Mini Project - CS5804 Intro to AI (Spring 2023)

Hacking Natural Selection

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Team 17

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Team Info. #17

Jinsol Jung

MEng in CS as simultaneous degree since 2022

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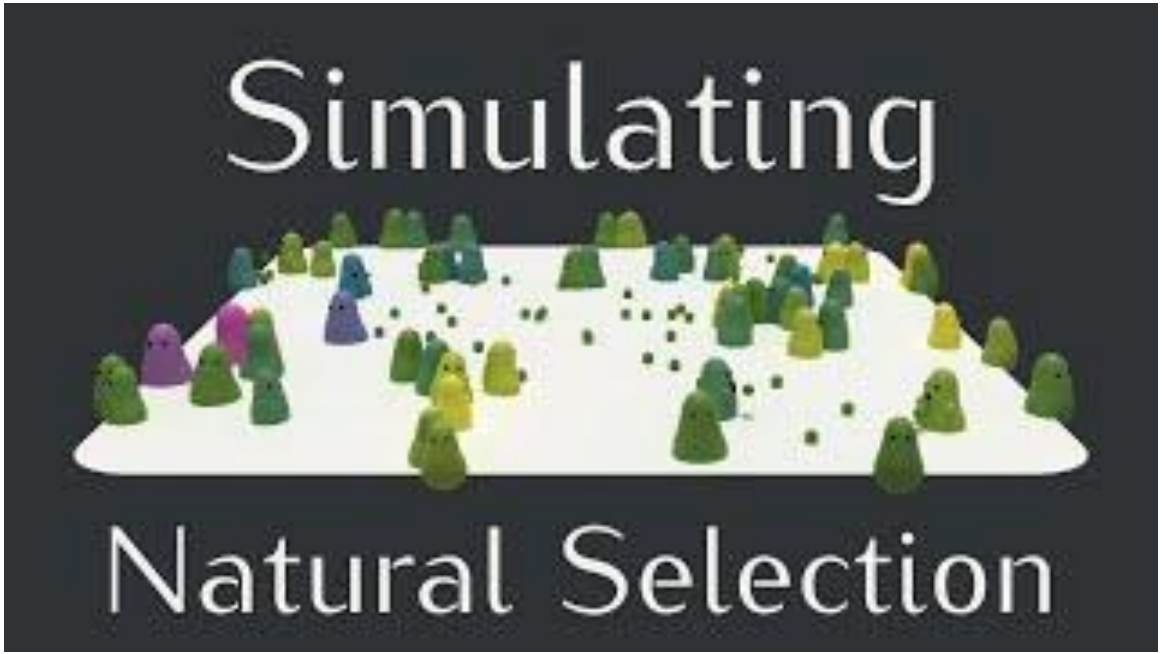
Jackson Livanec

MEng in CS since 2022

Full time technical data analyst

Motivation

YouTube, Primer, *“Simulating Natural Selection”*



Motivation

YouTube, Primer, *“Simulating Natural Selection”*

- Creatures
- Food appears every morning
- No food → Death / One food → Live on / Two food → Replicate
- Traits
  - Speed
  - Size (eat other creatures, if size is 20% larger than them)
  - Sense

Modeling Approach

“natural” reinforcement learning model

Variable traits

- *Speed*
- *Size*

Static traits

- Size of environment plane
- Amount of food
- Amount of energy required per step: $(size)^3(speed)^2$

Problem Description (1/2)

- At generation 0, agents and food are randomly spawned into a square environment
- Key agent field variables: **Energy**, **Speed**, and **Size**
- Start with a finite amount of energy and a speed of 1
- Search for the closest piece of food
- Determine whether the energy expenditure associated with moving to that food will be net positive
  - If it chooses to move, expend energy at the rate of $(\text{speed})^2(\text{size})^3$
  - If it chooses to remain, constantly lose energy at a rate less than movement
- A generation is complete when all agents are “satiated”
  - Satiation describes a stationary agent

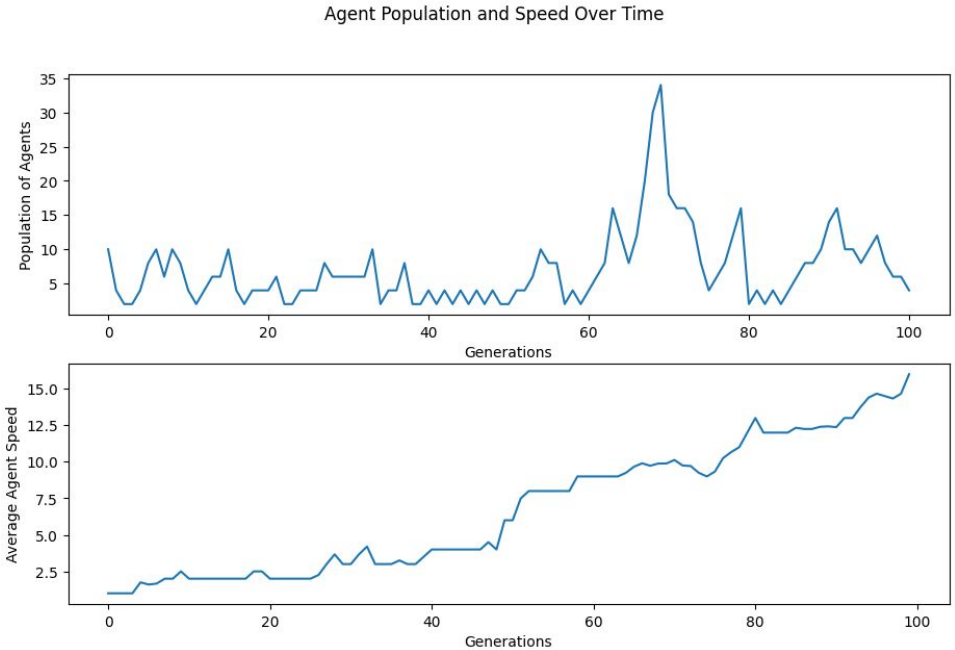
Problem Description (2/2)

- All agents depleted energy → **death**
- All surviving agents → **spawn successors** with matching traits
- Speed trait will mutate and increase with a small probability
  - 75% chance of staying the same
  - 20% chance to increase by 1
  - 5% chance to increase by 2
- Size trait may mutate with a random probability
  - 20% chance to increase/decrease by 15%
  - 80% chance of staying the same

For the next generation,

- All new and surviving agents are randomly distributed
- Amount of food remains constant to simulate scarcity and competition
- *Reward*: energy reward from food
- Average speed and size recorded

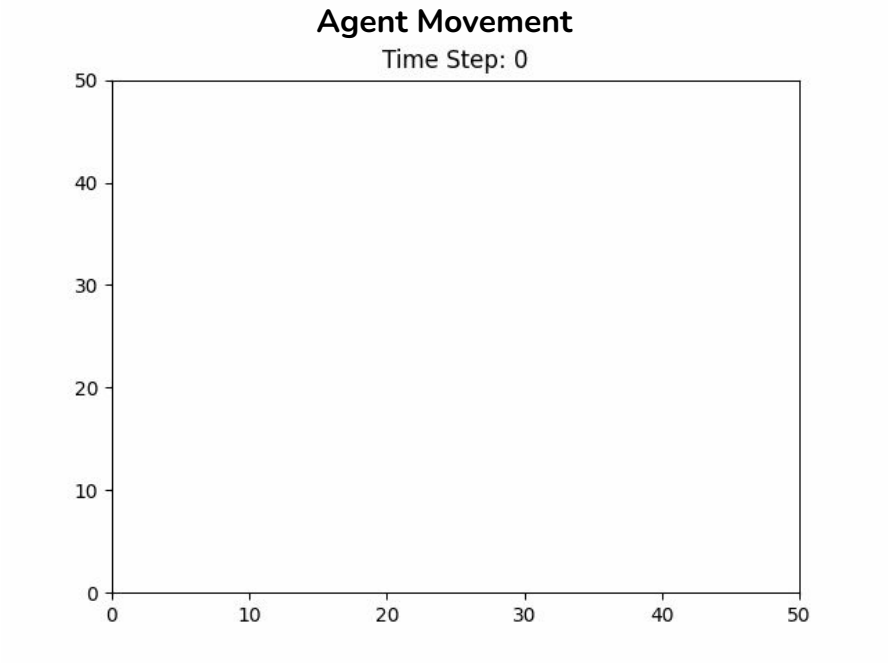
Results

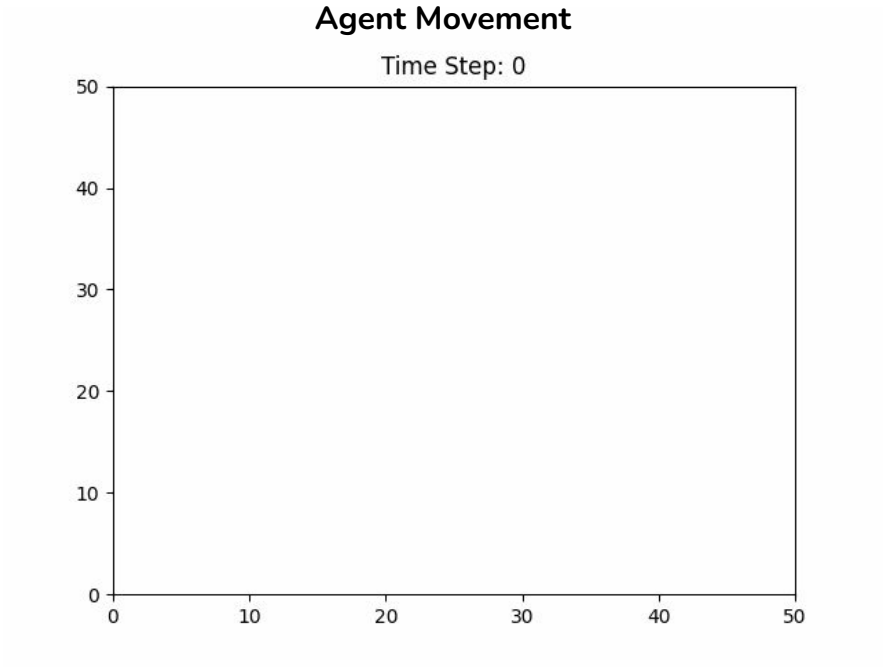


- 100 generations
- 10 starting agents
- 50 food
- 50x50 grid

- 15 starting energy
- 10 energy food reward
- -1 energy per stationary timestep

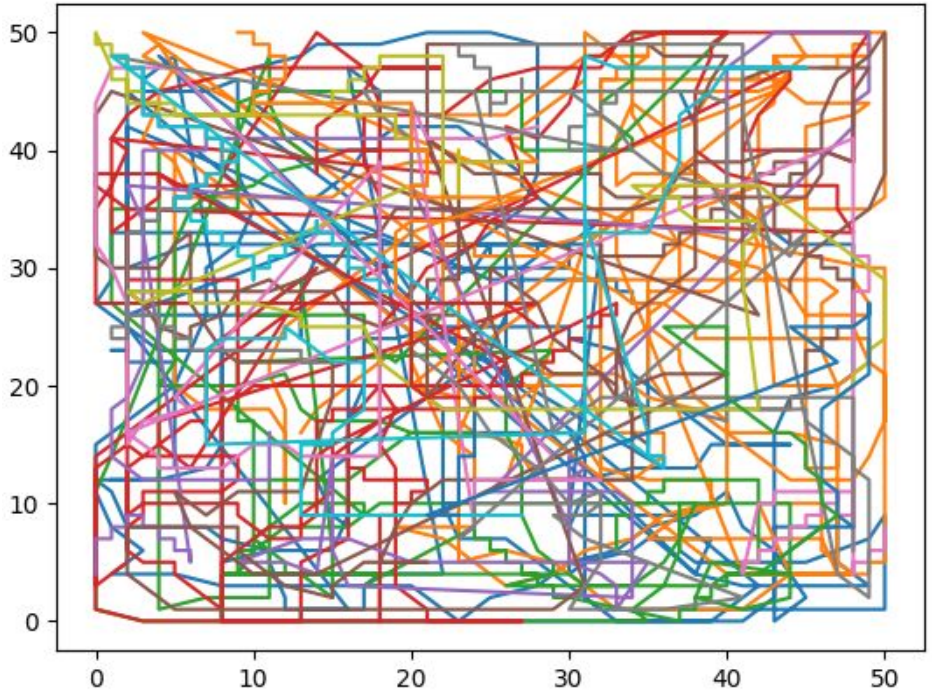
Results


Agent Movement
Time Step: 0
50
40
30
20
10
0
0
10
20
30
40
50


Agent Movement
Time Step: 0
50
40
30
20
10
0
0
10
20
30
40
50

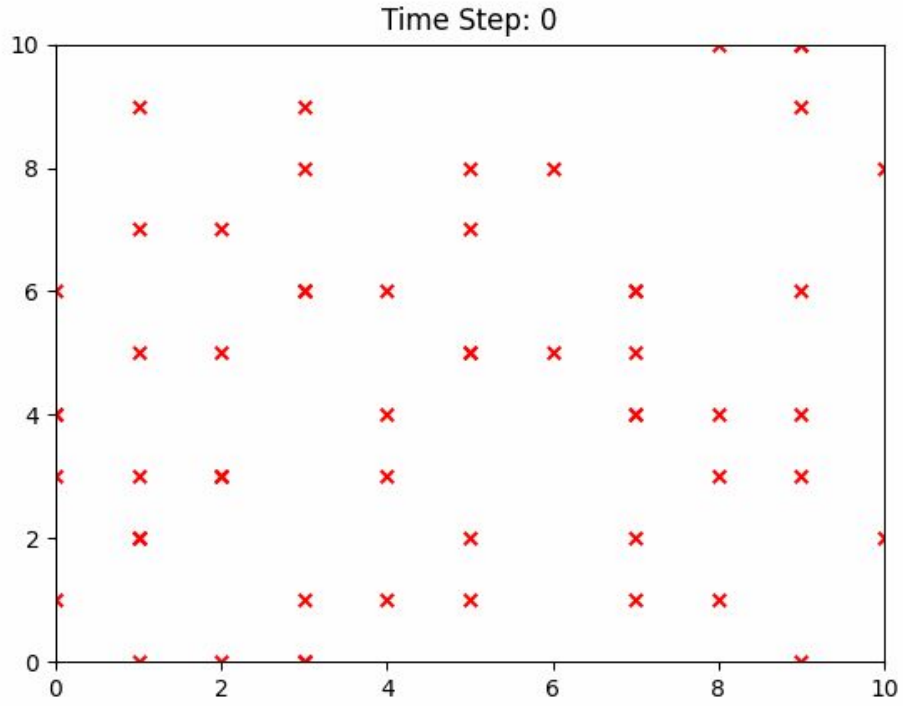
Result

All agents movement over generations

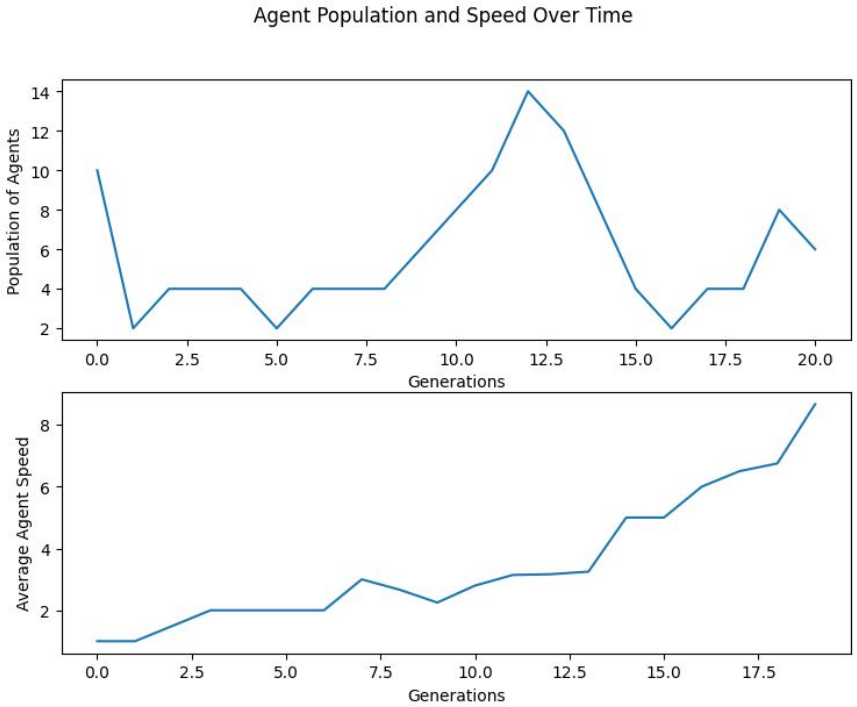


Results

- Agent uses greedy search
- Position reset after each generation



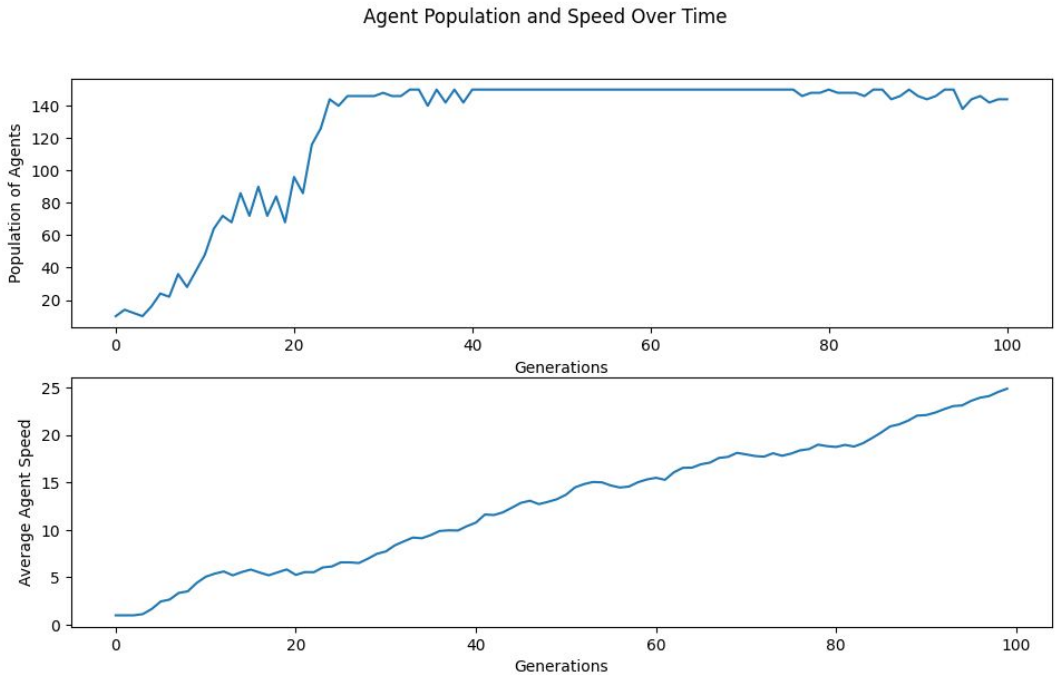
Overpopulation and Food Shortage



- 20 generations
- 10 starting agents
- 50 food
- 50x50 grid

- 10 starting energy
- 10 energy food reward
- -1 energy per stationary timestep

Food Surplus

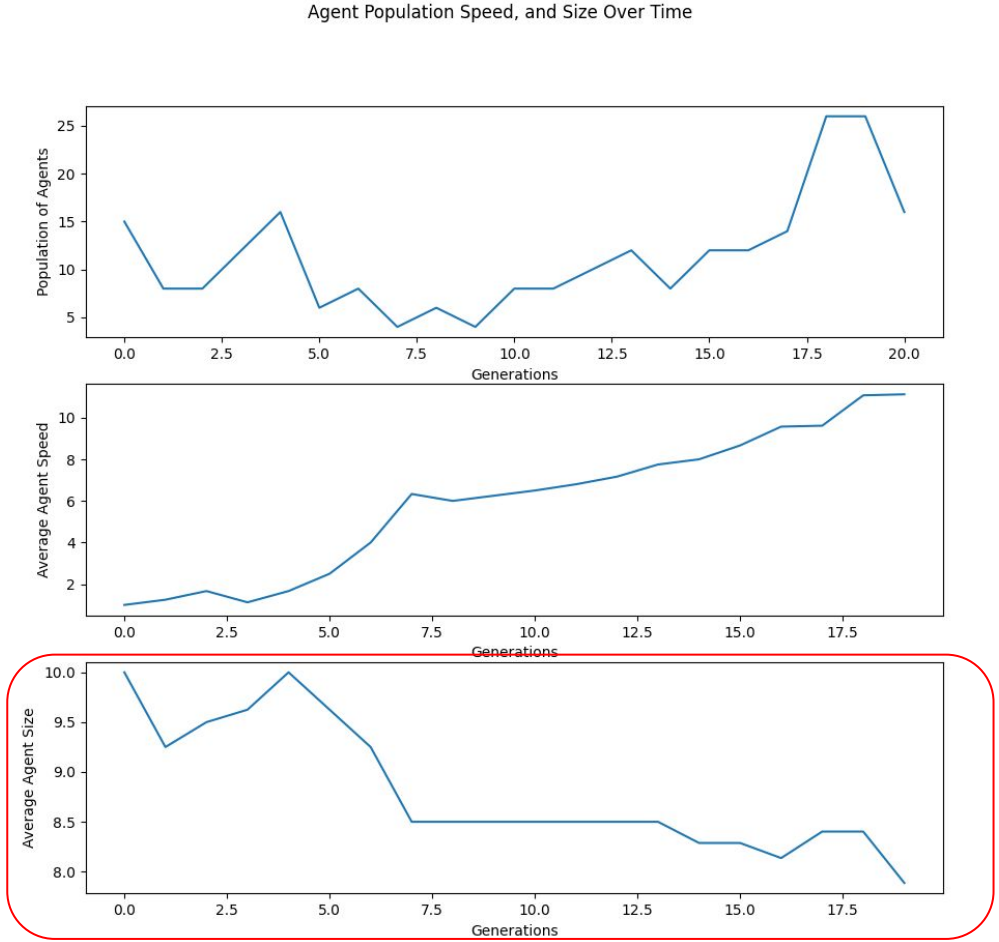


- 100 generations
- 10 starting agents
- 75 food
- 50x50 grid

- 10 starting energy
- 15 energy food reward
- -1 energy per stationary timestep

Unhelpful Trait: Size

- Larger agent = more energy expenditure
- This trait has a random chance of increasing or decreasing +/-15%
- Size serves no benefit to the agent



Other Notable Behavior

- High stationary cost leads to rapid speed increase
- Certain configurations support unbounded growth
- Certain configurations always end in extinction
- Traits can devolve when there is no utility to the agent
- Randomness can lead to inconsistent population outcomes

Future Work

- Implement competition behaviour

- Implement size-related aggression
  - If size(agent1) >= 1.2(size(agent2)) & they occupy the same square
  - **agent1 kills agent2**
  - Agent1 absorbs 50% of agent2's energy

- Implement secondary populations with different traits

Thank you
Q&A