

Exercise: Numpy

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1. Create a vector with values ranging from 10 to 99
2. Create random vector of size 100 and replace the maximum value by 0
3. Normalize a 5x5 random matrix
4. Write a program to find out covariance between column of the following matrix

$$\begin{bmatrix} 4.0 & 2.0 & 0.60 \\ 4.2 & 2.1 & 0.59 \\ 3.9 & 2.0 & 0.58 \\ 4.3 & 2.1 & 0.62 \\ 4.1 & 2.2 & 0.63 \end{bmatrix}$$

Puzzle on Transformations

Assignment

An unknown transformation matrix transforms a given set of points into an observed set of points. Determine the coefficients of the transformation matrix, including the shift. Calculate the error vector (residuals) and calculate the overall error.

Description

A 2D transformation—with an unknown rotation angle, scale factor and shift—transforms the following coordinates: (0.0, 0.0), (100.0, 0.0), (100.0, 100.0), (0.0, 100.0) and (50.0, 50.0), into the following observed coordinates: (0.0, 20.0), (108.3, 0.9), (127.4, 109.2), (19.1, 128.3) and (63.7, 64.6). Calculate the coefficients of the transformation matrix and shift vector, taking into account all five points.

Remember that the coefficients may be solved using the following formula: $\vec{p} = (A^T \cdot A)^{-1} \cdot A^T \cdot \vec{c}$

In which c is the vector of observed coordinates, A is the matrix constructed from the original coordinates, and p is the vector containing the coefficients of the transformation.

$$\vec{p} = \begin{bmatrix} p11 \\ p12 \\ p21 \\ p22 \\ p3 \\ p4 \end{bmatrix}, \quad \vec{c} = \begin{bmatrix} x_1' \\ y_1' \\ x_2' \\ y_2' \\ \dots \\ x_n' \\ y_n' \end{bmatrix}, \quad \text{and } A = \begin{bmatrix} x_1 & y_1 & 0 & 0 & 1 & 0 \\ 0 & 0 & x_1 & y_1 & 0 & 1 \\ & & \dots & \dots & & \\ & & \dots & \dots & & \\ 0 & 0 & x_n & y_n & 0 & 1 \end{bmatrix}$$

The transformation itself looks like:

$$\vec{w}' = M \cdot \vec{w} + \vec{s}$$

or

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} p11 & p12 \\ p21 & p22 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} p3 \\ p4 \end{bmatrix}$$

What is the error vector v ? Calculate the total error.