

### Exercise 5 (Lessons 5 and 6), Restricted Boltzmann Machines (RBMs)

1. After the RBM has been trained, introduce a lower “temperature” in the sigmoid function (eventually zero: deterministic system) to generate the hidden layer and the visible fantasy data.
2. Check if the method at point 1 yields the closest category to each data sample, which ideally is its original category (“0”, “1”, “2”, “3”) before random corruption of bits. An estimate of the fraction of correct category recovery can be performed either with the method provided during the lecture or by writing on file the true label  $y$  during data generation and by reading it during the check.
3. Introduce a fifth state “4” (see table below) and check which is the minimum number of hidden units  $M$  for the RBM to work properly. Eventually repeat this also when a sixth state “5” is introduced.



0	11001100
1	00111100
2	11000011
3	00110011
<b>4</b>	<b>11111111</b>
<b>5</b>	<b>10101000</b>

4. If there is time, repeat the above points for systems with larger error rate ( $q > 0.1$ ) and for systems with larger block rate ( $Z > 2$ , so that  $L = 4 * Z > 8$ ). For example, for  $Z = 3$  one has  $L = 12$  and new states would be “4”=111111111111 and “5”=100100100000.