Simulation Study of the BML Traffic Model

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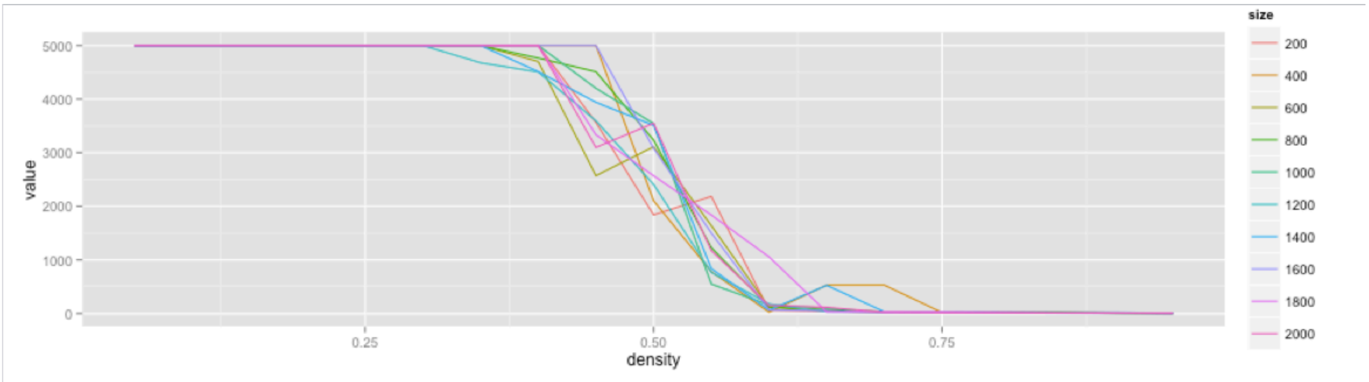
In this project, we implemented the BML traffic model, a statistical model used to study traffic flow with respect to the initial density of cars. This simulation, done using RStudio, executed a total of 5000 time steps (two moves, one for the red cars and one for the blue cars, was executed per time step) over varying initial car densities and grid sizes. If you notice the table attached below, 18 different car densities were considered (the values 0.5 to 9.5, with a step size of 0.5) and 10 different grid sizes were considered (the values 200 to 2000, with a step size of 200). In order to ensure accuracy, each value was calculated internally in the simulation 10 times, and the output value stored is the average of all ten tests.

The results of the simulation study were very insightful. The data shows that free-flowing traffic was most common with density values less that 0.3, while traffic jams seemed almost inevitable for values greater than about 0.5. For the values inbetween, there was a mixture of jams and free-flowing traffic – based on the randomized placement of initial cars, some would result in jams while others would still have free-flowing traffic past 5000 steps. With regard to the transitions in terms of size of the grid, I had initially hypothesized that larger grid size would see fewer traffic jams because there was more space available, but based on the data, this was not the case. Rather, the results indicate that grid size does not have much affect on transition patterns – this outcome is logical because, although there is more space in larger grids, since the density remains the same, the proportion of space is also the same. However, it is important to note that there is a high margin of error because of how limited our simulation study is. Because each simulation is initialized randomly, it is important to have a large test sets so that trends and generalizations can be made about the data. This simulation alone, run locally, took 18+ hours to complete, and is only a fraction of the size of the simulation studies from the references that were provided. Thus, all conclusions drawn in this particular simulation study is based on this data only, and may or may not be valid generalizations that apply to larger sets of data.

Car Density and Traffic Quality



The plot above visually represents the data below. Here, the x-axis shows the varying densities, while the y-axis shows the number of steps taken before a traffic jam occurs. Note that the maximum amount of steps possible is 5000, and thus, grids reaching 5000 steps indicate free-flowing traffic. The different lines represent the distinct grid sizes – as indicated by the key to the right, grid sizes were incremented by 200. The actual data is given below for convenience.

	row.names	200	400	600	800	1000	1200	1400	1600	1800	2000
1	0.05	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0
2	0.1	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0
3	0.15	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0
4	0.2	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0
5	0.25	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0
6	0.3	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0
7	0.35	5000.0	5000.0	5000.0	5000.0	5000.0	4677.4	5000.0	5000.0	5000.0	5000.0
8	0.4	5000.0	5000.0	4699.2	4765.0	5000.0	4504.5	4511.5	5000.0	5000.0	5000.0
9	0.45	3564.6	5000.0	2570.0	4510.1	4201.2	3594.7	3939.6	5000.0	3334.7	3097.5
10	0.5	1838.9	2102.7	3109.8	3234.2	3544.1	2406.4	3510.2	3080.9	2569.4	3549.5
11	0.55	2184.1	779.5	1639.5	1228.3	548.2	767.4	838.1	1501.5	1836.9	1171.3
12	0.6	59.4	25.5	116.0	125.2	158.7	178.6	62.7	68.8	1056.2	151.8
13	0.65	41.8	528.5	44.7	70.9	101.9	33.6	525.3	50.0	29.6	115.4
14	0.7	35.0	528.8	17.7	32.9	24.2	27.2	32.4	23.3	25.3	24.3
15	0.75	21.6	17.5	18.1	20.6	20.3	18.2	21.8	23.0	26.5	16.7
16	0.8	24.8	14.7	11.9	13.3	16.7	17.4	12.0	16.3	18.3	15.1
17	0.85	11.2	16.3	13.2	16.1	11.1	12.8	13.4	9.3	11.8	11.3
18	0.9	8.4	8.3	10.0	8.4	10.8	9.3	13.9	5.8	10.5	12.2
19	0.95	10.0	7.3	6.3	4.8	7.2	6.7	6.9	4.6	7.2	5.0