[Viola Chen]
07-400 update 5
[Andrew ID:yitaoche]

Summary

Recall from last time that we were modifying our model slightly due to undesirable performance, and we were thinking of a model heavily inspired by [1], in which we are thinking of the set up of robot swarm trying to switch from a noisy channel S1 (with a lot of noise) to a less noisy channel S2 (with significantly less noise). Although the overall ”switch” is beneficial, robots with different channels are not able to communicate effectively, therefore impede the overall performance of the swarm. However, over a long period of time with multiple generations of evolution, the hope is that as more robots switch to the better communication channel S2, the overall performance of the swarm will increase. Specifically, we would be interested in looking at the effect of different network structure in helping to propagate this change in ”gear”.
We have had a few more focused discussions in the past two weeks, and have come to the decision on studying the following two questions, which are more mathematically analytical and biologically relevant

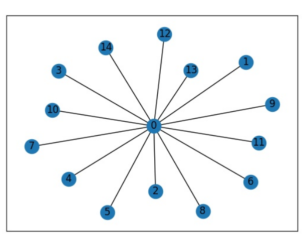
1. Investigate whether the geometric mean principle holds in evolution with a network structure

2. Simulate movement and attraction to spatial loci with a 2-dimensional Markov chain, which will allow us to both run stochastic simulations and validate it with analytical results

1 Investigating the effect of Variance of fitness

In evolutionary dynamic, we are often interested in the fixation or extinction of a mutant species when introduced to a population of wild type, where the mutant often has some slight fitness advantage over wild type. It has been studied and believed that, in an evolutionary dynamic setting, that not only the mean of fitness is important, but also the variance in the distribution of fitness in a population. Specifically, it is believed that it is not the fitness mean, but rather the quantity $\mu - \frac{\sigma}{2}$, which is termed geometric mean, that determines whether the mutant would have an evolutionary advantage than the wild type.

However, studies that produced this result have been assuming a well-mixed population, which fails to consider that communication within a population could be sparse. Here, we are interested to find out whether the same principle still holds for a population that resides on a specific network structure, such as a simple star graph.



2 Updated computational model setup

We realized that our simulation models have been having a lot of stochasticity and does not provide as much insights as we would love to see. Therefore, we would like to use this updated model that allow us to validate our results with mathematical analysis.

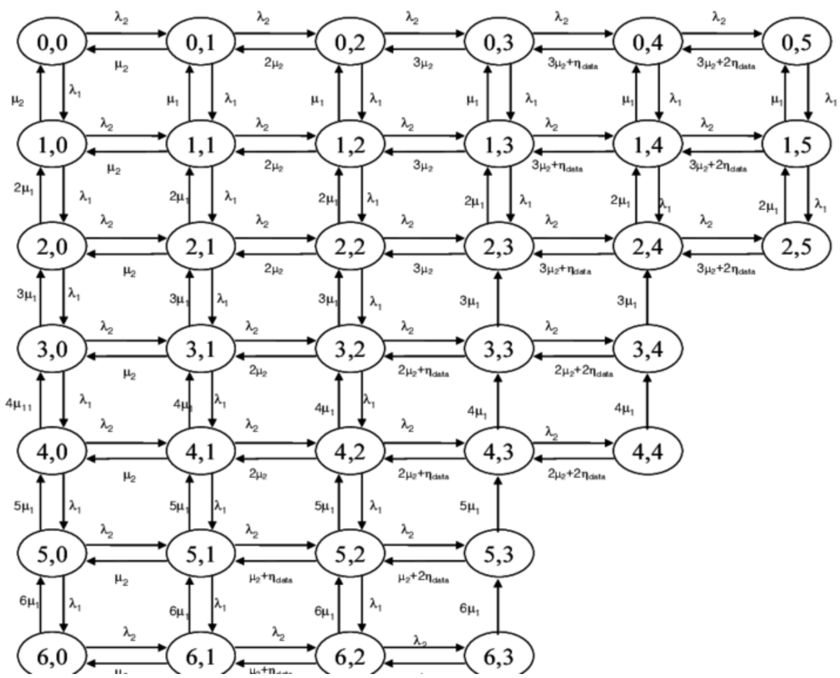


Figure 1: 2D random walking to spatial coordinates

Our previous simulations have been greatly affected by the randomness in agents' ability in reaching specific destinations. Here, the probability of an agent starting from a random node reaching a particular destination has been known by the Markov chain analysis, therefore we would like to switch to this simpler model and hopefully could see more stable results.

References

[1] Eldar, A. Social conflict drives the evolutionary divergence of quorum sensing. *Proceedings of the National Academy of Sciences 108*, 33 (2011), 13635–13640.