Istanbul Technical University - Computer Engineering
BLG 458E - Functional Programming
Term Project
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"The universe is no narrow thing and the order within it is not constrained by any latitude in its conception to repeat what exists in one part in any other part. Even in this world more things exist without our knowledge than with it and the order in creation which you see is that which you have put there, like a string in a maze, so that you shall not lose your way. For existence has its own order and that no man's mind can compass, that mind itself being but a fact among others."

Blood Meridian, Cormac McCarty

Cellular Automata are discrete computational models made up of cells that update simultaneously in distinct time steps, drawing inspiration from self-replicating biological systems. They serve as tools for modeling complex behavior, analyzing nonlinear dynamics, and performing computations or solving algorithmic tasks through localized interactions.

Game Of Life

Conway's Game of Life[2] is a cellular automaton defined on an infinite grid of square cells, where each cell is either alive or dead. A cell's neighborhood consists of the 8 adjacent cells, including those touching it diagonally. The state of the grid evolves in discrete steps, following these rules:

- A dead cell with exactly three living neighbors becomes alive.
- A living cell with two or three living neighbors remains alive; otherwise, it dies.

Despite their simplicity, these rules lead to remarkably intricate behavior. When the system is initialized randomly, it usually begins with a phase of chaotic activity that eventually stabilizes into clusters of persistent living cell patterns.

Within this evolving system, certain patterns known as oscillators play a central role in understanding the dynamics of Life. An oscillator is a finite configuration of live cells that returns to its original state after a fixed number of generations, called its period. These patterns are important not only as stable and recurring structures in an otherwise unpredictable system, but also as foundational components in constructing more complex behaviors, such as logic gates, signal pathways, and even universal computation. Studying oscillators provides insights into the interplay between local rules and global order, and their diversity and abundance are key indicators of a cellular automaton's expressive power.

Select five oscillator patterns from Brown et al. [1] and generate them using Haskell. The necessary skeleton code is shared. Please include the generated pattern names in your report.

References

[1] Nico Brown, Carson Cheng, Tanner Jacobi, Maia Karpovich, Matthias Merzenich, David Raucci, and Mitchell Riley. Conway's game of life is omniperiodic. *arXiv preprint arXiv:2312.02799*, 2023.

[2] Martin Gardner. Mathematical games: on cellular automata, self-reproduction, the garden of eden and the game" life". *Sci. Am.*, 224:112–117, 1971.