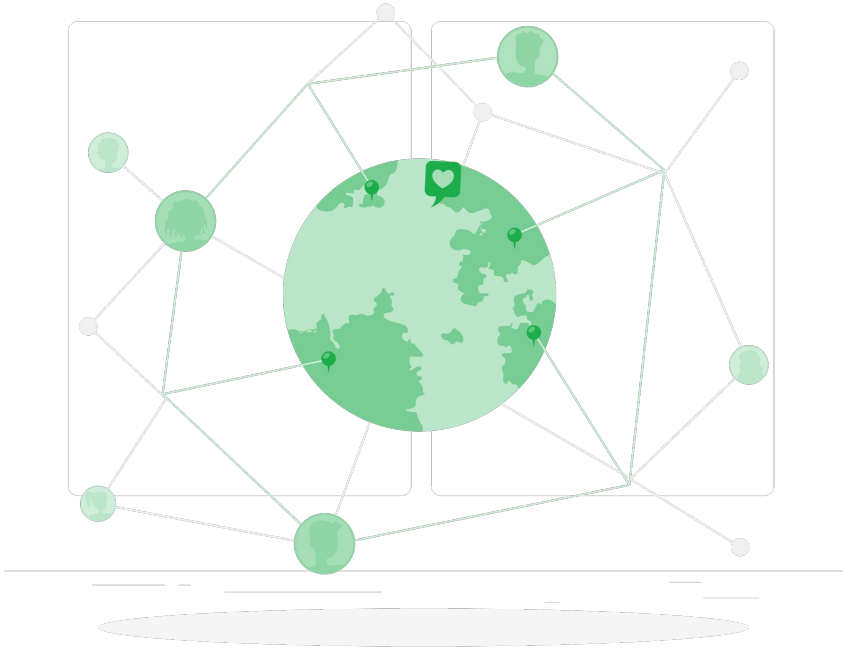
ES 491 - Modeling and Simulation of Complex Systems

SIMULATING NATURAL SELECTION OF SPEED



MOTIVATION

- To study if there is an optimal value of speed which a system approaches.
- To study what factors such an optimal value depends on if it exists.

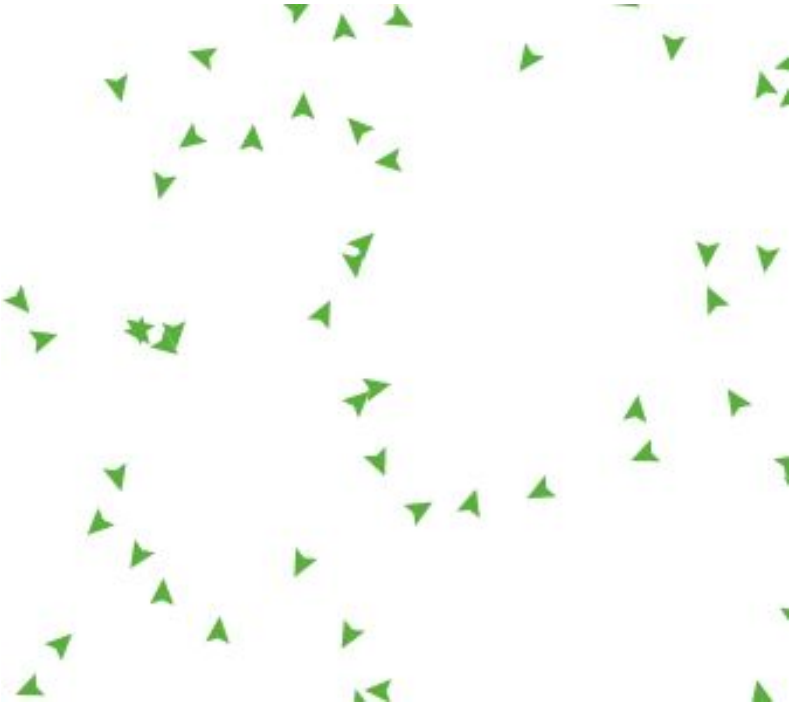
AGENTS

FOOD

- ➔ A turtle breed.
- ➔ Cannot move in the environment.
- ➔ Spawns randomly in the environment at the start of a generation.
- ➔ No. of food = food-count

ANIMALS

- A turtle breed.
- Can move around in the environment and eat food.
- Spawns randomly at the start of a generation.
- Dies, survives or reproduces at the end of a generation.



AGENT PROPERTIES

FOOD

- xcor, ycor
- shape
- color
- size

ANIMALS

- ➔ xcor, ycor
- ➔ size
- ➔ shape
- ➔ color
- ➔ energy
- ➔ cost = speed^2
- ➔ speed
- ➔ food-collected

ENVIRONMENT

- Empty except for food and animals that spawn at the start of each generation.
- World is 33×33 patches and wraps around.

FLOW OF EVENTS

- ➔ Every 240 time steps is a generation.
- ➔ At the start of each generation, food and animals spawn at random locations.
- ➔ During the generation, animals move around in the environment.
- ➔ In each time step, an animal moves a distance equal to its speed and its energy decreases by an amount equal to its cost.
- ➔ If it finds a food within a radius of 1 unit, it eats the food.

- In each time step, an animal moves a distance equal to its speed and its energy decreases by an amount equal to its cost.
- If it finds a food within a radius of 1 unit, it eats the food.
- When a food is eaten by an animal, it dies and the food-collected of the animal increases by 1.
- At the end of a generation, an animal dies if its food-collected is 0.

- ➔ At the end of a generation, an animal survives and creates (food-collected - 1) new animals if its food-collected is > 0.
- ➔ The energy of the surviving animal is reset to max-energy.
- ➔ The remaining food is cleared and the next generation begins.

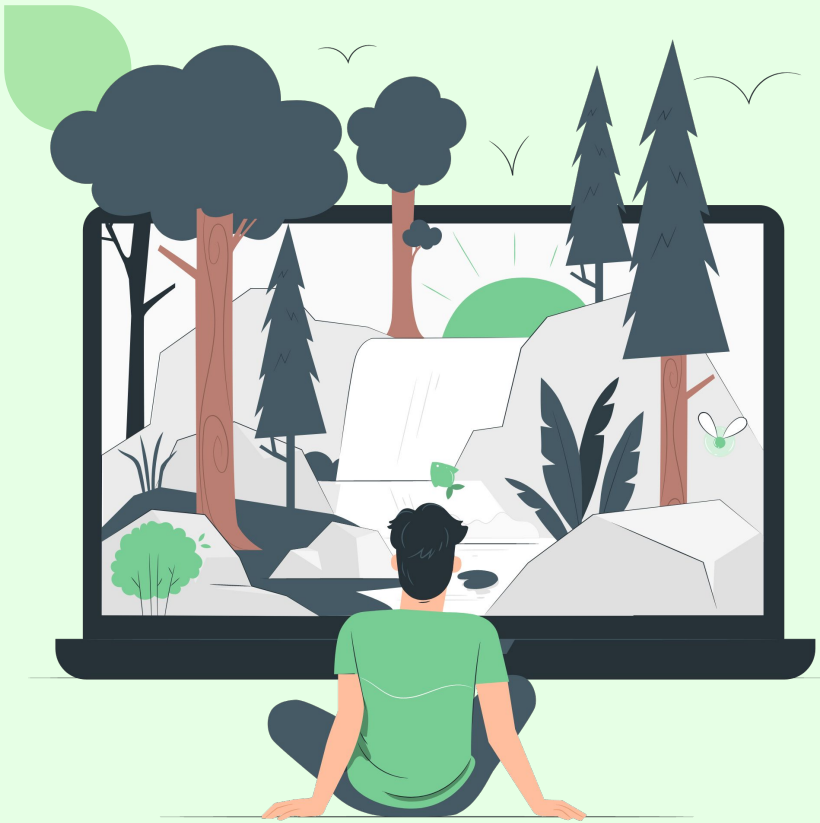
MUTATIONS

- When an animal reproduces, the new animal has a 50% chance of having a mutation.
- A mutation may cause its speed to increase or decreasing by a number less than 0.1
- cost = $speed^2$

SPEED VS COST TRADE-OFF

- ➔ cost = speed^2
- ➔ If speed = 2, cost = 4

  ie, the animal can move 2 units in every step but has to use 4 units of energy
- ➔ cost ~ energy
- ➔ energy ~ $mv^2/2$



DEMO

OBSERVATIONS

- ➔ Regardless of the initial speed, the average speed of the animals approaches a value that is optimal for the system.
- ➔ The population approaches food-count.
- ➔ The optimal value of speed depends on max-energy.

CONCLUSIONS

➔ Even though we do not know the optimal speed for the system, the agents themselves interact with each other and attain the speed optimal to them.

➔ This emergent value of speed depends on max-energy because:

if animals start with more energy, they can afford a higher cost, while they can't if they start with less energy.

THANK YOU

Chris Francis

18110041