COMP4702/COMP7703 - Machine Learning

Prac 2 – Bayesian Belief Networks

Aims:

- To complement lecture material in understanding the principles of inference with Bayesian networks.
- To gain experience with simulating Bayesian networks in software.
- To produce some assessable work for this subject.

Procedure:

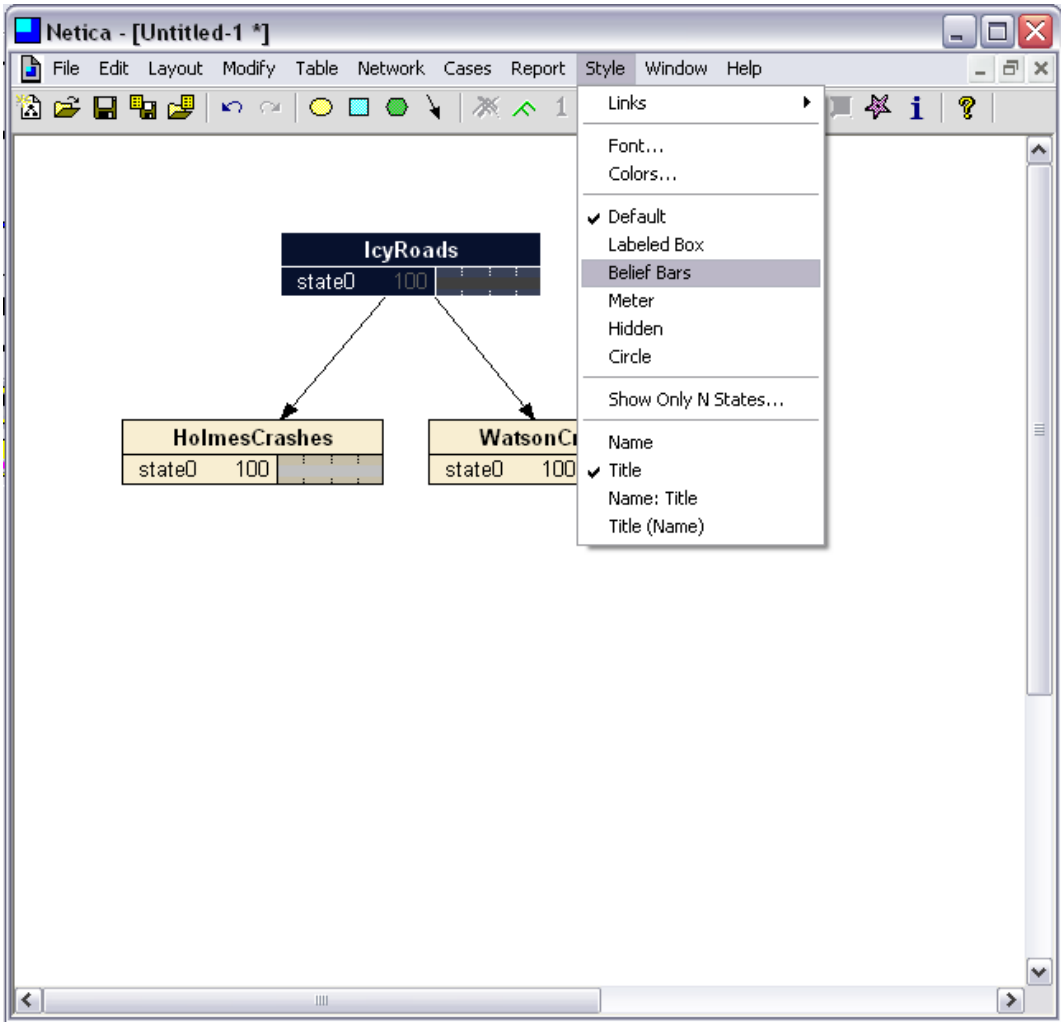
In this prac we will use a software package to simulate some simple Bayesian networks. The software we are using is Netica, which is commercial software (from http://www.norsys.com) but can be trialed for free in a limited way. Fortunately, we only need to use about 5% of Netica's features for this prac! We will walk through the first example to learn how to use the software.

The first few questions in this prac are based around examples from lecture notes used in past years for this course (specifically, the examples – "Icy Roads", "Burglar Alarm" and "Research Assistant"). The relevant material is "Neural computing notes 10" from the course webpage. Bayesian networks are covered very briefly in our textbook, so these should notes should provide useful reading material to help you understand Bayesian networks. For this prac, you just need to refer to the examples presented in these notes.

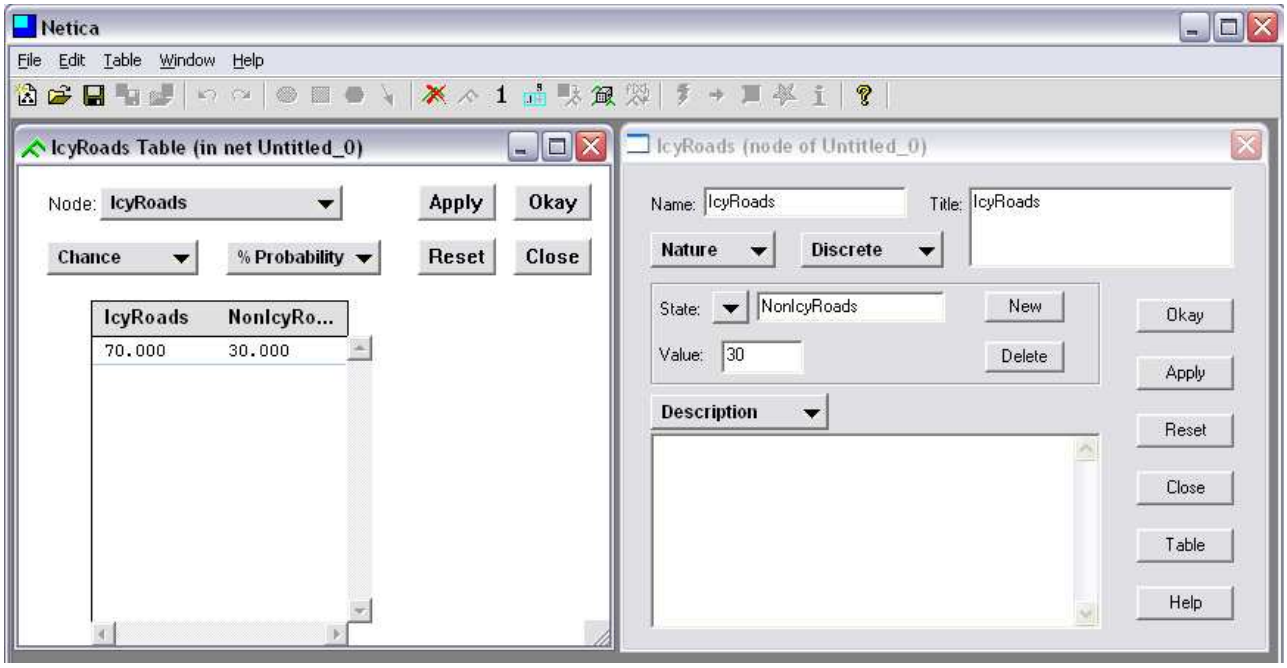
Introduction

Run the software (in limited mode!), and create a new network (File menu). You create a network by creating nodes and the links between them. Using the "yellow circle" button and the "arrow" button, create a network to mimic Figure 10.1 in the notes.

To get a better idea of what goes on in the network, change the display of each node by clicking on it and selecting Style->Belief Bars (don't worry about the values on the bars yet). You should also change the names of the nodes by double clicking on them and entering something more descriptive (like "IcyRoads").



You now need to specify probabilities for the nodes. By default, the nodes you have used will be discrete random variables with two possible outcomes ("True" and "False"). Click on your "IcyRoads" node, and select Relation->View/Edit… from the menu. This provides a table where you can enter values. Since this node is not influenced by others, you just need to specify prior values – from the lecture notes, set the probability of icy roads to 0.7 and the probability of non-icy roads to be 0.3 (NB: the software takes these values as percentages, so 70 and 30). You can enter the probabilities for the other nodes similarly (again using the values in the lecture notes). Since the other nodes are influenced by one other node, "IcyRoads", you have four values to specify.



Once you have specified all probability values, select Network->Compile. You should see the probability values on the nodes change. The values on the "WatsonCrashes" node can be related to Table 10.1 in the notes – they specify the marginal probabilities (e.g., probability of Watson crashing on either icy or non-icy roads), which are obtained by adding the values in the rows of Table 10.1.

Now (as in the notes), we want to update probabilities given a fact (that Watson has crashed). Right-mouse click on the "WatsonCrashes" node and set it to "True". Confirm that this produces the values for the "HolmesCrashes" node as given in Table 10.2.

→ **Q1:** Suppose that Holmes is actually a much better winter driver than Watson – so change the probability of Holmes crashing in the case of icy roads to 0.4. Recompile the network. Given the same news (that Watson has crashed), what is the probability now that Holmes has crashed?

→ **Q2:** Implement the Bayesian network from the "Burglary" example in the notes. Use the probability values given and verify the result.
- a) If Mrs Gibbons instead said that she didn't hear an alarm (but Watson did), what is the probability that there is a burglary?
- b) If Dr Watson instead said that he didn't hear an alarm (but Gibbons did), what is the probability that there is a burglary?

→ **Q3:** Implement the Bayesian network from the "Research Assistant" example in the notes. Use the probability values given and verify the result.
- a) If the rain alarm does NOT go off, what are the probabilities for the other nodes? Does this make sense to you? Explain in a couple of sentences.

→ **Q4:** (this is exercise 5 from Chapter 3 in the textbook) In figure 3.4, calculate P(C|W);
- a) Work the answer out by hand (using pen and paper, showing your working).
- b) Use Netica to simulate this network and calculate the answer.

→ **Q5:** (this is exercise 6 from Chapter 3 in the textbook) In figure 3.5, calculate P(F|C);
- a) Work the answer out by hand (using pen and paper, showing your working).
- b) Use Netica to simulate this network and calculate the answer.

Optional Exercise

→ To have a look at some more complex example applications of Bayesian networks, open some of the examples that come with the software (in the Examples->Tutorial folder).