TDT4171 Artificial Intelligence Methods

Exercise 1

January 25, 2017

- **Delivery deadline: February 14, 2017** by 23:59.
- 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 5% of the final grade.
- Cribbing from other students (koking) is not accepted, and if detected will lead to the assignment being failed.

I 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?

II Bayesian Network Construction

Construct Bayesian Networks that represents the following factorized distribution:

1. $p(A, B, C, D) = p(A|B, C)p(B|D)p(C|D)p(D)$
2. $p(X_1, \cdots, X_n) = p(X_1) \prod_{i=2}^{i=n} p(X_i|X_{i-1})$
3. $p(\text{RainToday}, \text{RainYesterday}, \text{FloorWet}, \text{UseUmbrellaToday}, \text{CloudSky})$
   $= p(\text{RainYesterday}) \times p(\text{CloudSky}) \times p(\text{RainToday}|\text{RainYesterday}, \text{CloudSky})$
   $\times\, p(\text{FloorWet}|\text{RainToday}, \text{RainYesterday})$
   $\times\, p(\text{UseUmbrellaToday}|\text{RainToday}, \text{CloudSky})$

Suppose all variables in the previous examples are binary, explain and construct the conditional probability tables for each variable and explain how the independence structure between the variables is helping with the construction of this tables.

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. 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.