

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

Department of Mathematics

CPDS

Assignment - III

Course: CPDS

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1. Write a Python program using NumPy to create a 4×4 matrix containing integers from 1 to 16. Find its transpose, diagonal elements, row-wise sums, column-wise means, and determinant.

2. Generate 100 equally spaced values in the interval $[0, 2\pi]$ using NumPy. Evaluate the function

$$f(x) = \sin(x) + 2\cos(2x)$$

   and determine its maximum, minimum, mean, and the corresponding values of x at which the maximum and minimum occur.

3. Write a NumPy program to generate a 5×5 matrix containing random integers between 1 and 100. Replace all elements greater than 50 with zero and determine the number of nonzero elements in the modified matrix.

4. Given two 3×3 matrices, write a Python program using NumPy to calculate their sum, element-wise product, matrix product, determinants, and eigenvalues.

5. Using NumPy and Matplotlib, plot the following functions over $[-2\pi, 2\pi]$:

$$f(x) = \sin(x), \qquad g(x) = \cos(2x), \qquad h(x) = \sin(x) + \cos(2x).$$

   Display all three functions in a single figure with different line styles, appropriate labels, a legend, and a grid.

6. Consider the experimental data

$$\text{Time} = [0, 1, 2, 3, 4, 5, 6],$$
$$\text{Temperature} = [25, 28, 33, 37, 35, 31, 29].$$

   Write a Python program using Matplotlib to display the data using a line plot, scatter plot, and bar chart in three separate subplots. Include appropriate titles and axis labels.

7. Generate 1000 random observations from a normal distribution using NumPy. Plot a histogram of the observations using Matplotlib with 20 bins. Display the mean and standard deviation of the generated data.

8. A CSV file contains the columns `Student_ID`, `Name`, `Mathematics`, `Physics`, and `Chemistry`. Write a Python program using Pandas to read the file, calculate each student's total and average marks, identify students with an average above 75, and arrange the records in descending order of average marks.

9. Write a Python program using Pandas to read a dataset containing missing values. Identify the number of missing observations in each column, replace missing numerical values with their respective column means, and save the cleaned dataset as a new CSV file.

10. A dataset contains daily observations of temperature, humidity, and rainfall. Using Pandas and Matplotlib, calculate the mean and standard deviation of each variable, identify the day with maximum rainfall, and construct suitable plots to visualize the variations.

11. Using NumPy and Matplotlib, generate 200 equally spaced points in $[-3, 3]$ and evaluate

$$f(x) = x^3 - 4x.$$

Plot the function, identify the maximum and minimum values among the generated points, and mark the corresponding points on the graph.

12. Write a Python program using Pandas, NumPy, and Matplotlib to read a CSV file containing numerical observations, calculate the mean and standard deviation of a selected column, normalize that column using

$$z_i = \frac{x_i - \mu}{\sigma},$$

and plot the original and normalized observations in two separate subplots.

13. Consider the matrix

$$A = \begin{pmatrix} 10 & 20 & 30 & 40 \\ 15 & 25 & 35 & 45 \\ 20 & 30 & 40 & 50 \\ 25 & 35 & 45 & 55 \end{pmatrix}.$$

Using NumPy and Matplotlib, calculate the row-wise and column-wise means, display the matrix as a heatmap using `imshow()`.

14. Write a Python program to read an image using the Pillow (`PIL`) library, convert it into a NumPy array, determine the dimensions of the image, convert it into grayscale, and display the original and grayscale images using Matplotlib.

15. Write a Python program using NumPy to perform a valid 2×2 filtering operation on a 5×5 matrix. Extract each patch, multiply it element-wise by a given 2×2 kernel without reversing the kernel, sum the products, and display the resulting output matrix.