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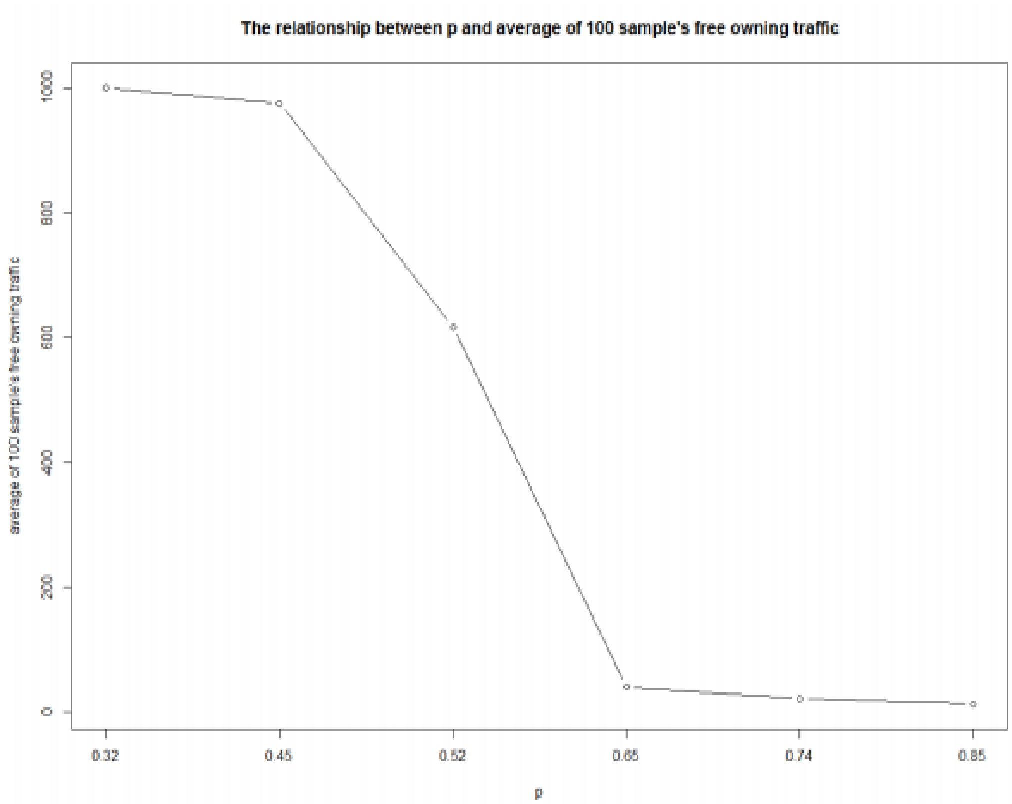
In my BML simulation study, the simulation (bml.sim (r,c,p)) shows # of steps taken until it gets gridlock (traffic jam). If the step equals to 1000, a maximum step in my simulation, I consider it as free owning traffic, because "1000 steps", is enough to show the free owning traffic

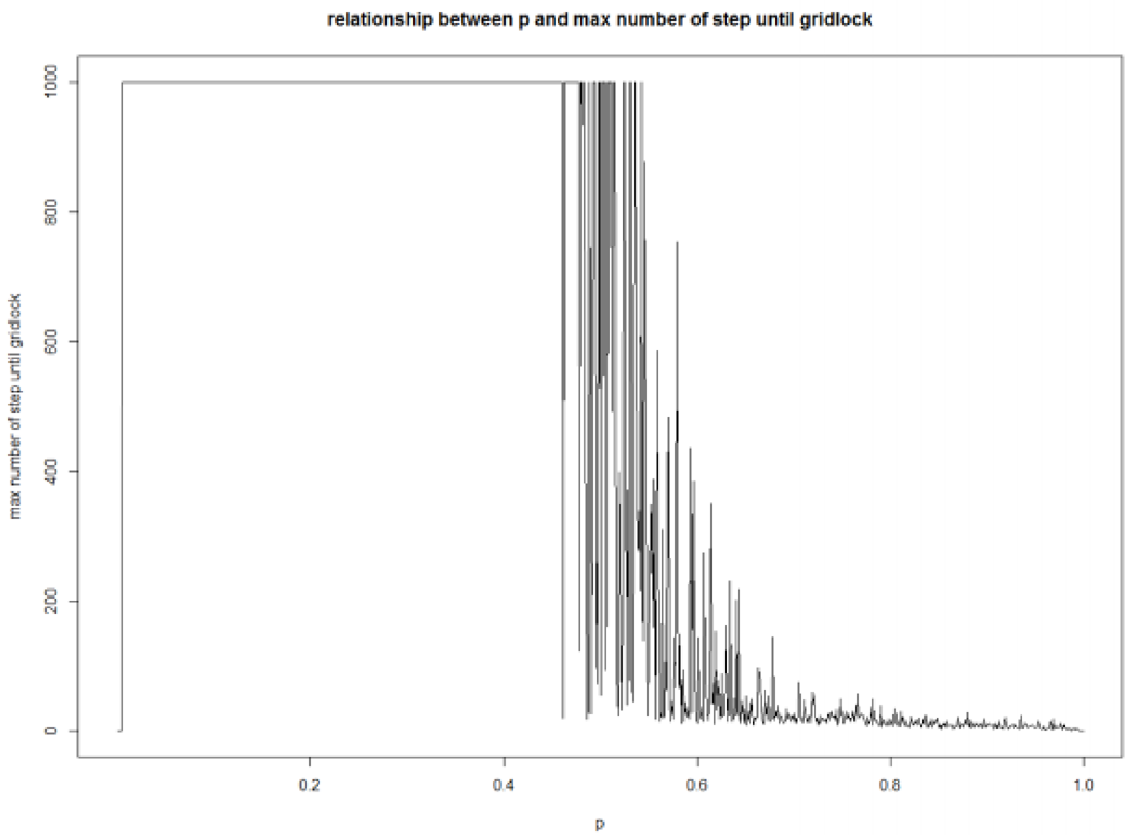
1. **For what values of p, the density of the grid, did you find free owing traffic and traffic jams? Did you find any cases of a mixture of jams and free owing traffic?**

   In order to answer this question, I went through the simulation of 20 x 20 sample and 10 x 10 sample and 'replicated' the simulation 1000 times. In 20 x 20 sample, p is less than 0.38, there were always free owning traffic, which means 1000 samples all showed "1000 steps". Therefore, $p<0.32$ and $p=0.32$ will always show free owning traffic. However, when $p = 0.38$, there was 1 traffic jam, which means other 999 samples showed "1000 steps". In 10 x 10, when $p = 0.39$, there was 1 traffic jam. As a result, it is concluded that when p is greater than or equal to 0.38 and less than 1.0, a sample starts showing a mixture of jams and free owning traffic. In conclusion, as p increases, the chance of getting free owning traffic goes lower.



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

   Since replicate function was used, in 20 x 20 of 1000 samples, when p=0.38, as it is mentioned, there was 1 traffic jam out of 1000. When p=0.40 with 20 x 20 of 1000 sample, there was 4 traffic jam. In 10 x 10 of 1000 samples, when p=0.39, there was 1 traffic jam. When p=0.40 there was 2 traffic jam. It means, because I used "replicate" function, I cannot verify how max steps I have run. As a result, as p goes higher, the chance of getting the traffic jam (gridlock) get higher.



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

I set p = 0.8. When p= 0.8 with 10 x 10 samples, there was no free owning traffic, which means all 1000 different samples of 10 x 10 were all traffic jammed. When p=0.8 with 5 x 20, there were 124 free owning traffics out of 1000 samples. When p=0.8 with 4 x 25, there were 397 free owning traffics. When p=0.8 with 5 x 20, there were 999 free owning traffics.

Therefore, as a rectangle (shape of sample) gets narrower, the chance of getting free owning traffic increases.

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

As the table shown, as the size of Grid gets larger in square shape (r = c), the chance of getting free owning traffic decreases.