2- Intro to Numpy

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1 Objective

Develop familiarity with numpy and scipy, the most commonly used computational libraries in Python.

2 Overview

Numpy is basically MATLAB but integrated into Python. If you don't know what that means, don't worry! It basically means we can work with matrices in Python. Documentation for numpy is hosted at **their website**. It can be imported by writing `import numpy`, but it is generally imported as np by writing `import numpy as np` instead. It is often paired with functions from **scipy**, which can be similarly imported using `import scipy`.

Some of these assignments are a little tricky, and use potentially unfamiliar concepts. This is on purpose! I want you to try to look stuff up and learn!

3 Problems

3.1 Vector and Matrix Generation

Generate a vector of even numbers from 2 to 32 (inclusive) using both indexing and linspace. Then reshape the vector into a 4x4 matrix, with elements going left to right then up to down. Finally, extract the first row and the third column from the 4x4 matrix you generate.

3.2 Fun with Functions

a) Generate a vector $\vec{x}$ from 0 to 2π using linspace, and find the sine at each point in $\vec{x}$.

b) Find the value of e^{ix} for each value in $\vec{x}$, then check the magnitude of each value you find. You might notice something interesting...

c) Generate values of $f(x) = x^2 + 2x + 4$ using values from $\vec{x}$, then numerically evaluate the integrals of $f(x)$ and $sin(x)$ from 0 to 2π using a function such as scipy's cumtrapz. Compute the difference between the numerical solution to $\int_0^{2\pi} x^2 + x + 4$ and the analytic solution, which I will give to you as $\frac{8\pi^3}{3} + 2\pi^2 + 8\pi \approx 127.56$.

d) Generate a matrix of 20x20 normally distributed values with zero mean and unit standard deviation, then add I_{20}, the 20x20 identity matrix, to your result.

3.3 A Movie I Haven't Seen

Use matrix algebra techniques ($\vec{x} = A^{-1}B$) to solve the following system of equations:

$$3x - y + 4z = -4$$

$$-x + 5y + 9z = 4$$

$$2x + 6y - 5z = 46$$

I promise the solutions will be all integers!

(If you are still taking MA110 and have not been exposed to matrix algebra before, you might want to skip this one)

3.4 Dataset Analysis

Download the Iris dataset from **here**, and load it into your script. Then:

a) Remove the last column, the outputs from the script.

b) Find the mean and standard deviation of each column (each of which represents one input).

c) Standardize the data in each column so that each column is zero-mean, unit variance.

d) Find the correlation matrix for the inputs based on the standardized matrix (look up what a correlation matrix is).