Prometheus AI

Phase 1

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ECSE-498 Presentation

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Swarm Robotics

Coordinating multiple robots

The aim is to create an intelligent system controlling multiple agents simultaneously working in a swarm. Possible applications include robots in hazardous environments:

1. Outer space (Moon, Mars)
2. Nuclear disaster aftermath
3. Oil pipeline inspection
4. Military zones

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Prometheus AI

A model of the human brain

The Prometheus AI model aims to mimic the basic structure of the human brain with four layers:

1. Neural Network
2. Knowledge Node Network
3. Expert System
4. Meta Reasoner

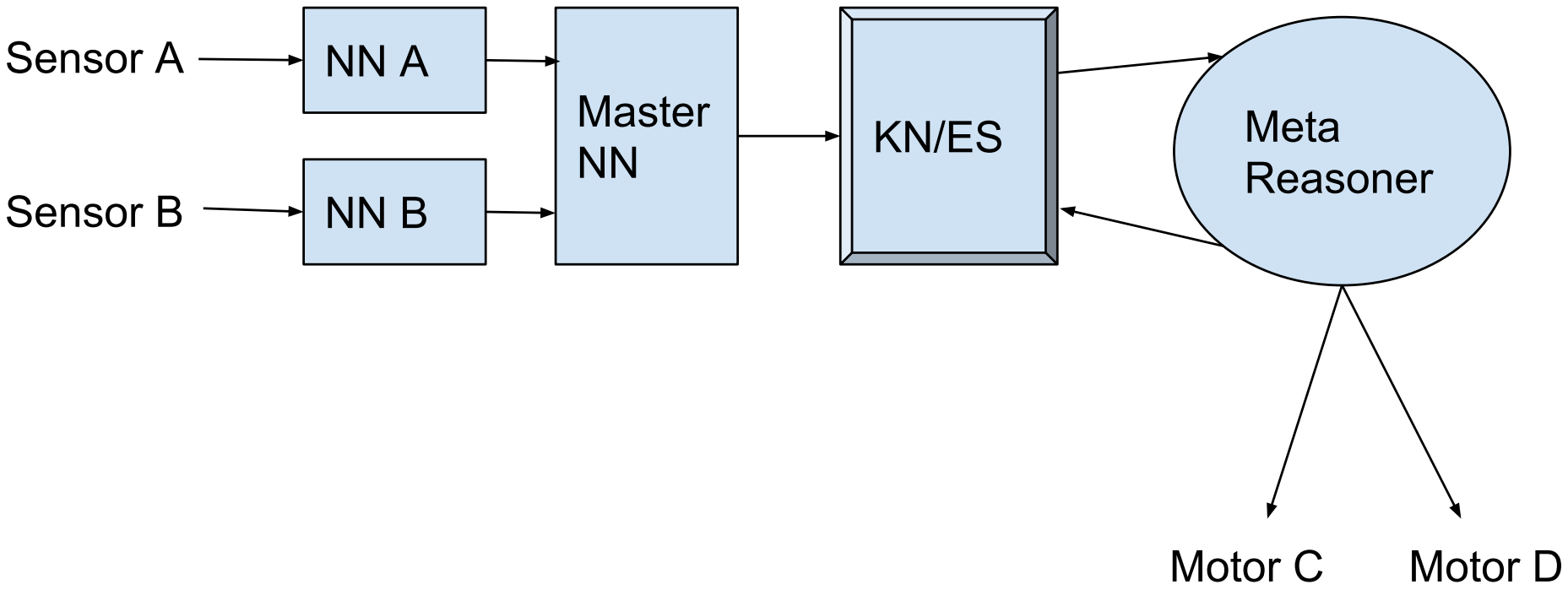

Figure 1: Full AI model[1].

[1] Joseph Vybihal. *Full AI Model*. 2016.

Neural Network

Signal classifier

The Neural Network (NN) is the first interface between the sensors and the rest of the system. It outputs tuples to be passed on to the next layer.

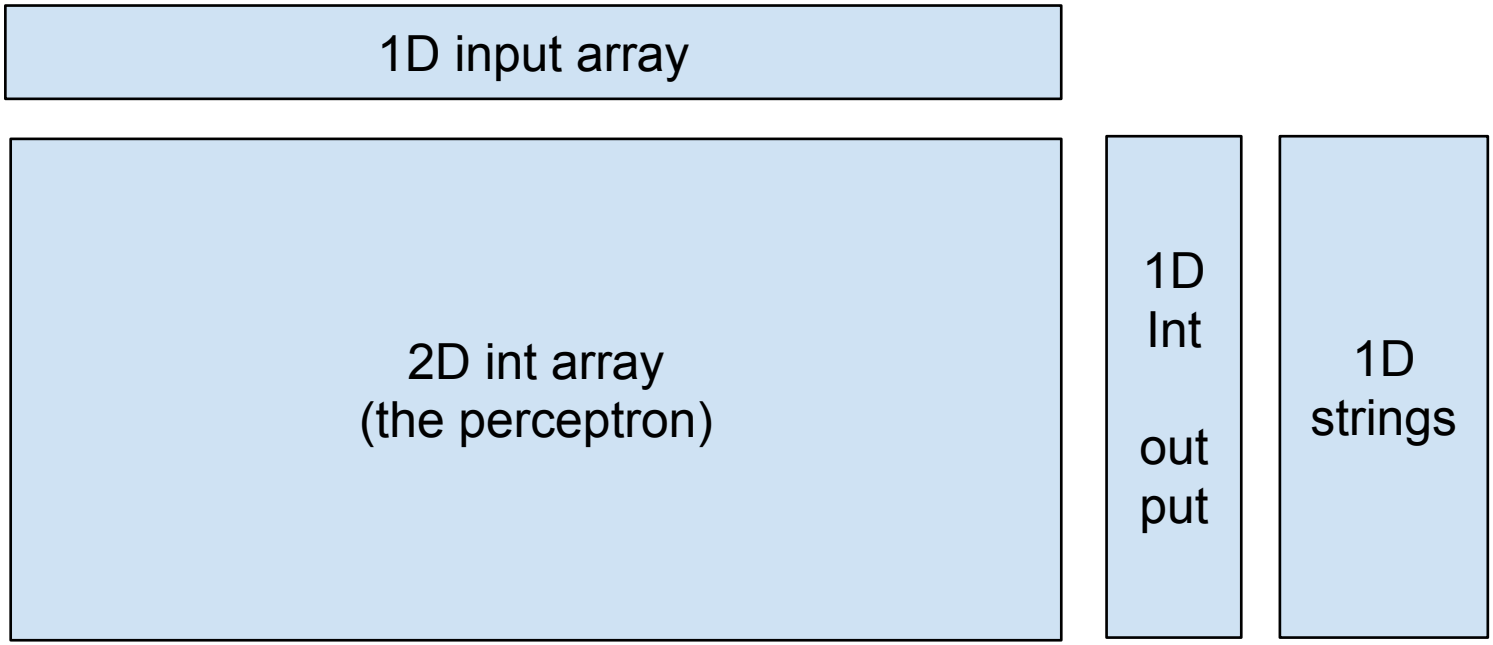

Figure 2: A perceptron[2].

[2] Joseph Vybihal. *Full AI Model*. 2016.

Knowledge Node Network

Memory

The Knowledge Node Network (KNN) represents cascading memory in the AI brain and outputs tags.

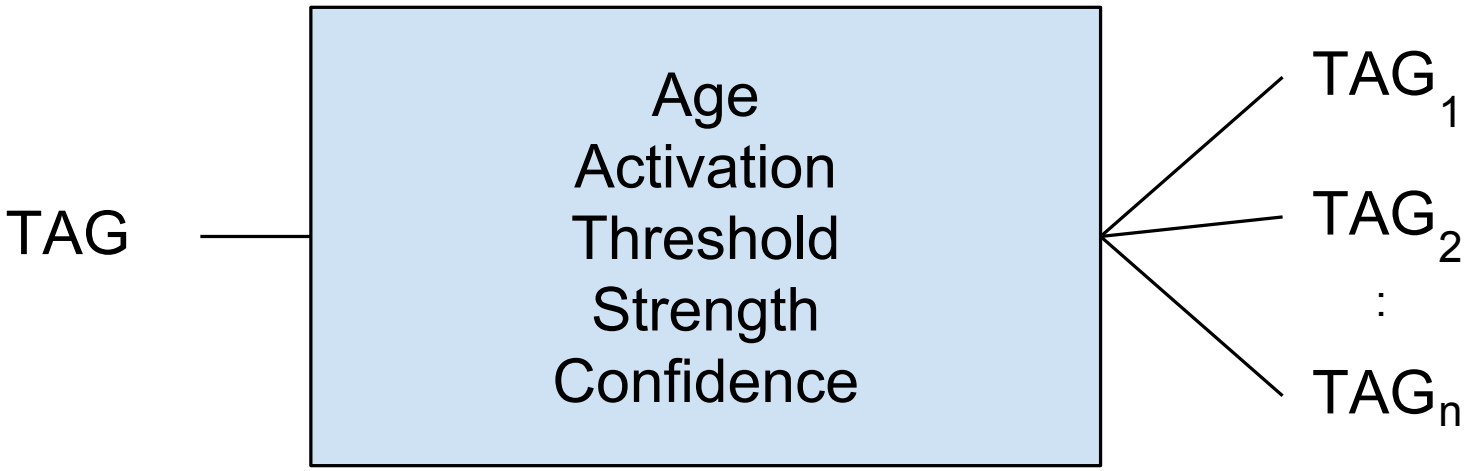

Figure 3: An abstract view of the Knowledge Node[3].

[3] Joseph Vybihal. *Full AI Model*. 2016.

Expert System

Basic logic reasoner

The Expert System (ES) looks at the tags given by the KNN and outputs a recommendation.

Meta Reasoner

High-level thinking

The Meta Reasoner (META) receives data from the KNN and makes an intelligent decision based on context (its own paranoid view of the world).

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Assigned Task

The task assigned to me was to implement the Expert System and Knowledge Node Network in Java based on some preliminary specifications.

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Fundamentals of AI

First I learned about the fundamentals of AI, including Intelligent Agents.

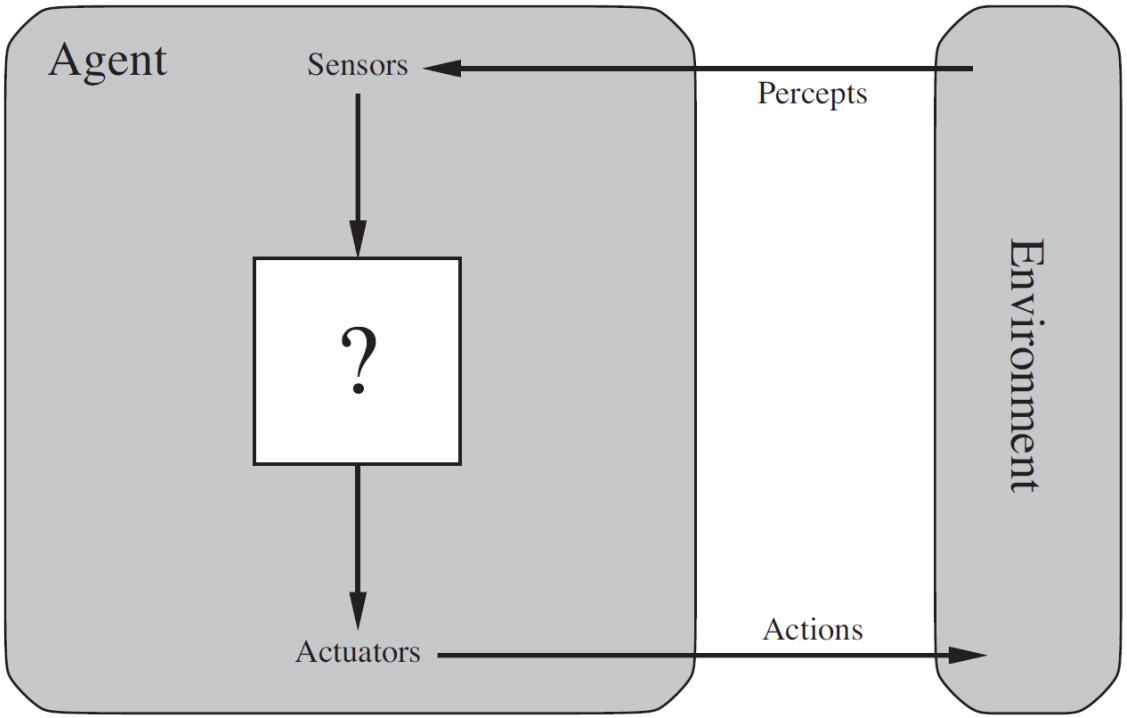

Figure 4: Rational agents[4].

[4] S. Russell and P. Norvig. *Artificial Intelligence: A Modern Approach, Global Edition*. Always learning. Pearson Education, Limited, 2016. ISBN: 9781292153964. URL: https://books.google.ca/books?id=XS9CjwEACAAJ.

Neural Networks

I read about neural networks, deep learning and stochastic gradient descent.

Figure 5: MNIST data set.[5].

[5] Michael A. Nielsen. *Neural Networks and Deep Learning*. http://neuralnetworksanddeeplearning.com/. Determination Press, 2015.

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Weekly Meetings

Weekly meetings were conducted to assess progress in the project.

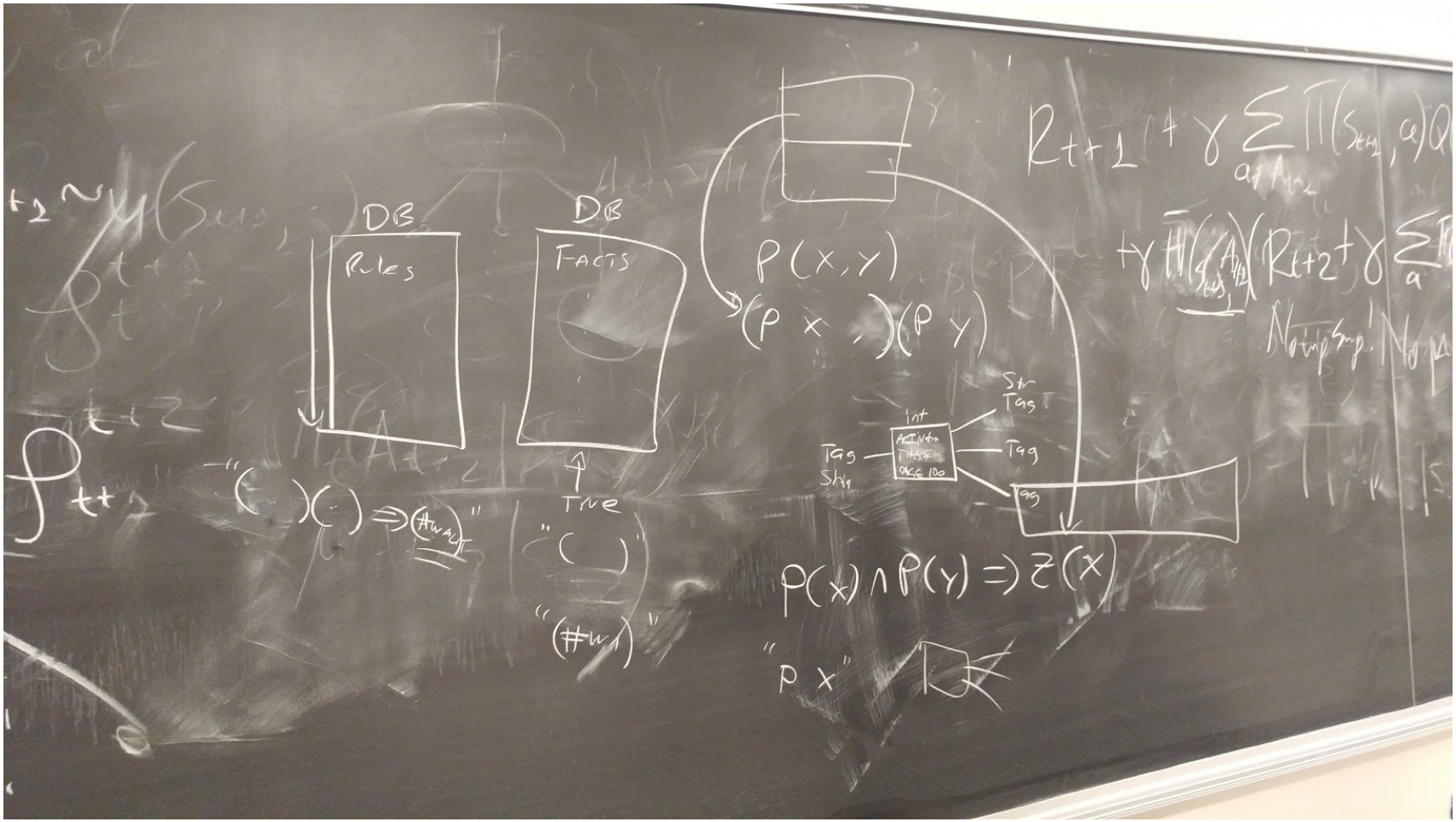

Figure 6: One of the weekly discussions on the blackboard.

Design Criteria

The design of both the Expert System and Knowledge Node Network had many criteria:

- Object-Oriented Design
  - Encapsulation
  - Abstraction
  - Readability
- Speed
- Documentation

Tags

The entire system revolves around tags, which can be one of three types:

1. Fact
2. Recommendation
3. Rule

To follow object-oriented design, these tags are implemented as a Tag class in Java, with Fact, Rule and Recommendation subclasses.

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Knowledge Nodes

The Knowledge Node Network is based around the Knowledge Nodes and their behaviour.

Thinking

The KNN has three main ways of thinking:

- Forwards
- Backwards
- Lambda

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Rules

The Expert System is based around cascaded activation of Rules, which may pass recommendations up to the META layer.

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Knowledge Node Network Finalization

Some more complex features of the KNN are still to be implemented:

- Lambda thinking
- Backwards thinking (possibly in a background thread)
- Confidence and strength
- Sigmoid activation
- Timestamp aging

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Expert System Finalization

Some features of the Expert System are still to be implemented:

- Fact token matching (? $<$ $>$ $=$)

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Integration

The ES and KNN layers will have to be merged with the NN and META, which will probably lead to some conflicts. Time will be required to ensure proper functionality.

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Simulation

The Java simulation library Simbad will be used to test the entire system on virtual robots.

Physical Testing

Prof. Vybihal's lab has multiple simple robots with ultrasonic sensors that can be tested on.

References I


Michael A. Nielsen. *Neural Networks and Deep Learning*. http://neuralnetworksanddeeplearning.com/. Determination Press, 2015.


S. Russell and P. Norvig. *Artificial Intelligence: A Modern Approach, Global Edition*. Always learning. Pearson Education, Limited, 2016. ISBN: 9781292153964. URL: https://books.google.ca/books?id=XS9CjwEACAAJ.


Joseph Vybihal. *Full AI Model*. 2016.