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NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

SBA 4102

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH

SBA 4102 ALGORITHMS AND HEURISTICS

DECEMBER 2024 EXAMINATION

Time : 3 hours

Candidates should attempt **ALL** questions from Section A and **ANY THREE** questions from Section B. Each question should start on a fresh page.

SECTION A

Answer ALL questions in this section [40 Marks]

A1. State any two factors that can be used to evaluate the performance of an algorithm. [2]

A2. Explain any five characteristics of an algorithm. [10]

A3. (a) Explain the difference between divide and conquer and dynamic programming. [4]

(b) Explain the Traveling Salesman Problem (TSP) and why it is considered an NP-hard problem. [5]

A4. (a) Write down mathematical formal definition of big O notation. [3]

(b) Suppose two algorithms perform the same task, explain how you will determine the more efficient one. [6]

A5. Illustrate asymptotic and complexity analysis of algorithms. [10]

SECTION B

Answer any THREE questions in this section [60 Marks]

B6. (a) Distiguish between O(n!) - factorial time and O(1) - constant time big O notations. [4]

(b) Explain the insertion sort algorithm's time complexity. [4]

(c) Compare and contrast insertion sort and merge sort in terms of time complexity and use case. [4]

(d) Write down algorithm to sort the following list of integers (6, 20,15,1,4) using the Insertion Sort algorithm. [12]

B7. (a) What is a flow chart? [1]

(b) Distinguish between algorithms and heuristics. [4]

(c) Why is the big O notation important in analyzing algorithms? [3]

(d) What is Dijkstra's algorithm and what type of problems does it solve? [4]

(e) Explain the Traveling Salesman Problem and why it is considered an NP-hard problem. [8]

B8. (a) What are greedy algorithms. [2]

(b) Explain how the Kruskal's algorithm works to come up with a minninimum spanning tree [11]

(c) Interpret the following output produced after executing Kruskal's algorithm to link the four cities. [5]

```
Following are the edges in the constructed MST
2 -- 3 == 4
0 -- 3 == 5
0 -- 1 == 10
```

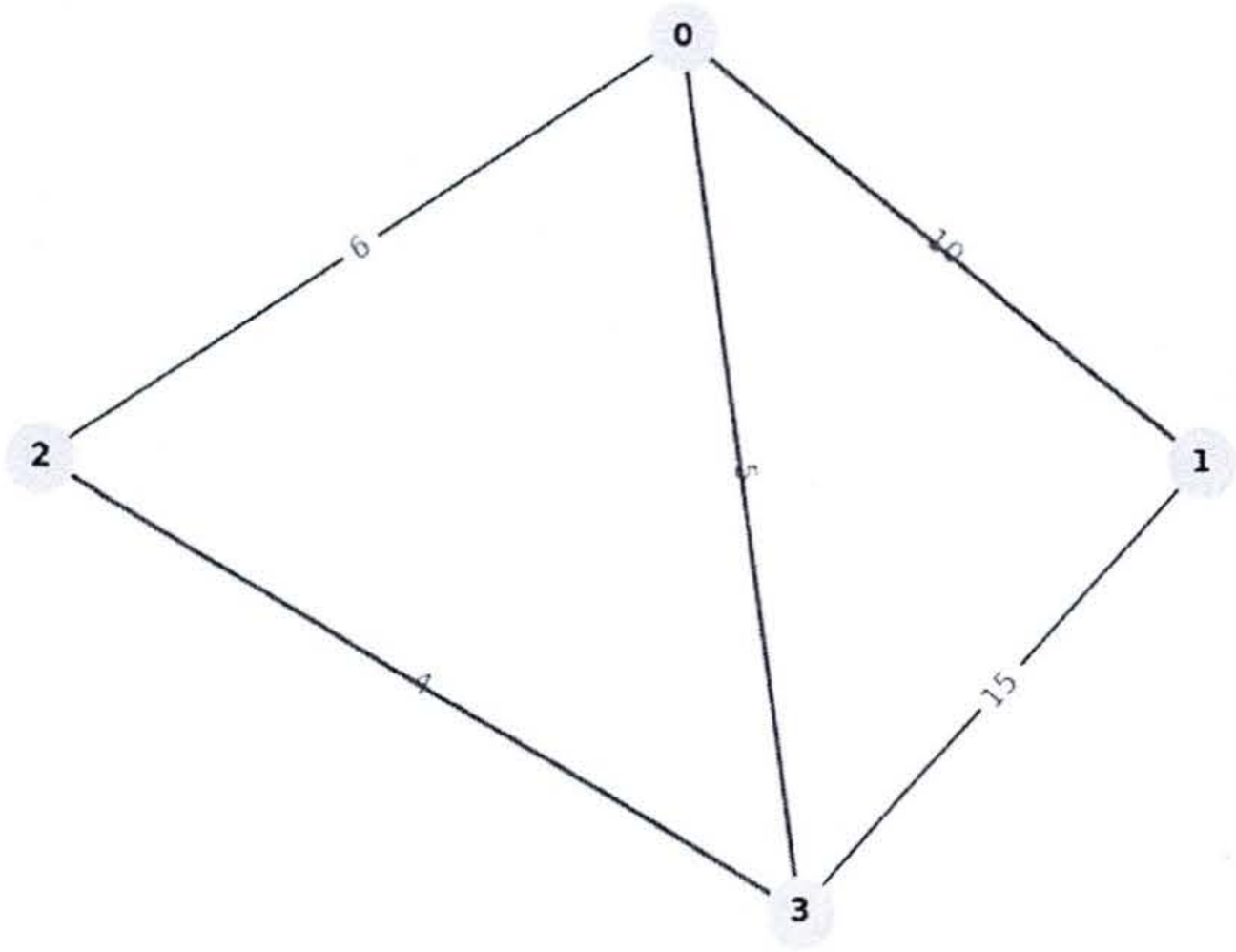

Figure 1: Minimum Spanning Tree Output

(d) What is the optimal distance to connect all the cities basing on the above output. [2]

B9. (a) What are machine learning algorithms? [2]

(b) Explain the steps presented by the following machine learning algorithm. [10]

```python
import numpy as np
from sklearn.linear_model import LinearRegression
import matplotlib.pyplot as plt

# Sample data
X = np.array([[1], [2], [3], [4], [5]])
y = np.array([1, 3, 2, 3, 5])

# Create and train the model
model = LinearRegression()
model.fit(X, y)

# Make predictions
predictions = model.predict(X)

# Plot the results
plt.scatter(X, y, color='blue')
plt.plot(X, predictions, color='red')
plt.xlabel('X')
plt.ylabel('y')
plt.title('Linear Regression')
plt.show()
```

Figure 2: Machine Learning Algorithm Python Code

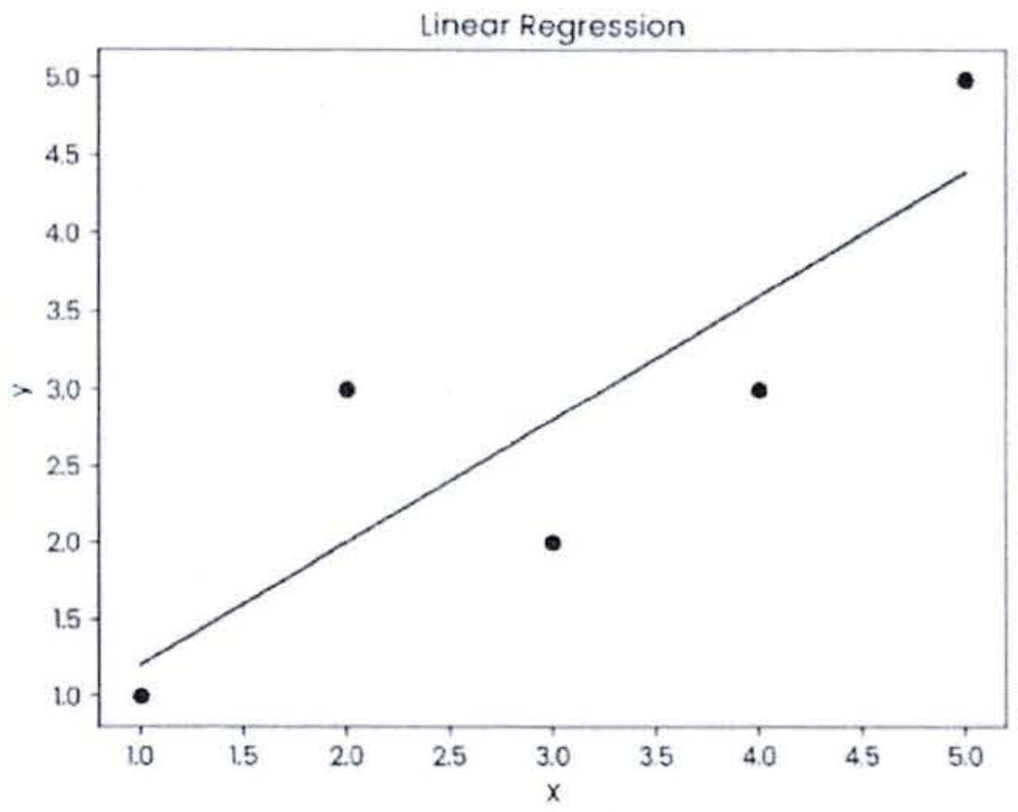

Figure 3: Machine Learning Algorithm Pyhton Code Corresponding Output

(c) Explain the model's time complexity and where it can be implemented. [5]

(d) Interprete the output produced. [3]

END OF QUESTION PAPER