# Comments Lab 3

# 3.1

**First Question:** No, only the first pattern (with one distorted bit). The other two it depends. This is because, in theory, for reducing the error below 1%, the number of stored patterns is N ≈ 0.138d (where d is the number of Neurons). In our case d = 8, so N ≈ 0.138\*8 = 1.104, and we have 3 patterns, so that’s why sometimes sometimes they do not converge to the expected pattern. After 1000 simulations, we obtained that the first pattern always is attracted by the desired attractor, while the second and the half are attracted by the desired one around 50 % times. ASYNCHRONUS!

**Second question:** 6 attractors using the asynchronous mode. These attractors are the stored patterns and their symmetrics. Using the synchronous mode: 64 attractors. If self-connections are removed: 16 attractors in synchronous and 12 attractors in synchronous mode.

**Third question:** When more than half is distorted the reached attractor is never the desired input. Obvious: the desired attractor is very far in terms of similarity. ASYNCRHONOUS CASE.

## 3.2

**First Question:** yes

**Second question:** 6

## 3.3

**Third question:** view graph. In around 1000 hundred the first pattern (p10) reach an attractor (1 update of each node) and around 2000 in the second pattern (p11) (2 updates of each node). Sometimes the second pattern reach an attractor and other times other (sometimes p3 and sometimes the same attractor of 2).

**Fourth question:** the network does not converge since the W matrix is not symmetric. If we plot the result of introducing p10 and p11 throughout the NN we can see that is a noisy image (with arbitrary black and white pixels). The graph of energy vs iterations decreases in the beginning but then oscillates without convergence (in asynchronous mode: different each time). This is because if W is not symmetric the E(X) function is not monotonic and oscillates.

**Fifth question:** in this case the network converges (see graph) as the matrix W is symmetric. However, the output of the NN also is a noisy image.

## 3.4

**First Question:** see graph. If the pattern is slightly distorted the NN is able to recover the original one. The more distortion, the more likely to recover it (see the graph). When the number of distorted samples are above 40% of the vector length the NN hardly ever recovers it, and when distorted samples are >= 50% is never recovered. Above 70% is very likely to recover the symmetric to the original, as seen in the graph.

**Second Question:** yes, p2 is the one with “more” resistance to noise and p3 the one with “less” resistance to noise. ¿Why? Is because p2 is less correlated with others patterns than p1 and p2 (see correlations matrix)

**Third question:** extra iterations does not help (see graph with 1 and 10 iterations) since when an attractor is reached the system remains in that stable state.

## 3.5

**First Question:** when the pattern p4 is added to W and the experiment of 3.4 is repeated (only changing W), the ratio of recovered patterns drops to 0 for p1,p2 and p3. ***¿Why? Patterns highly correlated each other.***

**Second Question*:*** when introducing random patterns *(composed by -1 and 1)* (see graphs), if we introduce only 1 or 2 random pattern p1 and p2 and p3 can almost always be recovered (with very little distortion). With 3 random patterns only p2 and p1 can be recovered. From 4 until 8 p2 is sometimes recovered. From 9, no one is recovered.

**Third Question:** because patterns used to train the network (to form W) are supposed to be at least quasi-ortogonal (what is, with very little crosstalk each other). In this case patterns are highly correlated each other.

**Fourth Question:** The more patterns we include to W, the bigger is the ratio of stable patterns

**Fifth Question:** We flipped 5 random samples in each pattern. The peak is reached with 17 patterns added, which is close to the theoretical value (0.138\*100 = 13.8 ≈ 14). The more patterns added, the less patterns recovered successfully

**Sixth Question:** without self-connections the number of stable patterns reach a peak when W have 14 patterns. The number of stable patterns does not increase with number of patterns in W because now there are not self connections, which supported units to remain in its current state. Regarding the number of recovered patterns, in this case the proportion of recovered patterns in the peak is bigger, and the peak is now reached for 13 patterns stored in W.

**Seventh Question:** Now the peak appears for 6 patterns in W ¿Why? Maybe because now there are more 1s than -1 and patterns are more correlated.

## 3.6

**CORRELATIONS**

**Corr =**

**1.0000 0.3945 0.5000 0.4355 0.3906 0.4336 0.5059 0.1758 0.2832**

**0.3945 1.0000 0.4219 0.3613 0.3555 0.3867 0.3418 0.2148 0.2480**

**0.5000 0.4219 1.0000 0.6191 0.4844 0.5742 0.5449 0.3008 0.3457**

**0.4355 0.3613 0.6191 1.0000 0.4668 0.5020 0.4922 0.3301 0.3203**

**0.3906 0.3555 0.4844 0.4668 1.0000 0.4180 0.4238 0.1289 0.3457**

**0.4336 0.3867 0.5742 0.5020 0.4180 1.0000 0.5566 0.2734 0.3027**

**0.5059 0.3418 0.5449 0.4922 0.4238 0.5566 1.0000 0.1855 0.2969**

**0.1758 0.2148 0.3008 0.3301 0.1289 0.2734 0.1855 1.0000 0.1777**

**0.2832 0.2480 0.3457 0.3203 0.3457 0.3027 0.2969 0.1777 1.0000**

**SUM\_CORRELATIONS**

**4.1191 3.7246 4.7910 4.5273 4.0137 4.4473 4.3477 2.7871 3.3203**