



# United International University (UIU)

## Dept. of Computer Science & Engineering (CSE)

### Final Exam: Fall 2021

Course Code: CSE 3811, Course Title: Artificial Intelligence

Total Marks: 40

Duration: 2 hours

**Answer all questions.** Marks are indicated in the right side of each question.

[Any examinee found adopting unfair means will be expelled from the trimester/program as per UIU disciplinary rules. ]

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**Consider the following for Questions 2(b), 3, 4 and 5:**

$$X = (\text{your\_student\_id} \% 2) + 1$$

$$Y = (\text{your\_student\_id} \% 3) + 1$$

1. Suppose you have to prepare a schedule for a factory for a particular day. The factory remains open for 8 hours. 5 jobs need to be finished within this period. The duration of each job is given below:

Job 1: 4 hours, Job 2: 2 hour, Job 3: 3 hours, Job 4: 2 hours, Job 5: 1 hour

There a few more rules that must be followed:

Job 1 and Job 3 must be started at the same time.

Job 3 must be done before Job 2.

Job 1 and Job 5 cannot be done at the same time.

Job 4 has to be done last.

- a. Formulate this problem as a CSP. [3]
  - b. Draw the constraint graph. [2]
  - c. Show the steps followed by backtracking search algorithm with minimum remaining values heuristic and derive a solution. [3]
2.
  - a. Suppose CSE 3811 has three sections. In section A there are 12 female and 18 male students. In section B there are 20 female and 15 male students. In section C there are 16 female and 18 male students. The professor picks a section at random and then picks a student at random in that section. Compute the following:
    - i. Probability that the student chosen is a female. [1.5]
    - ii. The conditional probability that the student is in section B given that she is a female. [1.5]

b. Suppose you are doing a survey on a store that sells clothes, shoes and handbags. The survey is done on 100 customers. 40 of them are young, 30 are middle-aged and the rest are of old age. Among the young customers, 40% bought clothes, 30% bought shoes and the rest bought handbags. Among the middle-aged groups the ratio of buying clothes, shoes and handbags is  $X:(8-X):2$ . Among the old people, it is  $Y:4:(6-Y)$ . Now answer the following:

- Construct a full joint probability distribution table with two random variables Age(A) and Product Type(P). [3]
- What is the probability of a person buying shoes? [1]
- Find the conditional probability  $P(A | \text{clothes})$ . [2]

3.

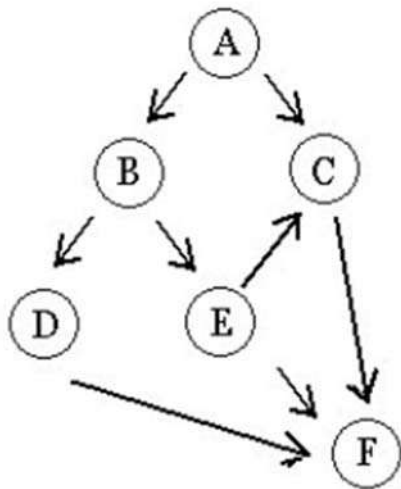


Figure 1: Bayesian Network for Ques: a and b

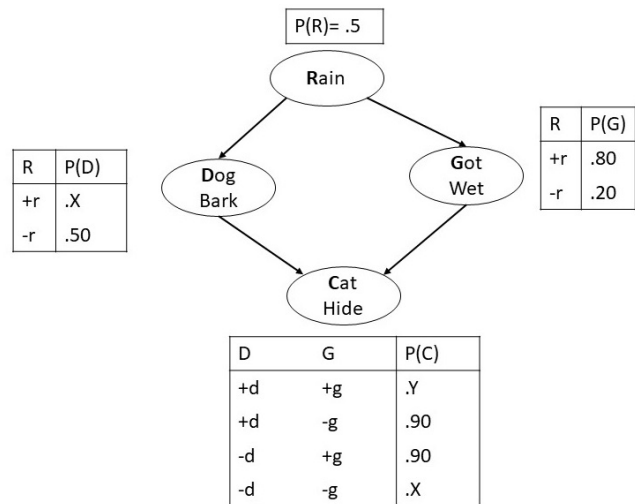


Figure 2: Bayesian Network for Ques: c

a. Consider the **Bayesian network** at fig. 1. Determine whether the following probability expressions are true or false. Explain your reasoning very briefly. [3]

- $P(E | B, C) = P(E | C)$ ;
- $P(E | A, B) = P(E | B)$ ;
- $P(B, C | A) = P(B | A)P(C | A)$ ;

b. Consider the **Bayesian Network** at figure 1, where all the random variables are Boolean. What are the probability entries in all the tables of the network? [2]

c. Consider the **Bayesian Network** at figure 2, with all Boolean random variables. Determine the following probability information from this network. [1 + 4]

- Probability of a rainy weather, the dog is not barking, the cat didn't get wet, and the cat hid.
- Probability of a rainy weather if the cat didn't hide.

4. Consider the following data from your file search history that categorize a document to either relevant or irrelevant for the AI final exam. The data set consists of three features (Contains “AI”, Contains “Probability”, Length) and Is\_Relevant as the class label.

Contains “AI”	Length	Contains “Probability”	Is_Relevant
Frequently	Short	Yes	Relevant
Frequently	Short	No	Relevant
Frequently	Medium	Yes	Relevant
Rarely	Medium	No	Irrelevant
Rarely	Long	Yes	Relevant
Frequently	Long	No	Relevant
Rarely	Short	Yes	Irrelevant
Sometimes	Short	No	Irrelevant
Rarely	Medium	Yes	Irrelevant
Sometimes	Medium	No	Irrelevant
Sometimes	Long	Yes	Irrelevant
Sometimes	Long	No	Irrelevant

Use Naive Bayes classifier with Laplacian smoothing ( $K = X$ ) to determine whether a document with the features  $\langle Y, \text{Medium}, \text{No} \rangle$  is likely to be relevant for your AI final exam or not, where **Y=1 means Frequently, Y=2 means Sometimes, and Y=3 means Rarely**. [6]

5. In the early days humans migrated among Africa, Asia and Europe. Suppose, following is the transition probabilities of the migration.

Next → Prev	Africa	Europe	Asia
Africa	0.7	0.1	0.2
Europe	0.1	0.8	0.1
Asia	0.2	0.3	0.5

- If an ancient human initially lives in Europe in Year 1, what is the probability that is lives in **Y** in Year 4, where **Y=1 means Africa, Y=2 Europe E, and Y=3 means Asia**? [4]
- Determine the probability of relocating to each continent in the long run (stationary distribution). [3]