Dr. Izquierdo
Midterm Project Final Report
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<u>Design the brain, body, and environment:</u> I decided to make my project a continuation of my midterm project. The goal is to simulate a camel surviving in the desert. The environment is an 800x800 grid with a large circular pool located at an arbitrary location. The body is a simple sphere with a visual sensor that simulates a forward-facing vision field with an fov of pi/3 and a range of 300 pixels.

The brain is a feedforward neural network with four hidden layers with 8, 16, 8, and 4 nodes respectively (Fig. 1). The network has five input features (referred to as X henceforth) and two output actions (referred to as Y). The inputs consist of: angle, speed, direction, whether the camel can see the pool (0.0 or 1.0), the distance from the pool if the camel can see it (This is set to the maximum possible distance if the camel can't see the pool), and the angle difference between the camel's current angle and the angle to the pool . All inputs are standardized to values between 0 and 1. The outputs from the network are linear acceleration (scaled between -1.0 and 1.0) and angular velocity (scaled between -0.2 and 0.2). All layers except the output use a ReLu activation function, and the output uses a sigmoid activation.

The camel is trained on a simple MGA evolutionary algorithm in which the fitness is based on the difference between the camel's starting distance from the pool and the final distance from the camel to the pool. Since there are times in which the camel may never reach the pool, a maximum time parameter is also specified.

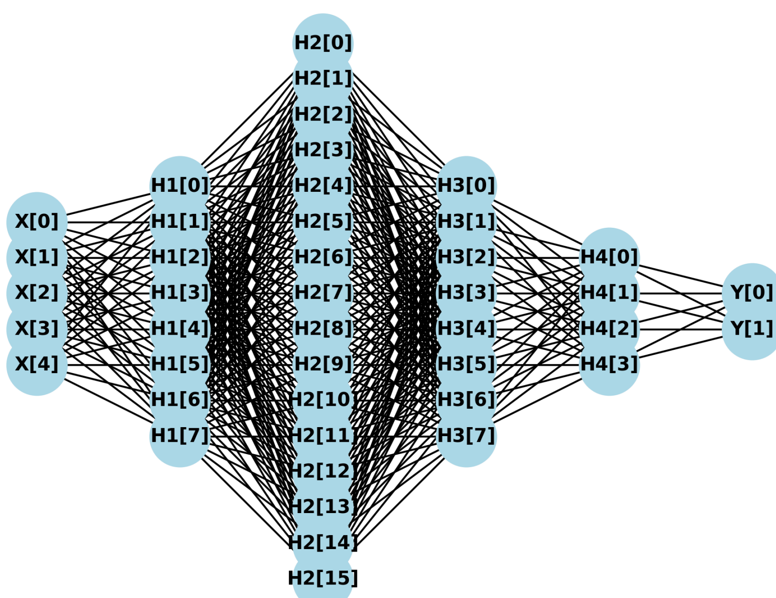

Fig. 1 Visual Depiction of NeuralNetwork

Evolve the neural network controlling a vehicle to perform a behavior of your choice:
The camel was evolved using a simple MGA algorithm with a recombination probability of 0.9, a mutation probability of 0.2, a population size of 20, and 1000 tourneys (Fig. 2). It seems clear that from the plot of the fitness over each generation, the camel evolves in plateaus. In each of these plateaus, the camel will reach a local max for its fitness for a number of generations, then drop, then rise again to a higher plateau later on. My hypothesis for why this could be is due to the high propensity for exploration (Mprob = 0.2) in the learning.

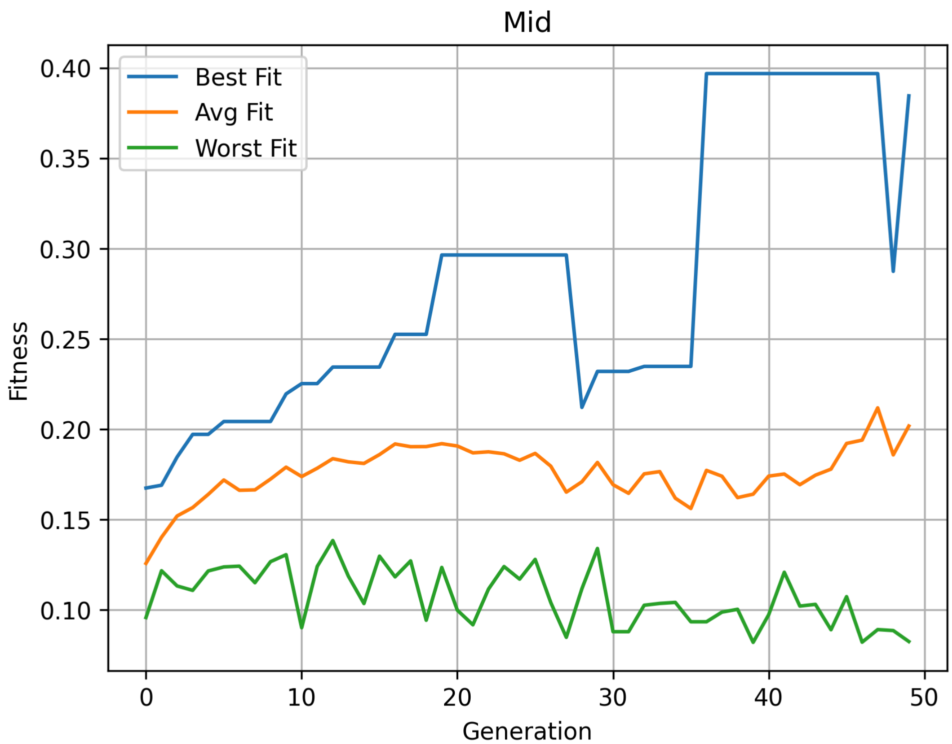

Fig. 2 Plot of Camel Fitness Evolution

Looking at the results in the ordered and random simulation for testing the camel behavior (Figs. 3 and 4) it's clear there are a number of patterns and differences that have emerged. Most strikingly, it seems that the camel is not very good at reaching the pool. There are some instances in which the camel found it, but it seems that most often the camel would head directly for the wall and would simply ride the wall. My theory for why this is is that the camel training was not diverse enough, in that of the nine positions the pool started in, it directly bordered the wall in eight of them, meaning the camel evolving a strategy of simply hugging the wall ended up working well. To fix this, in the future I could add more training spots for the pool.

Attached in the github repository is a gif that shows an individual sample of the camel finding the water.

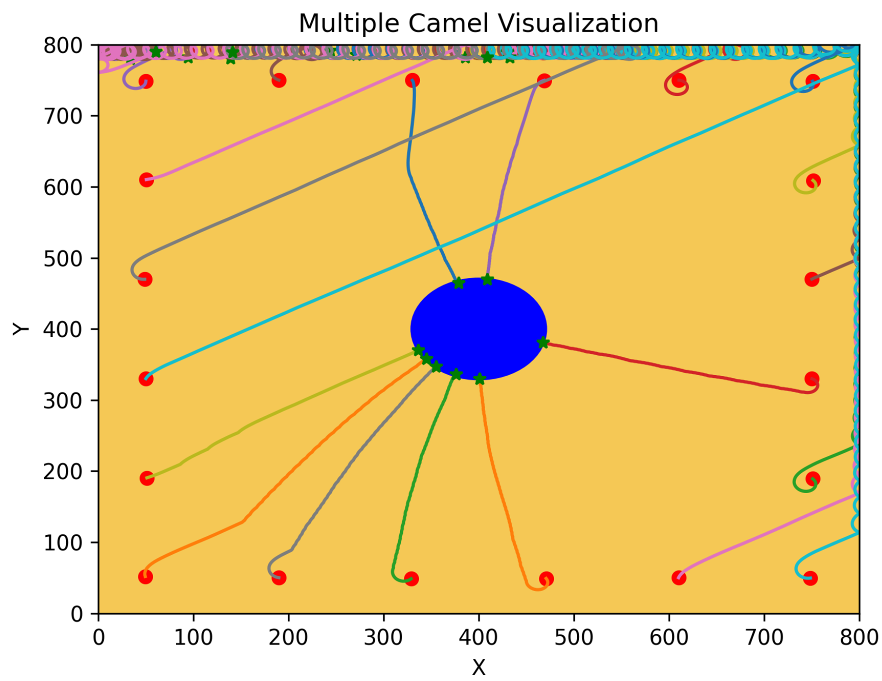

Fig. 3 Multiple Camel Visualization for Ordered Camel Positions

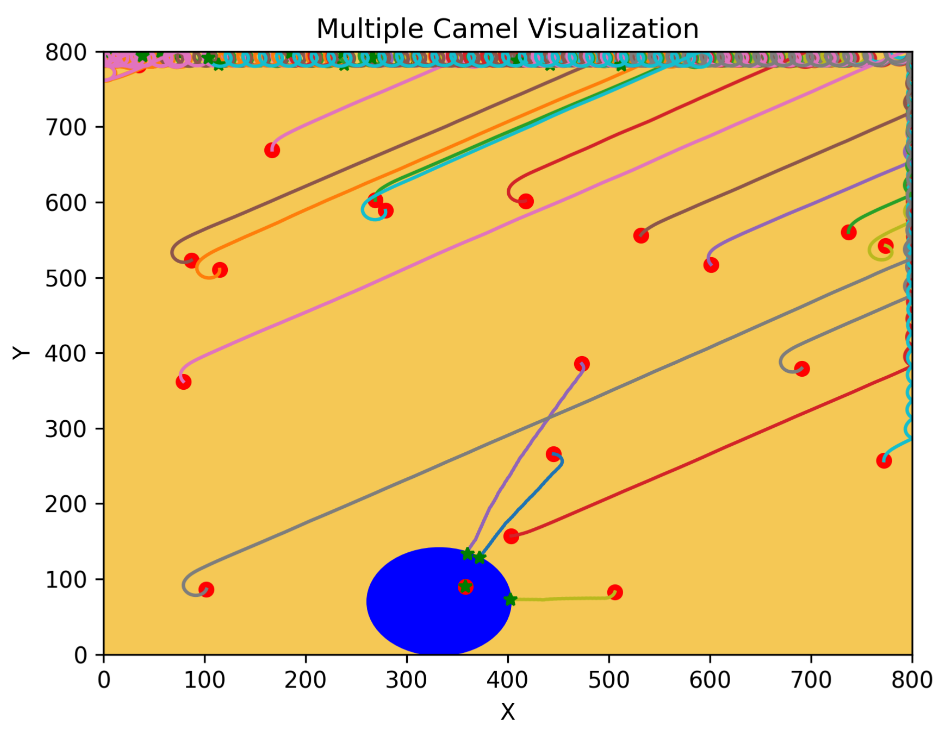

Fig. 4 Multiple Camel Visualization for Random Camel Positions