1. What is the magnitude of $\vec{w} = [0.5, 0.5]$?

       |w| = sqrt(0.5² + 0.5²)
       |w| = sqrt(0.25 + 0.25)
       |w| = sqrt(0.5)
       |w| = 0.7071

2. Multiple the following two vectors $(\vec{x} * \vec{w}^T)$, where $\vec{x} = [0.5, 0.5]$ and $\vec{w} = [0.75, 1.25]$

       x = [[0.5, 0.5]
       w = [[0.75, 1.25]]
       wT = [[0.75],
             [1.25]]

       x * wT = [[0.5*0.75 + 0.5*1.25]]
             = [[1]]

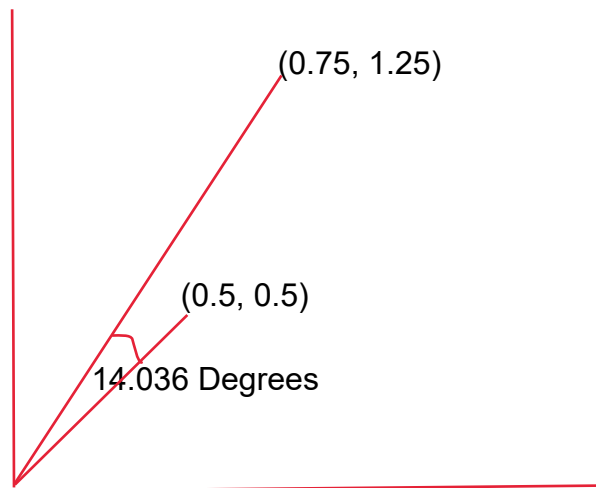3. Multiple the following two vectors ($\vec{x}^T * \vec{w}$) using the vectors from the previous problem.

x = [[0.5, 0.5]
w = [[0.75, 1.25]]
xT = [[0.5],
      [0.5]]

xT * w = [[0.5*0.75, 0.5*1.25],
          [0.5*0.75, 0.5*1.25]]
       = [[0.375, 0.625],
          [0.375, 0.625]]

4. What is the dot product of $\vec{x}$ and $\vec{w}$ using the values from the previous problem?

x = [[0.5, 0.5]
w = [[0.75, 1.25]]

x•w = 0.5*0.75 + 0.5*1.25
= 1

5. What is the angle between $\vec{x}$ and $\vec{w}$ using the values from the previous problem? Draw the vectors and label the angle that you found.

θ = cos-1((x · w) / (|x| · |w|))
x · w = 1
|x|= sqrt(0.5² + 0.5²) = 0.7071
|w|= sqrt(0.75² + 1.25²) = 1.458
θ = cos-1(1 / (0.7071 · 1.458))
θ = 14.036

(0.75, 1.25)

(0.5, 0.5)

14.036 Degrees

6. Add the following vectors, and draw the resultant and the original vectors.
   $\vec{x} = [0.5, 0.5]$ and $\vec{w} = [0.75, -1]$

(0.75, 1.25)

(0.5, 0.5)

(1.25, -0.5)
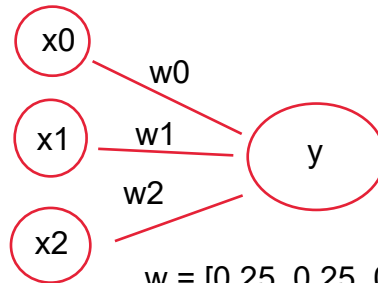
x = [0.5, 0.5]
w = [0.75, -1]
x + w = [1.25, -0.5]
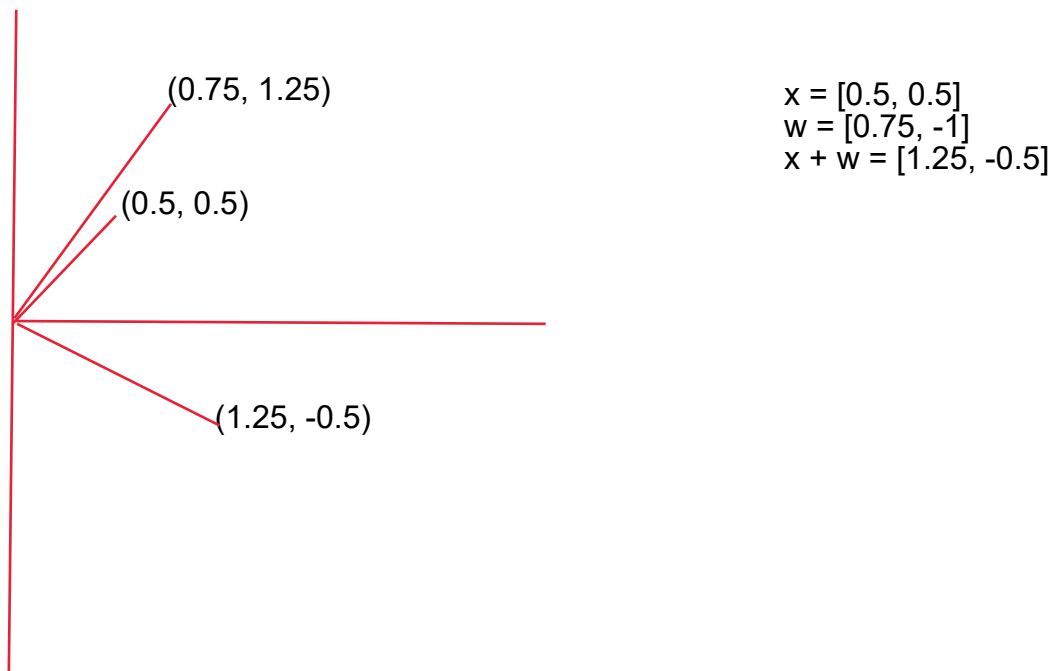
7. What is the difference between prediction and classification?

Prediction tries to predict a missing or unknown element. Classification separates data into categorical groups or classes.

8. Using the perceptron learning algorithm and a single neuron, find the weights that correctly predict the "OR" function. Continue updating the weights using the algorithm discussed in class until you converge on a correct solution. Show all of your work. The initial weights are $w_0 = 0, w_1 = 0.5, w_2 = -0.5$ and the learning parameter $\nu = 0.25$. You may also assume that $x_0 = 1$.

x_1	x_2	OR
0	0	0
0	1	1
1	0	1
1	1	1

w = [0, 0.5, -0.5]
x = [1, 0, 0]
w . x = 0 <= 0
w = w - 0.25 * (0 - 0) * x

w = [0, 0.5, -0.5]
x = [1, 0, 1]
w . x = -0.5 <= 0
w = w - 0.25 * (0 - 1) * x
w = w + [0.25, 0, 0.25]

w = [0.25, 0, -0.25]
x = [1, 1, 0]
w . x = 0.25 > 0
w = w - 0.25 * (1 - 1) * x

w = [0.25, 0, -0.25]
x = [1, 1, 1]
w . x = 0 <= 0
w = w - 0.25 * (0 - 1) * x
w = w + [0.25, 0.25, 0.25]

w = [0.5, 0.25, 0]
x = [1, 0, 0]
w . x = 0.5 > 0
w = w - 0.25 * (1 - 0) * x
w = w - [0.25, 0, 0]

w = [0.25, 0.25, 0]
x = [1, 0, 1]
w . x = 0.25 > 0
w = w - 0.25 * (1 - 1) * x

w = [0.25, 0.25, 0]
x = [1, 1, 0]
w . x = 0.25 > 0
w = w - 0.25 * (1 - 1) * x

w = [0.25, 0.25, 0]
x = [1, 1, 1]
w . x = 0.5 > 0
w = w - 0.25 * (1 - 1) * x

w = [0.25, 0.25, 0]
x = [1, 0, 0]
w . x = 0.25 > 0
w = w -0.25 * (1 - 0) * x
w = w - [0.25, 0 ,0]

w = [0, 0.25, 0]
x = [1, 0, 1]
w . x = 0 <= 0
w = w - 0.25 * (0 - 1) * x
w = w + [0.25, 0, 0.25]

w = [0,.25 0.25, 0.25]
x = [1, 1, 0]
w . x = 0.5 > 0
w = w - 0.25 * (1 - 1) * x

w = [0.25, 0.25, 0.25]
x = [1, 1, 1]
w . x = 0.75 > 0
w = w - 0.25 * (1 - 1) * x

w = [0.25, 0.25, 0.25]
x = [1, 0, 0]
w . x = 0.25 > 0
w = w - 0.25 * (1 - 1) * x
w = w - [0.25, 0 ,0]

w = [0, 0.25, 0.25]
x = [1, 0, 1]
w . x = 0.25 > 0
w = w - 0.25 * (1 - 1) * x

w = [0, 0.25, 0.25]
x = [1, 1, 0]
w . x = 0.25 > 0
w = w - 0.25 * (1 - 1) * x

w = [0, 0.25, 0.25]
x = [1, 1, 1]
w . x = 0.5 > 0
w = w - 0.25 * (1 - 1) * x

w = [0, 0.25, 0.25]
x = [1, 0, 0]
w . x = 0 <= 0
w = w - 0.25 * (0 - 0) * x