TDT4171 Artificial Intelligence Methods

Exercise 1

February 3, 2016

- **Delivery deadline: February 18, 2016** by 8:00 (am).
- Required reading for this assignment: Chapter 13, 14 (the parts in the curriculum)
- Deliver your solution on *It's Learning*
- Students can NOT work in groups. Each student can only submit solution individually.
- This homework counts for 3% of the final grade.
- The homework is graded on a pass/fail basis. A pass grade will only be given when a good attempt has been made to solve **all** questions in the exercise. In other words, you should try to solve all questions.
- Cribbing from other students (koking) is not accepted, and if detected will lead to the assignment being failed.

I Counting and basic laws of probability

I.1 5-card Poker Hands (Ex. 13.7 Russel & Norvig)

Consider the domain of dealing 5-card poker hands from a standard deck of 52 cards, under the assumption that the dealer is fair.

a How many atomic events are there in the joint probability distribution (i.e., how many 5-card hands are there)?

b What is the probability of each atomic event?

c What is the probability of being dealt a royal straight flush? Four of a kind?

I.2 Two cards in a deck

Two cards are randomly selected from a deck of 52 playing cards.

a What is the probability they constitute a pair (that is, that they are of the same denomination)?

b What is the conditional probability they constitute a pair given that they are of different suits?

I.3 Conditional probability

If the occurrence of B makes A more likely, does the occurrence of A make B more likely? Why?

Obs: you can explain with words, or using the formula for conditional probabilities $P(A|B) = \frac{P(A,B)}{P(B)}$.[1]

II Bayesian Network Construction

Consider the following variables relating to a single household consisting of a couple and possibly some children:

- *Illness at the moment*, with states *severe illness*, *minor illness*, and *no illness.*
- *History of illness*, with states *cases of severe illness*, *often minor illnesses*, and *rarely minor illness.*
- *Number of children*, with states *none*, *one*, *two*, *three*, and *four and up.*
- *Working parents*, with states *both*, *father*, *mother*, and *none.*
- *Religion*, with states *Christianity*, *Judaism*, *Islam*, *Buddhism*, *Atheism*, and *other.*
- *Household income*, with states *$0-$50000*, *$50000-$100000*, and *$100000 and up.*
- *Fish-eating habits*, with states *often fish* and *rarely fish.*
- *Fiber-eating habits*, with states *lots of fiber* and *not much fiber.*
- *Drinking habits*, with states *never alcohol*, *wine once in a while*, *often wine*, and *wine every day.*

Try to construct a Bayesian network incorporating the above variables accurately according to your perception of the world. What are the conditional independence properties of the network you constructed? Are they reasonable?

III Bayesian Network Application

You are are confronted with three doors A, B, and C. Behind exactly one of the doors there is $10000. The money is yours if you choose the correct door. After you have made your first choice of door but still not opened it, an official comes in. He works according to some rules:

[1] Hint: use the conditional probability formula and start with the inequality $P(A|B) > P(A)$

1. He starts by opening a door. He knows where the prize is, and he is not allowed to open that door. Furthermore, he cannot open the door you have chosen. Hence, he opens the door with nothing behind.
2. Now there are two closed doors, one of which contains the prize. The official will ask you if you want to alter your choice (i.e., to trade your door for the other one that is not open).

Should you do that?

You can choose to answer this question by hand on paper or use the recommended tool (see below):

By hand Draw a Bayesian network that represents this problem. One possibility is to use three nodes representing the following door status: ContainsPrize, MyChoice, and OpenedByOfficial. Draw the structure of conditional dependency, probability tables to the nodes. Show how the probability tables changes as each of the described actions are taken. Answer the question through providing constructed Bayesian network, conditional probability table, and the descriptive or numerical evidence to support your final decision.

Using GeNIe 2.0 The Graphical Network Interface GeNIe can be used to complete this question.

Installation and brief tutorial:

- If you are working on your own computer, you must download GeNIe 2.0 from `http://dslpitt.org/genie/download/genie2_setup.exe`
- After downloading and installing the tool, start up by clicking the program icon.
- Click Help in the top menu, and choose Help Topics.
- You get to a Web page with an intro and several pointers.
- Click on the "GeNIe Turorials" pointer in the text, about midway down from the top of the rst page. Then click "Tutorial 3, Building a Bayesian Networks" in the directory.
- Follow the example instructions to construct and run the example Bayesian network described.

Detailed instruction for this exercise:

- Build the network (the three nodes with dependency links)
- Fill in the node denition tab, with the appropriate conditional probabilities.
- Save the network.
- Enter the evidence for MyChoice and OpenedByOfficial step by step, and see the probability changes for the other nodes with 'update'.
- Provide your constructed Bayesian network, conditional probability table, and reasoning result as the answer to this question and **give the necessary description**. Include the GeNIe file with your work.