Homework 7

1.

We define type 2 neuron with the following function:

$$y = \frac{1}{1 + \sum_{i=1}^{k} \frac{|x_i - w_i|}{|s_i|}}$$

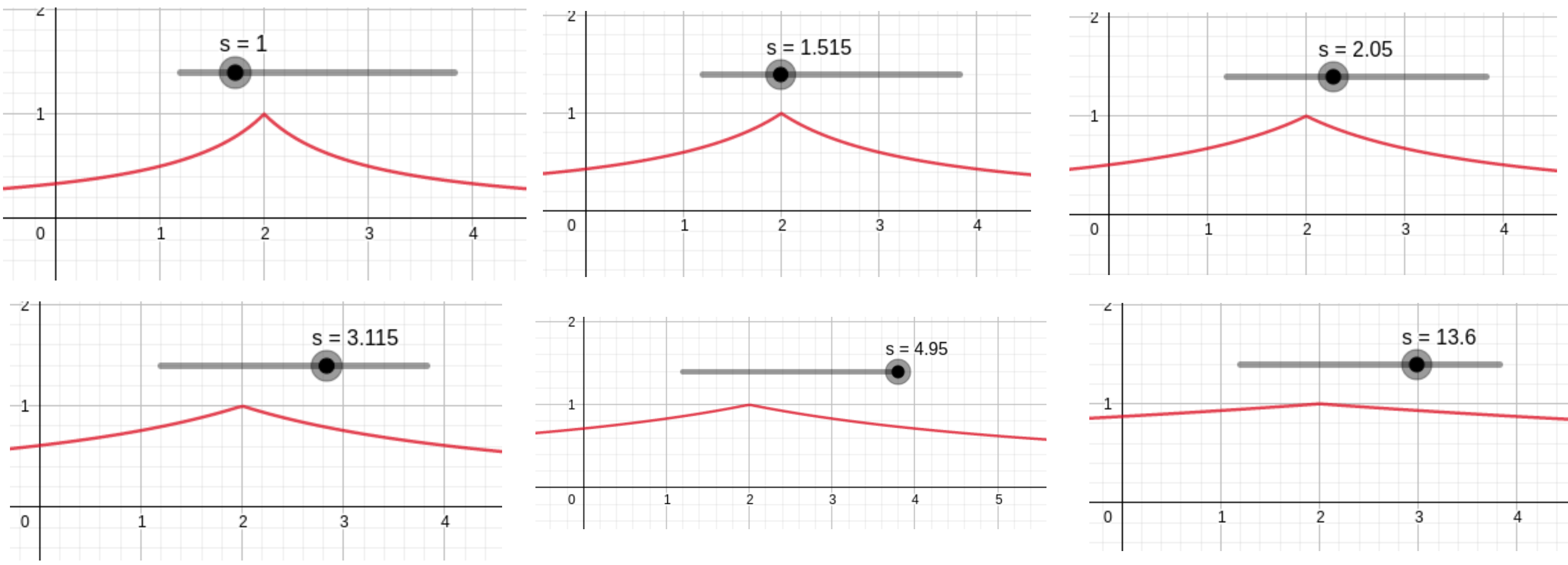
where $\vec{x}$ are inputs, $\vec{w}$ are neuron weights' and $\vec{s}$ is scaling vector.
This function calculates the similarity between input and nuurons' weights.

For the case when input to neuron is 1-dimensional we have reduction to:

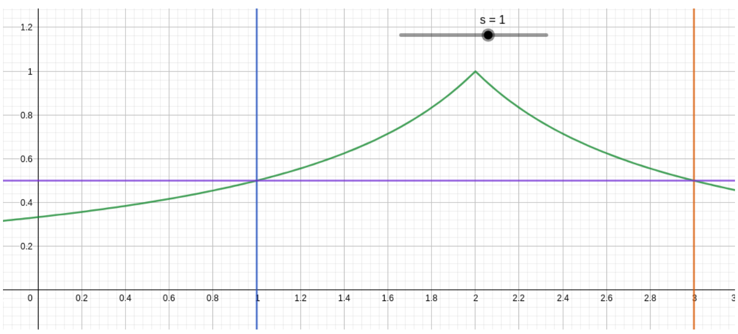
$$y = \frac{1}{1 + \frac{|x-w|}{|s|}}$$

Example 1D
***** We plot y(x; **w** = 2) for 1-dimensional input and for different parameter **s.**

As we control parameter s we get these plots.



We can see that by increasing scaling parameter s more and more inputs x become similar to weight w. As s -> ∞ we get constant function where every input x is equally similar to w.

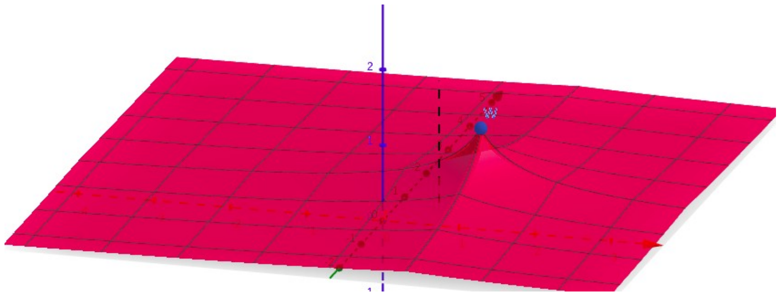


S = h : h units away from the peak of the function y(x) function reaches 0.5

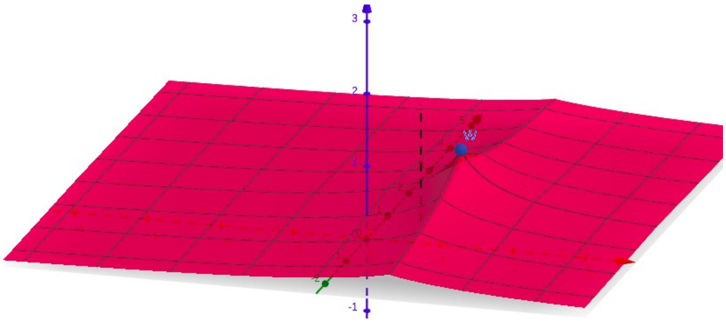
h = |x(y=1) - x(y=0.5)|

Example 2D

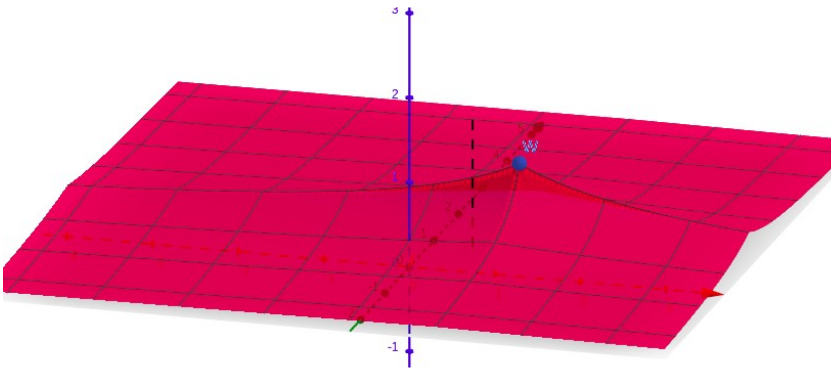
W = (1,1)



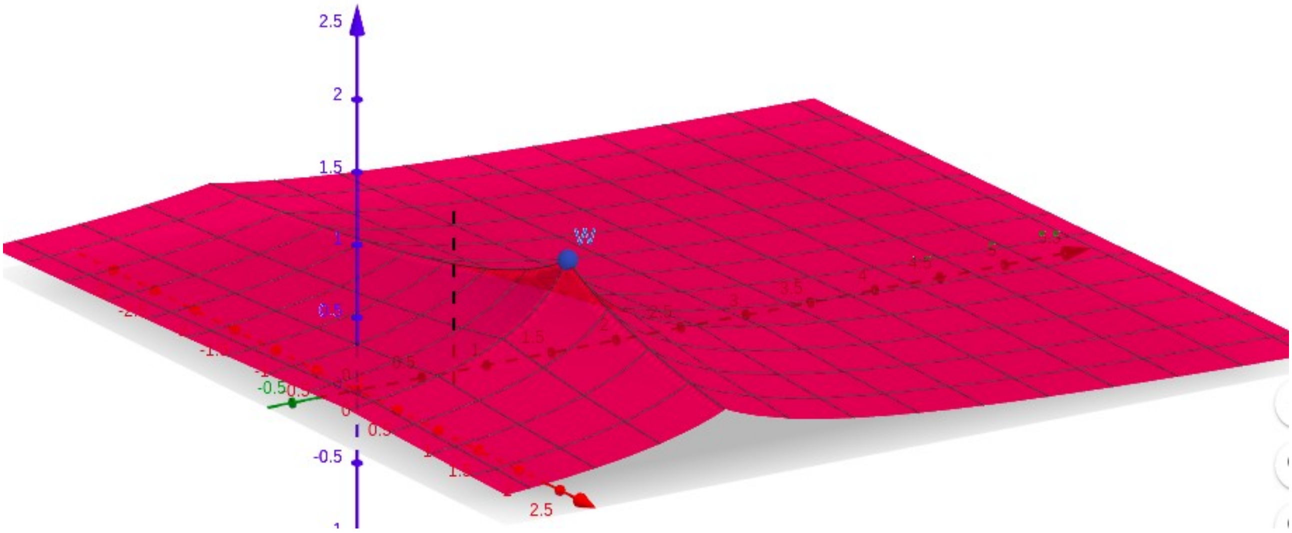
S = (0.6, 0.8)



S = (0.6, 2)



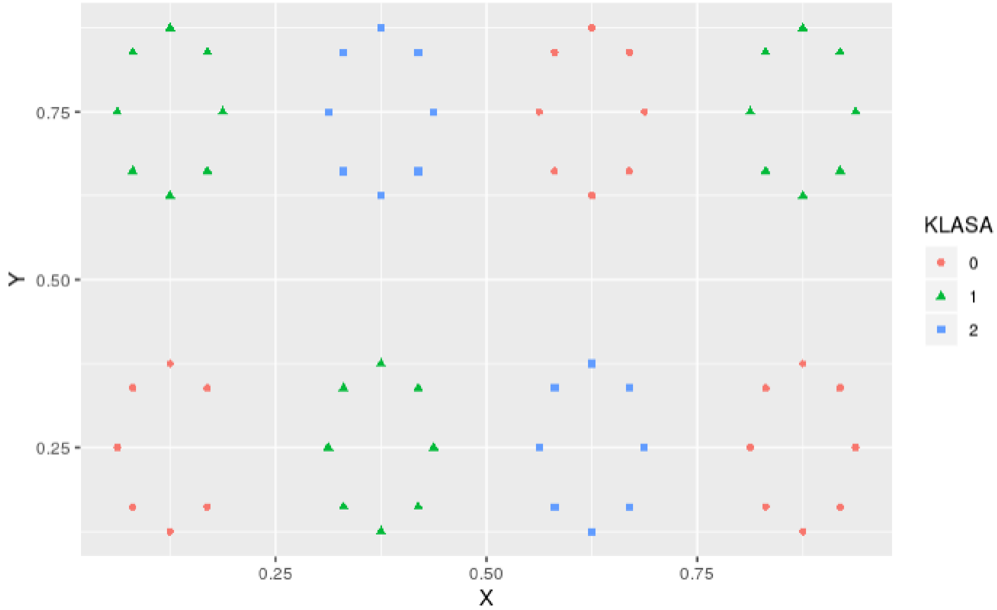
S = (2, 0.6)



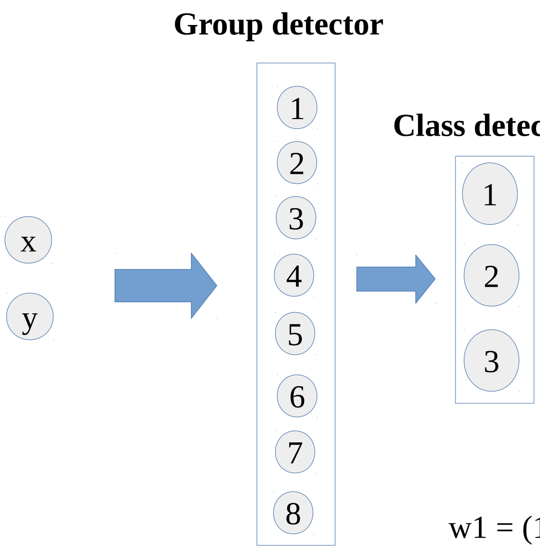
Further on, we will refer $\vec{s}$ as similarity factor. In 2D example we can see how components of this vector controls similarty across dimensions.

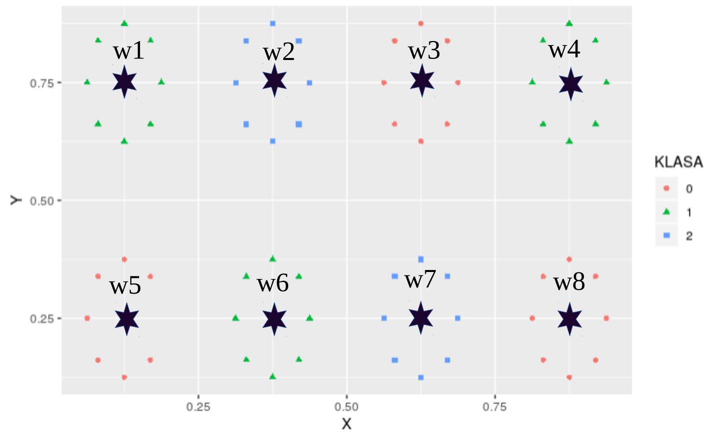
2. Dataset

The dataset is composed of 8 equal rings, it is fairly complex and it isn't linearly separable. Hypothesis space on which model must operate shoud be highly nonlinear. Reasonable assumption is that model should classify ring's interior with the same class as the border.



Because we have 8 distinct groups we could construct 2 x 8 x 3 neural network, where hidden layer could be group detector. Last layer could detect class given the group which is easier task than to detect class given raw input.





w1 = (1/8, 3/4)
w2 = (3/8, 3/4)
w3 = (5/8, 3/4)
w4 = (7/8, 3/4)
w5 = (1/8, 1/4)
w6 = (3/8, 1/4)
w7 = (5/8, 1/4)
w8 = (7/8, 1/4)

S = (1/8, 1/4)