Bayesian Risk and Decision Analysis
Semester B, 2023

Coursework 1

Instructions

This coursework requires an answer in two parts. Your answer should be prepared using the MSWord word processor, or equivalent, and submitted electronically. All calculation/analysis steps must be clearly shown, and formal mathematical working shown explicitly.

This coursework is marked out of 100 and counts for 15% of the final mark for the module.

This is an individual coursework. ALL submissions will be carefully screened for signs of group work (including similar screen dumps and formatting) and if found College regulations governing assessment will apply.

Questions

Question 1: Suppose you have to determine the probability of each of the following three events:

- England win the next FIFA World Cup
- The first baby born in California on the 1 January next year will be a boy
- OJ Simpson murdered his wife

In each case BRIEFLY explain whether you can meaningfully assign a subjective probability in each case and give reasons for doing, or not doing, so. **[5 marks]**

Question 2: Consider an experiment in which two fair dice are thrown.

A: `the sum of the dice is greater than or equal to 7'
B: `the second die is a 3'
C: `the difference between the dice is less than or equal to 2'.

Calculate the respective probabilities of these events:

1. $P(A)$ **[7 marks]**
2. $P(B)$ **[3 marks]**
3. $P(C)$ **[7 marks]**
4. $P(A \cap B)$ **[3 marks]**
5. $P(A \cup B)$ **[4 marks]**
6. $P(B \cap C)$ **[6 marks]**
7. $P(B \cup C)$ **[5 marks]**

Make clear any assumptions you are making.

Answers derived *solely* by means of enumeration will be penalised. **[35 marks]**

Hints:

Try enumerating over all possible events for the two dice and deriving probabilities for these.

Also, be careful about independence assumptions.

When assessing difference use the *absolute* difference not the arithmetical difference.

Question 3: Produce a BN model in agena.ai modeller to calculate these probabilities, discussed in question 2.

1. *P*(Dice 1)
2. *P*(Dice 2)
3. *P*(Sum of Dice 1 and Dice 2)
4. *P*(Difference between Dice 1 and Dice 2)
5. *P*(A)
6. *P*(B)
7. *P*(C)
8. *P*(A∩B)
9. *P*(A∪B)
10. *P*(B∩C)
11. *P*(B∪C)
12. *P*(A∩C)
13. *P*(A∪C)

Show a screen shot with the BN structure showing all marginal probability distributions for all thirteen 'nodes' in the above list. Enter all nodes into a table with the following entries:

No	event/variable	Name of node	Parent nodes	Node type	Node states	NPT or Expression
1	Dice 1	A	B, C	Boolean	H, T	insert screen dump of expression or NPT
2						
3						
4						

A total of one mark will be awarded for a correct parent-child relationship in the BN and two marks for the correct NPT/Expression for each node. Marks will be deducted for wrong node types and wrong states. **[40 marks].**

Note: JPEGs can be generated from the software by simply cutting and pasting the graph, with or without charts. To generate NPT JPEGS simply do screen grabs.

We are assuming that you will manually declare discrete or continuous states and declare Boolean nodes using manual NPTs. But as a bonus consider:

- For the numeric nodes you can use simulation INTEGER valued nodes with Uniform[1,6] and arithmetic functions as appopriate. **[5 marks]**

- You might want to model Boolean node NPTs as IF statements. **[5 marks]**

Question 4: Use the BN produced in Question 3 to calculate *P*(Dice 1 | A∩C = True). Show the marginal probability distribution for this result. **[10 marks]**