

# Predator v. Prey: Pacman v. Ghost

Jacob Page and Matthew Walters

## Introduction/Motivation:

- Goal: To create and visualize a predator/prey evolution simulation between Pacman and the Ghosts
  - Pacman will learn to run away from the Ghosts
  - The Ghosts will learn to hunt down Pacman
  - After one side evolves, the other side must improve to defeat their opponent's new tactics
  - Should expect mutual improvement over time
- Initial Tests involve 4 stages: Evolve Pacman, Evolve the Ghosts, Evolve Pacman Again, Evolve the Ghosts Again
  - Will Pacman be better at running from the Ghosts or will the Ghosts be better at catching Pacman?

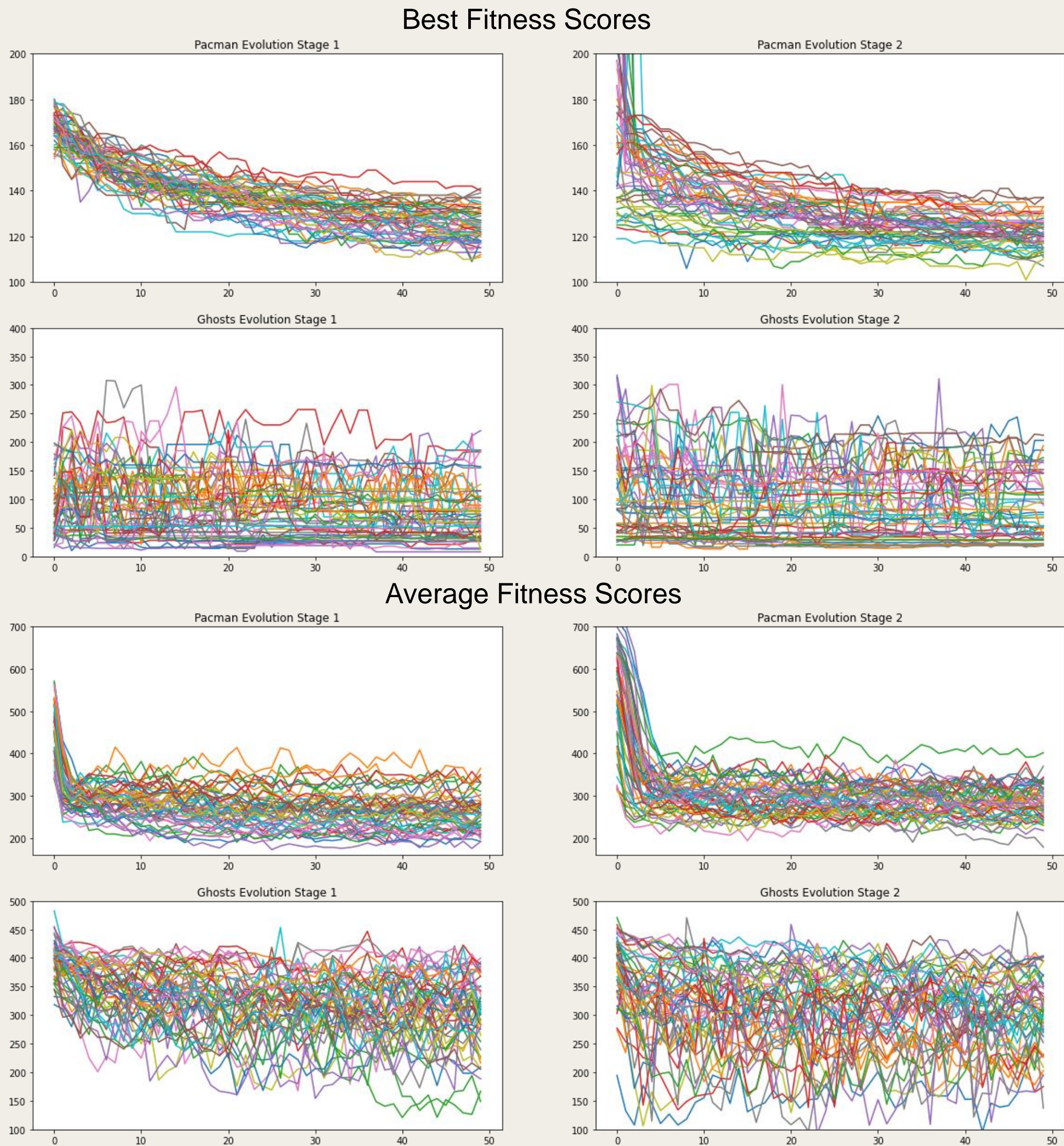
## Methods/Approach:

- Visualization of the game
  - X = Wall
  - | = Portal to Opposite Side
  - P = Pacman Starting Position
  - G = Ghost Starting Position



- Pacman starts at map location x = 6 and y = 13
  - Initial movement determined by a set-length random list of numbers, 0 = 'up', 1 = 'left', 2 = 'down', 3 = 'right'
  - Pacman's fitness is based on the number of spaces on the map that he reaches in the set time, and the number of time-steps that he survives
- Ghosts start at x = 13 and y = 9
  - Initial movement determined in the same way
  - The Ghost's fitness function is the number of time-steps before one of the 4 Ghosts catches Pacman, plus the sum of each Ghost's minimum distance from Pacman throughout the game
- Both Pacman and the Ghosts use the same method for selection and the same numbers for mutation, crossover, population size, and number of generations
  - Tournament selection is used to take a general average of the best paths being used from the population
  - There is a set 1% chance for mutation
  - There is a set 10% chance for crossover
  - The population size of each generation is 200
  - Each stage contains 50 generations of evolution
- Minimize the fitness score
  - Higher fitness scores mean lower performance

## Results:



- Our tests show consistent improvement in Pacman's fitness score but wild inconsistency for the ghosts
  - For statistical reliability, we tested the simulation 50 times.
  - While Pacman's best fitness score from any given population does generally improve, the average score of the entire population varies
  - The ghosts' evolution stage seemingly improves Pacman's score even though their own scores cannot reliably improve

## Conclusion:

- Pacman
  - He does not touch as many spaces as we would like
  - Usually covers no more than 1/3 to 1/2 of the map
  - We look to further improve coverage while still avoiding the Ghosts
  - Although in general Pacman's fitness is greatly improved from the initial to the final version
- Ghosts
  - There is very little improvement in Ghost's fitness scores
  - There are certain cases that do perform well, but those cases are few in numbers and seem to get lost in the mutation and crossover
  - Look into farther increasing these cases or farther preserving their characteristics
- Future work
  - First general goal is to compare hyper-parameter combinations of different generation sizes, population sizes, mutation probability, and crossover probability
  - After finding optimal hyper-parameters we want to run 50 or more stages instead of the current 4 to see if that allows for more improvement



THE UNIVERSITY OF  
TENNESSEE  
KNOXVILLE