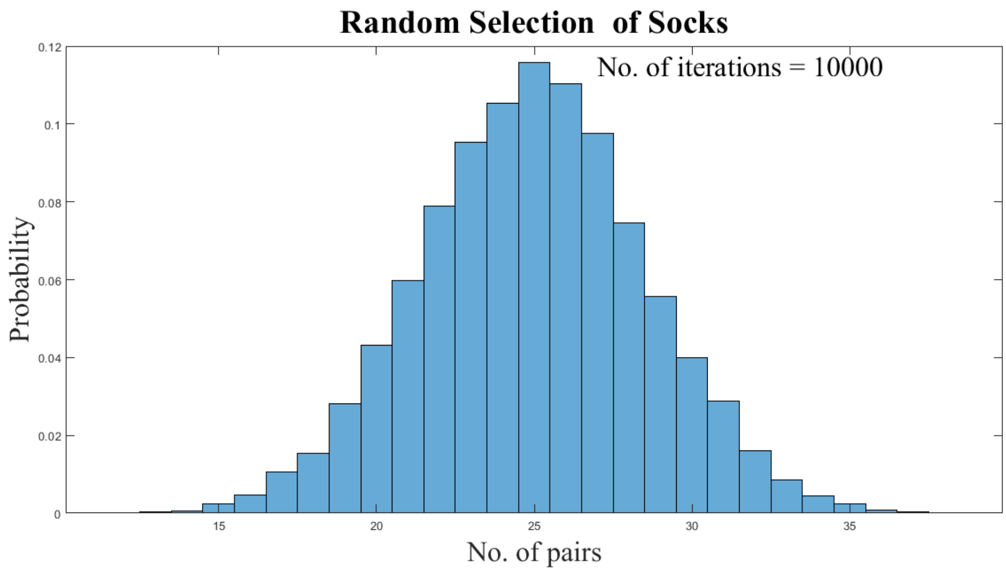

Figure 3: Histogram of the number of pairs (white or black) obtained when two pairs are randomly picked from a bag containing 50 white and 50 black socks, ignoring the total sum of white socks and the total sum of black socks finally worn by all 50 people.

Since I'm using rand to draw socks, there is a possibility that the final 100 socks drawn don't have 50 black and 50 white socks. This can be seen by setting counters b_socks and w_socks to 50 each and reducing them as the draws are made. The no. of black and white socks left can be stored for each iteration to verify that the total number of black and white socks drawn are each 50.
Using this method to examine the case of no replacement, I observed that the total number of black socks and white socks were not 50 each.
I made the same observation when I repeating the same experiment for 100 black and 100 white socks.

3 Problem 3

I started by making a 10×10 grid with a layer of padding (marked by the red region) all around, shown in (Figure 4).
To randomly decide where the information is going to be passed, I used a 1×4 array of random numbers using the rand function. If the index of the maximum of this array is 1, the information is passed to the person above. If it is 2, the information is passed to the person below. If it is 3, the information is passed to the person on the right and if it is 4, the information is not passed on.
I used while loops to ensure that the information doesn't enter the padding region and obeys the mentioned boundary conditions.
I obtained the following five paths, shown in (Figure 5).
This model could be used to represent the spread of COVID-19 in a neighbourhood by taking into account

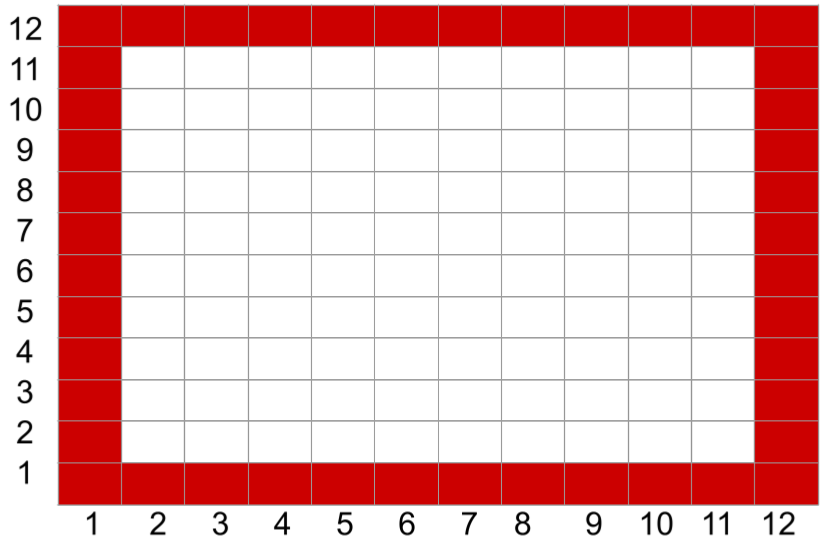

Figure 4: 10×10 grid with adding

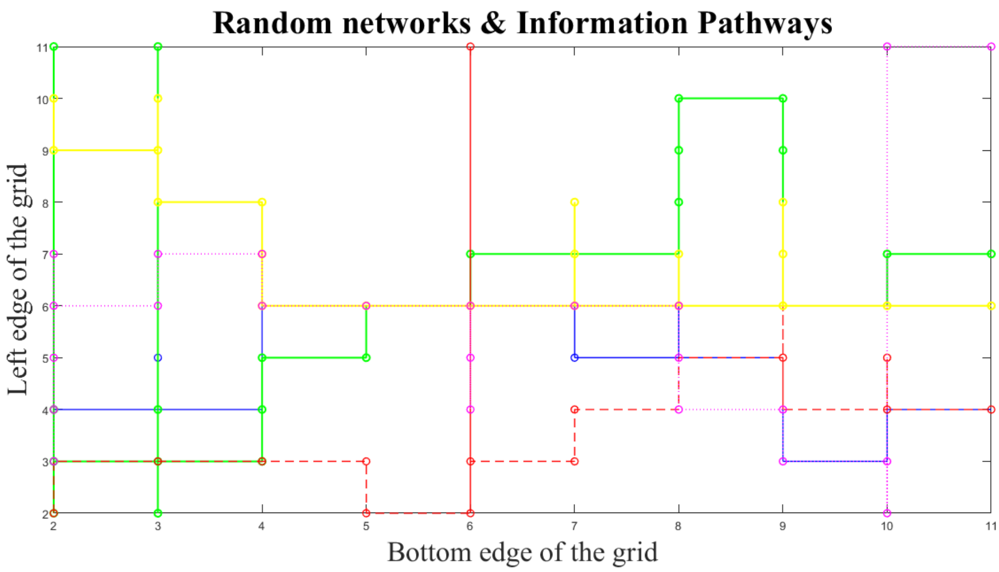

Figure 5: The output obtained in Problem 3

parameters like the immunity of the inhabitants, the frequency and scale of social in-person interactions and whether they choose to follow the protocols provided by the Government.