

## WORKSHEET FOR EXERCISES FROM CHAPTER 12

### EXERCISE 12.1

1. **Examine the responses of the network to the training set, as well as the errors computed for each output unit and each training pattern. Your network should be making 4 misses. What logical operations are causing the perceptron difficulty? (Note: if an output unit is generating three correct responses for a logical operation, but is generating an error for the fourth response, then we will say that this operation is posing a problem, simply because the output unit has failed to respond correctly to all of the input patterns.)**

The network is having problems with only two of the logic problems; that is, only 2 of the output units (unit 7 and unit 10) are making mistakes.

2. **Focus on the errors being made by the perceptron in more detail. For each output unit that is making at least one error, describe the output unit's response to each of the four input patterns.**

Both output units 7 and 10 are making mistakes to two of the four training patterns, but are also generating correct responses for the other two patterns. Unit 7 is incorrectly turning on to patterns 1 and 4, while unit 10 is incorrectly turning off to these same two patterns.

3. **For each output unit that is making at least one error, examine the threshold for that unit as well as the two connection weights that are feeding into that unit. Use this information, in the context of your description of responses in question 2, to explain why the output unit is not responding correctly. (Remember – if you used the Delta rule, then the output units are using the step activation function.)**

Unit 7 has a threshold of 0, and two small positive connection weights (0.12). The problem with this configuration is that the combination of signal and threshold will always lead to a value of 0, which will always turn the network on – even when it is supposed to turn off. Unit 10 has the reverse configuration – a small negative threshold, and negative connection weights. In this case, the combination of signal and threshold will always lead to a negative number, and the output unit will turn off to every pattern.

4. **On the basis of your answer to question 3, is it possible in principle for these incorrect output units to eventually learn to respond correctly, or are they doomed to eternal failure? If you think that they cannot learn to respond correctly, then explain this belief. If you think that they can respond correctly, then explain why, and return to the program to try to validate this belief empirically. (Hint: I don't recommend this latter approach!)**

Unit 7 corresponds to the XOR problem, and unit 10 corresponds to the  $\sim$ XOR problem. Both of these problems are linearly nonseparable, so the perceptron will never be able to configure its weights in a fashion that will permit these two problems to be solved.