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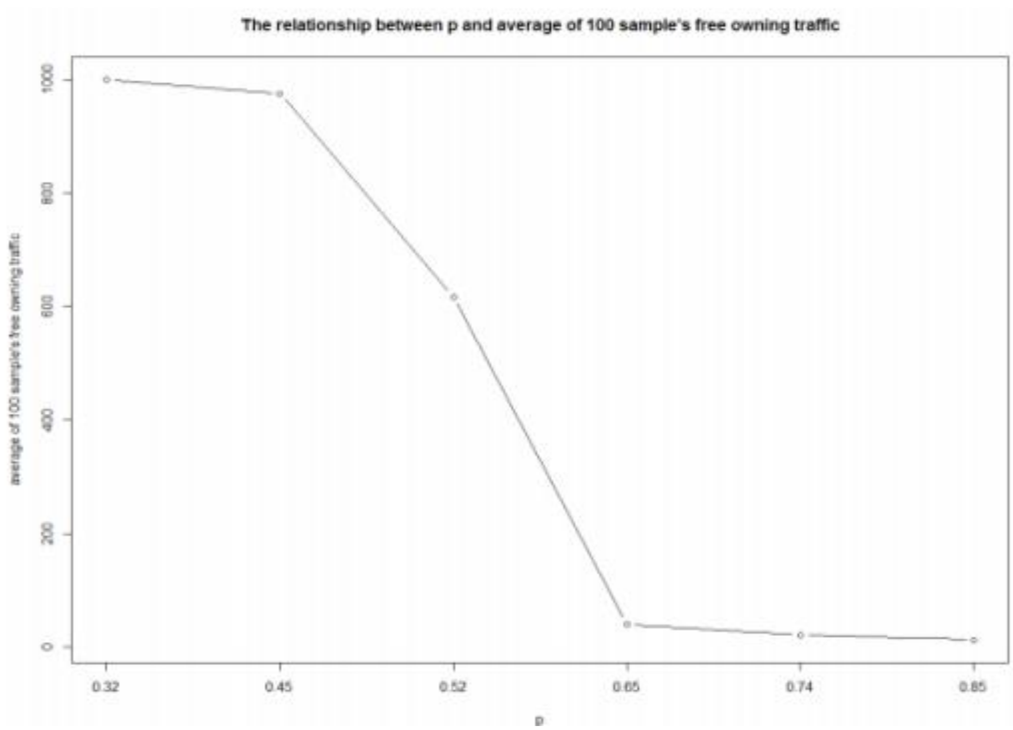
The BML simulation study shows that the simulation function (bml.sim (r,c,p)) shows # of steps taken until it gets gridlock (traffic jam). If the step equals to 1000, a maximum step in my simulation, I consider it as free flowing traffic, because "1000 steps", is considered reasonable large enough to show the free flowing traffic for this experiment.

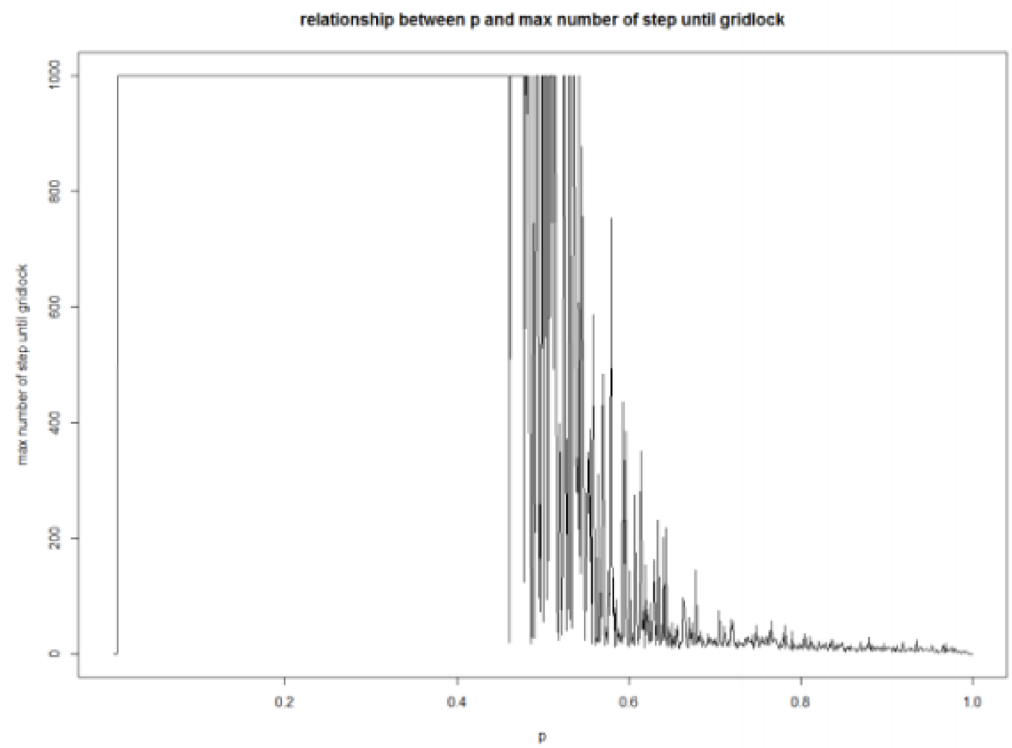
1. For what values of p, the density of the grid, did you find free owing traffic and traffic jams? Did you find any cases of a mixture of jams and free owing traffic?

For this experiment I set the particle number of 400 and 100. For 20 * 20 sample, when p is smaller than 0.38, which means the density of the traffic was less than 0.38, all of the 1000 replicates showed same result of 1000. This means all of the 1000 simulations went through 1000 steps each and never reached Gridlock, meaning there is a free flowing traffic under the given assumption. Therefore, p<0.36 and p=0.36 will always show free owning traffic. When p is given as 0.38, this changes. There exists one sample out of 1000 samples that has one traffic gridlock, meaning only 999 of the sample was free flowing under the given assumption. In 10o sample the same gridlock happens when p equals 0.39. We can reasonably assume from this experiment that for small sample size, around 100 to 400, there is a transition from complete free flowing traffic to one or two samples showing gridlock starting at the point where density of traffic lattice is higher than or equal to 0.39. Briefly explaining, the possibility of gridlock increases along with the density, p, while the possibility of free flowing traffic decreases with higher p.



2. How many simulation steps did you need to run before observing this behavior?

When p is assigned a value of 0.38, for 400 mixture of red and blue and empty particles, 1000 repetition of simulation shows one case of gridlock and rest of free flowing traffic. If p is changed to 0.4, the number of gridlock cases increase to 4, while keeping everything else constant. In 100 particles were simulated 1000 times with density level, p=0.39, there was 1 gridlock; for p = 0.4 two gridlocks occured. It is difficult to verify the exact maximum number of simulations required, because the simulation uses rep function primarily, but we can know for sure that as p increases, possibility of gridlock increases.



3. Does the transition depend on the size or shape of the grid?

Grid Size (r x c)	p	Traffic Jam	Free Owning Traffic
10 x 10	0.8	1000	0
5 x 20	0.8	876	124
4 x 25	0.8	603	397
2 x 50	0.8	1	999

When p=0.8 with 10*10 shaped lattice, there were 0 free flowing traffics, meaning gridlock.

When p=0.8 with 5 *20 shaped lattice, there were 124 free flowing traffics.

When p=0.8 with 4 * 25 shaped lattice, there were 397 free flowing traffics.

When p=0.8 with 5 x 20 shaped lattice, there were 999 free flowing traffics.

In other words, as the shape of the lattice gets narrower, and more linear, the possibility of free flowing traffic increases regardless of the number of particles in the lattice.

Grid Size (r x c)	p	Traffic Jam	Free Owning Traffic
10 x 10	0.8	1000	0
5 x 20	0.8	876	124
4 x 25	0.8	603	397
2 x 50	0.8	1	999

When p=0.5 with 5*5 shaped lattice, there were 7 gridlocks, 993 free flowing traffics.

When p=0.5 with 10*10 shaped lattice, there were 363 gridlocks, 637 free flowing traffics.

When p=0.5 with 20*20 shaped lattice, there were 886 gridlocks, 114 free flowing traffics.

In other words, as the size of the grid gets larger, the possibility of free flowing traffic decreases.