CIS 730 Artificial Intelligence
CIS 530 Principles of Artificial Intelligence
Fall 2007

Homework 7 of 10: Problem Set (PS7)
Artificial Neural Networks and Probabilistic Reasoning

Assigned: Wed 31 Oct 2007
Due: Wed 07 Nov 2007 (before midnight)

The purpose of this assignment is to exercise your basic understanding of probabilistic reasoning by studying codes for probabilistic inference.

This homework assignment is worth a total of 20 points.
Each problem is worth 4 points for CIS 730 students and 7 points for CIS 530 students.
Upload a copy of your solution (scanned or typed) to your K-State drop box before the due date.

Refer to the *Bayesian Network Tools in Java (BNJ)* web site:
http://bnj.sourceforge.net

and the screenshots and AVI movies for BNJ v3.0a:
http://www.kddresearch.org/Groups/Probabilistic-Reasoning/BNJ/Screenshots/v3/

Start by downloading BNJ v3.3 (May 2006 release) to your local computer and installing it.

1. **(530/730) Belief Propagation.**

   a) **(Causal chains)** Use BNJ v3.3 to reproduce the causal chain example from Example 5 in Section 4.2.2, p. 153 – 162 Pearl (1988), as discussed in class on Fri 02 Nov 2007 and Mon 05 Nov 2007. Consult slides 4-13 of the notes below.

   Step through the last stage, propagation, and take screenshots after each update of X, Y, and Z. Turn in the screenshots in JPEG form, titled *mp6_1a-n.jpg.* Paste the images into a Word or HTML file and write a caption under each one showing the actual λ and π messages.

   b) **(Trees)** Now look at the propagation examples in Section 4.2.3, p. 162 – 174, particularly Example 6, p. 165 – 166.

   Reproduce this example as above using BNJ v3. Turn in the screenshots in JPEG form, titled *mp6_1b-n.jpg.* Paste the images into a Word or HTML file and write a caption under each one showing the actual λ and π messages.

   Reference:

   Lerner, B. (2006). Lecture 6: Exact Inference in Bayesian Networks. *Learning Probabilistic Graphical Models.* Be'er Sheva, Israel: Ben-Gurion University. Retrieved 31 Oct 2007 from: http://snipurl.com/1szrl

2. **(730 only) Polytrees and Singly-Connected Networks.** Watch the AVI movies of the `Burglary` example and follow the steps shown in the "screenshots" page to produce a set of eleven captioned screenshots for `Burglary`. Save these as *mp6_2-n.jpg.* Paste

them into a Word or HTML file and caption each picture with a brief one-**sentence** description.

3. **(530/730) Multiply-Connected Networks.** Watch the AVI movies of the Asia (Chest Clinic) and Alarm examples. Collect informal statistics on the runtime latency of algorithm animation by selecting the "Visualization" tab and running "Play" at normal speed, maximum speed, and without animation (stepping through to the next step immediately), using a stopwatch. Report the running time in tenths of a second. Turn in a table of these wall-clock times.

4. **(530/730) Multi-layer Perceptrons and Parity.**

   a) **(Problem 20.11, p. 761 R&N 2e).** Construct by hand a neural network that computes the XOR function of two inputs. Make sure to specify what sort of units you are using.

   b) **(Problem 20.13, p. 761 R&N 2e).** A simple perceptron cannot represent XOR (or, generally, the parity function of its inputs). Describe what happens to the weights of a four-input, step-function perceptron, beginning with all weights set to 0.1, as examples of the parity function arrive.

5. **(730 only) Backpropagation of Error (Problem 20.19, p. 762 R&N 2e).** Suppose that a training set contains only a single example, repeated 100 times. In 80 of the 100 cases, the single output value is 1; in the other 20, it is 0. What will a backpropagation network predict for this example, assuming that it has been trained and reaches a global optimum? (*Hint*: to find the global optimum, differentiate the error function and set to zero.)

Class participation (required). On or before the due date, please post to the class mailing list (CIS730-L) a brief discussion of how you might use either a predictive Bayesian network, decision network, or artificial neural network in *human-competitive game AI* – for example, to guide a bot in a first-person shooter (FPS), real-time strategy (RTS) game, or massively multiplayer online role-playing game (MMORPG). If you are working on an *Angband* or *TAC-Classic*-related project, you may also use your project domain as the discussion topic.

Extra credit (5 points). Write down a list of *BNJ* program behaviors (including GUI features) needing documentation, or reports of any errors you encounter, and send them to CIS730TA-L by Mon 12 Nov 2007.