



# University of Central Punjab

## Faculty of Information Technology

**Artificial Intelligence – Lab (F6)**  
**Spring 2024**

**Instructor:** Anaba Shafiq  
**Code:** CSAL3241  
**Program:** CS

**Time Allowed:** 100 Minutes

**Total Marks:** 80

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### Instructions:

- Time to attempt the exam is 90 minutes. Last 10 minutes are for submission.
- Understanding of a question is part of exam. Don't ask invigilator for any explanation.
- Plagiarism will be penalized.
- Name your solution as "<your roll number>\_mid\_<section>", zip and submit.
- Implementation of both tasks in a single notebook is recommended.

### Question 1: Genetic Algorithm

**35 Marks**

You manage a retail store and need to optimize the arrangement of 8 different products on 2 display shelves. The goal is to maximize customer satisfaction by arranging products according to their popularity and visual appeal, while ensuring each shelf does not exceed its weight capacity and maintains a balanced aesthetic.

Products and Specifications:

1. Product A: Weight = 5 kg, Popularity = High
2. Product B: Weight = 3 kg, Popularity = Medium
3. Product C: Weight = 7 kg, Popularity = High
4. Product D: Weight = 2 kg, Popularity = Low
5. Product E: Weight = 4 kg, Popularity = Medium

6. Product F: Weight = 6 kg, Popularity = High
7. Product G: Weight = 3 kg, Popularity = Medium
8. Product H: Weight = 5 kg, Popularity = High

Constraints:

- Each shelf has a maximum weight capacity of 15 kg.
- Products A, C, and F are considered heavy and should be distributed evenly across both shelves for balance.

Outline the steps of a genetic algorithm approach to optimize this product display arrangement:

a) **Fitness Function:** Define a fitness function that evaluates the quality of a given arrangement based on customer satisfaction (popularity and visual appeal), adherence to weight limits per shelf, and balance in distributing heavy products.

b) **Initial Population:** Create an initial population of 5 different display arrangements randomly, ensuring they satisfy the weight distribution constraint for heavy products.

c) **Selection:** Describe how you would select the top 2 arrangements (based on fitness) from the current population to be parents for the next generation.

d) **Crossover:** Explain the process of crossover (e.g., uniform crossover) to create new display arrangements from the selected parents.

e) **Mutation:** Outline how you would introduce mutations (e.g., swapping products between shelves) to explore new potential solutions while maintaining constraints.

f) **Termination:** Specify the termination criteria for the algorithm, such as achieving a certain level of fitness improvement or after a fixed number of iterations. Describe how you would determine the optimal display arrangement based on the best fitness achieved.

## Question 2: Naïve Bayes Classifier

45 Marks

### Bank Marketing Data Set:

The data is related with direct marketing campaigns of a Portuguese banking institution. The marketing campaigns were based on phone calls. Often, more than one contact to the same client was required, in order to access if the product (bank term deposit) would be ('yes') or not ('no') subscribed.

### Input variables:

1. **Age:** Age of Client
2. **Job:** type of job (categorical data)
3. **Marital:** marital status (categorical data)
4. **Education:** Education Level (categorical data)
5. **Default:** has credit in default?
6. **Balance:** average yearly balance
7. **Housing:** has housing loan?
8. **Loan:** has personal loan?
9. **Contact:** contact communication type (categorical data)
10. **day\_of\_week:** last contact day of the week
11. **Month:** last contact month of year (categorical data)
12. **Duration:** last contact duration, in seconds (numeric). Important note: this attribute highly affects the output target (e.g., if duration=0 then y='no').
13. **Campaign:** number of contacts performed during this campaign and for this client (numeric, includes last contact)
14. **pdays:** number of days that passed by after the client was last contacted from a previous campaign (numeric; -1 means client was not previously contacted)
15. **Previous:** number of contacts performed before this campaign and for this client
16. **poutcome:** outcome of the previous marketing campaign (categorical data)

### Output Variable:

-  **Y:** has the client subscribed a term deposit?

The dataset is attached in the submission folder.

You have to perform the following tasks on the given dataset.

1. Read the data and explore it.
2. Separate labels from the data
3. Implement Naïve Bayes
4. Perform prediction.
5. Evaluate your model using different evaluation methods.

**Note:** Not allowed to use built-in ML Algorithm.