Executive Summary

Team Members: Aakash Parikh, Hannah Hasan, Abdullah Naeem Malik, Cagatay Ayhan, Ece Karacam, Karuna Sangam

Project Goal: We need to identify starting configurations in a 25x25 grid of Game of Life, given ending configurations. This is a nontrivial problem as the forward of evolution is many-to-one.

Key performance index: We will measure our algorithm's performance using its classification accuracy, ratio of the correctly classified starting configurations against total number of configurations.

Description of data set: For the training set, we are given 50,000 instances start variable $\mathbf{y} \in \mathbb{Z}^{25\times 25}$ and 50,000 instances of ending configurations $\mathbf{x} \in \mathbb{Z}^{3+25\times 25}$. The extra three starting tuples here are the binary-equivalent value of $\delta \in \{1,2,3,4,5\}$, which indicates the number of steps taken to evolve. Each y was chosen by filling the board with a random density between 1% full (mostly zeros) and 99% full (mostly ones), and letting it evolve over 5 steps. After this "warm-up", each δ was chosen to be uniformly random between 1 and 5 to yield x. All nonempty x were chosen.

Approaches: We treat the problem as a classification problem involving 50,000 classes to begin with. We then minimize the number of classes by first identifying similar warm-ups, and then treating two warm-ups as equal if they are close enough. We say that $\mathbf{y}_1$ and $\mathbf{y}_2$ are p-close if any subsequence of length $p \leq 625$ comprising of consecutive p (grid) values appears the same number of times both in $\mathbf{y}_1$ and $\mathbf{y}_2$. We choose $p = 9$ to account for one whole neighborhood. We then take two different approaches: one involves letting the δ values be treated on an equal footing as the features, and the other discards them altogether. Our task then is to find models $M_0\left(\mathbf{x}^{(\mathbf{0})}\right) = \mathbf{y}$ and $M_1\left(\mathbf{x}^{(\mathbf{1})}\right) = \mathbf{y}$, where $\mathbf{x}^{(\mathbf{0})} \in \mathbb{Z}^{25\times 25}$ and $\mathbf{x}^{(\mathbf{1})} \in \mathbb{Z}^{3+25\times 25}$

Algorithms Employed: We then use Bayesian Classifiers and Decision Trees, and calculate accuracy of classification for each approach.

Takeaways: The project seems simple, but clearly requires knowledge of more sophisticated techniques than was feasible in the time we had during the bootcamp, but we learned, and are motivated to continue to learn, what we can from the process. Specifically, we also learned that training a large dataset requires patience, time and resources! In the future, we would like to learn and implement other different approaches by people who have worked on the same problem with a higher classification accuracy.