The Instantiation of Brains

Design Document, Final project

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**Abstract:**

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# 1. Introduction :

This paper rigorously establishes that neural network design models can be used to manipulate learning on simulated biological system. All the research was done Using professor Thomas Caudell’s animal robot environmental model.1 The starting point of the research involved 3 architectures, used to establish the parameters of life with respect to the simulated organism and its environment. These provide a basis for analyzing the implemented neural network algorithms. The goal of which is to create a “neuron” based brain for the organism to live as long as possible in its environment.

# 2. Description of Anticipated Designs:

### 2.1 Architecture 0: staying in place

In this design, the robot animal was set to stay in one place until it dies

### 2.2 Architecture 1: movement

In this design, the robot animal was set to move in a direction until it dies. The direction was incremented by 5o, after every epoch.

### 2.3 Architecture 2: Movement and eat-all-on-contact

In this design, the robot animal was set to move in a direction, eating everything in its path, until it dies. The direction was incremented by 5o, after every epoch. The goal of which is to establish weather there is good food and bad food on the board.

### 2.4 Architecture 3: Movement, eat all on contact, classification with Delta Rule Neuron for one eyelet

In this design, the robot animal was set to move in a direction, eating everything in its path, until it dies. The direction was incremented by 5o, after every epoch. The goal of which is to classify good food and bad food on the board based on the LMS neuron architecture. It is expected that this architecture will be used later for movement based on food classification based on light input.

### 2.5 Architecture 4-10: Movement based on light and sound inputs with additions of the Backpropagation algorithm.

In these future designs, the robot animal will move based on light and sound inputs and their classification. The goal of which is to either move the animal or have it stay in place based on its own energy and what it sees and smells in its environment. All subsequent architectures will take a little step in this general direction (all steps will be based of the results of the previous steps). In a predictive fashion, architecture 4 will expand what the animal sees moving from one forward input direction of light to all 31 input light vectors and associate them with the Backpropagation algorithm, architecture 5 will take architecture 4’s ability to see food in all directions of one and apply it to both eyes, architecture 6 will play off the previous 2 and try to get the robot to change directions based off what it sees. The next potential architectures, will try to incorporate what was gleaned from the eyes and apply it to smell as well. The overall encompassing project goal, of these architectures, will be to keep the animal alive as long as possible.

# 3. Learning Approach :

### 3.1 Initial approach:

Our initial approach involves making small incremental steps that can be implemented by the next iteration depending on its success/or failure.

### 3.2 learning:

The goal of the first “real” neuron architecture (3) is simply to classify food as either good, bad, or neutral; based on how much life points were removed or added after eating the food. This data will be tied in with the RGB vector, for incoming light straight ahead of the robot, and used to update weights for classifying objects.

Moving down this line of logic, after the robot can correctly classify food, we can use the food classification and association with light vectors to determine a direction to move. For Example: if the robot sees food coming in from one of its RGB vectors. The robot can re-orient in the direction of the good food based off the output of the neuron for food classification.

### 3.3 Combining the learning:

More neurons can be added to the system based of the light vector food classifier making a good setup for a Backpropagation multilayer feedforward network. In this network we plan on implementing our LMS neuron into a Backpropagated network, after which it is planned that we applied the same set of logic to the sounds and smell sensors. The goal of which is that at the end of these architecture builds is to combine them all to determine the direction in which the mouse moves. Once this is set up we can add another neuron into the loop that determines if the robot should stay in one spot or move towards food based off weather it has lots of energy of need to go feed.

# 4. Evaluation Approach:

### 4.1 Testing the robot/brain in the environment

The overall test of the robot brain will be to see if we can push the lifespan of our robot greater than any of the naive architectures (0-2) using the neural algorithms described in 3.3 and 3.2.

### 4.2 Collected Data

Ideally we would like to do over 1000 runs for our data collection. This is done with every architecture model. Data will be collected and stored after every epoch to be used in plots, table, and graphs to emphasize any changes a new architecture presents. RMS error data will be collected for all neuron architectures. Furthermore any significant information “learned” by the neurons will be save for presentation, such as wavelengths for RGB vectors of poisonous and non-poisonous foods.

### 4.3 Criteria for success of the project

Our success will be determined by being able to make an accurate decision, based on the data, that there were either positive or negative changes in the robots life span, for each architecture. The main goal of this project is to lengthen the lifespan of the robot animal but if we are also able to rule out bad architectures in the process the experiments will still be successful even if they didn’t extend the organisms lifespan

# 5. Analysis/Presentation Approach :

### 5.1 Analysis

For each architecture model: histograms, averages, and standard deviations for each experimental condition for each architecture model.

### 5.2 Presentation

How are you going to analyze your experimental data during development?  - What plots are you going to produce showing the performance of the robots? - How are you going to present your results to yourselves and in the final report? - What results are you going to give in the report?

# 6. Preliminary Results:

Descriptions of the first four architectures. - Preliminary performance results for each of these.

# 7. Known Issues:

Give a schedule for completing the project, including milestones. - Any major problems or questions? - Team issues? - Code issues? - Resource issues?

The first four architectures mentioned below are:

Architecture 0: No movement, measure lifetime. Architecture 1: Movement, measure lifetime as a function of speed. Architecture 2: Movement and eat-all-on-contact, measure lifetimes as a function of speed. Architecture 3: Movement, eat all on contact, classification with Delta Rule Neuron for one eyelet, plot RMS training error verses eat event.

Measurements should be collected over a number (>100) of trials, where the agent starts at random locations and headings. Report histograms, averages, and standard deviations for each experimental condition for each architecture.

Document: A title page listing the title of your team’s project, plus all team members with their email addresses, plus up to 10 single sided, 1.5 line spaced pages, 1” margins, 12 point Times font, including figures and references. Number all pages at bottom. Put captions on all figures. Label all axis of graphs. Be very concise!