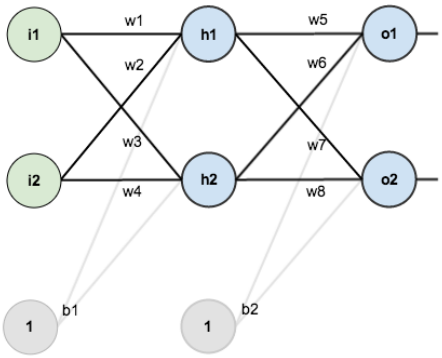
CMSC 25300/35300, STAT 27700
Homework 7

Submission Instructions:

- Please submit your homework in PDF to Gradescope (which can be accessed from the course's website on Canvas);
- Please paste your code in the submitted PDF. In other words, your submission should be a single PDF that contains both your writing solutions and your code.
- Note that you do not need to copy the problem statements in your solution, *as long as you clearly indicates the problem numbers* (e.g., 1.a, 2.c, etc).

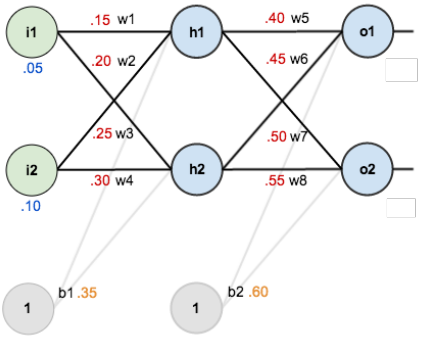
1. Read `https://mattmazur.com/2015/03/17/a-step-by-step-backpropagation-example/`.

2. Consider this network architecture:



a) (10 points) What is the feature dimension p?

b) (20 points) Now let's practice neural network's computation. Imagine we obtained the following networks with associated weight parameters and input values:



Note that each layer i also has the "bias term" b_i for $i = 1, 2$, which can be equivalently viewed as the weight for a special feature $i0 \equiv 1$. The first bias term $b_1 = 0.35$ and the second bias term $b_2 = 0.6$.

If we input $i1 = 0.05$ and $i2 = 0.1$, what will outputs $o1$ and $o2$ be, assuming logistic activation functions at each neuron? Please show the calculation.

c) (14 points) Assume the training labels are .01 and .99 for o1 and o2, respectively. What is the mean squared error L of the outputs of the forward pass?

d) (48 points) What is the value of dL/dw_k for $k = 1, \ldots, 8$? Please show steps for all w_k.

e) (8 points) Give an expression for the update of w_k in terms of a step size τ.