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Mathematics and Methods in Machine Learning and Neural Networks
Mathematics / Python Exercises 1

1. Calculate in Python (if defined)

   a) $\begin{bmatrix} 3 & 6 \end{bmatrix} \begin{bmatrix} 5 \\ 2 \end{bmatrix}$ b) $\begin{bmatrix} 5 \\ 2 \end{bmatrix} \begin{bmatrix} 3 & 6 \end{bmatrix}$ c) $\begin{bmatrix} 5 \\ 2 \end{bmatrix} \begin{bmatrix} 3 \\ 6 \end{bmatrix}$ d) $\begin{bmatrix} 1 & 2 \\ 3 & 5 \end{bmatrix} \begin{bmatrix} 4 \\ 6 \end{bmatrix}$

   e) $\begin{bmatrix} 4 & 6 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 3 & 5 \end{bmatrix}$ f) $\begin{bmatrix} 4 \\ 6 \end{bmatrix}^T \begin{bmatrix} 1 & 2 \\ 3 & 5 \end{bmatrix} \begin{bmatrix} 4 \\ 6 \end{bmatrix}$

2. Let
$$A = \begin{bmatrix} 1 & 0 \\ 0 & 2 \\ 3 & 0 \end{bmatrix} \qquad B = \begin{bmatrix} 0 & 4 \\ 0 & 5 \\ 6 & 0 \end{bmatrix}.$$

   Calculate in Python
   a) AB, b) $A * B$, c) $A^T B$, d) AB^T, e) $10A$, f) $10 + A$.

   Here AB is the matrix product (dot), and $A * B$ is the coordinatewise product also known as the Hadamard product.

3. Plot the function
$$g(x) = \frac{1}{1 + e^x}$$
   with $x \in [-2, 2]$.

4. Plot the function
$$f(x) = \frac{x^3 + |x| + \ln(x + 10^{-8})}{\sqrt{100 + x} + 0.01xe^x}$$
   with $x \in [0, 5]$.

5. Write the equations
$$\begin{cases} x + 2y + 4z = 12 \\ -3x + y + 5z = 2 \\ 2x - 4y + z = -7 \end{cases}$$

   in matrix form $AX = B$, where
$$X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}.$$

   Solve the system of equations using the inverse matrix A^{-1}.

6. Let
$$A = \begin{bmatrix} 2 & 5 & -1 & 3 & 6 \\ 1 & 0 & 0 & -2 & 0 \\ 4 & 1 & -2 & 0 & 7 \\ 0 & 3 & 5 & 1 & -1 \end{bmatrix}$$

Using Python choose
   a) the elements $A(1,1)$, $A(2,4)$ and $A(4,4)$,
   b) the third row,
   c) the first three columns.

7. Let matrices A and B be as defined in the Exercise 2. Concatenate matrices A and B in Python and create matrices

$$C = \begin{bmatrix} A & B \end{bmatrix}, \qquad D = \begin{bmatrix} A \\ B \end{bmatrix}.$$

Reshape C as a column vector.