MSc/ICY Introduction to Artificial Intelligence
Homework 2
Due Date: Monday 21th March 2016, 23:59 GMT
Late Penalty: -5 points per day (not including weekends and holidays).

This homework is marked out of 100 points and is worth 10% of the entire module mark. This homework covers material from Lectures 11-14 and Chapters 13, 14, and 15 of the Russell Norvig book.

You must hand in your assignment electronically in PDF FORMAT ONLY via Canvas: https://canvas.bham.ac.uk/.

Type out all your answers using a text editor or word processor, and always give at least brief explanations of your results where appropriate.

1. (25 points) With the help of the additional values, fill in the following joint probability table, then provide the requested values. Do not assume that the variables are independent. Make sure you show the steps you went through to work out the answer. Calculate to 2 decimal places.

$P(a) = 0.4$ $P(\neg a \bigwedge \neg b) = 0.11$
$P(b) = 0.82$

| | c | | ¬c | |
|---|---|---|---|---|
| | b | ¬b | b | ¬b |
| a | 0.05 | | | 0.06 |
| ¬a | | 0.02 | 0.42 | |

$P(c \bigvee \neg c) =$

$P(\neg b \bigwedge \neg c) =$

$P(b \mid a) =$

2. Below is a table showing Marvel superheroes who have been featured in an Avengers team at some point during their career, their gender, whether they were a founding member of the Avengers in *The Avengers vol. 1 #1 (September 1963),* and whether they appeared in the 2012 film as part of the Avengers. From this data, work out:

a) (12.5 points) The probability of superhero being not in the film and being female.
b) (12.5 points) The probability of superhero being not in the film given both they were not in the original team and their powers come from Mutation.

| | Gender | 1963 Original Team | 2012 Film Team | Source of powers |
|---|---|---|---|---|
| **Ant-Man** | M | TRUE | FALSE | Technology |
| **Black Widow** | F | FALSE | TRUE | Technology |
| **Captain America** | M | FALSE | TRUE | Technology |
| **Hawkeye** | M | FALSE | TRUE | None |
| **Hulk** | M | TRUE | TRUE | Mutation |
| **Iron Man** | M | TRUE | TRUE | Technology |
| **Spider-man** | M | FALSE | FALSE | Mutation |
| **The Wasp** | F | TRUE | FALSE | Technology |
| **Thor** | M | TRUE | TRUE | Alien |
| **Wolverine** | M | FALSE | FALSE | Mutation |

3. (25 points) The Second City Derby has been played between Aston Villa and Birmingham City 120 times since 1887. Villa have won 51 times, and City have won 38 times (results from here).

Jon is a Villa fan who likes to predict the results of the derby. When Villa win, his predictions turn out to be correct 3 times out of 10. When there's a draw, he's right just 7 times in 10. When City win, his predictions turn out to be incorrect 4 times out of 10.

What is the probability Villa will draw their next encounter, given Jon has predicted correctly? Show the steps you take to reach your conclusion.

4. (25 points) Create a Bayesian network that models the way various factors interact when a person goes out for a social event. The event could be anything and we assume this event will never change.
Construct a network using the following variables and probabilities.

| Variable | Values | Probabilities |
|---|---|---|
| Weather | Wet, Dry | P(Wet) = 0.7<br>P(Dry) = 0.3 |
| AvaliableCash | None, A little, Some, A lot | P(None) = 0.1<br>P(A little) = 0.6<br>P(Some) = 0.2<br>P(A lot) = 0.1 |
| Transport | Walk, Bus, Train | P(Walk \| Wet ^ None)= 1<br>P(Walk \| Wet ^ A little)= 0.6<br>P(Walk \| Wet ^ Some)= 0.1<br>P(Walk \| Wet ^ A lot)= 0<br>P(Walk \| Dry ^ None)= 1<br>P(Walk \| Dry ^ A little)= 0.8<br>P(Walk \| Dry ^ Some)= 0.7<br>P(Walk \| Dry ^ A lot)= 0.7<br><br>P(Train \| Wet ^ None)= 0<br>P(Train \| Wet ^ A little)= 0<br>P(Train \| Wet ^ Some)= 0.3<br>P(Train \| Wet ^ A lot)= 0.5<br>P(Train \| Dry ^ None)= 0<br>P(Train \| Dry ^ A little)= 0<br>P(Train \| Dry ^ Some)= 0.1<br>P(Train \| Dry ^ A lot)= 0.1<br><br>P(Bus \| Wet ^ None)= 0<br>P(Bus \| Wet ^ A little)= 0.4<br>P(Bus \| Wet ^ Some)= 0.6<br>P(Bus \| Wet ^ A lot)= 0.5<br>P(Bus \| Dry ^ None)= 0<br>P(Bus \| Dry ^ A little)= 0.2<br>P(Bus \| Dry ^ Some)= 0.2<br>P(Bus \| Dry ^ A lot)= 0.2 |
| OnTime | True, False | P(True \| Walk)= 0.5<br>P(True \| Bus)= 0.8<br>P(True \| Train)= 1<br><br>P(False \| Walk)= 0.5<br>P(False \| Bus)= 0.2<br>P(False \| Train)= 0 |
| RepeatEvent | True, False | P(True \| OnTime= True)= 0.8<br>P(False \| OnTime= True)= 0.2<br><br>P(True \| OnTime= False)= 0.4<br>P(False \| OnTime= False)= 0.6 |

Create your network in AISpace (http://aispace.org/bayes) and complete the conditional probability tables appropriately. There are tutorials on the website.
Once completed take a screenshot of the network with the probability tables displayed with no observations.
Then observe how setting the weather to ‘wet’ and the available cash to ‘some’ and explain the affects on the rest of the variables, include another screenshot of the probability tables too.
Then try a few observations and show how they affect the rest of the variables via more screenshots and explain the effects the observations have.

Bonus Question. (20 points)
On HackerRank.com complete the Basic Probability Puzzles #6 challenge and the Basic Probability Puzzles #7 challenge under the AI domain and the Probability & Statistics – Foundations subdomain.

To be marked for this when you register your account add the University of Birmingham to your school details and provide your username with your submission of this exercise. (Make sure you are properly registered on the website as if you are not you may not show up on the leaderboards which means you will not be marked!)