

# CS 652 Final Project

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## Abstract

Conway's Game of Life is the classic example of emergence in cellular automata. Presented here is a 2D and 3D expansion of the original version of Conway's Game of Life. Extension into 3 spatial dimensions as well as an extension of the 1 or 0 based neuron approach to a numerical scale ranging from 1 to 10. During this study we witnessed distinct emergent behaviors... when completed...

## 1.2 diffusion

Diffusion is transportation mechanism that doesn't require bulk movement. Molecular diffusion is considered the result of the random walk powered by thermal energy. Diffusion is most often modeled using vector wave equations. Vector calculus models of diffusion allow for the modeling of an infinite number of particles quickly and computationally less intensive. Discretization of diffusion allows for a more fine grained approach, at the cost of an increase in computational complexity.

## 1 Introduction

Conway's Game of Life, further referred to as GoL, is a cellular automata based game based upon the mathematical problems presented by John von Neumann. The GoL provides a simple mechanism for the study of emergence in self-organization. Extending the GoL to 3 spatial dimensions and increasing the complexity of each individual automata state, allows a significant increase in the complexity of the interactions we are able to model. Allowing for the simulation of diffusion, whether that be diffusion of chemical reactions or heat flow.

### 1.1 Cellular Automata

Cellular automata modeling technique based on modeling a manifold using a finite number of discrete states. Each automata has a set of additional cells commonly referred to as its neighbors. This neighborhood of cells are the set of cells residing some specific minimum spatial distance from the cell itself. Cellular automata state transformation are dependent on the state of their neighbors and specific set of rules that the cellular automata is operating on. This respect is where cellular automata differ from coupled map lattice, state values are entirely dependent on initial conditions, and neighborhood state values. Traditionally the structure of cellular automata states are constructed using the neuron model, or the states can be either 'on' or 'off'. More complex automata can also be modeled with state complexity significantly more complex than 1s and 0s.