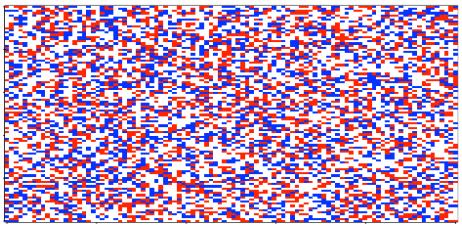
Atul Lanka
Stat 133 HW#6

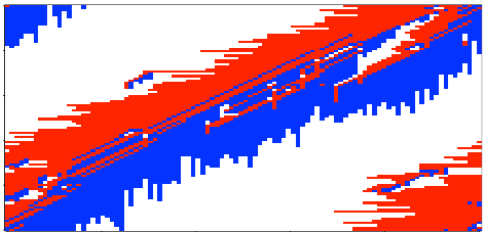
Using the functions in the bml_functions.R file, there are certain experiments that can be carried to study certain trends present in this traffic model.

Representation of gridlock using a 100x100 matrix and assigning the density 'p' to equal 0.5:

Initial state:

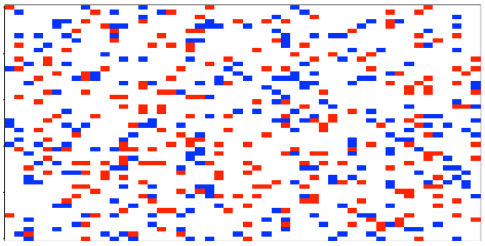


Gridlock:

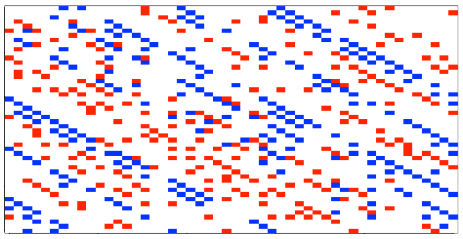


Representation of a system that does not reach gridlock after the maximum number of 50,000 steps for a 50x50 grid and density p = 0.2

Initial State:



After max. number of steps :



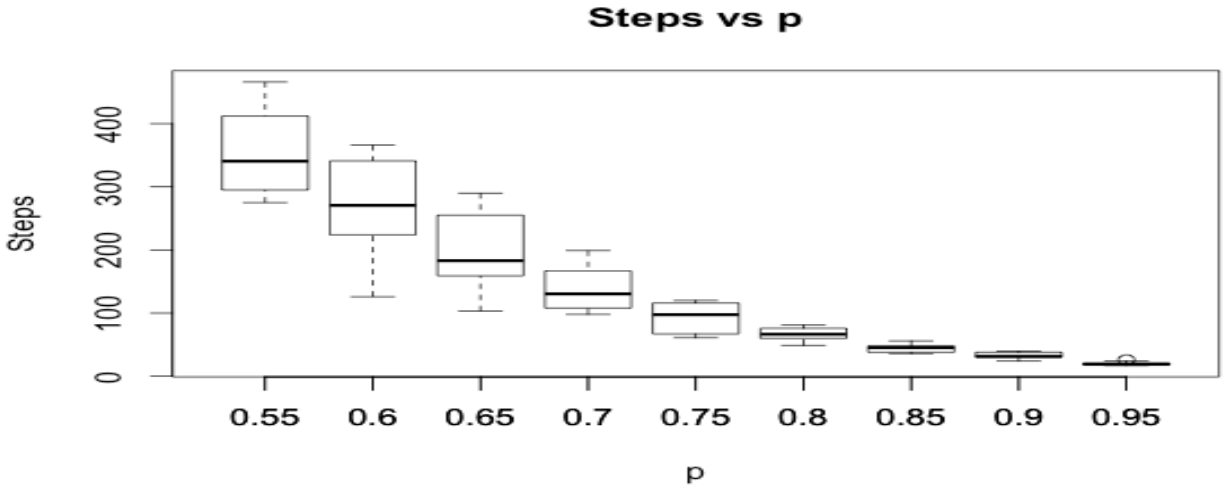
Case 1: Investigating the impact of increasing or decreasing 'p' or density in the function on the number of steps taken to reach gridlock, keeping the grid's dimension constant at 100x100 (increasing the density from 0.25 to 0.95, by 0.05 each time; for each density, the simulation is repeated 10 times)
NOTE: The criteria to determine whether the grid is free-flowing or not is that if a minimum of 40% of the 10 readings hit gridlock, the system is not free-flowing anymore.

ALL SIMULATIONS ARE DONE WITH 10 REPITITIONS.

Table to compile all the results:

p	Number of steps									
0.25	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
0.3	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
0.35	50000	751	50000	50000	50000	50000	50000	50000	50000	50000
0.4	10553	18306	9104	5712	6080	832	14246	612	16413	495
0.45	570	329	410	377	361	410	379	2947	652	736
0.5	544	760	5760	370	927	265	693	350	765	261
0.55	342	343	339	412	332	420	292	275	295	466
0.6	224	346	247	294	341	126	366	326	246	199
0.65	154	161	261	255	290	184	183	103	183	159
0.7	167	98	130	199	121	108	141	174	103	131
0.75	101	67	94	119	114	116	61	88	67	120
0.8	76	63	81	69	64	69	54	76	60	49
0.85	45	48	56	36	38	38	46	46	45	53
0.9	30	31	38	32	24	30	40	38	29	37
0.95	18	19	18	19	18	17	21	24	20	26

These values, including the repetitions, can be represented in a box and whisker plot (for clarity purposes, the graph only begins at p=0.55):



Additional information about this plot are available in summary.table in the bml_simulation.R file

Therefore, we can see that as 'p' increases, the grid first transitions from a free flowing state to a gridlock and with each increment, the number of steps taken to reach gridlock reduces. Furthermore, the critical density is between 0.35 and 0.4.

Testing this with a 10x10 matrix as well to compare and verify the first set of readings and even conclude if the critical density of each grid is more or less similar:

- The values for this test are available in table.1 in the bml_simulation.R file
- Additional statistical information for this test are available in summary.table.1 in the bml_simulation.R file
- Here, the critical density is between 0.4 and 0.45. So, as the grid increases in size, it can be assumed that the critical density falls down to value between 0.3 and 0.35 (approximately 0.32)

Case 2: Investigating the impact of 'r' and 'c' in the grid's dimension on the number of steps taken, giving a constant density 'p' of 0.5

Conclusion: Keeping the density constant, and changing the square grid's dimension from 10x10 to 50x50 and 100x100, it was observed that increasing the grid's size does decrease the chances of the system being free-flowing (decrease in the number of steps.

Quantitative proof can be seen by looking at table.2 in the bml_simulation.R file

Case 3: Investigating if using a rectangle grid, while keeping the area constant, would change the number of steps'

Conclusion: Comparing a 10x10, 20x5 and a 25x4 grid with a constant density of 0.7 that as the difference between the number of rows and columns decreased, the grid became more free-flowing in nature (decrease in the number of steps).

Quantitative evidence can be observed by looking at table.3.compiled in the bml_simulation.R file

Case 4: Investigating if a transposed grid would have any effect on the number of steps taken

Conclusion: From using a 10x50 and a 50x10 grid, with a constant density of 0.7, it is observed that there isn't much variation in the number of steps taken to reach gridlock. Therefore, transposing the grid does not impact the simulation to a great extent.

Quantitative evidence is given in table.4.compiled in the bml_simulation.R file