CogSci 109: Lecture 17

Tues Nov 20, 2006

Multilayer artificial neural networks, examples, and applications

Today's outline…

- Announcements
- Homework notes
  - How to download papers for free using your UCSD student access
  - Previous homework and midterm returns
    - Come discuss issues
- Review of last class (brief)
  - Some example matlab code
- Neural network architectures
  - Some common networks
  - For function fitting
  - For classification - *may get up to here today*
  - Application examples
  - How to code, how to use matlab's neural network toolbox

Announcements

- Previous homework return at end of class again
  - Hw1, 2, 3, midterm
- Hw 5 due next Tuesday

HW5 hints…

- How to access online journals from home/laptop, etc
  - No you don't have to pay fees!!! Hurrah!
  - Go to ACS homepage, set up network proxy on internet explorer, opera, netscape, firefox, etc…
    - http://www-no.ucsd.edu/documentation/squid/index.html
- Where to start?
  - A demo
  - Useful resources for papers: *jstor.com, ieee.org, melvyl, roger, library books, textbook reference sections*
- Library help session
  - *I'm arranging a library resource tour demonstrating how to use the resources in the best way possible*
  - *Not required but strongly strongly recommended*

If you will be away next week Tuesday…

- Email your assignment by Tuesday
- Turn in a hard copy thursday

Review of last class

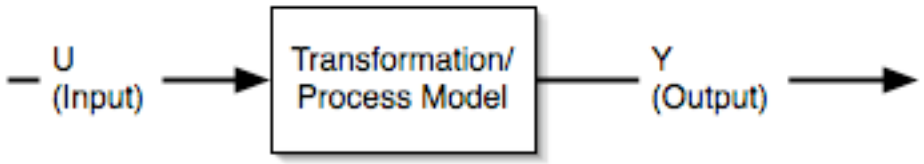
- Single unit perceptrons (TLU's)
- Comparison to biological neurons
- 3 types of learning (supervised, unsupervised, reinforcement)
- Supervised learning algorithm
  - Perceptron learning algorithm (PLA)
- Perceptrons as binary classifiers
  - Failure of perceptrons to classify all cases (XOR failure)

Generic PLA matlab code (not using neural network toolbox)

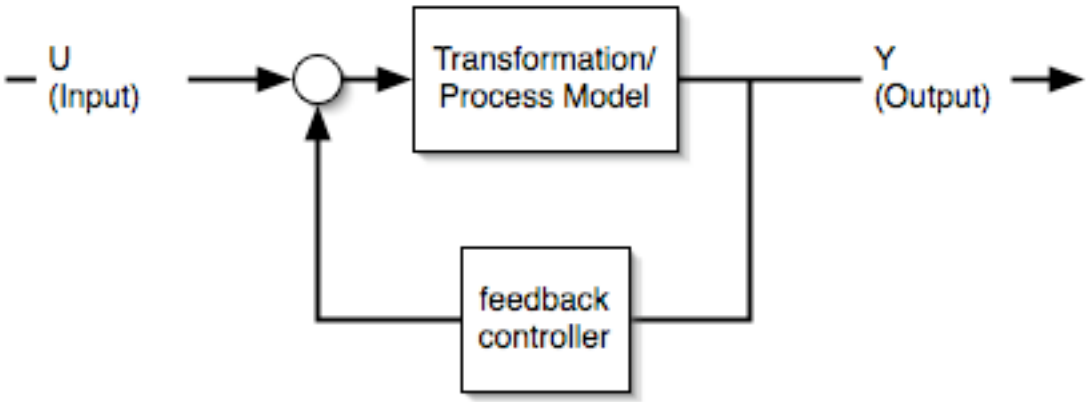
- Demo/explanation
  - Binary classifier

An important concept…

- Feedforward system



- Feedback system



Feedforward-feedback example

- Position control of a motor angle or human limb joint angle
- Path planning
- Feedforward has advantages and drawbacks
  - **Main drawback** - *model is never perfect, and noise can cause severe drift over time, leading to inaccuracies*
    - *Any small error in the model tends to cause massive inaccuracies*
    - *Any disturbances cause errors - noise or external inputs*
  - **Advantage** - *simplicity in computation and sensor requirements*
- Feedback has advantages of robustness and error correction

A common feedback example - inverted pendulum control

- People standing can be modeled as inverted pendulums

Another example - robotics application

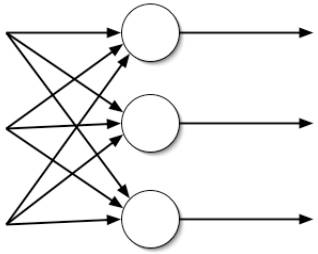
- Big dog video

Back to neural networks…

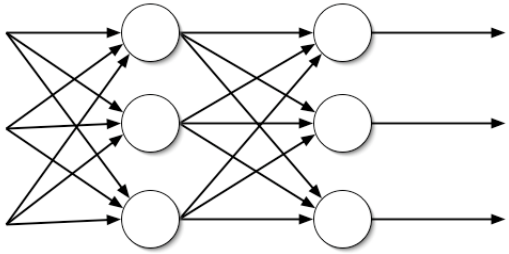
- Now that we have a concept of feedforward and feedback, and how single unit perceptrons work, let's move on to combinations of units to multi-layer networks

Some typical neural network topologies

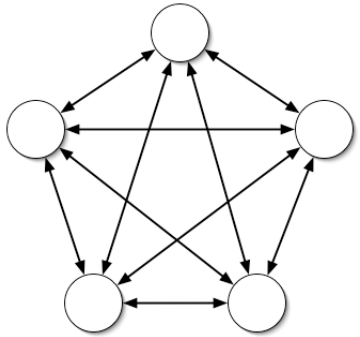
Single layer perceptron



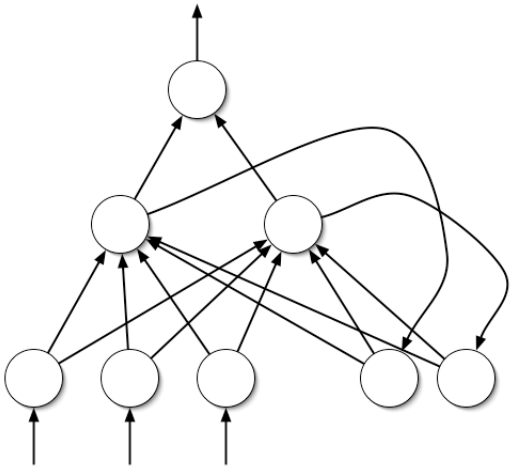
Multi-layer perceptron



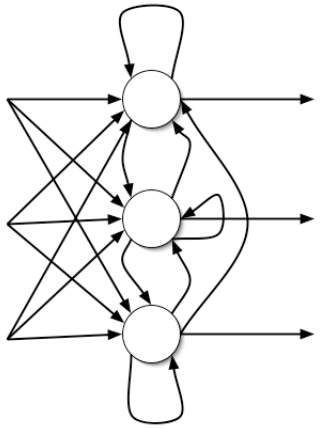
Hopfield network



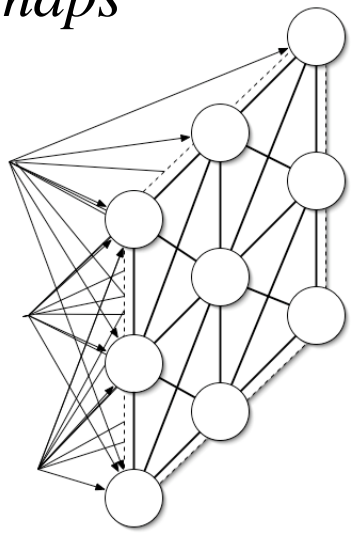
Elman recurrent network



Competitive networks



Self-organizing maps



Neural Network Demos in matlab

- In matlab (you need the Neural Network Toolbox)
  - **nnd2n1** One-input neuron demonstration.
  - **nnd2n2** Two-input neuron demonstration.
  - **nnd4db** Decision boundaries demonstration.
  - **nnd4pr** Perceptron rule demonstration.
  - **nnd9sdq** Steepest descent for quadratic function demonstration.
  - **nnd11nf** Network function demonstration.
  - **nnd11bc** Backpropagation calculation demonstration
  - **nnd11fa** Function approximation demonstration.
  - **nnd11gn** Generalization demonstration.

ANN's for function fits…