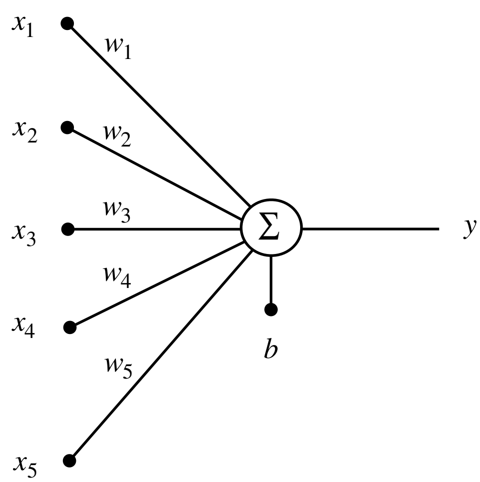
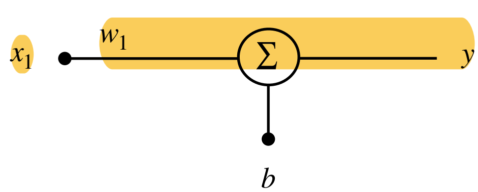
CSE 280 (Intro to ML) HW Assignment#4 Due Date: See Canvas
40 Points

Name:

(1) Below is a basic *Artificial Neuron*. Write an equation that represents the calculation of output variable "y"

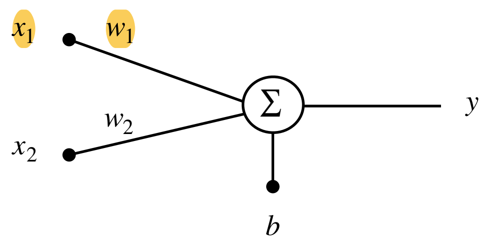


(2) Write the equation for a *single input* neuron, where x is the input and y is the output; this equation represents what common geometrical object?



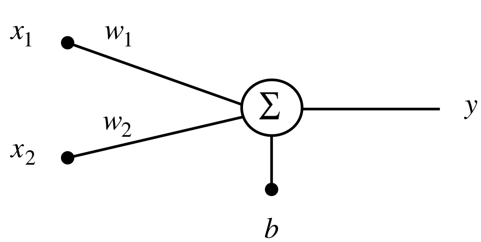
Equation: y =
Geometrical Object:

(3) Write the neuron equation for a *two input* neuron, where x_1 and x_2 are inputs and y is the output; this equation represents what common geometrical object?



Equation: y =	
Geometrical Object:	

(4) For the two input neuron below, let *y* be represented by the equation:



$$y = x_1 w_1 + x_2 w_2 + b$$

Determine the partial derivatives below:

$$\frac{\partial y}{\partial w_1} =$$

$$\frac{\partial y}{\partial w_2} =$$

(5) For the neuron below, which includes an activation function, let *y* be represented by the equation:

$$a = x_1 w_1 + x_2 w_2 + b$$

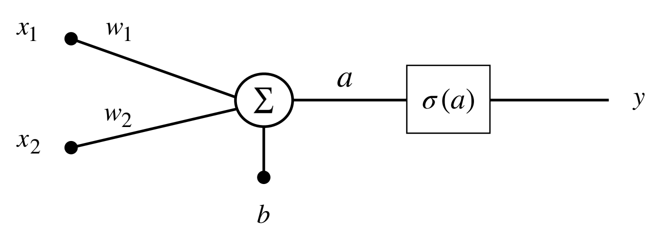
$$y = \sigma(a)$$

$$\boxed{y = \sigma(x_1 w_1 + x_2 w_2 + b)}$$ ← Complete Neuron Equation

The activation function is called a *Sigmoid Function* (a.k.a. *Logistic Function*). The Sigmoid function has the following equation and derivative:

$$\sigma(x) = \frac{1}{1 + e^{-x}}$$

$$\frac{d\sigma}{dx} = \frac{e^x}{(1 + e^x)^2} = \sigma(x)[1 - \sigma(x)]$$



Determine the partial derivatives below:

$$\frac{\partial y}{\partial w_1} =$$

$$\frac{\partial y}{\partial w_2} =$$

$$\frac{\partial y}{\partial b} =$$

The loss equation below has been discussed in class (on slides), and your book mentions it on page 45.

$$L = \frac{1}{m}\sum_{i=1}^{m}((wx_i + b) - y_i)^2$$

(6) In words, write what this equation represents and what its purpose is (why do we have it, what does this equation tell us. If we didn't have this equation how would we be effected).

(7) With the equation above, dust off your Calculus knowledge, and derive the partial derivative of *L* with respect to *w*. So derive the following partial derivative, showing your derivation steps, to where any student of calculus could follow your thinking (and conclude if the book is correct or not).

> *Hint*, let $m = 4$, meaning you have a small training set of (x_i, y_i) pairs; for example, say you have 4 pairs of training data:
>
> training data = $\left[(x_1, y_1), (x_2, y_2), (x_3, y_3), (x_4, y_4)\right]$
>
> Perform your derivation with the above training set.

$$\frac{\partial L}{\partial w} =$$

(8) What is the benefit of knowing this partial derivative(i.e. $\partial L / \partial w$). Your book uses this partial derivative equation in the training process, how does this partial derivative help the training process ?