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STAT 133

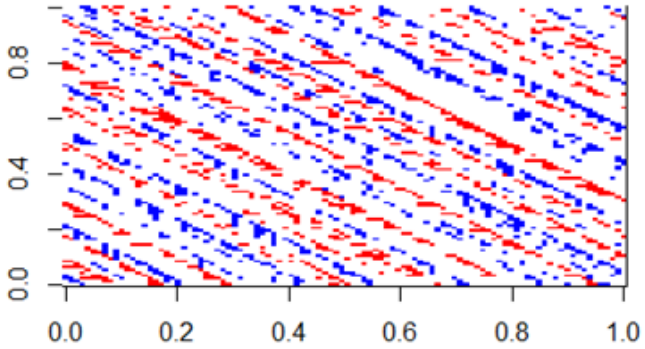
BML Simulation (Comment Write-up)

Questions #1-#3: *For what values of p, the density of the grid, did you find free flowing traffic and traffic jams? Did you find any cases of a mixture of jams and free flowing traffic? How many simulation steps did you need to run before the observing this behavior? Does the transition depend on the size or shape or the grid?*

For this write-up, I observed the flow of traffic at various parameter values:

- Size of grid: 100 spaces, 2500 spaces, 10000 spaces
- Shape of grid:
  - Square: 10x10, 50x50, 100x100
  - Wide: 20x5, 100x25, 200x50
  - Long: 5x20, 25x100, 50x200
- Densities (p): 0.20, 0.32, 0.50, 0.75
- Number of time steps for each simulation: 1000 time steps

At a density of 20%, there was free flowing traffic at all sizes and shapes of the grid, and this was observed in all 20 simulations done. Gridlock was never reached after 1000 time steps.



100x100 (p=0.20): Free-flowing traffic

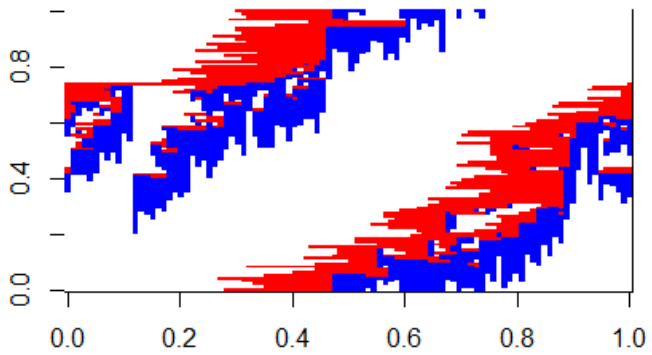
At a density of 35%, the grid did not reach grid lock when the grid size was small (100 spaces) for all shapes. However, after increasing the grid size, the majority of simulations (90%-100%) reached gridlock, on average, between ~150 and ~280 time steps.

Table 1: Traffic at 35% density

Grid Size	Mean time steps to gridlock	# of simulations reaching gridlock	# of simulations in free-flow	% reach gridlock
100 spaces				
10x10	NA	0	20	0%
20x5	NA	0	20	0%
5x20	NA	0	20	0%
25000 spaces				
50x50	158.1	18	2	90%
100x25	192.1	20	0	100%
25x100	194.4	18	2	90%

Table 1 (Continued)

Grid Size	Mean time steps to gridlock	# of simulations reaching gridlock	# of simulations in free-flow	% reach gridlock
10000 spaces				
100x100	273.4	20	0	100%
200x50	250.5	20	0	100%
50x200	265.2	20	0	100%

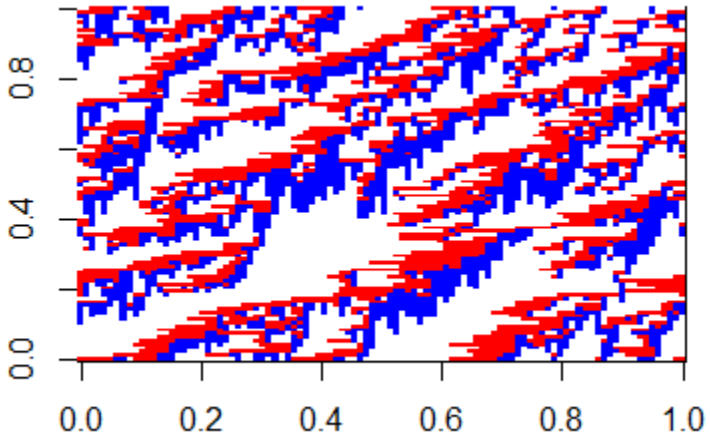


100x100 (p=0.35): Grid-lock

At a density of 50%, free-flowing traffic was still observed the majority of the time in the smaller grids, though gridlock did occur (10%-45%) of the simulations. By the grid size of 2500 spaces, all simulations resulted in a gridlock after 1000 time steps.

Table 2: Traffic at 50% density

Grid Size	Mean time steps to gridlock	# of simulations reaching gridlock	# of simulations in free-flow	% reach gridlock
100 spaces				
10x10	23.7	9	11	45%
20x5	43.0	4	16	20%
5x20	63.0	2	18	10%
2500 spaces				
50x50	67.7	20	0	100%
100x25	68.4	20	0	100%
25x100	63.0	20	0	100%
10000 spaces				
100x100	89.7	20	0	100%
200x50	88.5	20	0	100%
50x200	92.0	20	0	100%

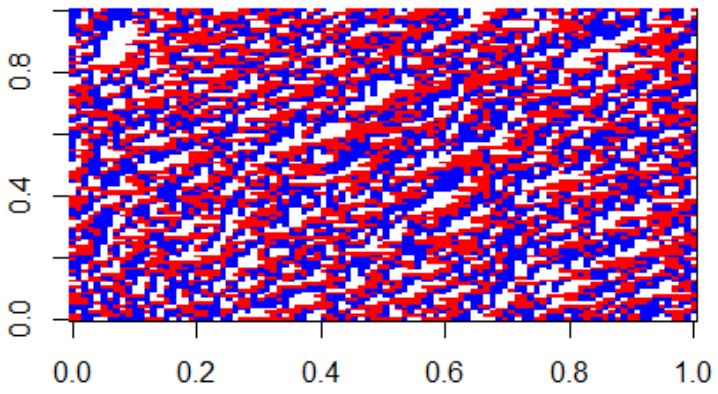


100x100 (p=0.50): Grid-lock

At a density of 75%, there were traffic jams at all sizes and shapes of the grid, but free-flowing traffic did occur (albeit infrequently) when the simulation was run multiple times for non-square, small grids.

Table 3: Traffic at 75% density

Grid Size	Mean time steps to gridlock	# of simulations reaching gridlock	# of simulations in free-flow	% reach gridlock
100 spaces				
10x10	7.9	20	0	100%
20x5	15.4	18	2	90%
5x20	12.1	18	2	90%
2500 spaces				
50x50	16.3	20	0	100%
100x25	18.3	20	0	100%
25x100	18.3	20	0	100%
10000 spaces				
100x100	21.7	20	0	100%
200x50	23.8	20	0	100%
50x200	22.7	20	0	100%



100x100 (p=0.75): Grid-lock

Conclusions

The time it took for a grid to reach gridlock was dependent on density, size of grid, and the shape of the grid. Gridlock was not observed until about 35%, though initially only in the larger grids (2500 and 1000 spaces). Generally, the smaller the grid, the less likely it would reach gridlock. Free-flowing traffic was observed in the smallest grids, even at higher densities (e.g. 35%, 50%, 70%). For grids that did experience gridlock, the larger the grid, the more time steps were needed to elapse before reaching this traffic behavior. Lastly, traffic behavior was also dependent on the shape of the grid. The average number of time steps required for the square grids to reach gridlock was generally fewer than those required for the long and wide grids.