NPTEL Course: Programming, Data Structures and Algorithms in Python (*by* Prof. Madhvan Mukund)

Tutorial (Week 3)

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Problem 1: Multiplication of two matrices in python

Considering two matrices $A_{m\ x\ n}$ and $B_{n\ x\ p}$. Their matrix multiplication will produce another matrix $C_{m\ x\ p}$.

Here's how:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & \dots & a_{2n} \\ . & . & a_{ik} & . & . \\ . & . & . & . & . \\ a_{m1} & a_{m2} & \dots & \dots & a_{mn} \end{bmatrix}, \quad B = \begin{bmatrix} b_{11} & b_{12} & \dots & \dots & b_{1p} \\ b_{21} & b_{22} & \dots & \dots & b_{2p} \\ . & . & b_{kj} & . & . \\ . & . & . & . & . \\ b_{n1} & b_{n2} & \dots & \dots & b_{np} \end{bmatrix}$$

$$\boxed{A_{m\times n} \times B_{n\times p} = C_{m\times p}}$$

$$C = \begin{bmatrix} c_{11} & c_{12} & \dots & \dots & c_{1p} \\ c_{21} & c_{22} & \dots & \dots & c_{2p} \\ . & . & c_{ij} & . & . \\ . & . & . & . & . \\ c_{m1} & c_{m2} & \dots & \dots & c_{mp} \end{bmatrix}$$

where, $\boxed{c_{ij} = \sum_{k=1}^{n} a_{ik} \times b_{kj}}$

For example;

$$\boxed{c_{23} = a_{21} \times b_{13} + a_{22} \times b_{23} + \dots + a_{2n} \times b_{n3}}$$

Problem 1: Continued …

Approach: List comprehension (nested) approach gives a one liner solution to matrix multiplication in Python.

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C = [[sum(i*j for i, j in zip(a_row, b_col)) for b_col in zip(*B)] for  a_row in A]
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This calculates 1 element of ‘C’ corresponding to a_row (A) and b_col (B)

This calculates a row of ‘C’ corresponding to a_row (A)

This calculates all the rows and columns of matrix ‘C’.

Problem 2: Calculate the monotonic trend in the given non-parametric data (Sen's slope)**

Sen's Slope:

Sen's slope estimator can be calculated by using the formula:

$$Sen's\,Slope = median\left(\frac{y_j - y_i}{j - i}\right) for\, j > i \qquad \text{Eq. (1)}$$

$$\begin{aligned} Median &= ((n+1)/2)^{th}\, term \quad if\, n\, is\, odd \\ &= [(n/2)^{th}\, term + ((n/2)+1)^{th}\, term]/2\; if\, n\, is\, even \end{aligned} \qquad \text{Eq. (2)}$$

Approach:

- ➢ First of all, we will calculate the slope between all the points in the dataset for the given condition as follow:

$$\left(\frac{y_j - y_i}{j - i}\right) for\, j > i$$

- ➢ Then we will sort all of then in ascending order to calculate the median using Eq. (2).

Problem 3: Calculating the ratio of multiplication of values across the column and multiplication across the diagonal of the given square matrix for all the columns

Approach:

- While solving this problem, we must assert a condition that matrix is a square matrix.
- If the multiplication of diagonal elements turns out to be zero, we can return the ratio to be undefined.
- For the given matrix A, the desired ration should look like:

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix}$$

$$Ratio\,Matrix = \begin{bmatrix} \frac{(a_{11} \times a_{21} \times a_{31} \times a_{41})}{(a_{11} \times a_{22} \times a_{33} \times a_{44})} & \frac{(a_{12} \times a_{22} \times a_{32} \times a_{42})}{(a_{11} \times a_{22} \times a_{33} \times a_{44})} & \frac{(a_{13} \times a_{23} \times a_{33} \times a_{43})}{(a_{11} \times a_{22} \times a_{33} \times a_{44})} & \frac{(a_{14} \times a_{24} \times a_{34} \times a_{44})}{(a_{11} \times a_{22} \times a_{33} \times a_{44})} \end{bmatrix}$$