Hybrid AI & Machine Learning Systems

Logan Kearsley
TJHSST Computer Systems Lab 2006-2007

Abstract:

The purpose of this project is to design a set of libraries and demonstration programs that combine the capabilities of multiple AI and machine learning models to produce a more flexible and versatile hybrid model.

I will primarily be working with back-propagation neural networks and subsumption architectures.

The primary demonstration program will be a character recognition system capable of simply and rapidly adding new characters to its memory and recognizing mulltiple fonts.

Background:

Most AI and Machine Learning research to this point has consisted of developing separate individual models to maximize utility for a single problem type or to duplicate biological models.

Comparatively little research has been done in AI systems combining the best aspects of multiple models to produce a more versatile hybrid system. One example, however, is 'hybrid neural networks', which were proposed in the late 1980s to incorporate symbolic processing and neural processing into a single system for speed and ease of control while retaining the flexibility of pure neural nets.

The subsumption architecture model was first used in 1984 and invented by Alexandre Parodi. Subsumption architectures make use of multiple simple rules layered over each other to produce complex emergent behaviors.

Procedures & Methods

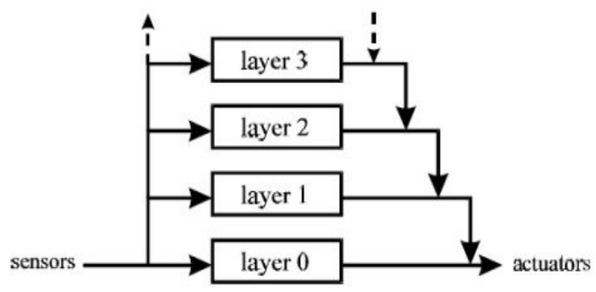
The programming for this project will be done in C, using the gcc compiler. For the neural network programming, I will be using a back-propagation learning algorithm with weight matrices to simulate neuron layers. I have devised a new data type, neuro_t, to store all of the relevant information for a single net. The project is planned to consist of 3 major stages:

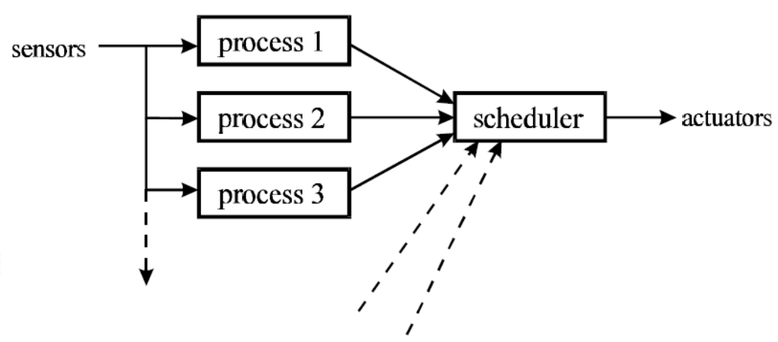
•Model Development- This stage consists of creating the code for the AI algorithms, including a back-propagation learning algorithm and subsumption scheduler/manager.

•Algorithmic Testing- In this stage, I will be evaluating and improving the effectiveness of the AI algorithms mostly by feeding test programs random input/output associations to ensure that they learn properly.

•Application Testing- In this stage, I will be writing the final character recognition program and testing with data from bitmap fonts.

Permanent Priority vs. Competitive Subsumption:



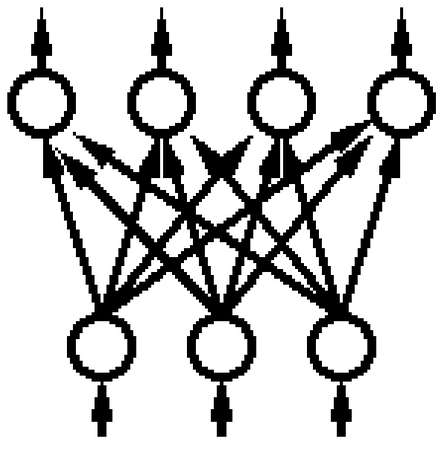


Expected Results

The results of the project will be a set of libraries and architecture descriptions for the manipulation and combination of multiple AI models, and a set of demonstration programs. The programs will be evaluated in terms of speed of learning and accuracy of character identification. I have already completed the initial back-propagation work.

It is intended that these results will provide a starting point for future researchers to work with the same algorithms, and provide inspiration for investigating more combinations of different AI models.

Neural Connectivity & the Associated Weight Matrix:



In1	In2	In3	
W1,1	W1,2	W1,3	Out1
W2,1	W2,2	W2,3	Out2
W3,1	W3,2	W3,3	Out3
W4,1	W4,2	W4,3	Out4

```
Load/Teach/Query/Exit? : Q

Input Vector:
1
0

Layer 1          1.000000                  0.000000

0.994611                   2.956922                   3.066278

0.485401                   0.530026                   0.538494
~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~
Layer 2          0.994611                  0.485401

0.920221                   4.082325                   -5.088287
~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~
```

Testing Interface Screenshot: Weight matrices for computing boolean XOR.