# ELE 364: Assignment #5

1. (10 pts)

   (a) (2 pts) Show a perceptron that implements a two-input AND function.

   (b) (2 pts) Show a perceptron that implements a two-input OR function.

   (c) (6 pts) Show a perceptron network that implements the Boolean expression $f = abc + de$ with an interconnection of only three perceptrons.

2. (10 pts) Derive the derivative of the $\tanh(z)$ activation as a function of the derivative of $\text{logistic}(2z)$.

3. (10 pts) Consider a two-layer feed-forward neural network with an input layer with two inputs, 1 and 2, a hidden layer with one neuron, 3, and an output layer with one neuron, 4. This neural network has five weights. Suppose the activation function is logistic for the hidden layer and linear for the output layer. Initialize all weights to 0.1, then determine their values after one training iteration of the backpropagation algorithm. Assume a learning rate of 0.3 and the following training data instance: (1,0;1), where the first two values denote the inputs and the third value the desired output.

4. (10 pts) Suppose we use dropout to avoid overfitting. Consider a hidden layer with four neurons. Suppose it uses the logistic activation function. Let the weighted sums fed to the four activations be 0.18, $-0.30$, 0.52, and $-0.10$, respectively, for some input pattern. A DropMask vector (0,1,1,0) has been obtained. If the probability that a neuron will not be dropped is 0.4, what are the activation values after dropout has been implemented?

5. (20 pts) **Coding project**

   For this project, you will train multi-layer neural networks to determine whether a patient has heart disease.

   The dataset consists of the following set of descriptive features:

   (a) numeric: age, resting blood pressure, serum cholesterol, maximum heart rate achieved, level of exercise-induced ST segment depression, number of major vessels colored by flouroscopy.

   (b) categorical: sex, chest pain level, whether fasting blood sugar $> 120$ (mg/dl), resting ECG type, whether the patient suffers from exercise-induced angina, slope type of peak exercise ST segment, type of thalassemia.

   The target feature is a binary variable, where 1 indicates the presence of heart disease.

   You will train multi-layer neural networks and investigate the impact of different hyperparameters, including width, depth, and the choice of the hidden activation function. You will also experiment with early stopping as a regularization strategy.

   See the Jupyter notebook for more details.