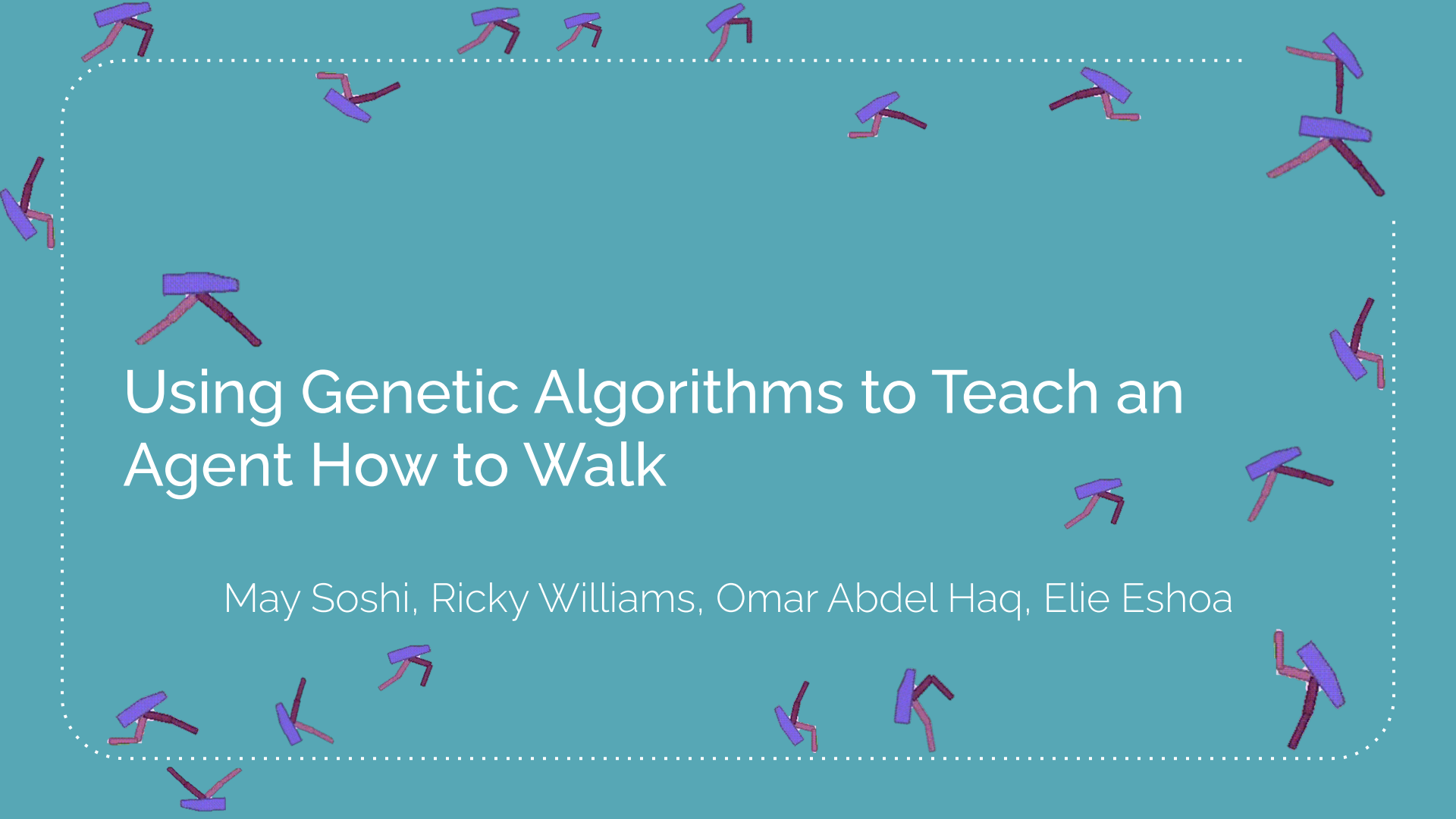
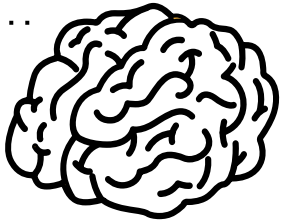


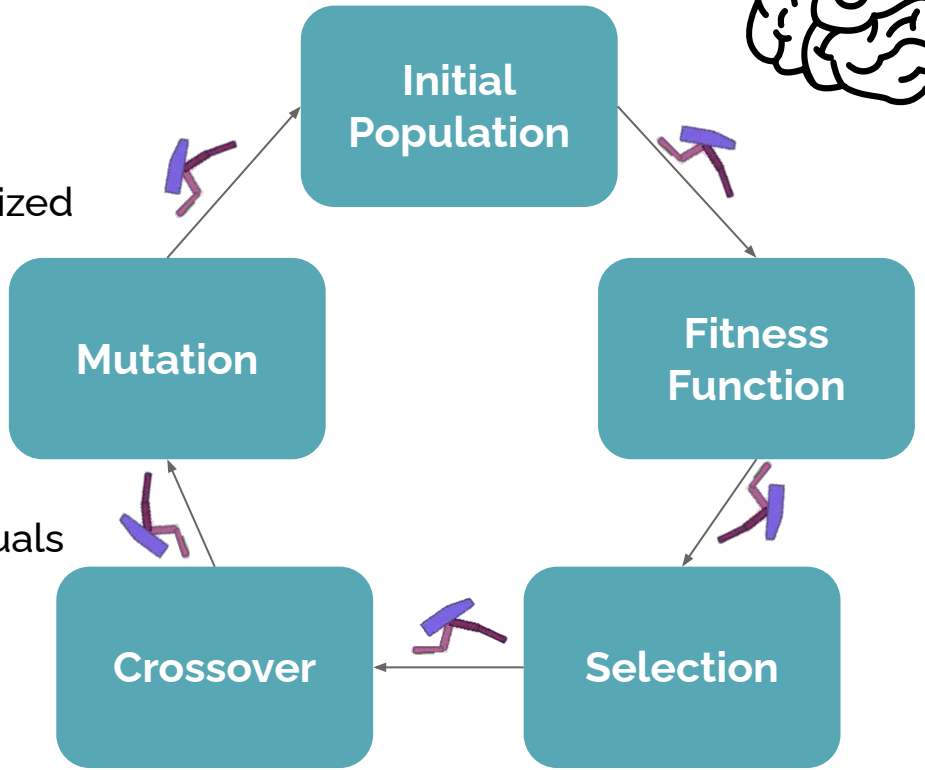
Using Genetic Algorithms to Teach an Agent How to Walk

May Soshi, Ricky Williams, Omar Abdel Haq, Elie Eshoa

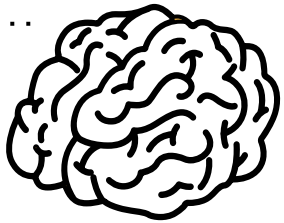
Genetic Algorithms



1. Initial Population
   a. Create population
   b. Each individual is characterized by a set of parameters
2. Fitness Function
   a. Evaluate each individual and give them a fitness score
3. Selection
   a. Select the most “fit” individuals
4. Crossover
   a. Use selected individuals to to reproduce
5. Mutation



Bipedal Walking Details



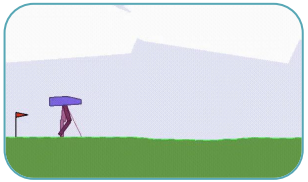
Agent

We have a box with **2** legs and **4** joints. In **GA**s terms, we define it as a set of **genes** (parameters) of two types:

- ***Physical characteristics:*** e.g. leg lengths, height, thickness
- ***Walking style:*** 4 torques to apply to each of the 4 joints

Physics Simulation

The movement and distance that the agent performs can simulated using the **C++** library *Box2D*



Fitness Evaluation

Fitness eva

Distance

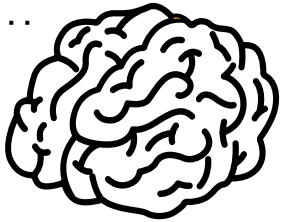
Agent State

Fitness Function Evaluation

In each generation, and for every agent, we need to compute its fitness via a fitness function. Fitness is calculated by running multiple trials for each agent, and then averaging them out. Each simulation is computationally expensive, and parallelization can help!

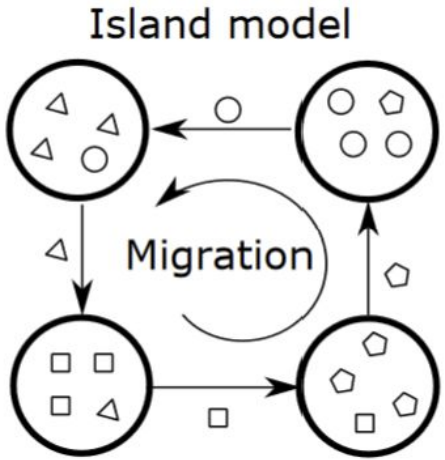
Using OpenMP, during each generation, agent fitness function evaluation can be done by dividing the load across threads using a parallel region - this load will be further divided within itself by spawning another parallel region, since every agent goes through an evaluation process multiple times.

Opportunities for Parallelization

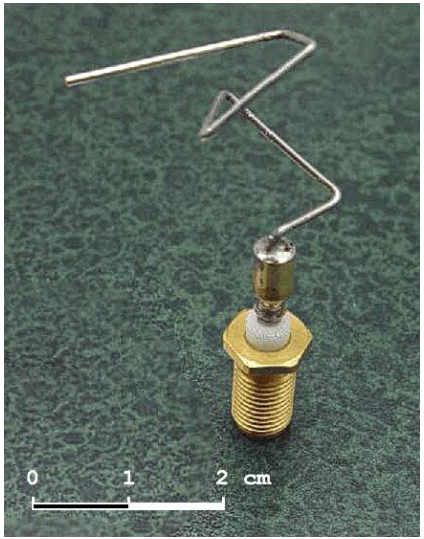


Multi-deme or “island” populations

- Can introduce more differentiated agents with better chances of survival
- Variations in number of populations, topology, migration rates
- Primary goal is diversification



(Falc ́on-Cardona et. al., 2021)



2006 NASA ST5 spacecraft antenna, inspired by GA

Citations & Sources

Falcón-Cardona, J. G., Gómez, R. H., Coello, C. A. C., & Tapia, M. G. C. (2021). Parallel multi-objective evolutionary algorithms: A comprehensive survey. *Swarm and Evolutionary Computation*, *67*, 100960.

https://www.gymlibrary.dev/environments/box2d/bipedal_walker/

https://github.com/wfleshman/Evolving_To_Walk