Artificial neural networks

Assigment 3: Recurrent neural networks

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1 Context

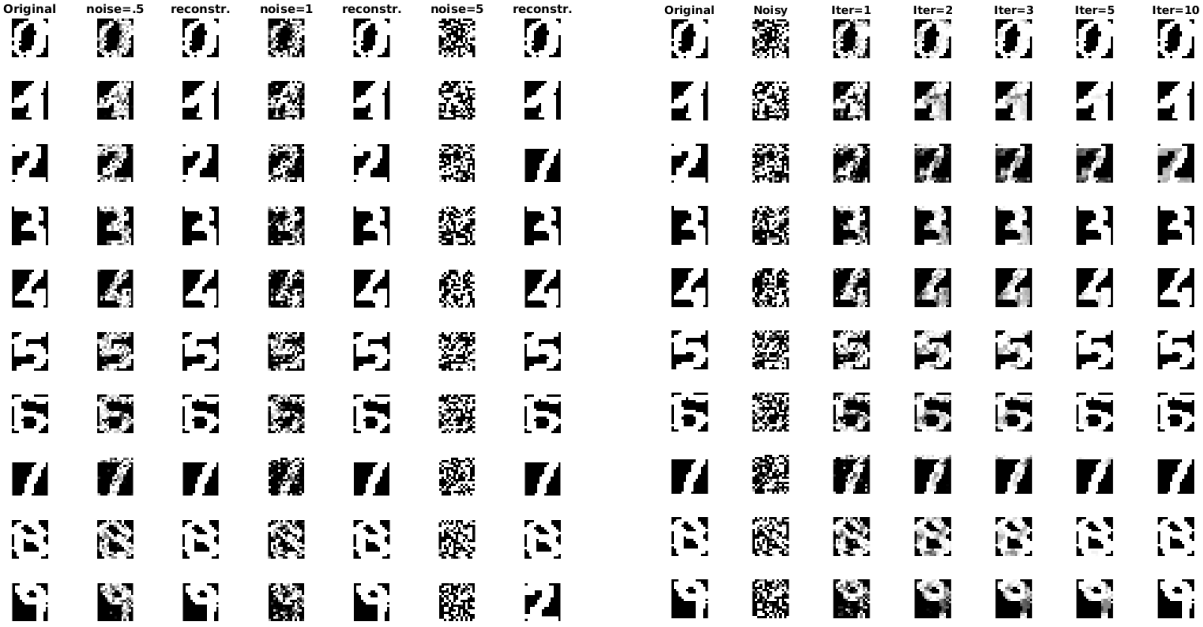
In this exercise, we explore the use of recurrent neural networks and their applications as associative memories. Items can be stored as equilibrium points of the network, similarly to those in dynamical systems.

2 Hopfield network

In this section, we use hopfield neural networks to store 10 digitized handwritten digits. The network has an architecture of 240 neurons. It is trained in such a way that each digit is an attractor point of the network, where they represent minimums of the energy function. To note is the architecture consisting of 240 neurons, so the storage of 10 patterns is possible with a small chance of error.

The first column of the left-hand side of figure 1a corresponds to the patterns that are stored in the network. Each digit is encoded as a 15 by 16 vector of pixels. Each 3 pairs of columns following the digits in the first column corresponds to an attempt at retrieving a noisy digit (the first column in a pair) through a fixed amount of iterations. As can be seen, the process is fairly good, failing only when the amount of noise is large - examples of failures are located in the last column of the digits 2, incorrectly reconstructed as a 7, and the digit 9, incorrectly reconstructed as a 2. In both cases, the error do seem to make sense to the human eye.

Similarly, the first column of the figure 1b displays the original pattern. A fixed amount of noise is then introduced (2.5 in our example), then an iterative reconstruction process is attempted.



(a) Fixed amount of iterations (50) *(b) Fixed amount of noise (2.5)*

Figure 1: Hopfield network reconstruction of noisy digits

3 Elman network

References