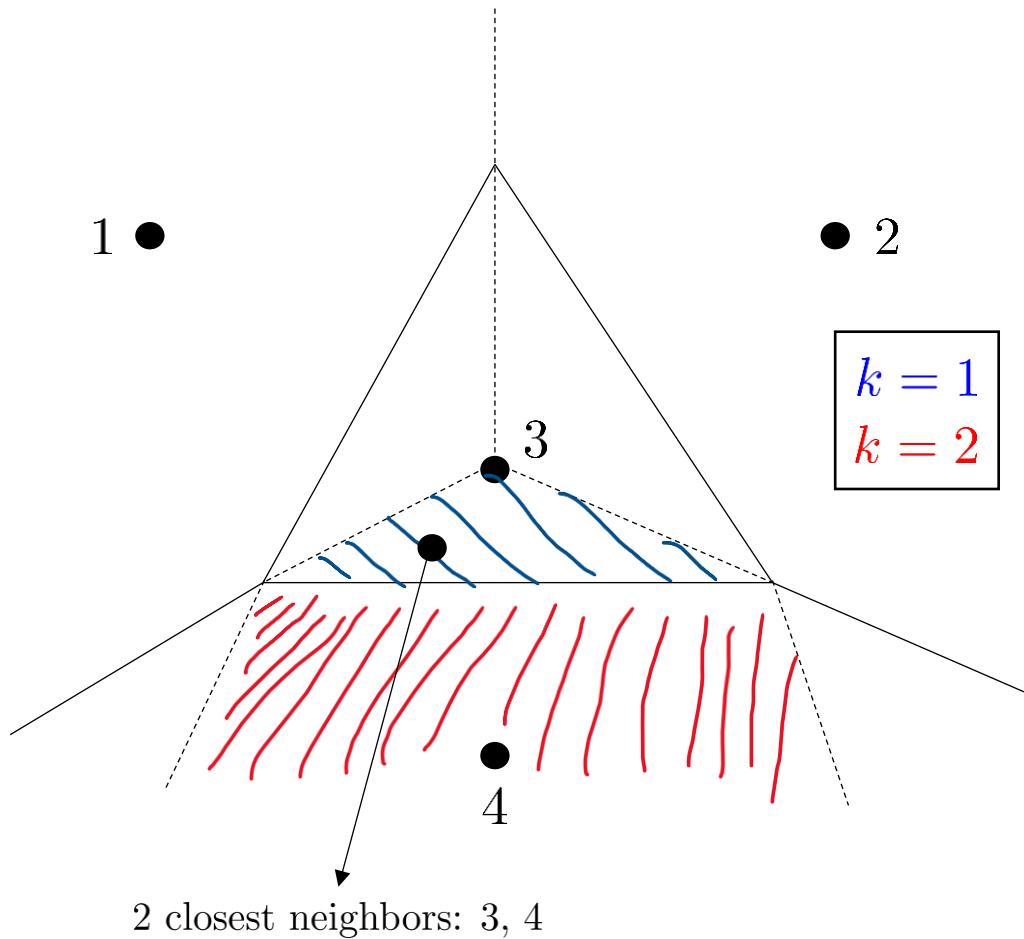


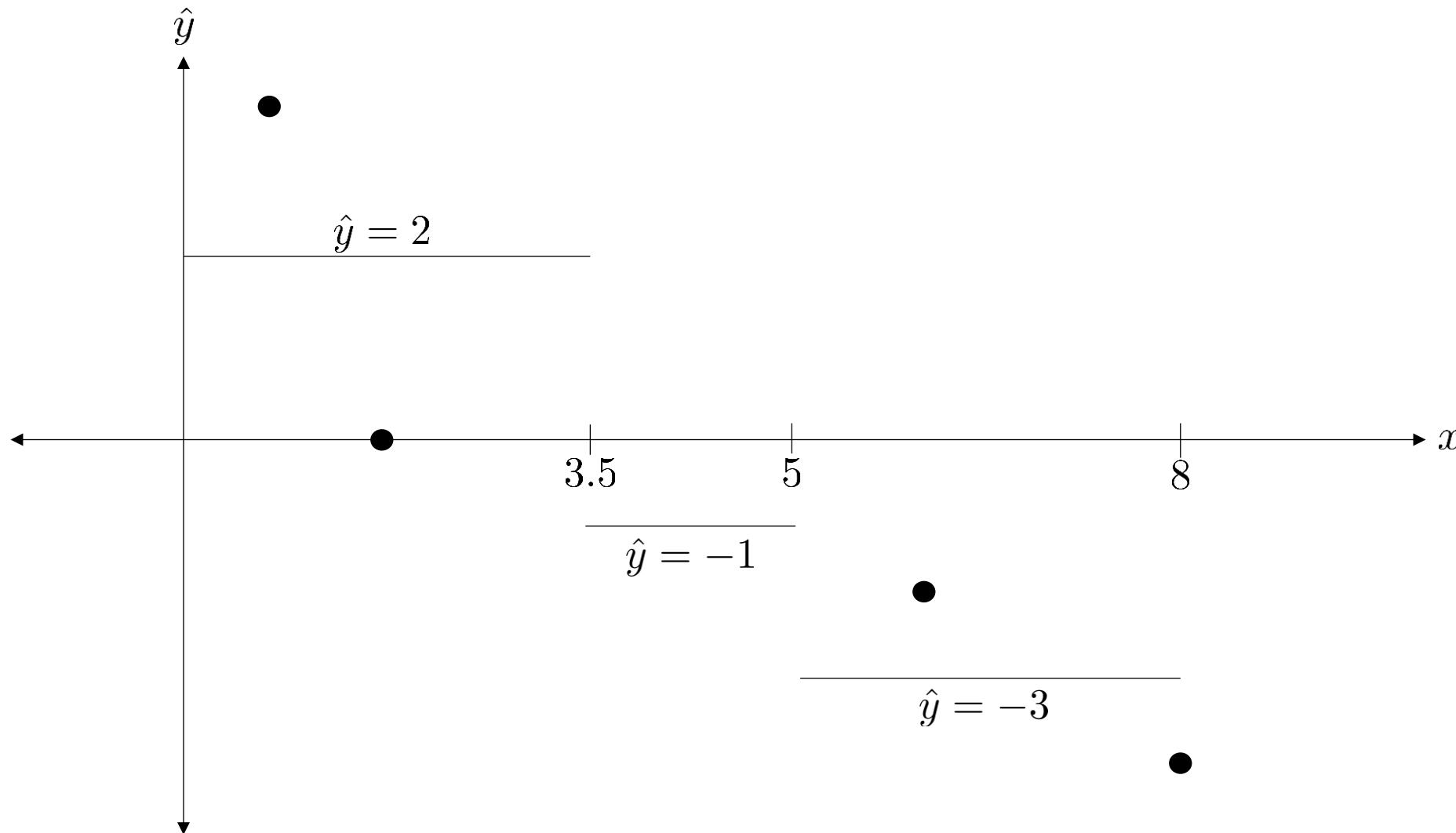
Diagrams used in Math 178 Notes: Ryan Gomberg

Please reference if you are going to use any of these!

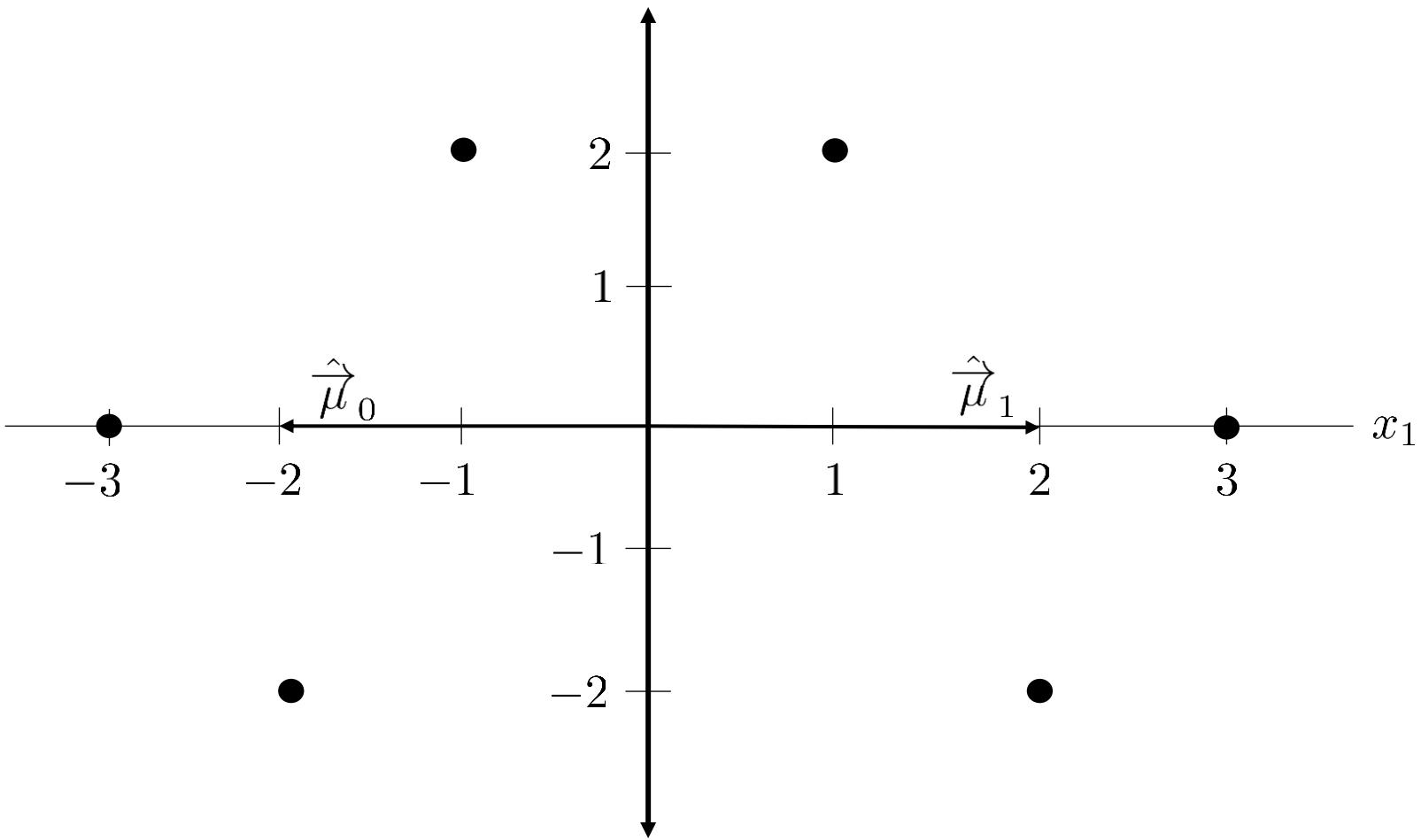
## Decision Boundary for kNN

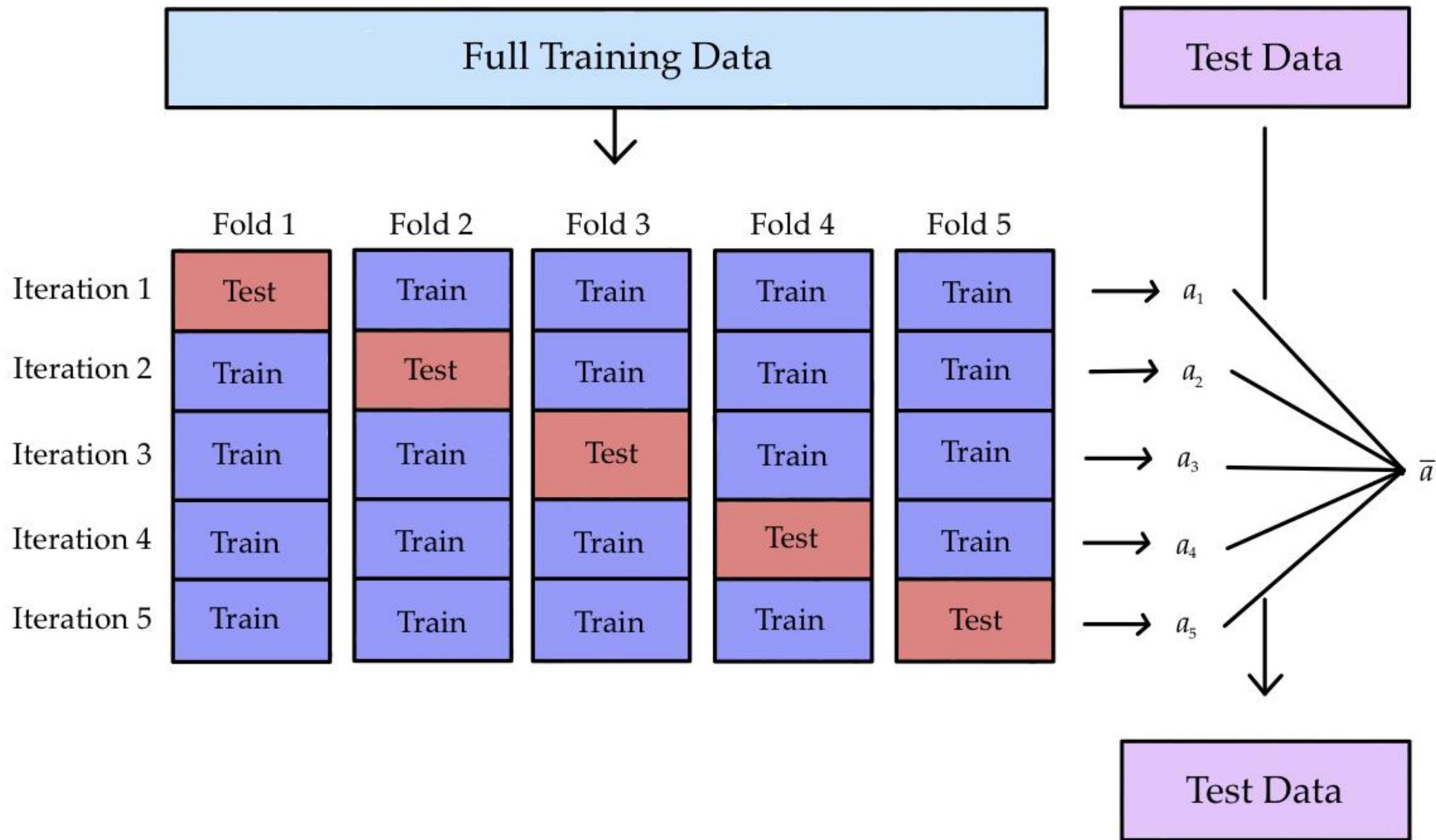


## kNN Regression in 1-dimension



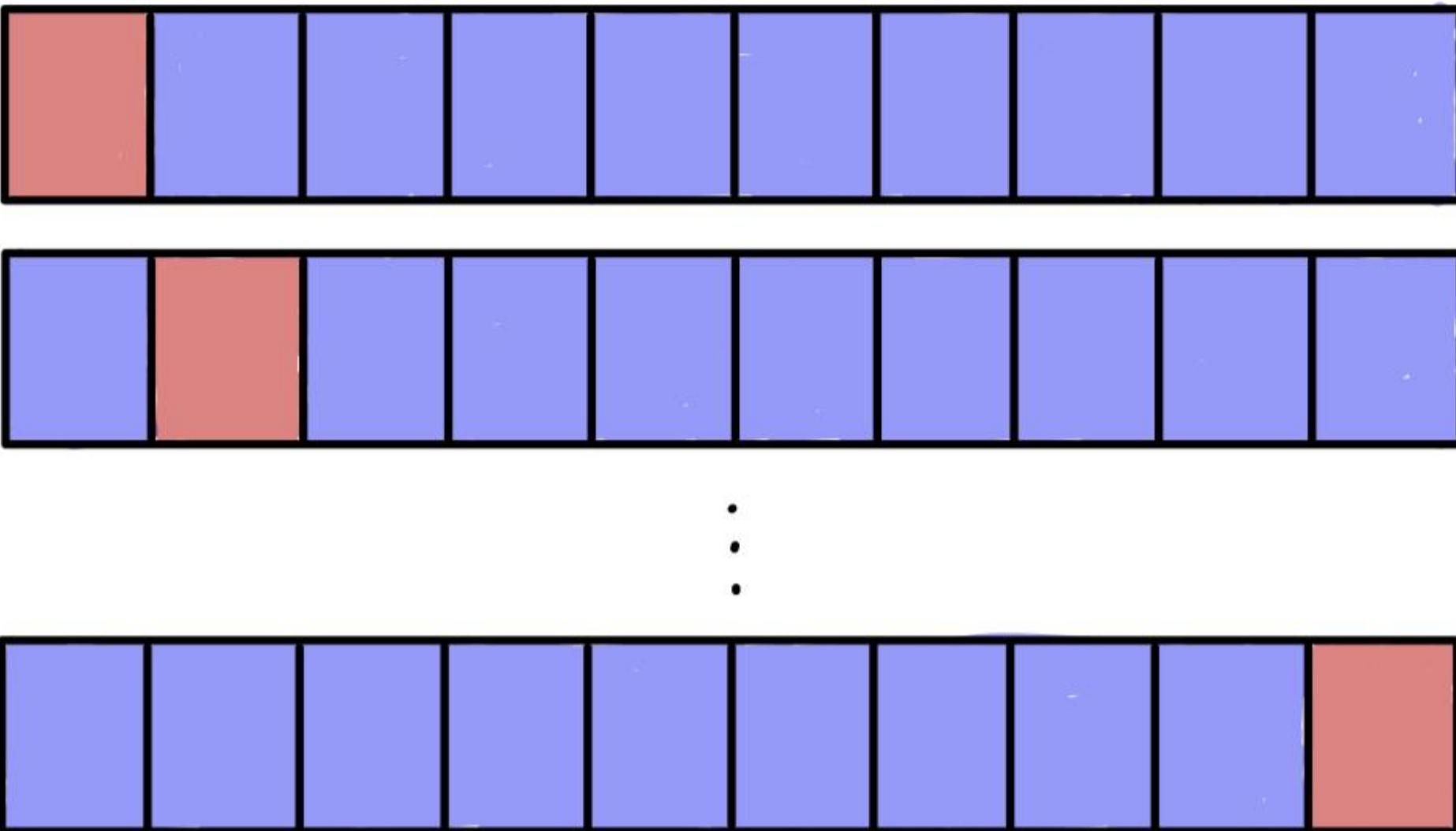
Decision boundary:  $x_2$ -axis



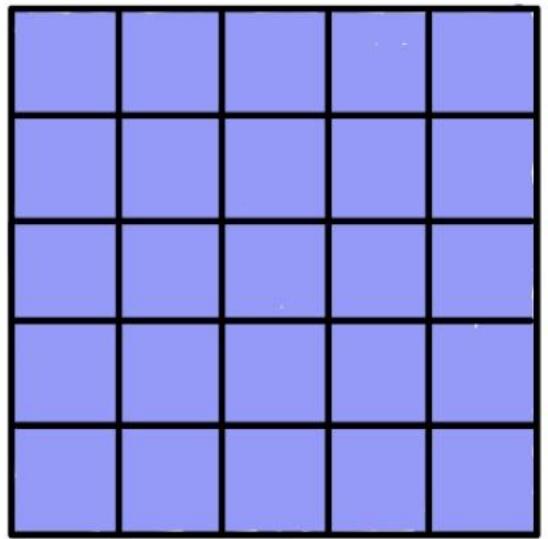


$k$ -fold cross validation

## Leave one out cross validation



# Bootstrapping

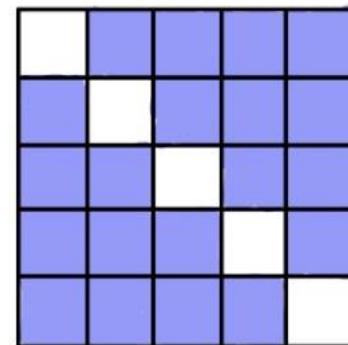
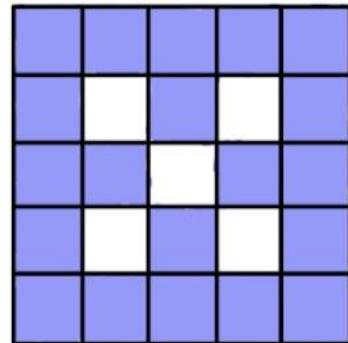
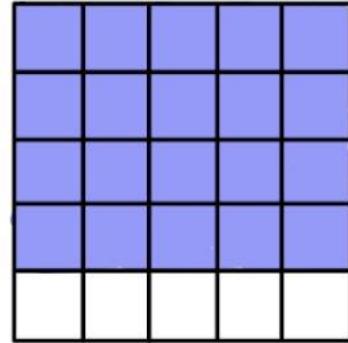


$N = 25$

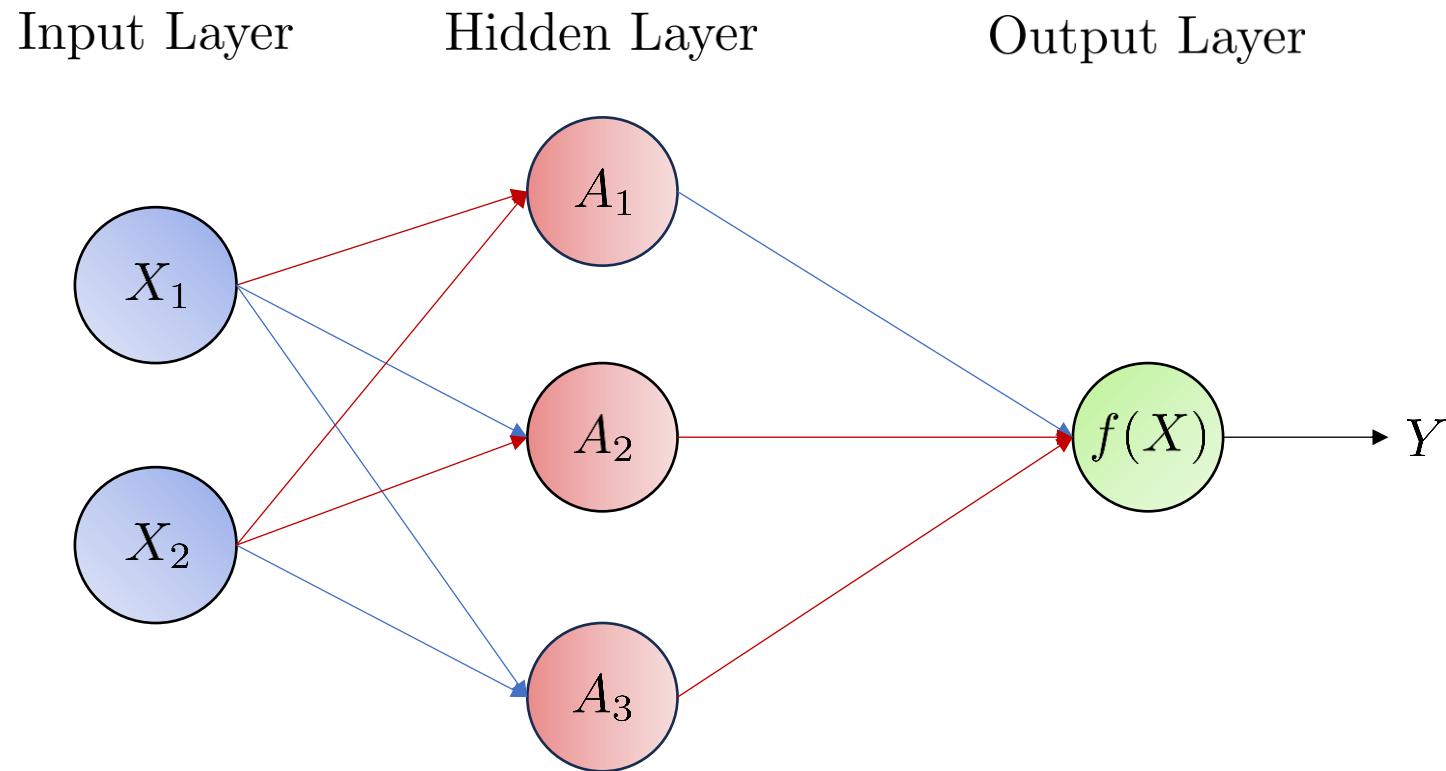
$n = 20$

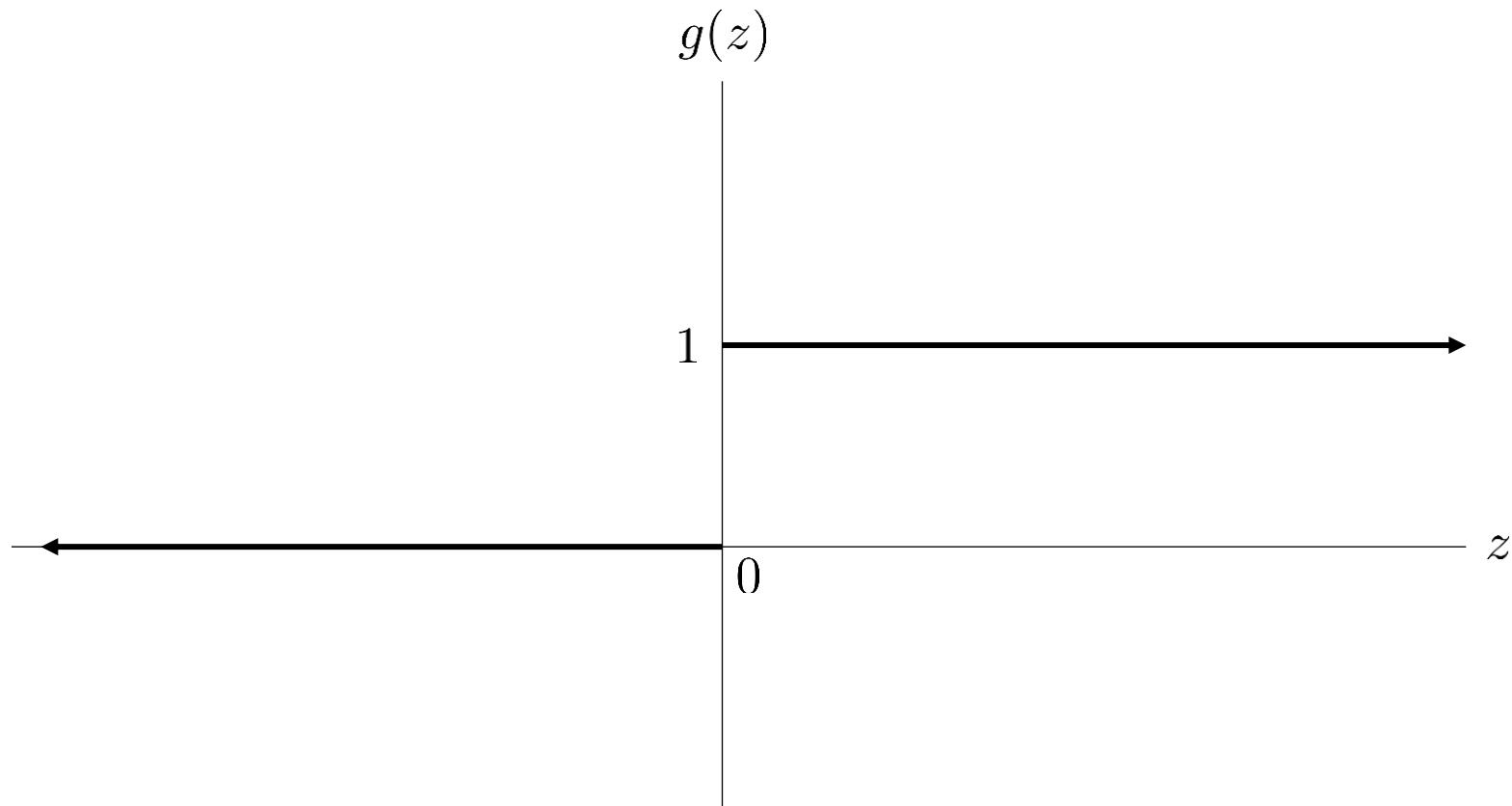
$n = 20$

$n = 20$

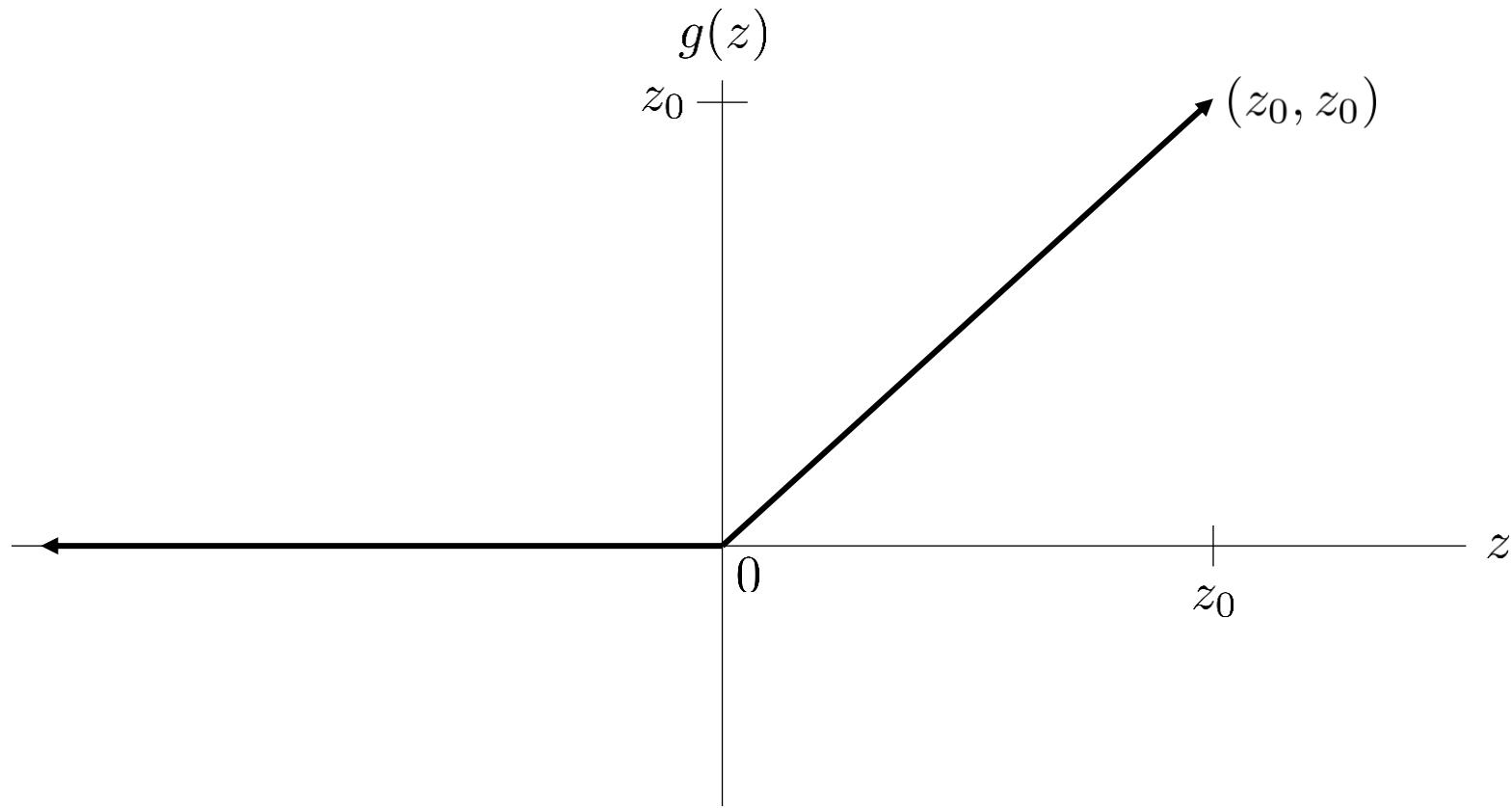


# Single Layer Neural Network



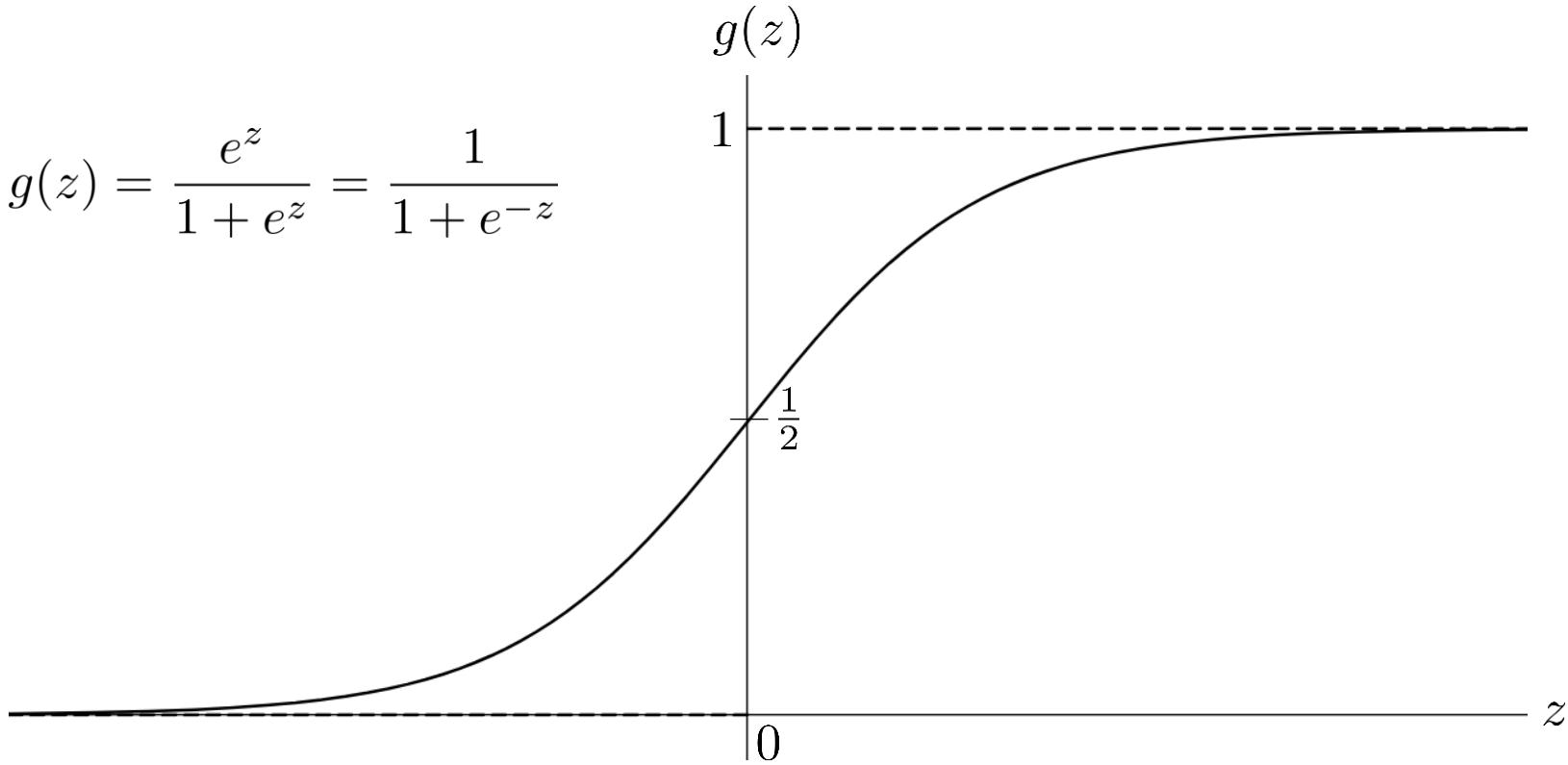


Heaviside Activation Function

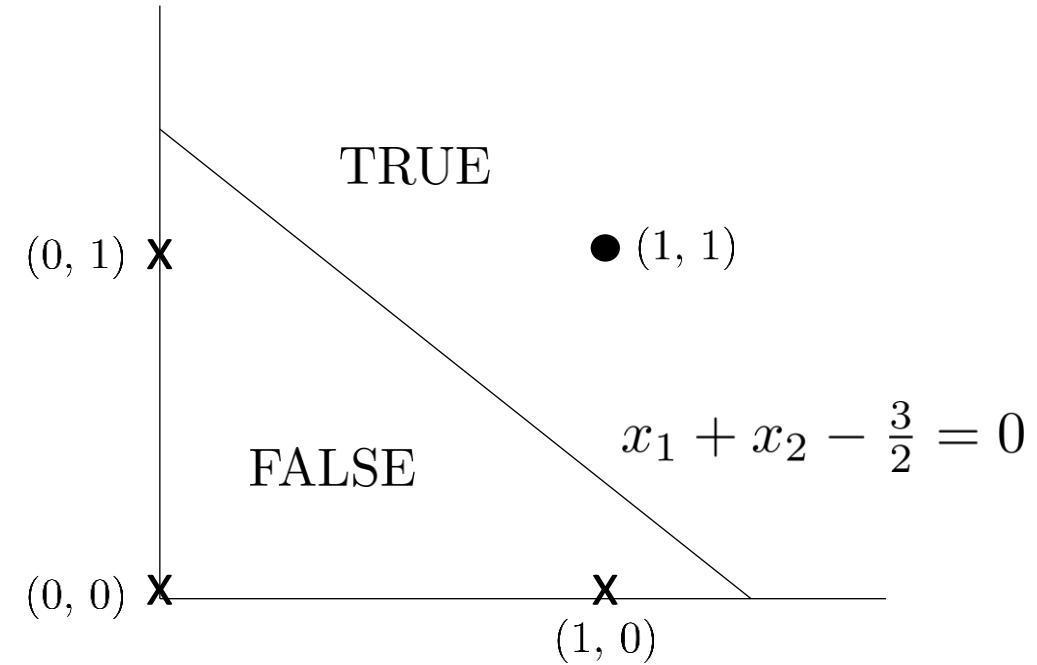


ReLU Activation Function

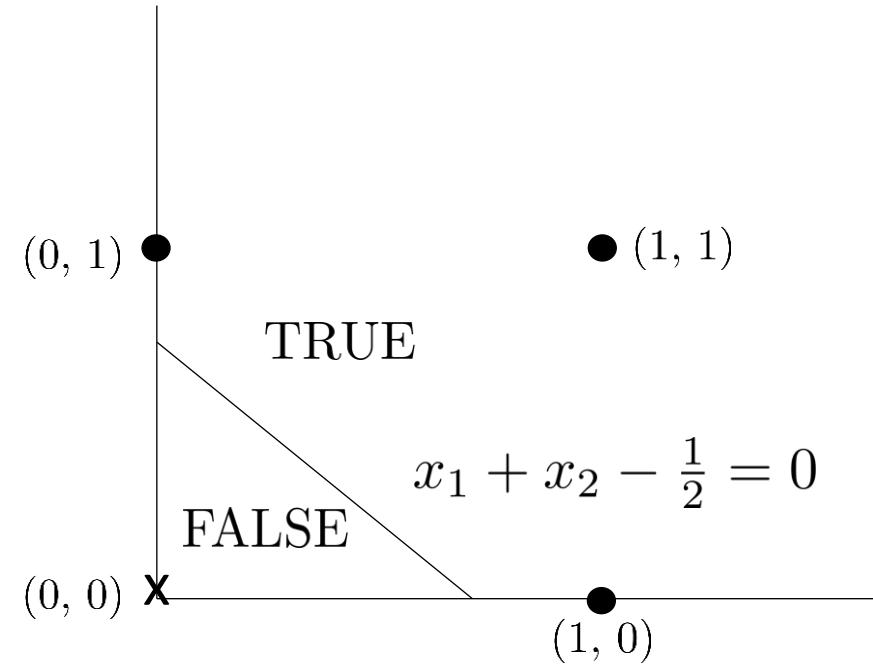
$$g(z) = \frac{e^z}{1 + e^z} = \frac{1}{1 + e^{-z}}$$



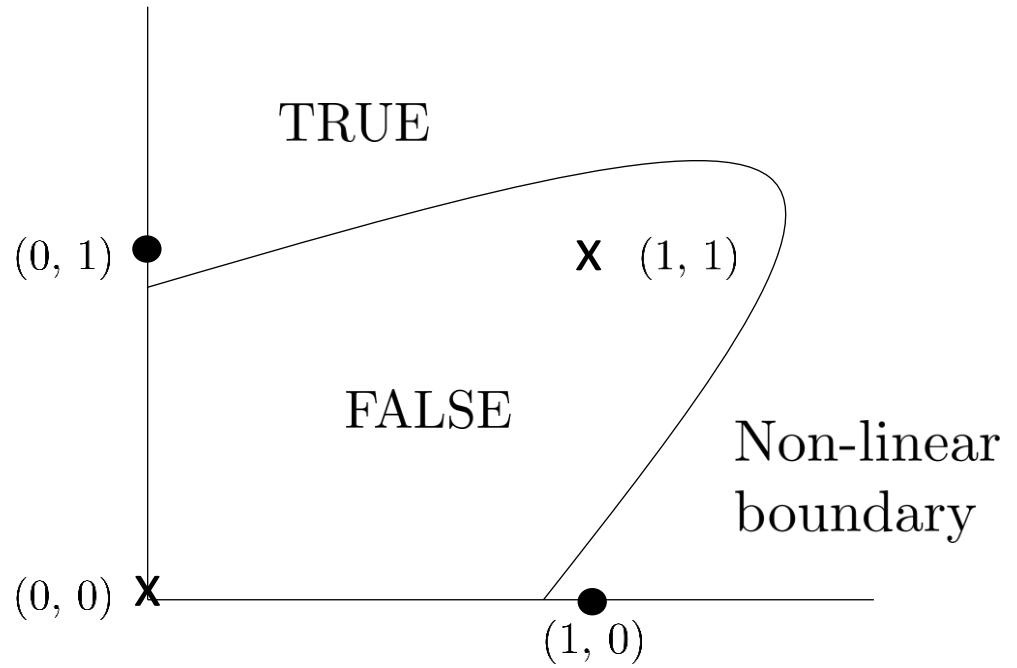
Sigmoid Activation Function



Decision Boundary: AND Boolean



Decision Boundary: OR Boolean

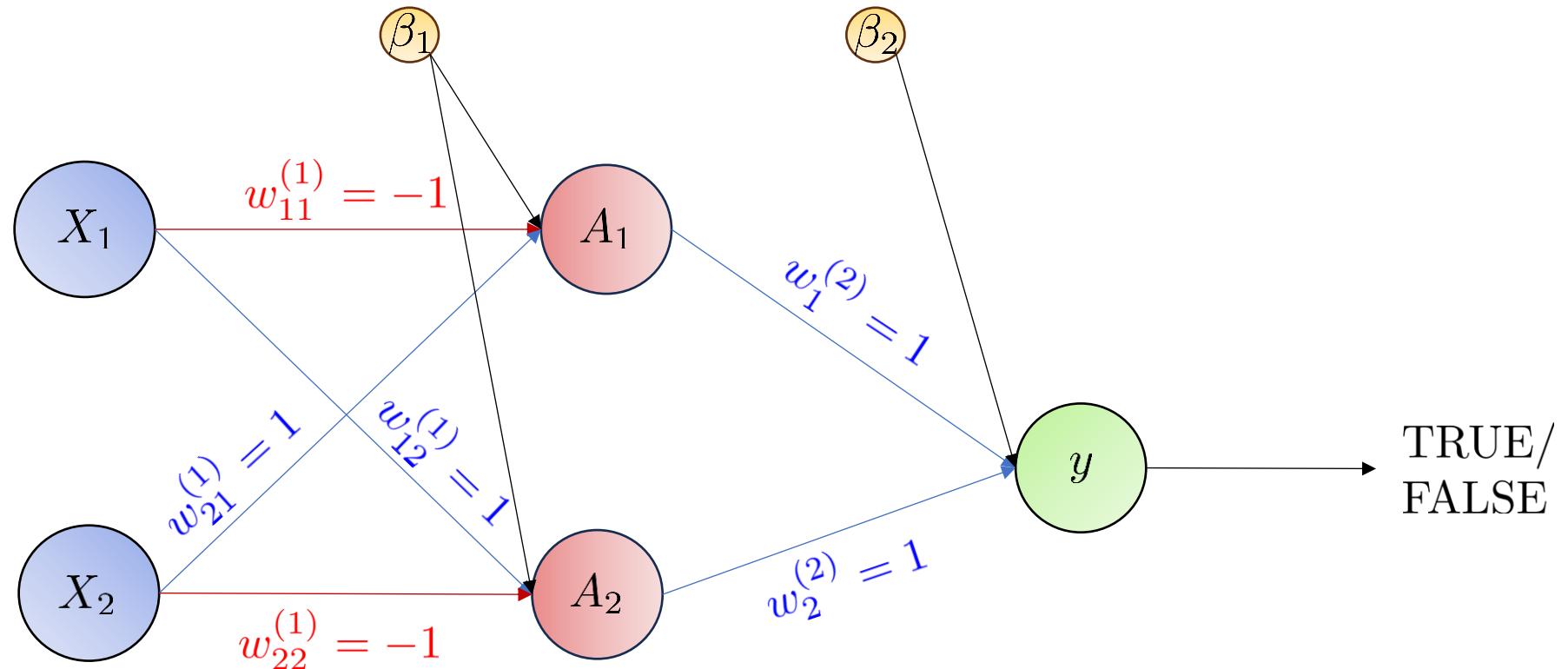


Decision Boundary: XOR Boolean

Input Layer

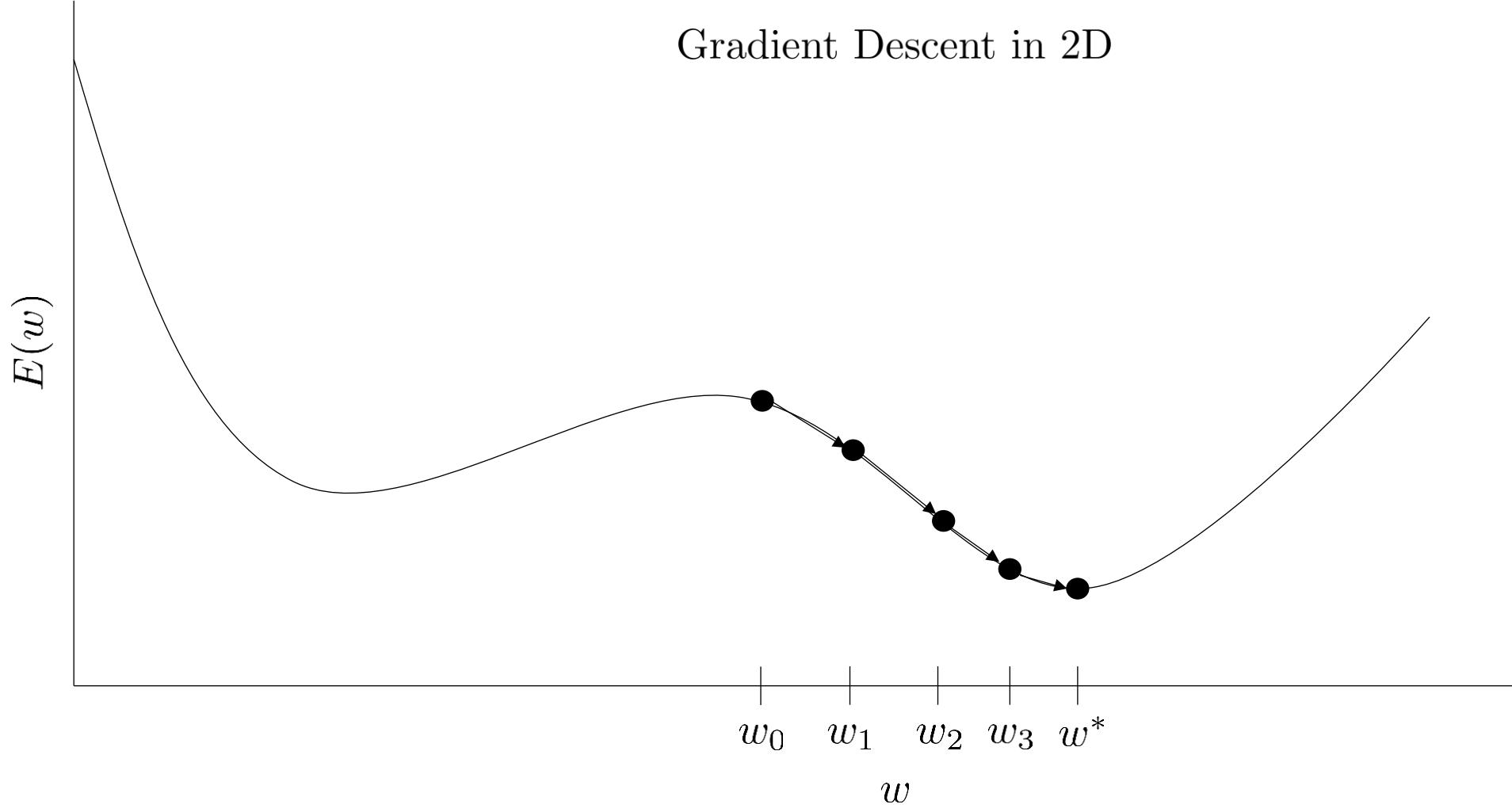
Hidden Layer  
 $g(z) = \text{ReLU}(z)$

Output Layer  
(sigmoid)

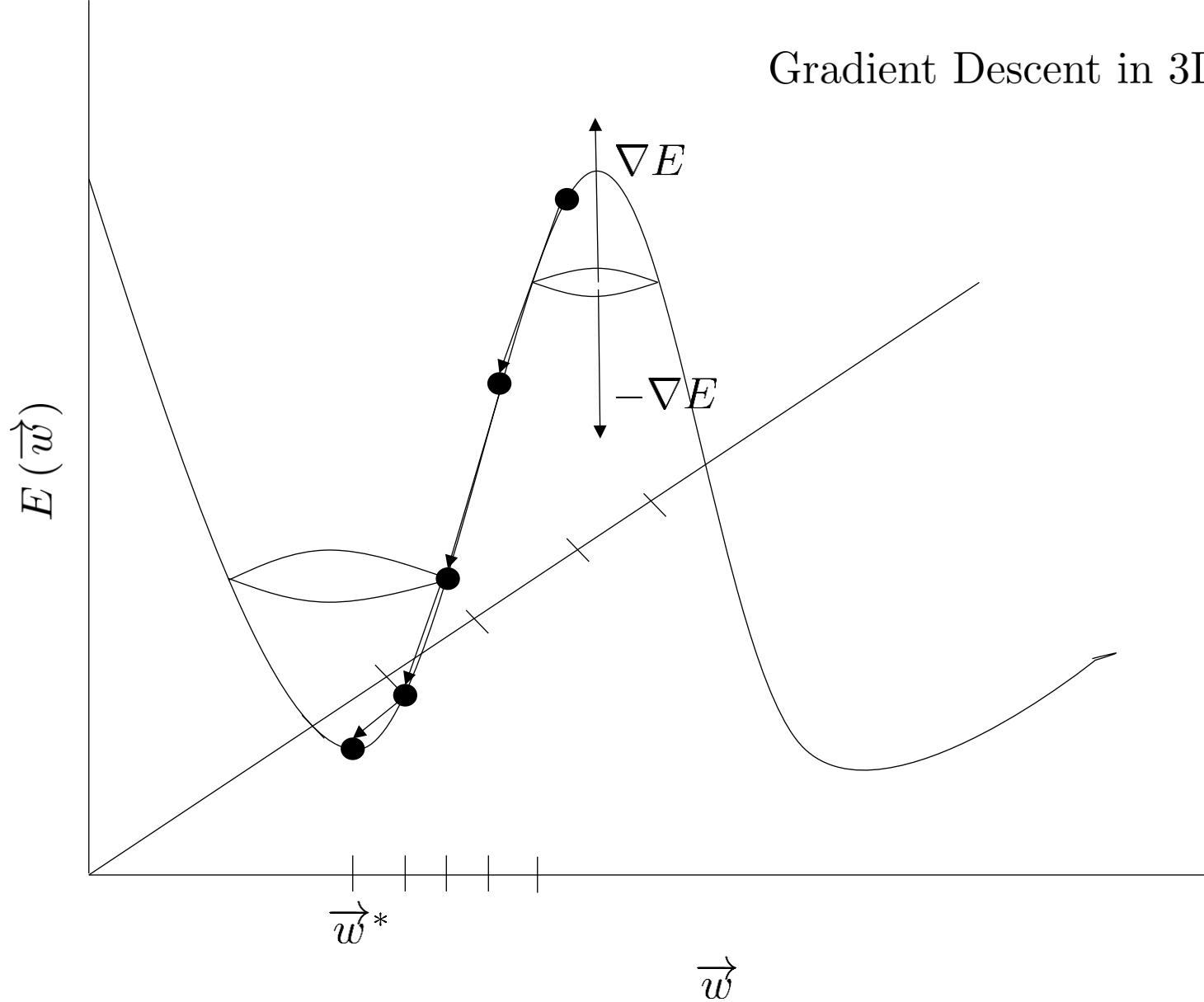


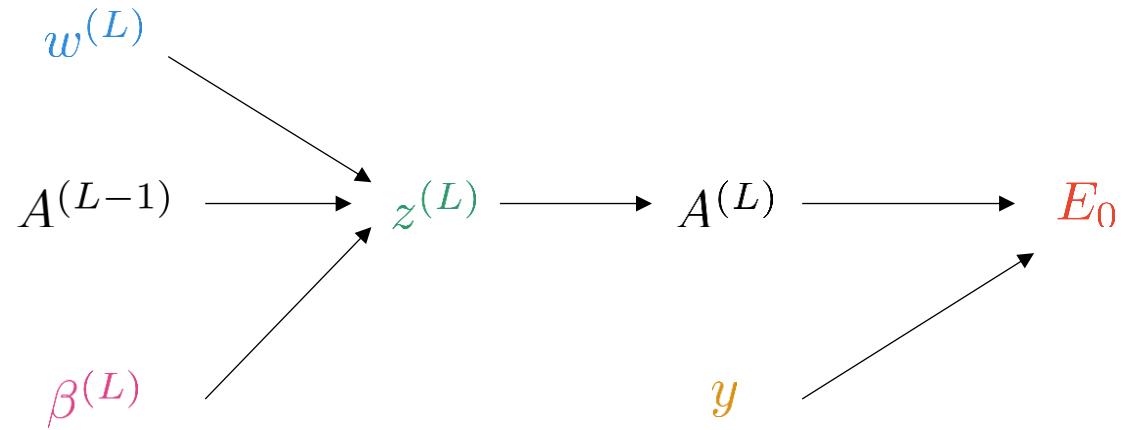
Neural Network: XOR Boolean

## Gradient Descent in 2D

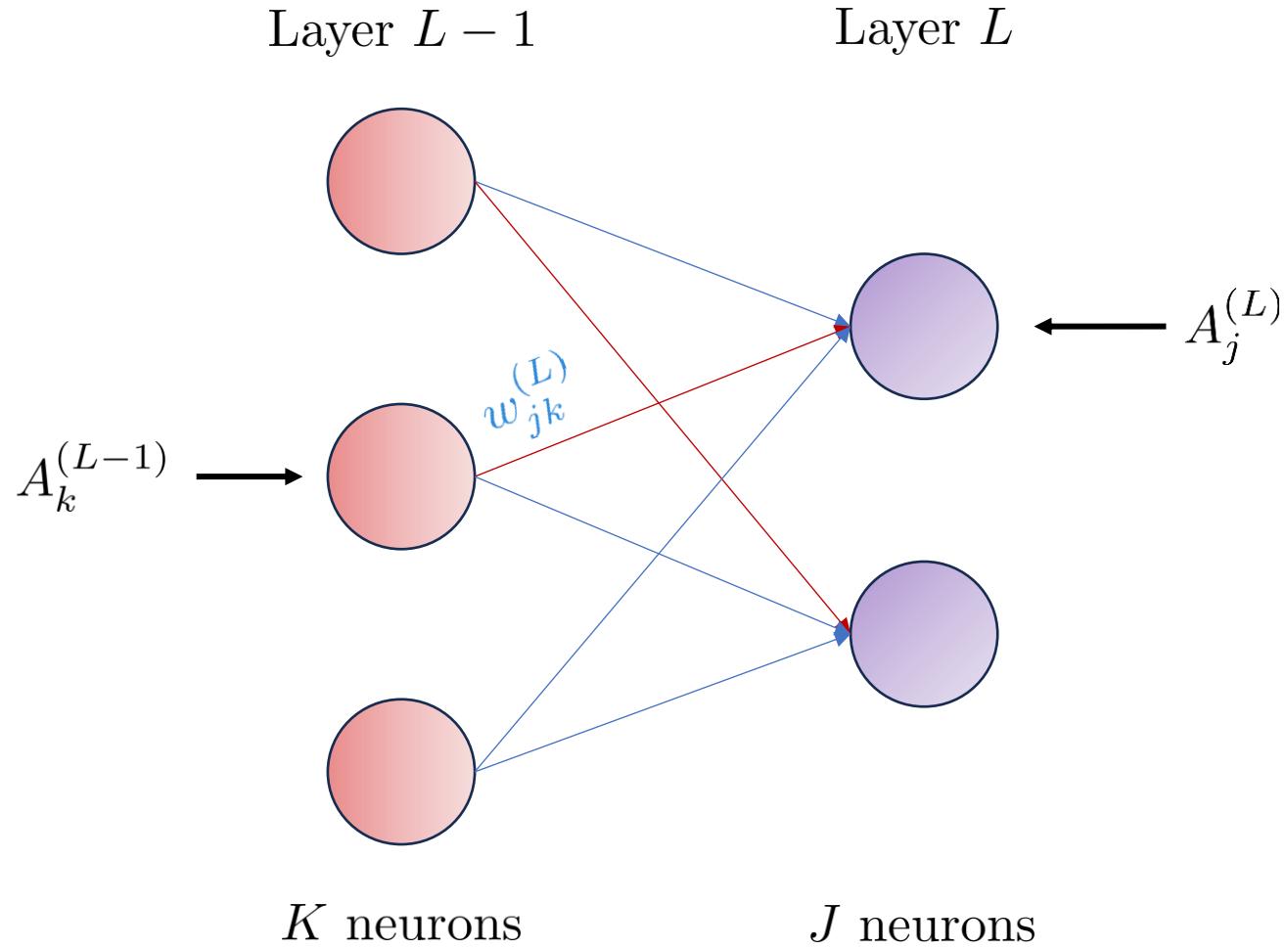


## Gradient Descent in 3D

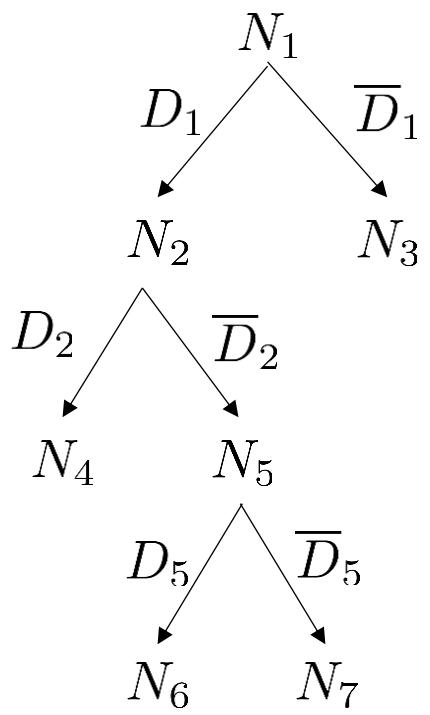




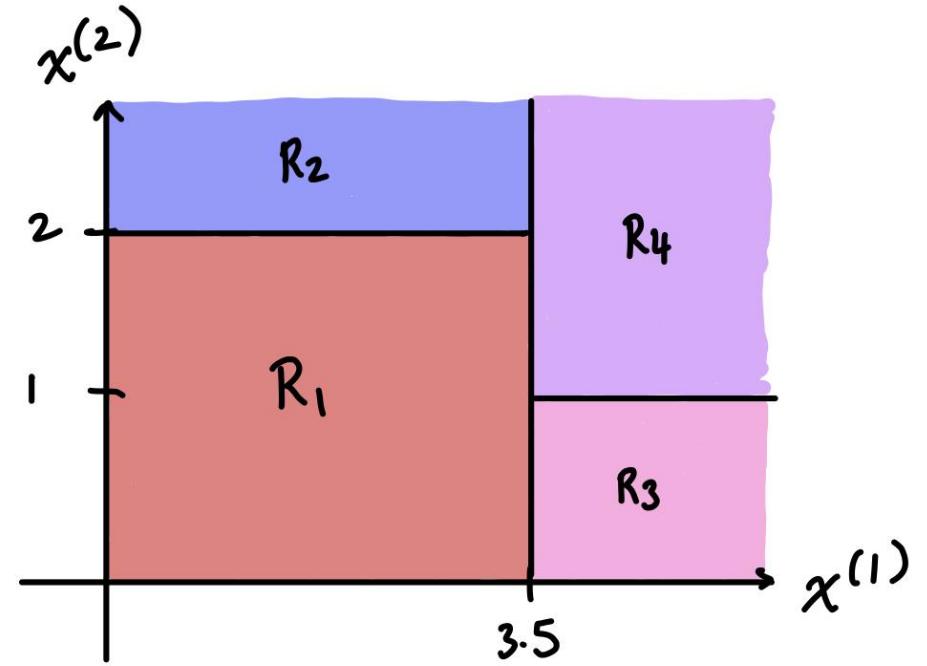
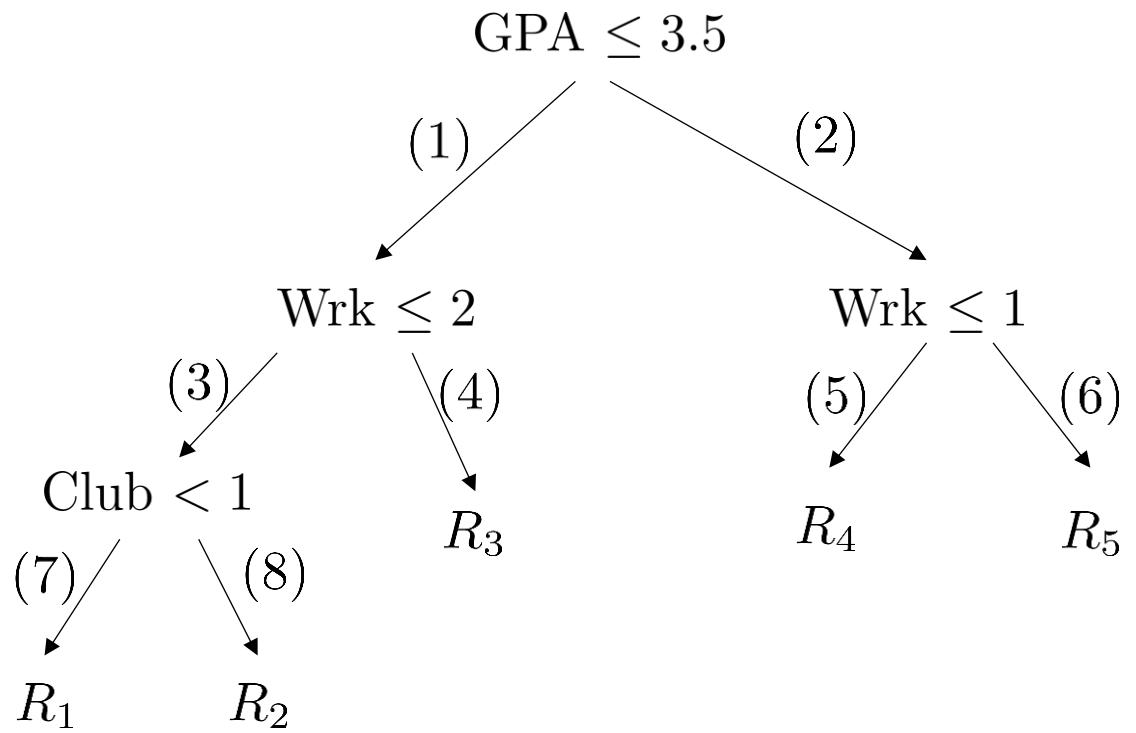
Backpropagation: Components of a Neural Network



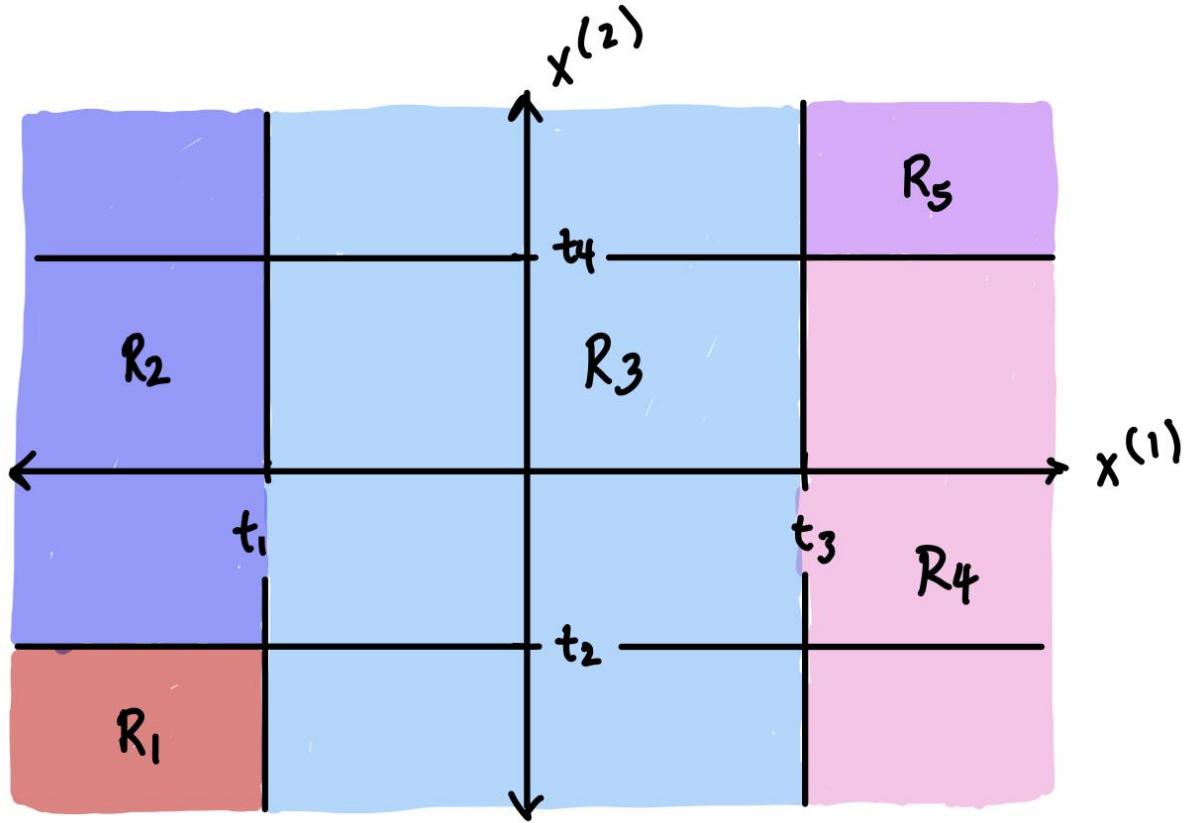
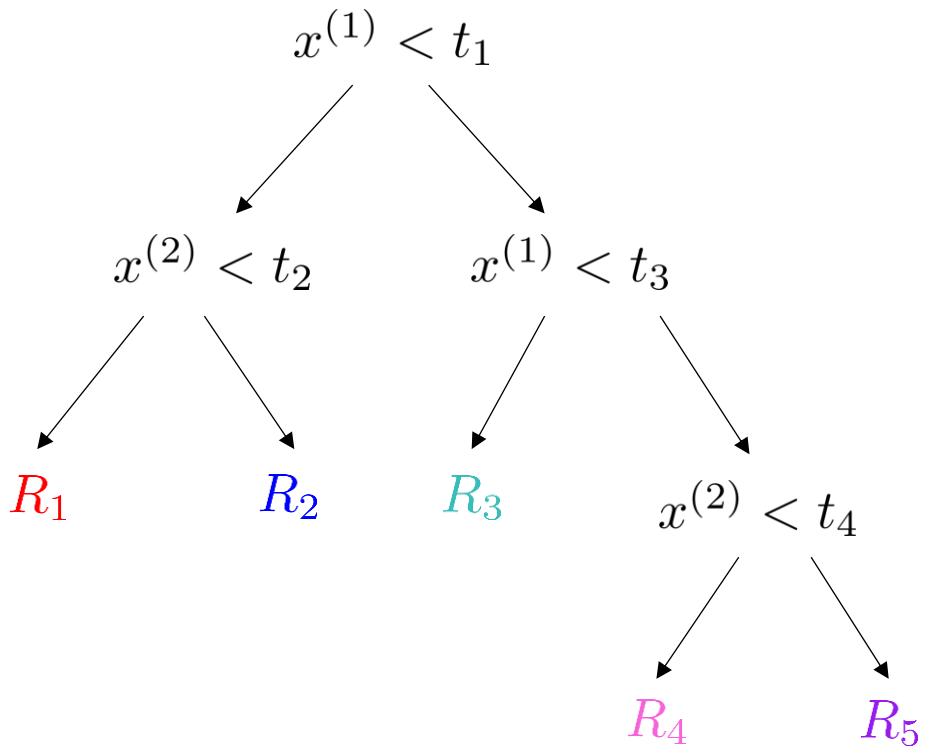
## Neural Network Notation with multiple neurons in each layer



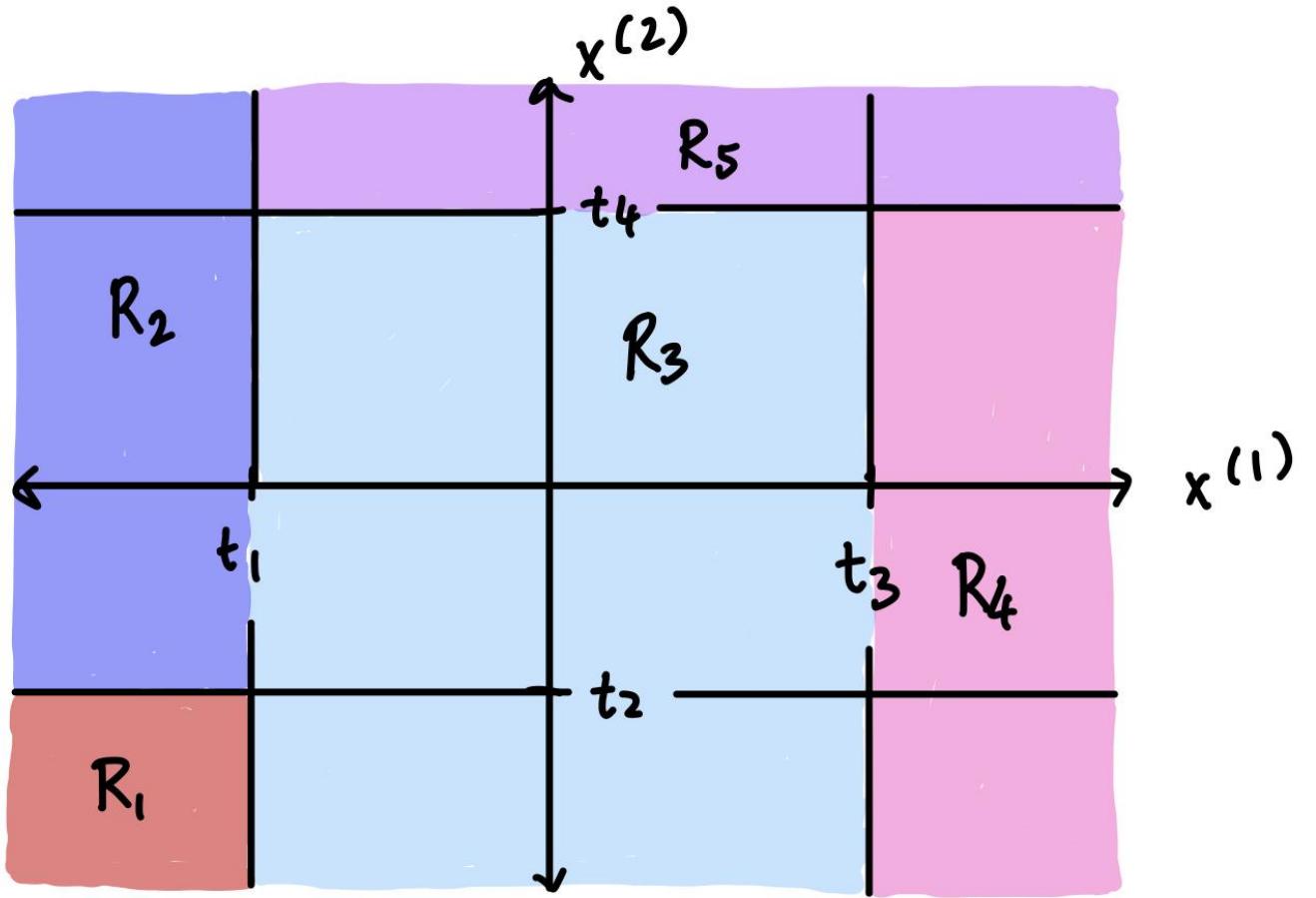
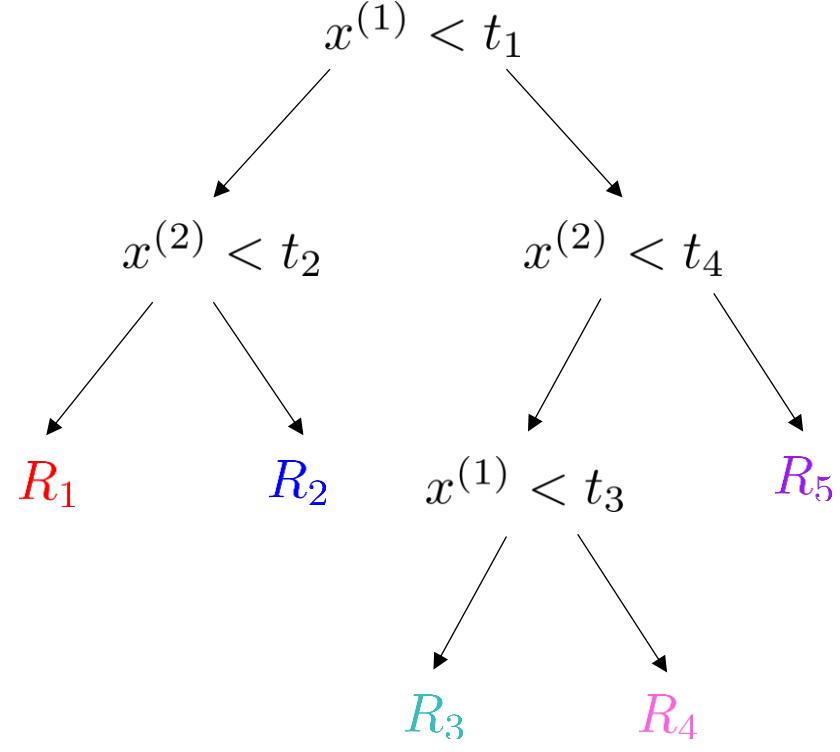
Layout of a Decision Tree

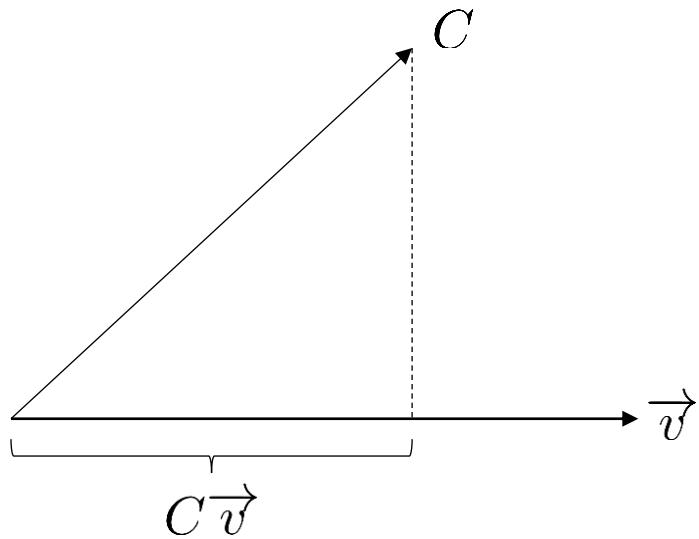


Grad School Decision Tree/Boundary

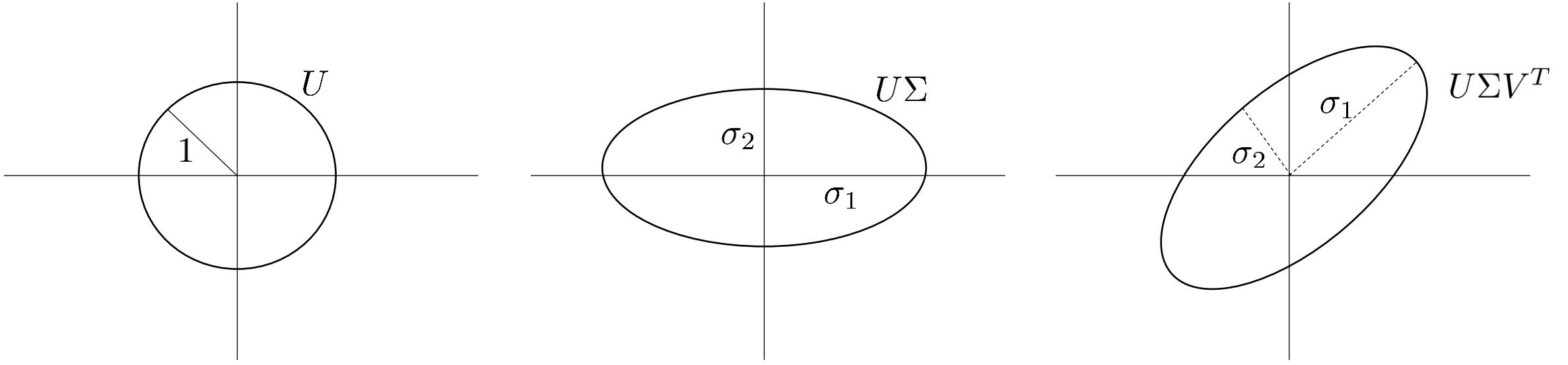


Decision Tree Permutation 1

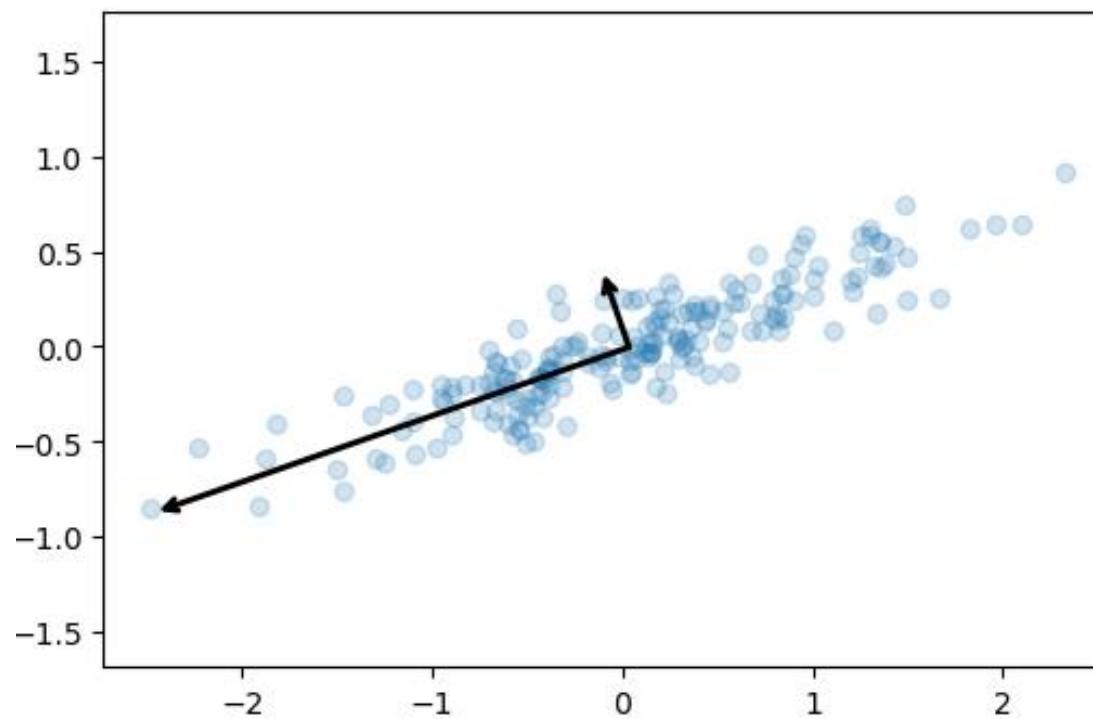




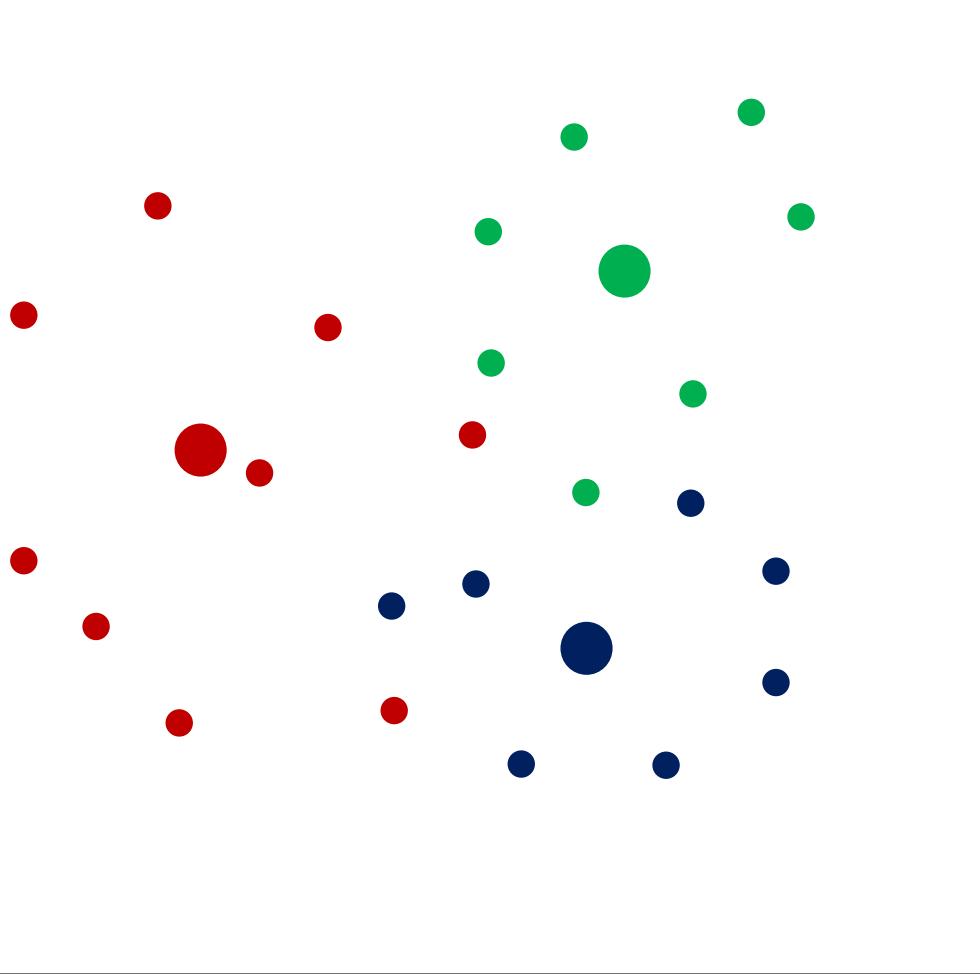
Projection onto a Vector



Visualizing SVD



PCA Visualization (See GitHub for Code)



*K-Means Iteration 1*

