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Mathematics and Methods in Machine Learning and Neural Networks
Mathematics

1. Let

$$A = \begin{pmatrix} 4 & -1 & 3 \\ 0 & 5 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 1 & 2 \\ 1 & 3 \\ 0 & 5 \end{pmatrix} \quad \text{ja} \quad C = \begin{pmatrix} -2 \\ 1 \end{pmatrix}.$$

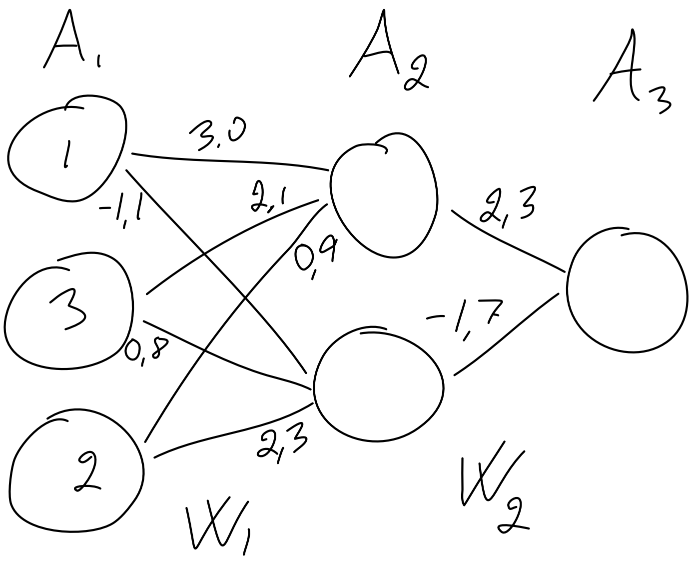
Calculate the matrices AB, $2A + B^T$ ja BC.

2. We have the following small network, where the weights are written beside the edges, and there are no bias terms.

The values of the cells are stored in matrices A_1, A_2 and A_3, where

$$A_1 = \begin{pmatrix} 1 \\ 3 \\ 2 \end{pmatrix}, \quad A_2 = W_1 A_1, \quad A_3 = W_2 A_2.$$

a) What are the matrices W_1 and W_2?
b) Calculate the matrices A_2 and A_3.



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3. Calculate the partial derivatives
$$\frac{\partial f}{\partial x}, \quad \frac{\partial f}{\partial y}, \quad \frac{\partial f}{\partial z}$$
of the function
$$f(x, y, z) = x^2 y + 3xz - 5yz + 2y.$$
Calculate the gradient ∇f at the point $(x, y, z) = (2, -1, 3)$.

4. The function
$$f(x) = x^4 - 7x^3 + 5x$$
has a minimum near $x = 5$. Use the Gradient Descent method
$$x_{i+1} = x_i - \alpha f'(x_i)$$
to find the value $x_{\min}$ at the minimum with at least 4 decimal places. Start with $x_0 = 5$ and use the learning rate $\alpha = 0.01$.

Calculate enough iterations until the first four decimals don't change between two consecutive iterations, or until you reach a maximum of 5 iterations.