

**GAMERS:**

Aakash Parikh  
Hannah Hasan,  
Abdullah Naeem Malik,  
Cagatay Ayhan,  
Ece KARACAM  
Karuna Sangam

# CONWAY'S GAME OF LIFE IN REVERSE

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ERDOS INSTITUTE DATA SCIENCE BOOTCAMP (SPRING 2023)

FINAL PROJECT SUBMISSION



# OUTLINE

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- Basics of Conway's Game of Life
- Project description
- Data Set
- Goal and data cleaning
- Approaches

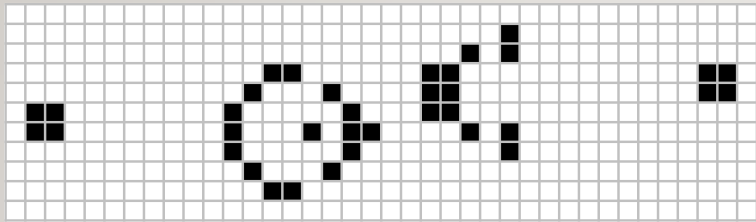
# BASICS

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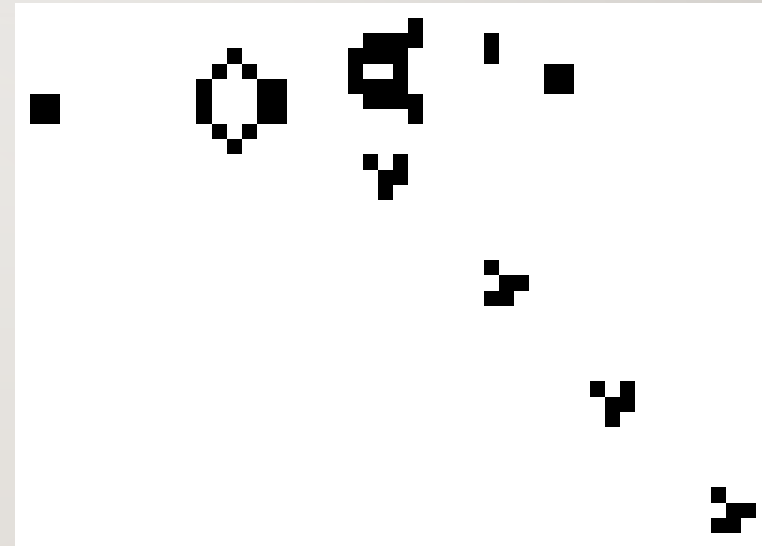
- Imagine  $n \times n$  grid.
- Each unit is a cell (8 neighbors) and is either alive or dead base on:
  1. Any live cell with fewer than two live neighbors dies.
  2. Any live cell with two or three live neighbors lives on to the next generation.
  3. Any live cell with more than three live neighbors dies
  4. Any dead cell with exactly three live neighbors becomes a live cell

# THE GAME OF LIFE

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By Bryan.burgers - Own work, Public Domain,  
<https://commons.wikimedia.org/w/index.php?curid=4513947>



By Lucas Vieira - Own work, CC BY-SA 3.0,  
<https://commons.wikimedia.org/w/index.php?curid=101736>

# PROJECT DESCRIPTION

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- Given configurations, predict starting point

# DATASET

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- 25 x 25 board
- 100,000 configurations ( $\mathbf{x}$ ) after  $\delta$ -steps and a “warm-up” (here  $\delta \in \{1,2,3,4,5\}$ )
- 50,000 starting configurations ( $\mathbf{y}$ )
- <https://www.kaggle.com/competitions/conways-reverse-game-of-life-2020/data>

# GOAL

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- Prediction for 50,000 starting configurations
- $M(\mathbf{x}) = y$

$$\frac{1}{n} \sum_{i=0}^n \|y_i - M(\mathbf{x}_i)\|^2$$

# APPROACHES

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- To  $\delta$  or to not  $\delta$ ?
- Bayesian Classifier

$$P(\text{starting configuration is } \mathbf{y} | \text{we observe } \mathbf{x}) = \frac{P(\text{starting configuration is } \mathbf{y} \text{ and we observe } \mathbf{x})}{P(\text{we observe } \mathbf{x})}$$

$$\operatorname{argmax}_{\mathbf{y}} P(\mathbf{y}) \prod_i P(\mathbf{x}_i | \mathbf{y})$$

- Reduction of classes



# DATA CLEANING

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- Split data into  $\mathbf{x}$  and  $\mathbf{y}$
- Split  $\mathbf{x}$  into  $\mathbf{x}^{(0)}$  and  $\mathbf{x}^{(1)}$
- Reduce classes in  $\mathbf{y}$ 
  - $d(\mathbf{y}_1, \mathbf{y}_2) = |\mathbf{y}_1 +_2 \mathbf{y}_2| = 0$
  - $\mathbf{y}_1$  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  $\mathbf{y}_2$

# CODE AVAILABILITY

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- <https://github.com/abdullahnaeemmalik/Game-of-Life-in-Reverse>