Announcements

• Today’s Handouts (see website):
  > Outline Class 4
  > LISP Notes 1

• Web Site
  > www.mil.ufl.edu/5840
  > Software and Notes

• Reading Assignment:
  > Nilsson Chapter 3
  > LISP Chapters 1-5

• Written Assignment Reminder
  > Homework 2 due Tue. 9/08 in class
Today’s Menu

• Example of a Classical AI Production System
  {See slides 15-22 from class #3}
    > Irrevocable Control Strategy
    > Tentative Control Strategy
• Architectures for the Implementation of Action Functions
  > B. State Machines
  > C. Artificial Neural Networks
  > D. Subsumption Architecture
• Final Thoughts on Stimulus-Response (SR) Agents - Chapter 2
Subjugator 2006

EEL5840: Elements of Machine Intelligence

Perception and Action

- **State Machines**: Implementation of Boolean (action) functions using a connected network of logical gates AND, OR, NOR, etc.
- **Networks**: Implementation of action functions using a connected network of threshold units or other elements that compute a nonlinear function of a weighted sum of their inputs. One such element is the *threshold logic unit* or TLU for short.

Boolean functions implementable by a TLU are called *linearly-separable functions*. (A TLU separates the space of input vectors into an above-threshold response from below-threshold response by a linear surface—called a *hyperplane* in $n$ dimensions.) Not all Boolean functions are linearly separable—however a monomial or any clause is linearly separable.
Example: Let $f = x_1 / x_2 x_3$

\[
\begin{array}{cccc}
\text{x}_1 / \text{x}_2 \text{x}_3 & f & \sum \text{TLU} \\
0 0 0 & 0 & 0 & 0 \\
0 0 1 & 0 & 1 & 0 \\
0 1 0 & 0 & -1 & 0 \\
0 1 1 & 0 & 0 & 0 \\
1 0 0 & 0 & 1 & 0 \\
1 0 1 & 1 & 2 & 1 \\
1 1 0 & 0 & 0 & 0 \\
1 1 1 & 0 & 1 & 0 \\
\end{array}
\]

Example: Let $b - f_4 = x_1 / x_2$

\[
\frac{s_2 + s_3}{s_4 + s_5} = \frac{s_2 + s_3}{s_4 / s_5}
\]

\[
\begin{array}{cccc}
s_2 s_3 / s_4 / s_5 \ b - f & \sum \text{TLU} \\
0 0 0 0 & 0 & 0 & 0 \\
0 0 0 1 & 0 & -2 & 0 \\
0 0 1 0 & 0 & -2 & 0 \\
0 0 1 1 & 0 & -4 & 0 \\
0 1 0 0 & 1 & 1 & 1 \\
0 1 0 1 & 0 & -1 & 0 \\
0 1 1 0 & 0 & -1 & 0 \\
0 1 1 1 & 0 & -3 & 0 \\
0 1 1 0 & 0 & -3 & 0 \\
0 1 1 1 & 0 & -2 & 0 \\
\end{array}
\]
The Subsumption Architecture

- An agent’s behavior is controlled by a number of “behavior modules.” Each module receives sensory information directly from the world. If the sensory inputs satisfy a precondition specific to that module, then a certain behavior, also specific to that module, is executed. One behavior module can subsume another.

- As contrasted with much other work in AI, these machines do not depend on complex internal representations of their environments or on reasoning about them.
Neural Networks

- Neural Networks (also known as Artificial Neural Networks or ANNs for short)
  - You need this framework to model processes that cannot be represented as analytical models, e.g., human actions, computer vision, non-linear control, the stock market...
The End!