EXERCISE 11

Human Reasoning and Computational Logic

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Problem 11.1

1. (slide 27) What is computed by the network if all units are updated synchronously?
2. (slide 27) Specify the states of the network ignoring input and output units.
3. (slide 28) What is computed by this automaton ?
4. (slide 32) Specify the automaton corresponding to the sample network from slide 27.
5. (slide 32) Specify a network $\mathcal{N}$ corresponding to the automaton presented on this slide, where the output should be a binary encoding of 1 - 3.
6. (slide 33) Specify a network $\mathcal{S}$ which determines whether a given network $\mathcal{N}$ of binary threshold units has reached a stable state. Initially, $\mathcal{S}$ should output 0; as soon as $\mathcal{N}$ has reached a stable state, $\mathcal{S}$ should output 1 once; thereafter $\mathcal{S}$ should output 0 until $\mathcal{N}$ - after being externally perturbated - reaches the next stable state.

Problem 11.2

1. (slide 39) Consider the simple perceptron on this slide.
   (a) What is computed by the perceptron
   if 1 and -1 are the possible values for i_1 and i_2, whereas i_3 always has value -1 ?
   (b) Is this problem linearly separable?
   (c) Now suppose that all weights have value 0.
   What happens if we apply the learning algorithm with $\eta = 0.15$?
2. (slide 41)
   (a) Construct a McCulloch-Pitts network which computes the addition modulo 2.
   (b) Consider the classification problem
   $\{(000, 0), (001, 1), (010, 1), (011, 0), (100, 1), (101, 0), (110, 0), (111, 1)\}$
   and show that there is no simple perceptron which can solve it.
   (c) Find a transformation mapping addition modulo 2 onto a classification problem $\mathcal{C}$ in $\mathbb{R}^3$ such that $\mathcal{C}$ is linearly separable. Construct a simple perceptron and train it until it solves $\mathcal{C}$.