# Project 4: Classification of handwritten digits using Hopfield network

## Motivation:

### The pattern classification and recognition, which is one of the most important tasks of machine learning, can be resolved using the Hopfield network.

## Paper purpose:

### Perform the classification of handwritten digits from the MNIST database using the Hopfield network. Develop the algorithm to train the Hopfield network that learns by 2 types of learning, Hebbian and Storkeythen. Compare the results of each learning technique by providing the following: 1. percent of correct and incorrect classification for digits, 2. the most common erroneous digits, 3. percent of spurious patterns.

## Good methodologies to find relationships:

Use the Hebbian learning rule and Storkey to train the network. Assumption from previous research point that the digit ‘1’ is most accurately recognized, probably, due to the small variability of its way of writing. Digits ‘9’ and ‘4’ have the smallest average relative Hamming

distance with respect to other digits, so they have the largest percentage of incorrect classification. Use these facts to improve your results by better preprocessing of data and by improving on the learning algorithm.

Also, as Hopfield networks operate with binary values (+1 or -1), arrays representing images must be binarized. Use the MNIST database with digitized images of handwritten digits at <https://www.nist.gov/itl/products-and-services/emnist-dataset>.

## Possible additional outcomes:

### Improved computational efficiency of Hopfield network relative to previous versions and other neural networks.

## Starting help resources:

Belyaev, & Velichko, A. A. (2020). [Classification of handwritten digits using the Hopfield network](https://ucumberlands.primo.exlibrisgroup.com/permalink/01UOTC_INST/1ib4vvq/cdi_iop_journals_10_1088_1757_899X_862_5_052048). *IOP Conference Series. Materials Science and Engineering*, *862*(5), 52048–.

<https://www.nist.gov/itl/products-and-services/emnist-dataset> (data sources)

## Keywords:

Neural network, Hopfield network, classification, associative memory, binary patterns.