Analysis of Simulation
Sprint - 2

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Contents

0.1 Introduction

An artificial agent's movement activity has been studied in this analysis. The agent will follow Markov principle to move from one place to another and generate different activity data. In reality, these data can be captured using sensors and kept in a database. We have performed simulation to analyze this movement using GAMA. GAMA comes with lot of inbuilt packages to facilitate the simulation and helps generating data from simulation for further analysis. Following sections describe about the simulation and analysis. Simulation includes problem formulation, UML diagram of the formulated problem, Markov process , data generation and heatmap. In analytics section, basic statistics such as variance, histograms,boxplot are discussed taking the simulated data.

0.2 Simulation

In this simulation model an extra target(entry/exit) has been added and, the agent visits that target based on a probability value drawn from the poisson distribution. The extra target acts a an entry/exit point and the movement between rest of the targets are based on markov process.

0.2.1 Simulation Model

1. Formation of a 50×50 grid
2. Five targets are chosen inside the 50×50 grid space
3. An agent would move between entry/exit point and rest of the targets based on a probability value picked from the poisson distribution(see equation 1).
4. The movement between 4 targets, excluding special target is based on markov process.

0.2.2 Poisson distribution

Poisson distribution is a discrete probability distribution that expresses the probability of a given number of events occurring in a fixed interval of time and/or space if these events occur with a known average rate and independently of the time since the last event (Frank A. Haight (1967). The Poisson distribution is popular for modelling the number of times an event occurs in an interval of time or space.

Probability of events for a Poisson distribution:

The probability of observing x events in an interval is given by the equation:

$$P(x) = e^{-\lambda}\frac{\lambda^x}{x!} \tag{1}$$

where, λ is the average number of events per interval.

0.2.3 Heatmap

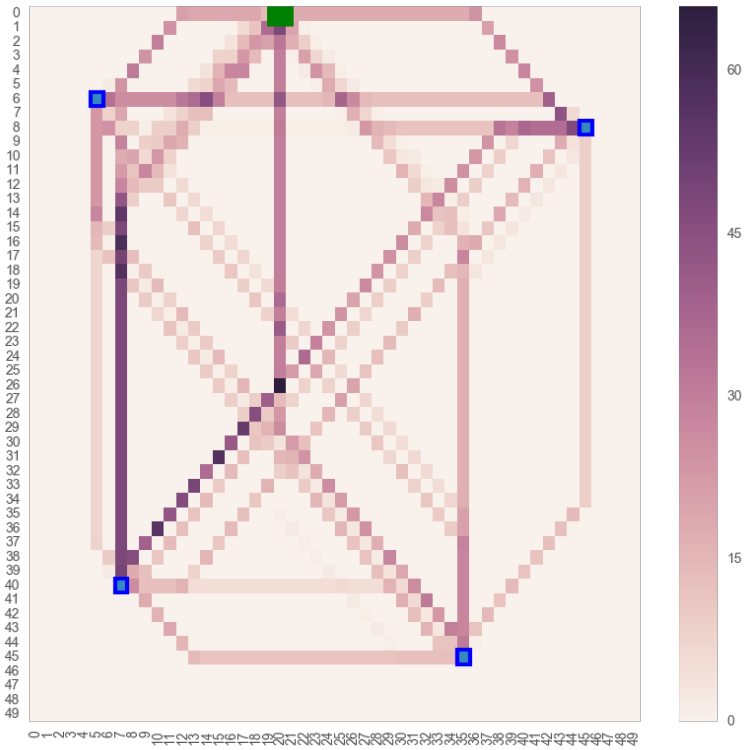

Figure 1: Heatmap generated from the agent movement. Target points are represented in blue and darker color represents prominent movement of agents on respective grids.

0.3 Analytics

In this part of the report, some analysis is performed on the simulated data. Following sections cover basic statistics such as total frequency, variance. For this analysis, 5 - 6 times simulations are performed for generating the frequency data which describes about number of times a target has been hit by an agent. There is an entry or exit point where agent's movement follows Poisson distribution.

0.4 Barplot

It describes about total number of times a target has been hit during 5 or 6 simulations with changing the value of *lambda* and K.

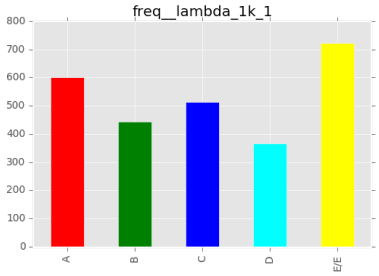

Figure 2: Simulation - 1

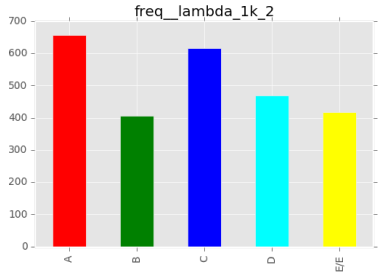

Figure 3: Simulation - 2

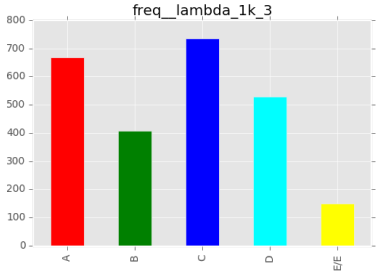

Figure 4: Simulation - 3

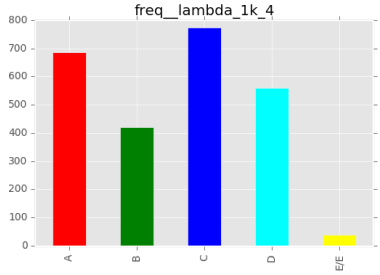

Figure 5: Simulation - 4

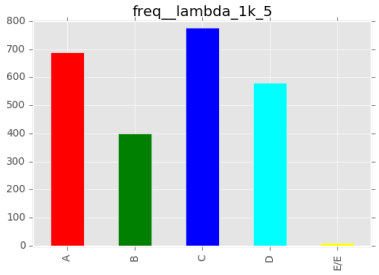

Figure 6: Simulation - 5

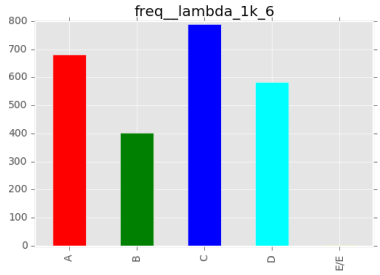

Figure 7: Simulation - 6

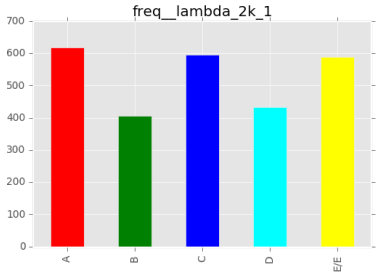

Figure 8: Simulation - 1

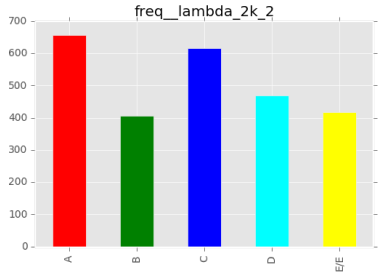

Figure 9: Simulation - 2

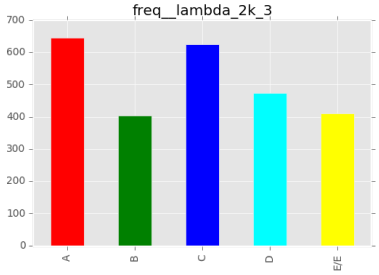

Figure 10: Simulation - 3

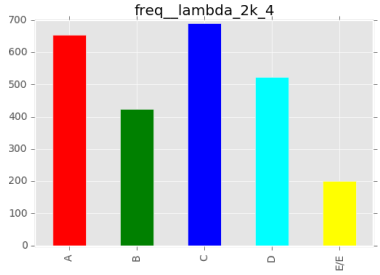

Figure 11: Simulation - 4

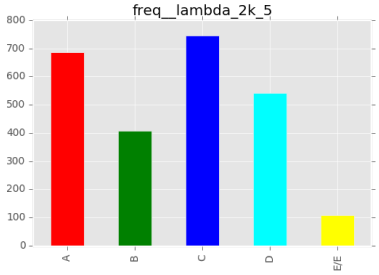

Figure 12: Simulation - 5

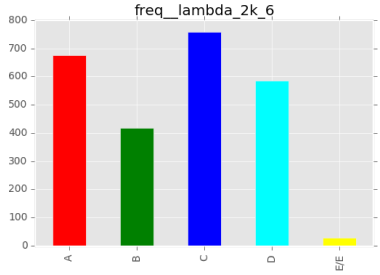

Figure 13: Simulation - 6

0.4.1 Inferences

1. Probabilty of going to E/E point of an agent is decreasing with varying $k = 1 to 6$ and keeping $lambda = 1$ and
2. The probability of going to E/E point takes more time (Number of simulations) to die out if we increase the value of *lambda*
3. At $Simulation - 6$, $lambda = 1$ and $k = 6$ the simulation becomes Sprint -1 where no E/E point is present.

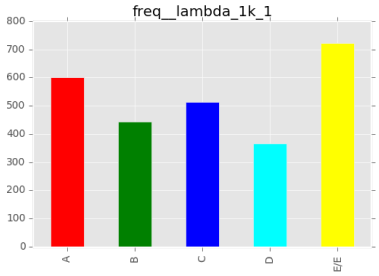

Figure 14: Simulation - 1

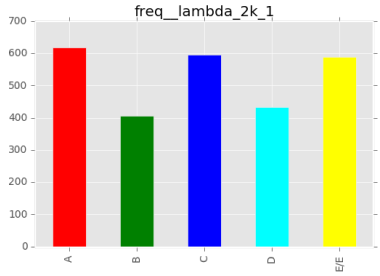

Figure 15: Simulation - 2

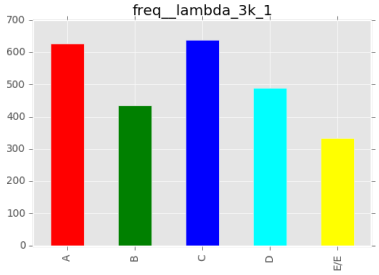

Figure 16: Simulation - 3

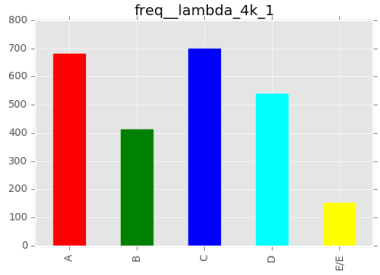

Figure 17: Simulation - 4

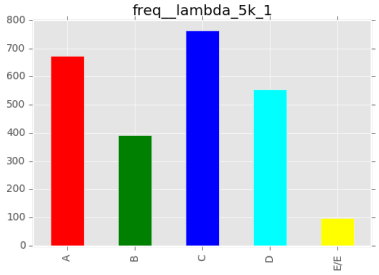

Figure 18: Simulation - 5

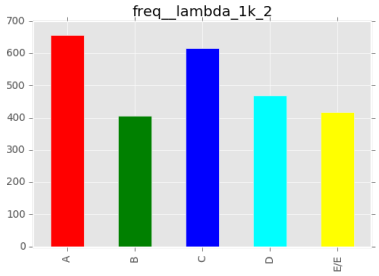

Figure 19: Simulation - 1

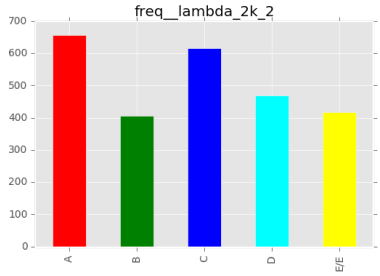

Figure 20: Simulation - 2

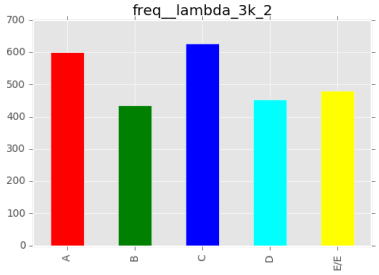

Figure 21: Simulation - 3

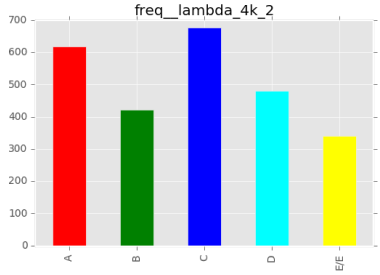

Figure 22: Simulation - 4

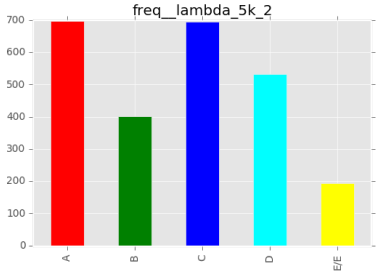

Figure 23: Simulation - 5

0.4.2 Inferences

1. Probabilty of going to E/E point of an agent is decreasing with varying $lambda = 1 - 5$ and keeping $k = 1 - 2$.
2. The probability of going to E/E point takes more time (Number of simulations) to die out if we increase the value of *lambda*

0.5 Variance

Variance has been studied to see the variance of hitting a target during 5 or 6 simulations.

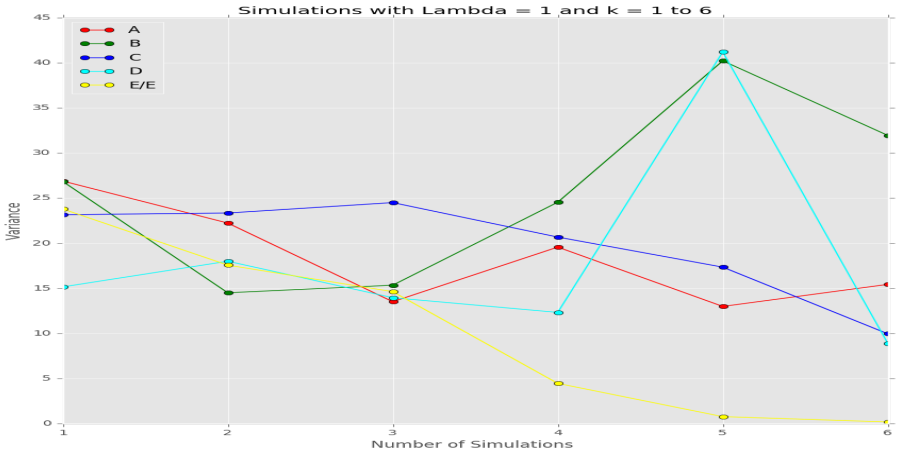

Figure 24: Variance

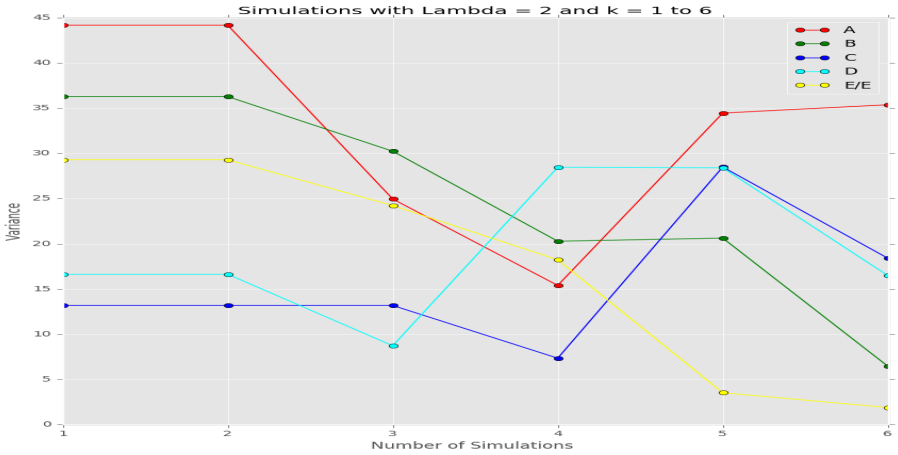

Figure 25: Variance

0.5.1 Inferences

1. Variation of going to E/E point of an agent is decreasing with varying $lambda = 1 - 2$ and keeping $k = 1 - 6$.
2. High variation gap between (B,D) and (A,c) with $lambda = 1$ and $k = 5$

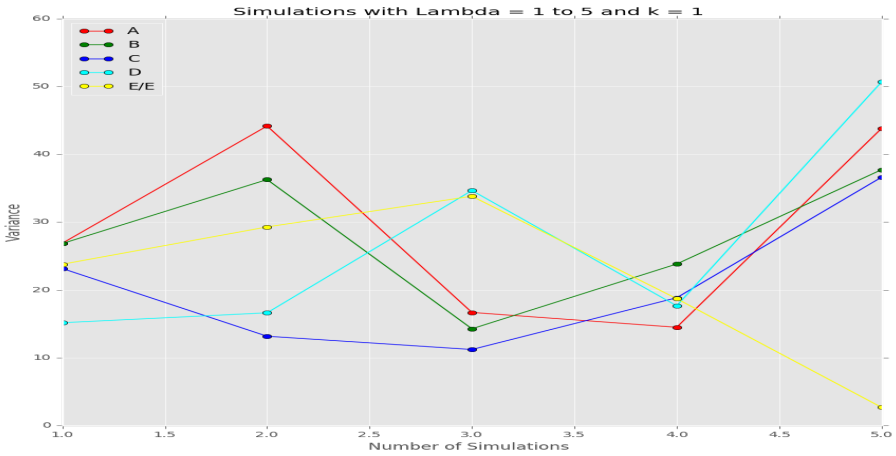

Figure 26: Variance

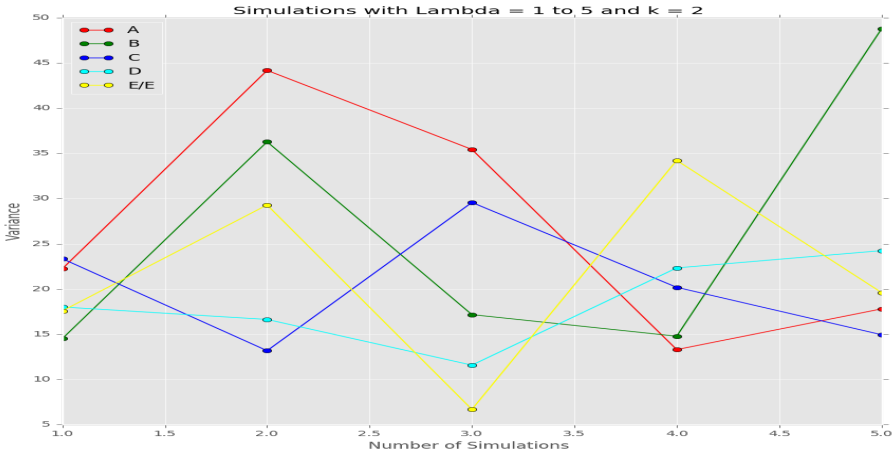

Figure 27: Variance

0.5.2 Inferences

1. Target B has highest variance

0.6 Variance of Entry and Exit

In this section, variance of entry or exit point has been analyzed only.

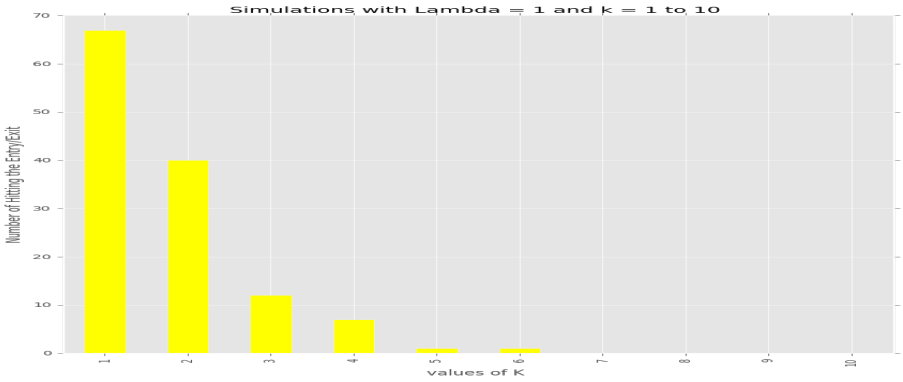

Figure 28: Variance

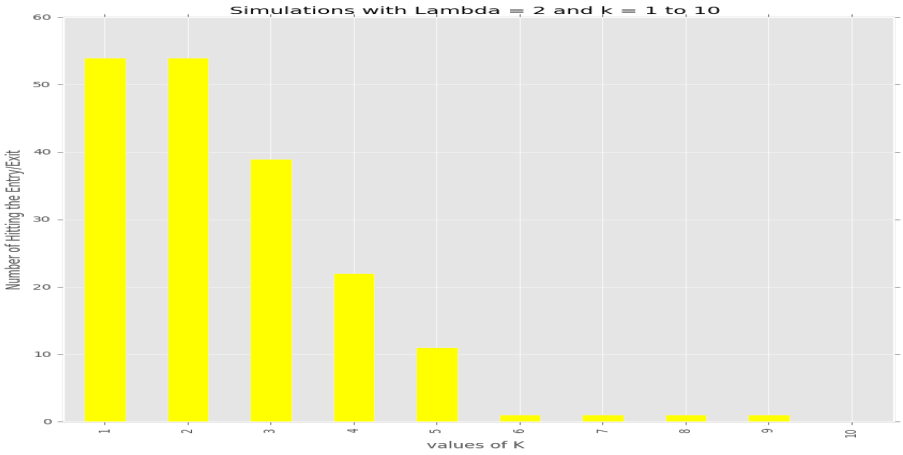

Figure 29: Variance

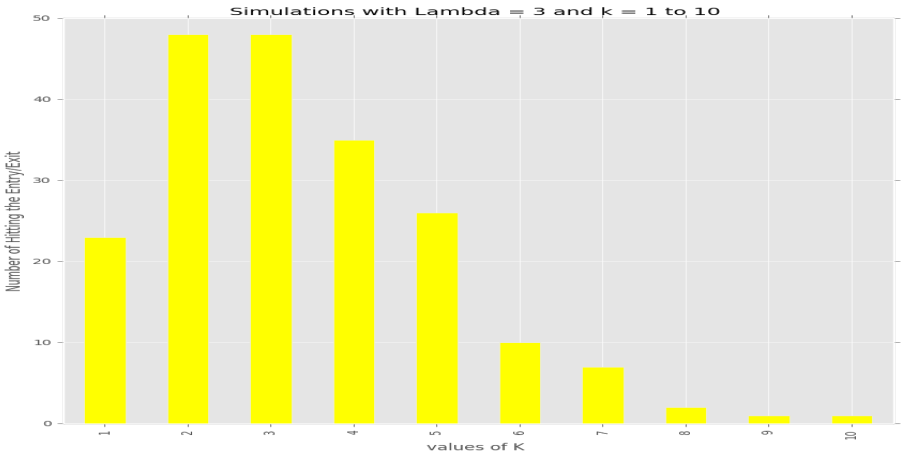

Figure 30: Variance

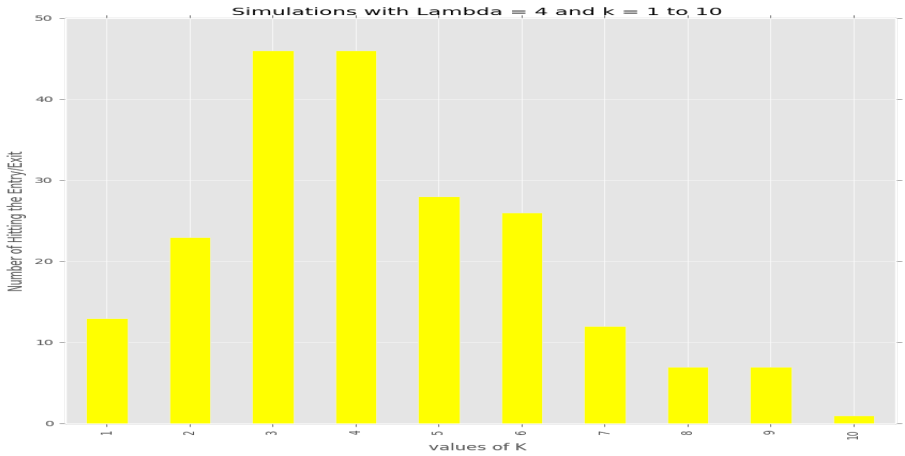

Figure 31: Variance

Figure 32: Variance

0.6.1 Inferences

1. Variance of poisson distributed Entry/Exit point becomes normally distributed Entry/Exit point with varition *Lambda* from 1 to 5.

0.7 Conclusion

1. From simulation point of view, increasing the number of simulations gives better result.
2. Putting more targets inside the grid helps to understand complex activity of an agent.
3. Multi agent environment can be studied in future.
4. Simulated trajectory data will be analyzed in future.