Andrew Cohen
PHYS 250
10/29/20

HW 2 Writeup

Even after repeating the game numerous times, it is difficult to draw firm conclusions. I specifically sought patterns and correlations between the starting conditions of the games, however, no strong trends emerged. My first experiment was to examine the effect the initial seeding probability (RN1) on the time required for the system to reach stability. Stability was defined as no novel evolutions, thus a remaining blinker counted as a stable, albeit oscillating system. I began with initial probabilities of 0.75, 0.5, 0.25 and tested the five seeds: 00001, 00010, 00100, 01000, 10000. I timed the evolution of the system in second then recorded and plotted my results. My initial hope was that I could repeat this process with different probabilities, aiming to maximize evolution time. Ideally, I would have a neural net to do this process for me, however, I don't know how to code those… yet. Doing my own un-rigorous gradient descent I adjusted the probabilities to maximize the evolution time. Since 0.5 had generated the largest mean evolution time, I then tested 0.7 and 0.6 (as well as 0.8 for thoroughness). The probability 0.6 resulted in an average time greater than that 0f 0.7 and 0.5, thus reducing my interval to [0.5, 0.6] for future testing. I once again performed this process with 0.57 and 0.585 and found 0.585 to be the second longest evolution time, right behind 0.6. If I were to continue this process in search of a maximized evolution time, I would then test the interval [0.585, 0.6] to further decimal places.

There was therefore a slight trend towards 0.6 being the probability that maximized Game length – however, more data is required for a strong conclusion. In addition to this finding, plotting the mean times based on initial seed showed that 00100 generated the longest Games. This is consistent with my observations as 00100 routinely created the longest and most interesting developments. In fact, one of my most surprising observations was the consistent uniqueness of the 00100 seed, it was the only seed to show consistent emergence potential.

My next inquiry was to test the effect of array size on the time evolution of the Games. I fixed the initial probability to 0.57 and the initial seed to 55555, I then tested a (35,35), (50,50), and (60,60) array.

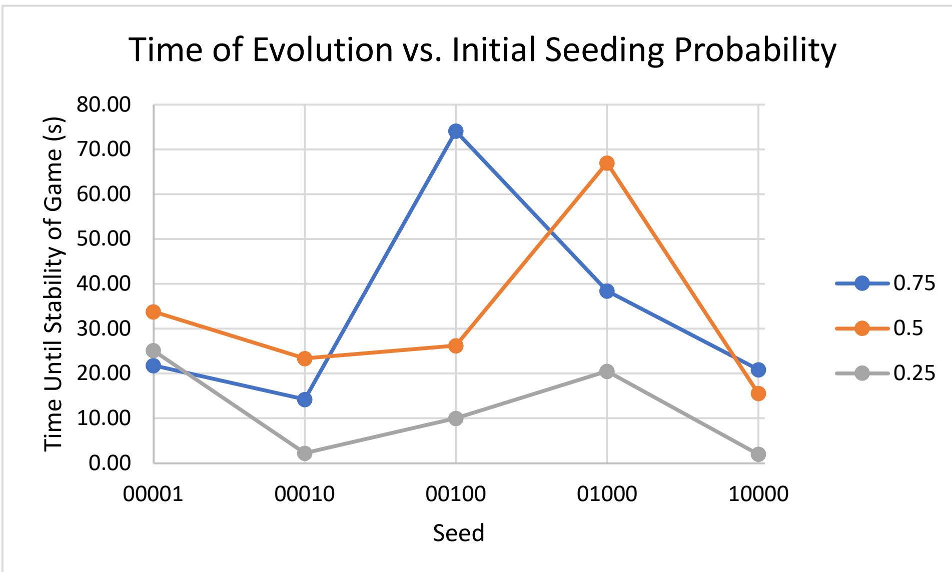
35,35	**50,50**	**60,60**
7.87	71.24	21.57

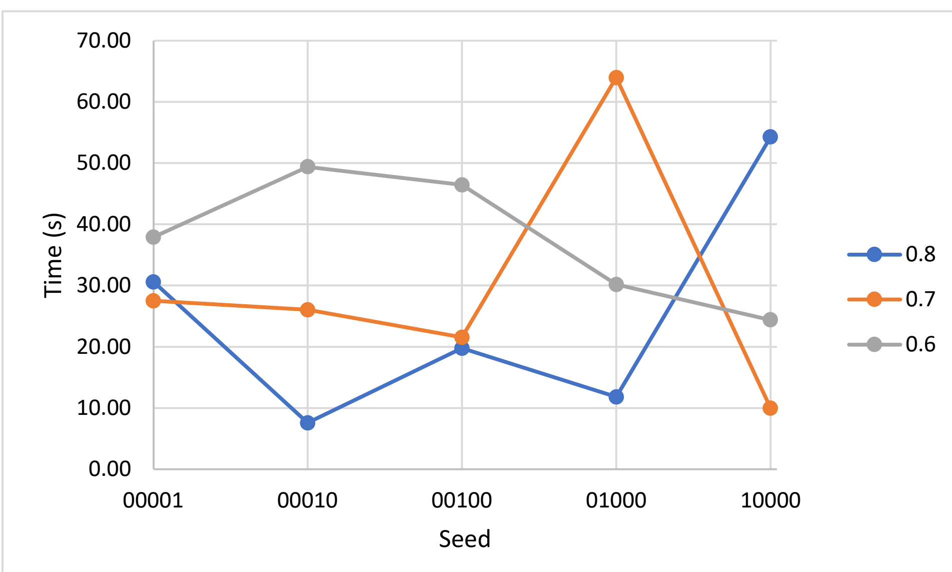
As seen in the table, the (50,50) array resulted in the longest game. A similar process to my intial experiment could be carried out with array size as well, testing multiple with the goal being to maximize Game time.

To further investigate these effects, I attempted to generate the longest Game I could based on my data. I created a (50,50) array and seeded it with a 0.585 initial probability and a 00100 seed. This combination with a (35,35) array had resulted in a game that lasted 90.86 seconds, 16.6 seconds longer than the previous maximum. Although I expected to create my longest Game yet, it only lasted 42.78 seconds – above the average Game length but well below the Game with the same parameters on a (35,35) array.

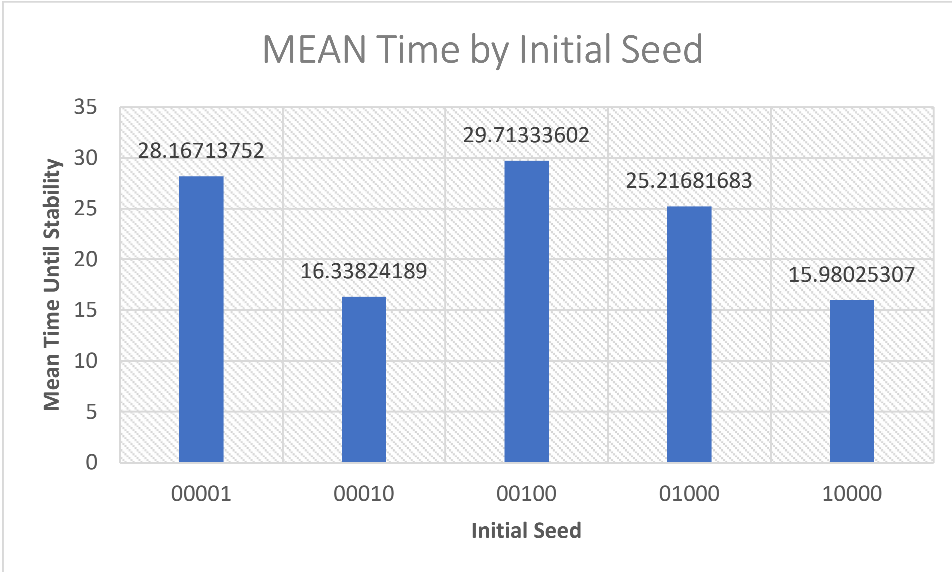
Andrew Cohen
PHYS 250
10/29/20

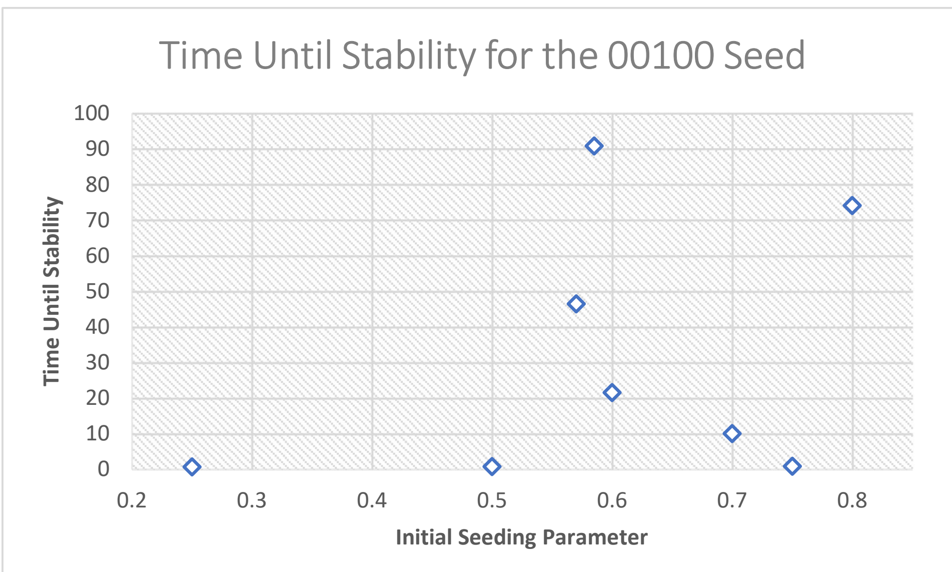
All of these investigations illustrate that the Game of Life is a delicate game of equilibriums. Its parameters do not result in linear effects on the Game's evolution. This is seen easily from my very last experiment above. This is observable as well. There is an equilibrium point for the initial seeding probability just as there is an equilibrium for array size. The cells must have enough space so as not to be overcrowded, but not to much as to become isolated or become stagnant. This can be seen as a Game begins to approach its final evolution. These two parameters, probability and array size are independent. Each probability has an optimal array size and vice versa. The same can be said of the initial seeds as they are affected by array size. This balanced eco-system is another example of the Game's tendency to mimic natural behavior.





Andrew Cohen
PHYS 250
10/29/20





As a final exploration, I created two variations on the Game of Life. The first introduces cancer cells, represented by hashtags into the Game. There is a very low probability (RN1=0.5) of initial seeding the array with a cancer cell, and a slightly greater probability (RN2<0.001) of a live cell spontaneously turning cancerous. If a live cell touches two or more cancer cells, the live cell becomes cancerous. Cancer cells cannot move, they can only spread. While there were Games where the cancer cells infected the entire board (and given enough time it eventually will as more spontaneously turn), there were also games that developed “islands” of cancerous cells. These islands or tumors did not spread however, instead the Game continued, with the live cells forming a movement pattern around the cancerous cells. Expanding the array of the cancer

Andrew Cohen
PHYS 250
10/29/20
Game, I achieved a Game that lasted nearly a minute with approximately 1/5 of the board cancerous. The live cells migrated around the islands and only became cancerous themselves when one of the live cells spontaneously tuned, disrupting the behavior. This represented a form of adaptation in the live cells to remain alive.

Another attempt of mine was to create a Game of Particles rather than a Game of Life. I attempted to simulate the "cells" as particles that attracted each other with a gravitational force. I intended on testing this game for different strength of gravity and particles of different "mass". However, although I successfully created gravity between 2 or even 3 particles, expanding beyond that number led to particles being duplicated. Perhaps I will look at the code further, but I felt it was time to submit the assignment. My goal would be to successfully create a game that features orbits or even introduce a repulsion force – much like between electrons, thus creating a game of atoms.