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Model setup and fitness distribution

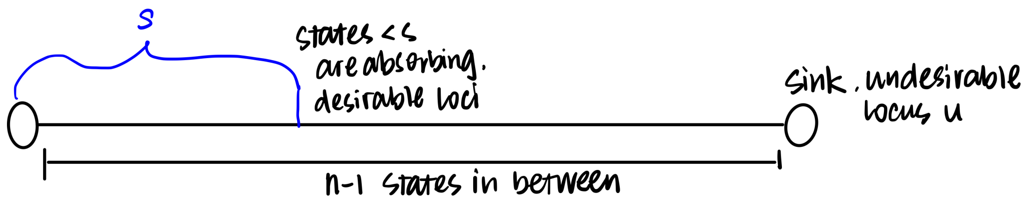
Recall from last time that we decided to update our model setup to a simpler and analytically solvable Markov model. The goal is for it to be

1. analytically predictable so we can always compare our model with the analytical results

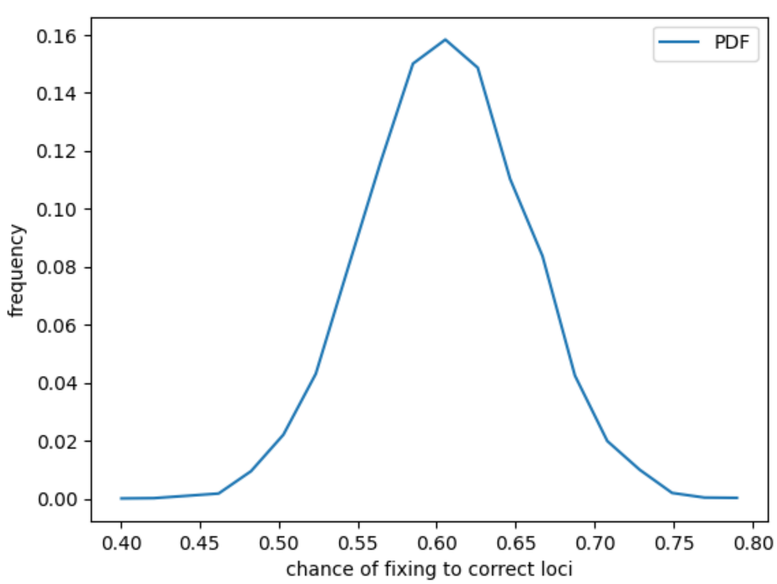
2. less stochastic with fewer model parameters

one-dimensional Markov model

To start off, and to make things simpler, we set up the following one dimensional Markov model, assuming a random walk with probability 0.5 to both sides,some states are absorbing, and the intermediate states are omitted.



In this model, agents are uniformly randomly initialized to one of the states, and eventually they will converge to either the desirable loci or the undesirable sink.
To study the distribution of "convergence" in this model, we did many runs and plotted the probability density function of the distribution.

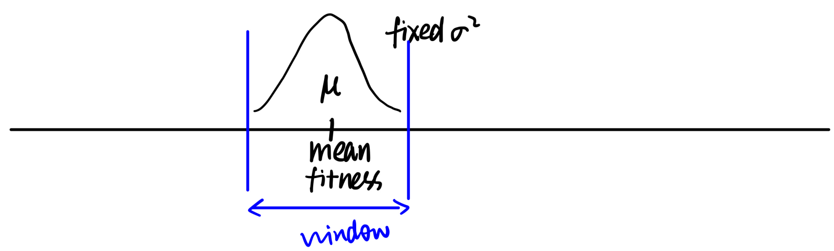


The bell shape is expected since we did a decent number of runs, but the specific distribution still needs more work to be figured out. Knowing this distribution is important in aiding simulations of birth-death on a network graph.

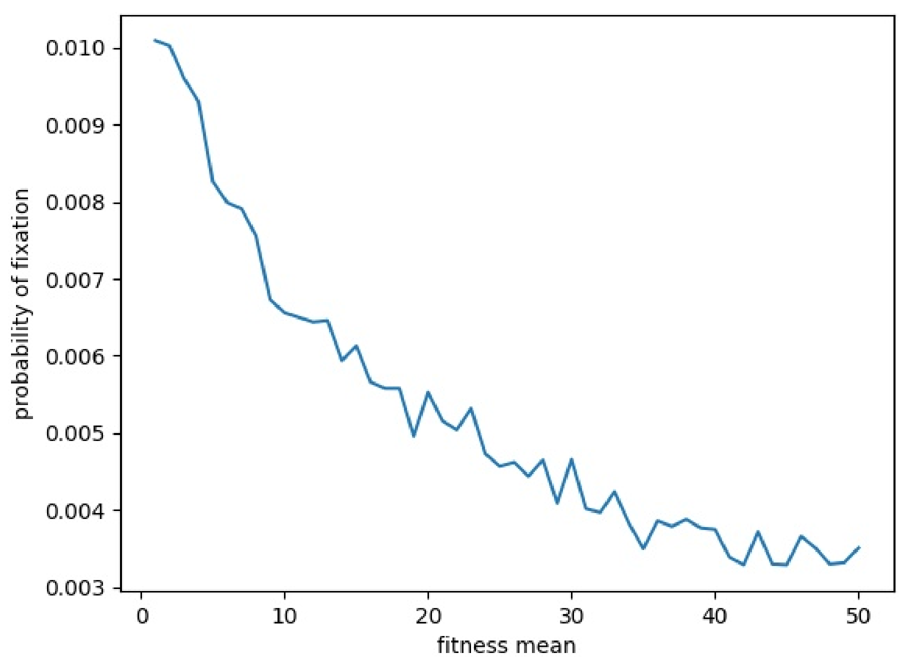
Fixation probability with different mean and same variance

Recall from last time that 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.

With a large number of simulations, we realize the effect of variance on fitness is not significant enough to be noticed, as supported by some prior literature. However, we did notice that the "window", namely the mean, seems to have an effect on the fixation probability.

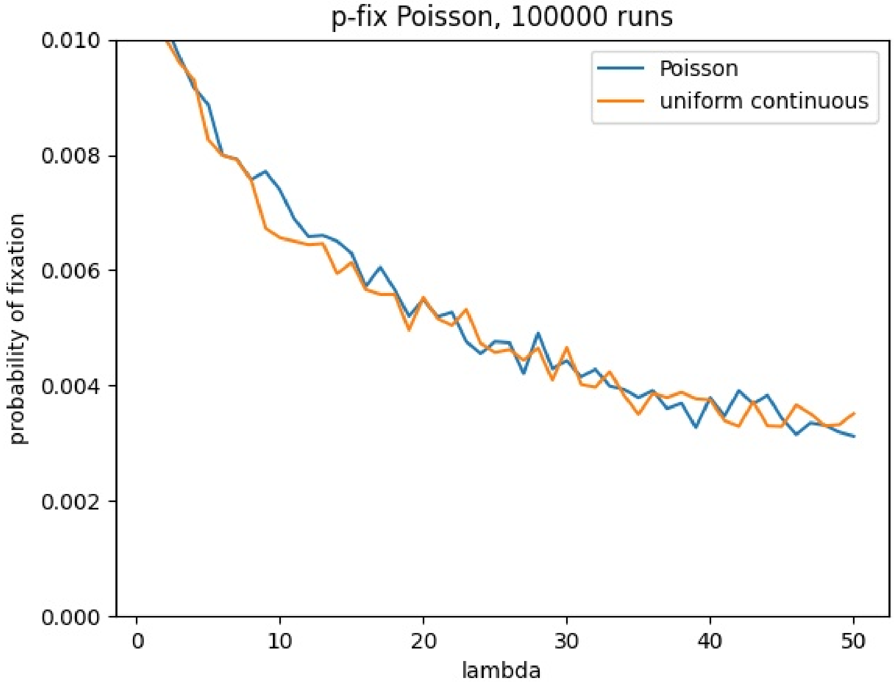


The exact reason for such effect is not yet fully known. I expected that with a larger mean, the fixed variance would have a smaller effect on the overall fitness and thus fixation probability, but it seems to be the opposite. We see a clear downward trend



For the next couple of days I will focus on trying to understand the reason behind this and discuss it with my group members.

Fixation probability under different fitness distribution for mutant



We expected that the distribution of the fitness mean may have an effect on fixation probability, so we experimented a few distributions, discrete or continuous, on the same set of means.

However, as seen in the figure above, there seems to be no difference in their fixation probability, and a possible reason is that the effect of variance is elusive to start with, and therefore the variance, by itself, may not make a significant enough difference.

Future work would be to experiment this on different network structures, and see if more information could be obtained there.