



# Welcome!

GM **#3** | HHS CS

OH, HEY, YOU ORGANIZED  
OUR PHOTO ARCHIVE!

YEAH, I TRAINED A NEURAL  
NET TO SORT THE UNLABELED  
PHOTOS INTO CATEGORIES.

WHOA! NICE WORK!



ENGINEERING TIP:  
WHEN YOU DO A TASK BY HAND,  
YOU CAN TECHNICALLY SAY YOU  
TRAINED A NEURAL NET TO DO IT.

> **When do we meet?**

Every **Tuesday**

At lunch (**1:30-2:10**)

in **i5** (here!)

# Neural Networks


Single Layer Perceptrons  
Multilayer Perceptrons



## > Starting off with a Problem

**Problem:** Predict grade on (my Econ) test

*What is some data I could use to predict my score?*

▼ WWLB Quizzes			14 / 20
WWLB Quiz #1	8/28/23		B- 5 / 6 83%
WWLB Quiz #2	9/06/23		D- 4 / 8 50%
WWLB Quiz #3	9/11/23		B- 5 / 6 83%



## > Starting off with a Problem

**Target / Label:** Grade of Econ test

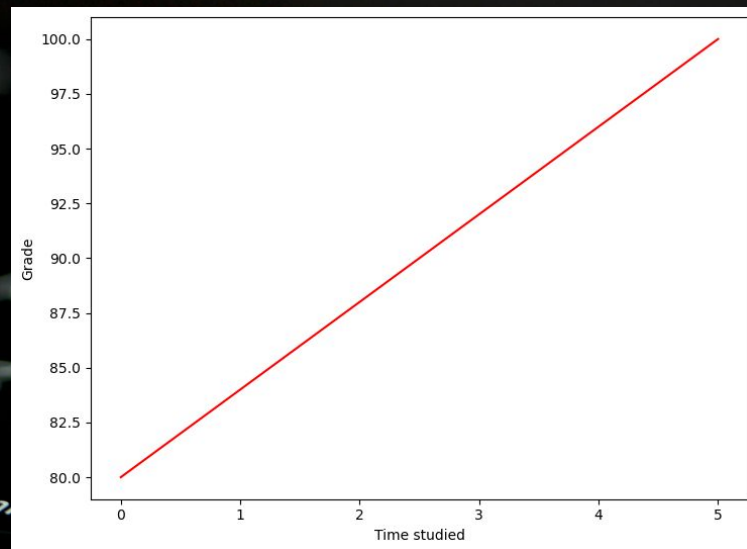
**Features / Covariates:** Time studied

## > The Model

**Target / Label:** Grade of Econ test

**Features / Covariates:** Time studied

$$\text{Grade} = w * \text{Time} + b$$



## > The Model

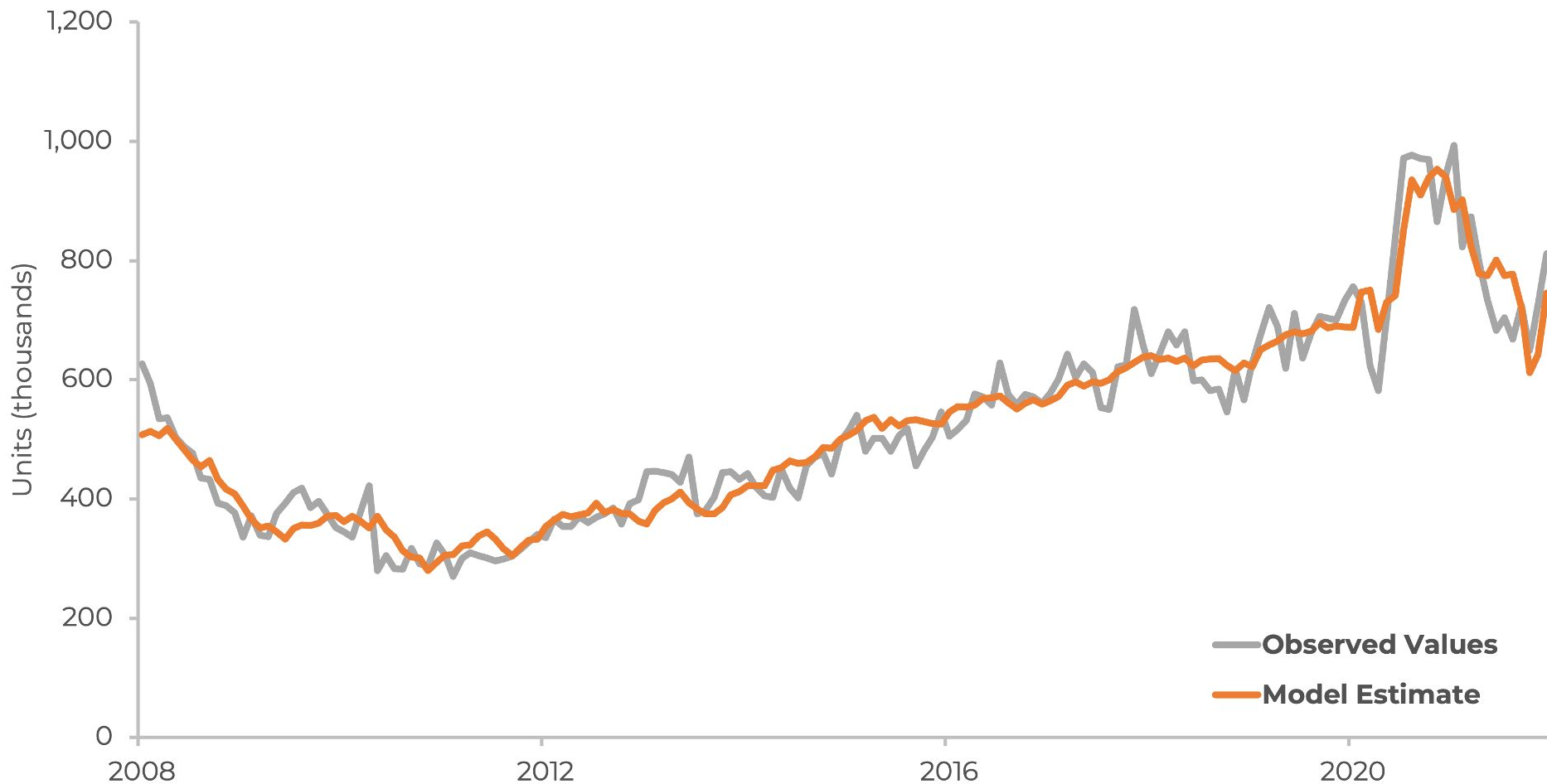
**Target:** Grade of Econ test

**Features:** Study time, current grade, sleep, constant

$$\text{Grade} = w_1 * \text{time} + w_2 * \text{cur\_grade} + w_3 * \text{sleep} + b$$



# Model Estimate: New Home Sales



## > The Model

**Target:** Grade of Econ test

**Features:** Study time, current grade, sleep, constant

$$\text{Grade} = w_1 * \text{time} + w_2 * \text{cur\_grade} + w_3 * \text{sleep} + b$$

## > The Model

**Target:** Grade of Econ test

**Features:** Study time, current grade, sleep, constant

$$\text{Grade} = w_1 * \text{time} + w_2 * \text{cur\_grade} + w_3 * \text{sleep} + w_4 * 1$$

## > The Model

**Target:** Grade of Econ test

**Features:** Study time, current grade, sleep, constant

$$\text{Grade} = [w_1, w_2, w_3, w_4] * [x_1, x_2, x_3, x_4]$$

## > The Model

**Target:** Grade of Econ test

**Features:** Study time, current grade, sleep, constant

$$\text{Grade} = \mathbf{w} * \mathbf{x}$$



## > The Model

**Target:** Grade of Econ test

**Features:** Study time, current grade, sleep, constant

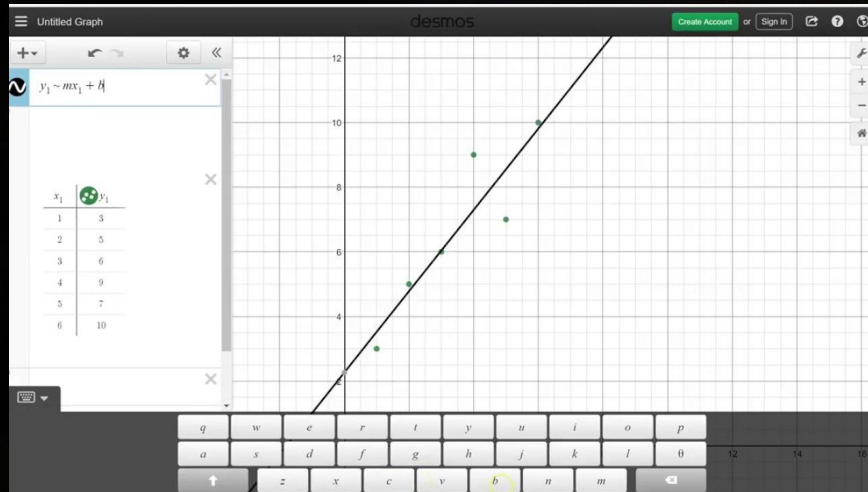
$$\text{Grade} = \mathbf{w} * \mathbf{x}$$

**Objective:** Using **data** to find the weights  $\mathbf{w}$

# > Regression

Labels => Arbitrary numerical values

*How much? How many?* questions

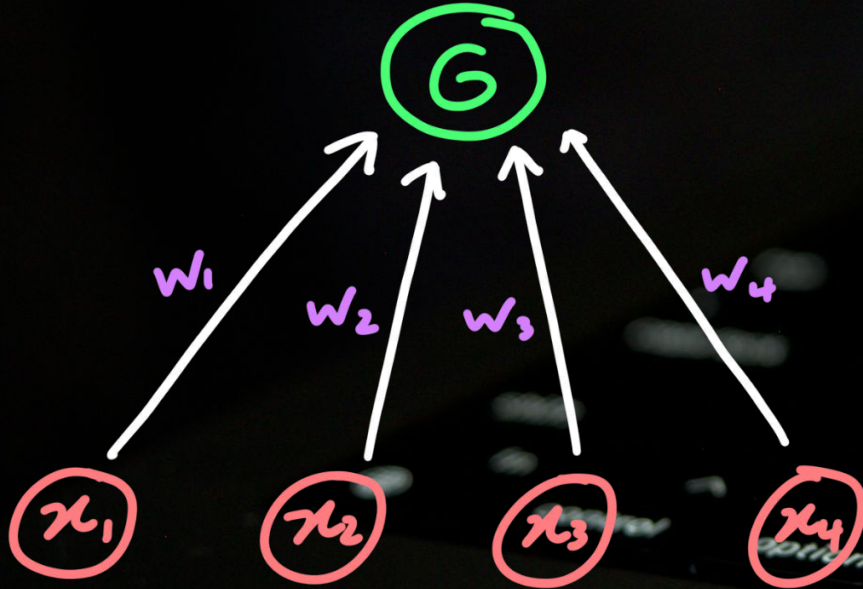


## > Regression Model

$$\text{Grade} = [w_1, w_2, w_3, w_4] * [x_1, x_2, x_3, x_4]$$

## > Linear Neural Network

$$\text{Grade} = [w_1, w_2, w_3, w_4] * [x_1, x_2, x_3, x_4]$$





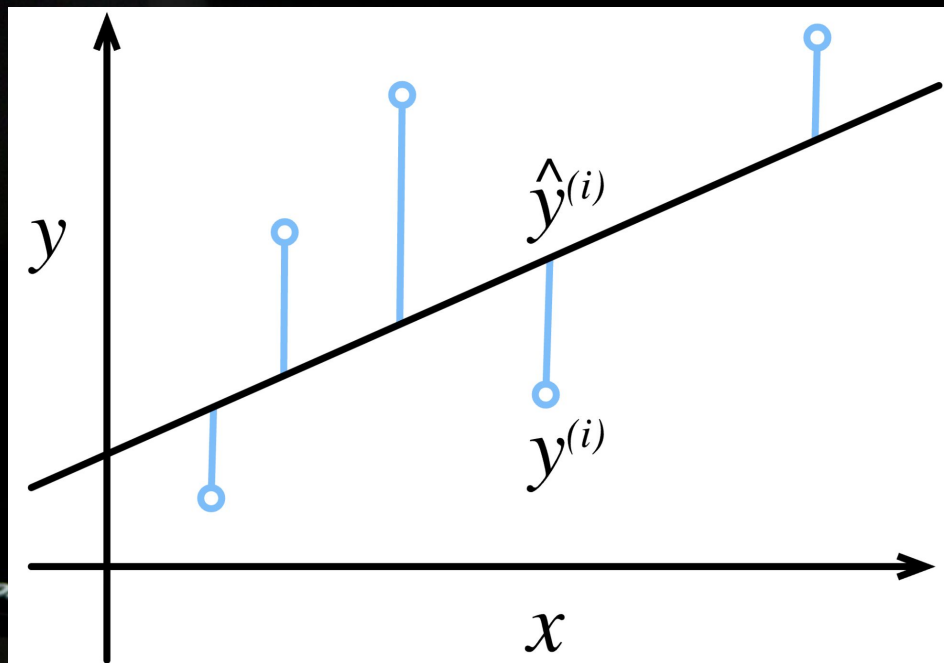
## > How do we find the weights?

Model fits data

- Minimize model error

### Loss Function

Mean Squared Error

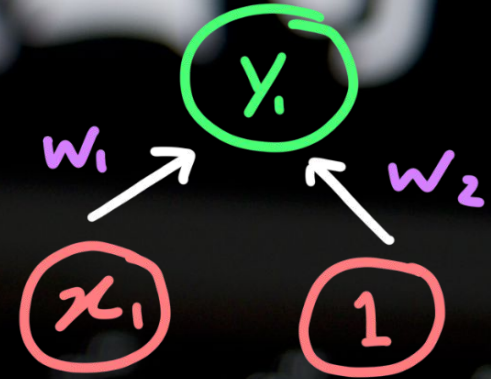




## > CoLab Activity 1

Link on Discord or [hhscs.club](https://hhscs.club)

Fit a regression model to the data



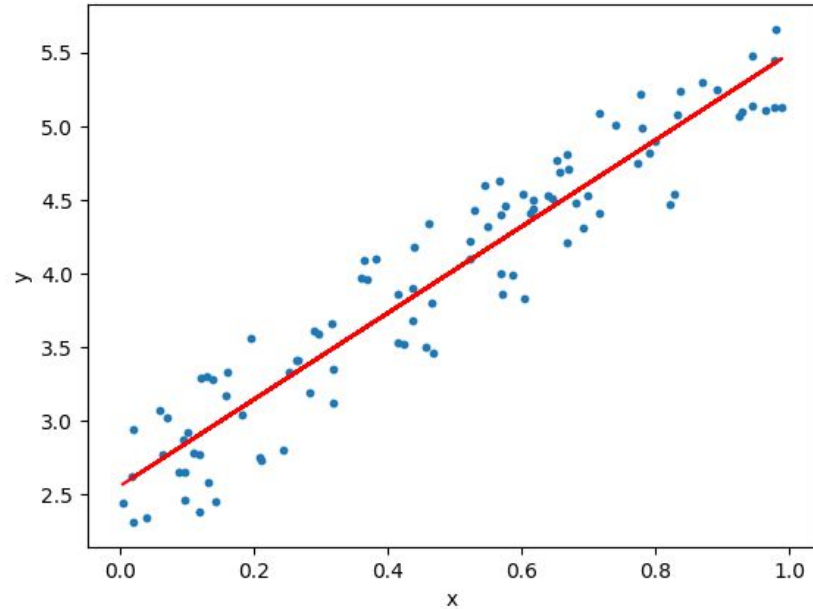
Usage:

**IF YOU WANT YOUR CODE/CHANGES TO BE SAVED,**

make sure you make a copy of the CoLab

Use your **personal** gmail account.

## > What were some limitations?



## > What were some limitations?

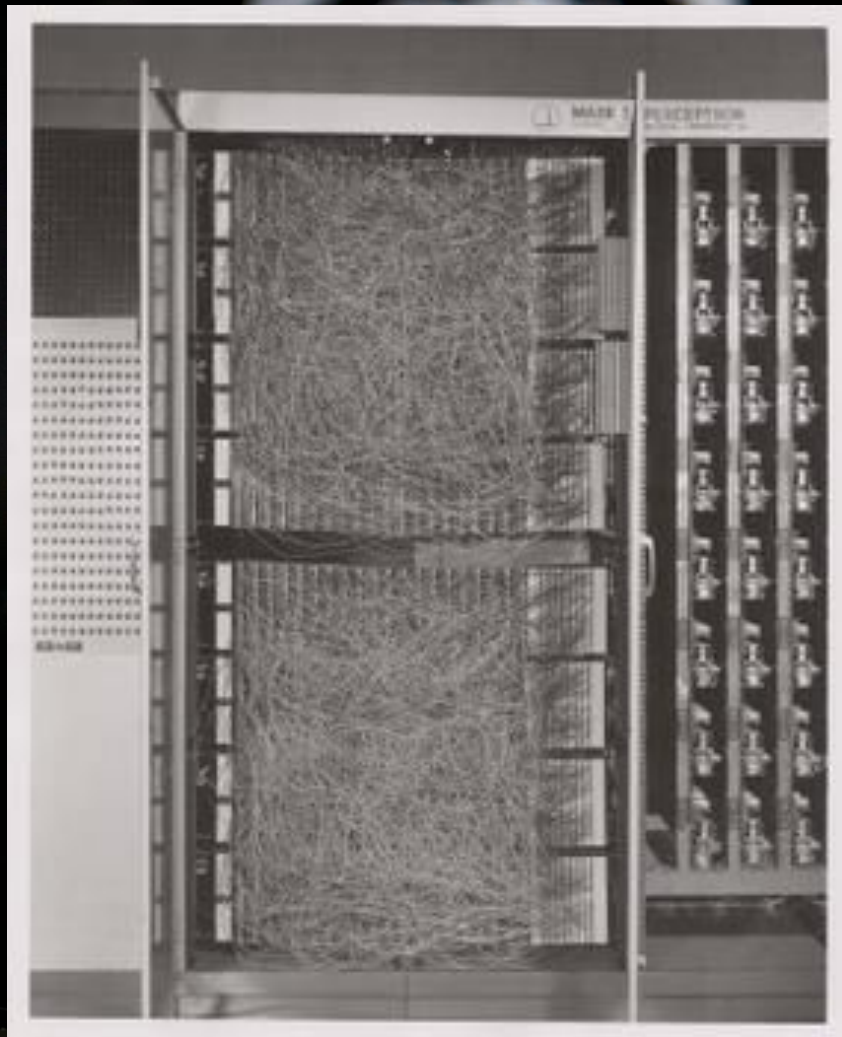
Function is Linear

Multilayer Perceptrons for Non-Linearity

# > Perceptron

Mark I Perceptron

1960

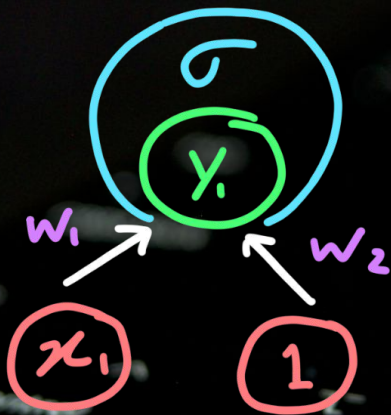




## > Perceptron

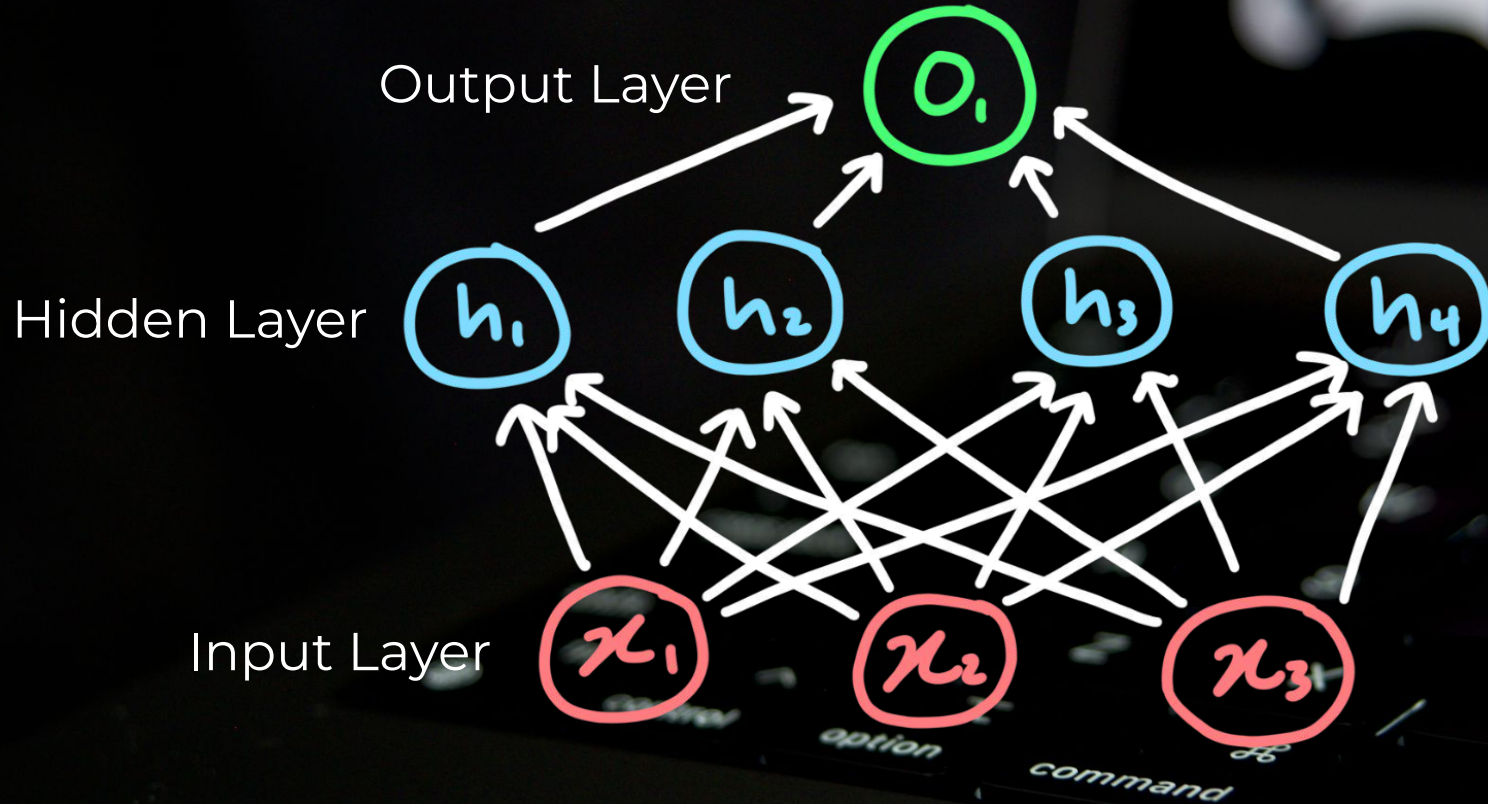
Linear NN with Activation Function  $\sigma$

$\sigma$  determines whether Neuron should “fire”

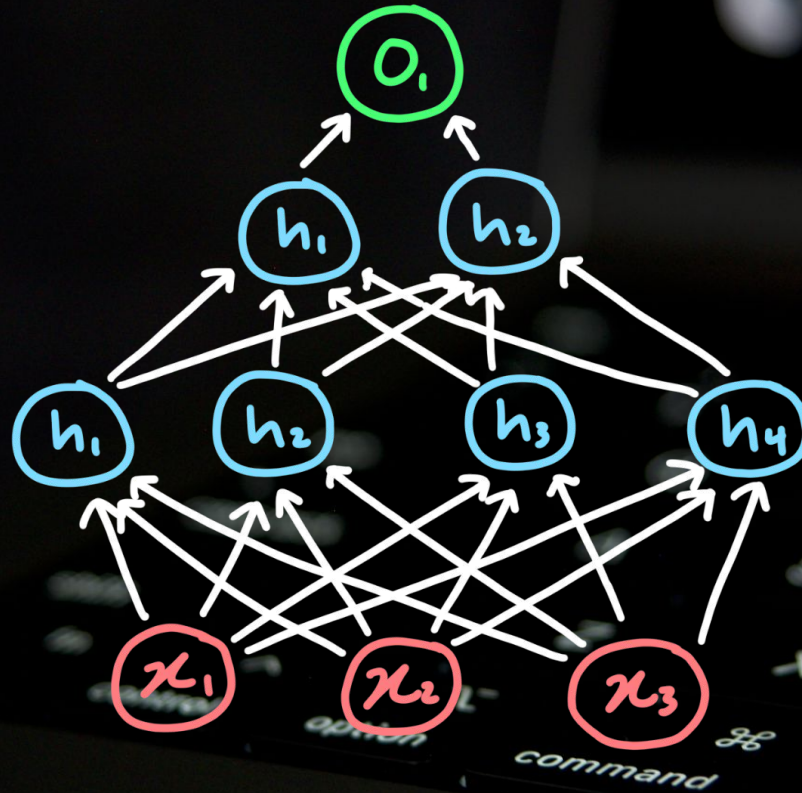




## > Multilayered Perceptrons



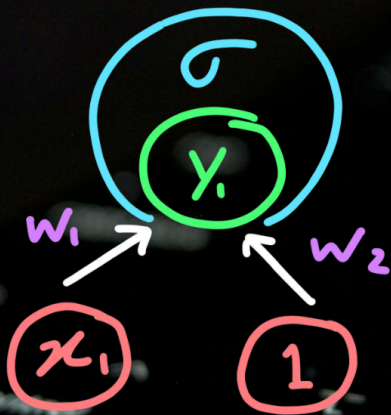
## > Multilayered Perceptrons



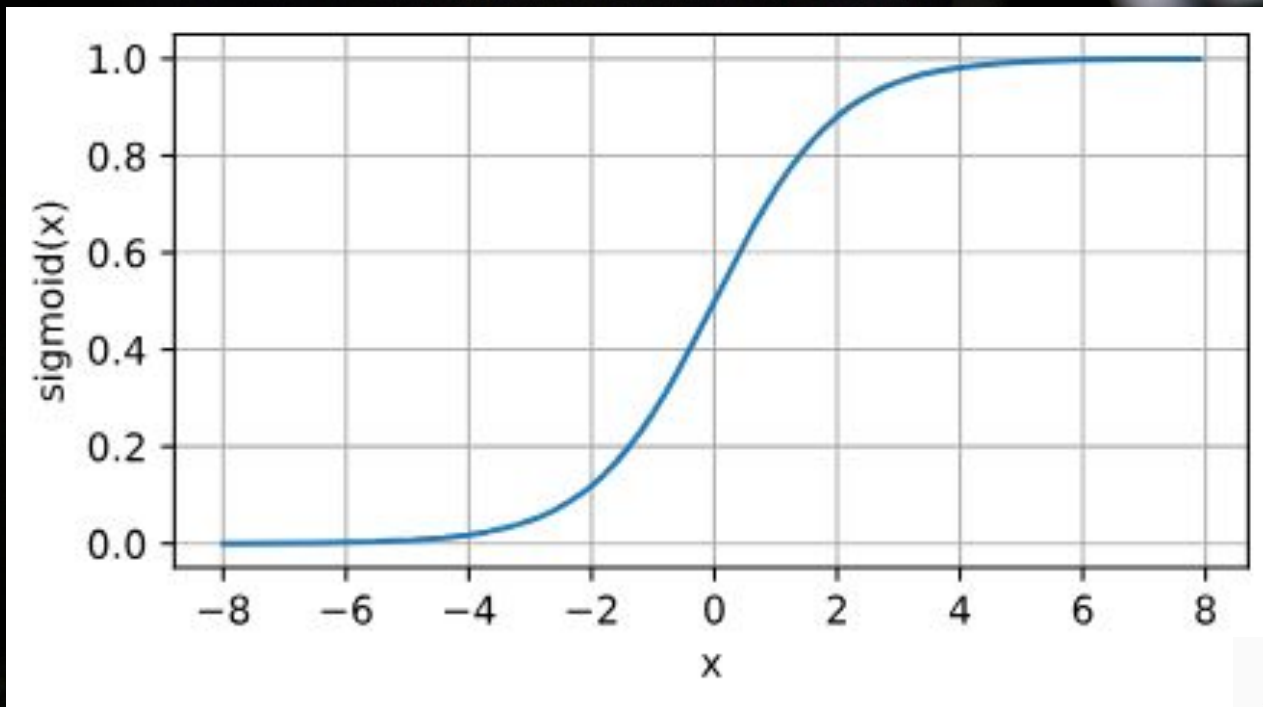
## > Perceptron

Linear NN with Activation Function  $\sigma$

$\sigma$  determines whether Neuron should “fire”



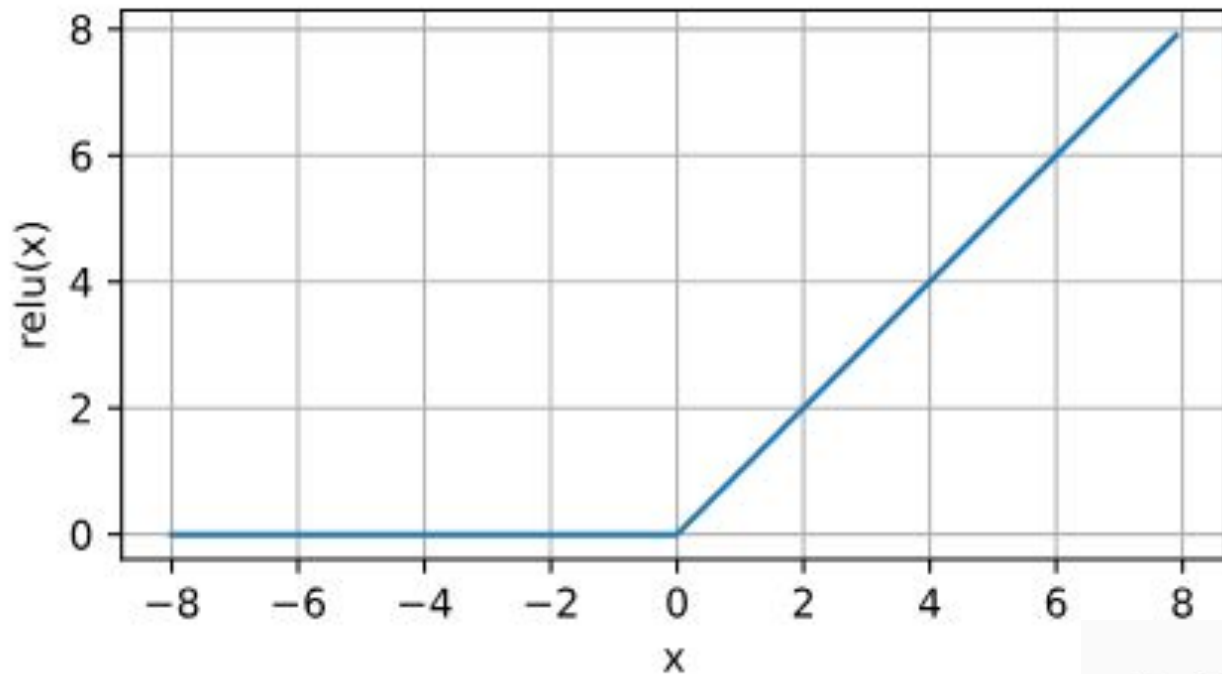
## > Activation Function: Sigmoid



$$\text{sigmoid}(x) = \frac{1}{1 + \exp(-x)}$$



## > Activation Function: ReLU



$$\text{ReLU}(x) = \max(x, 0).$$



## > CoLab Activity 2

**Link on Discord or hhscs.club**

Fit a regression model to the data

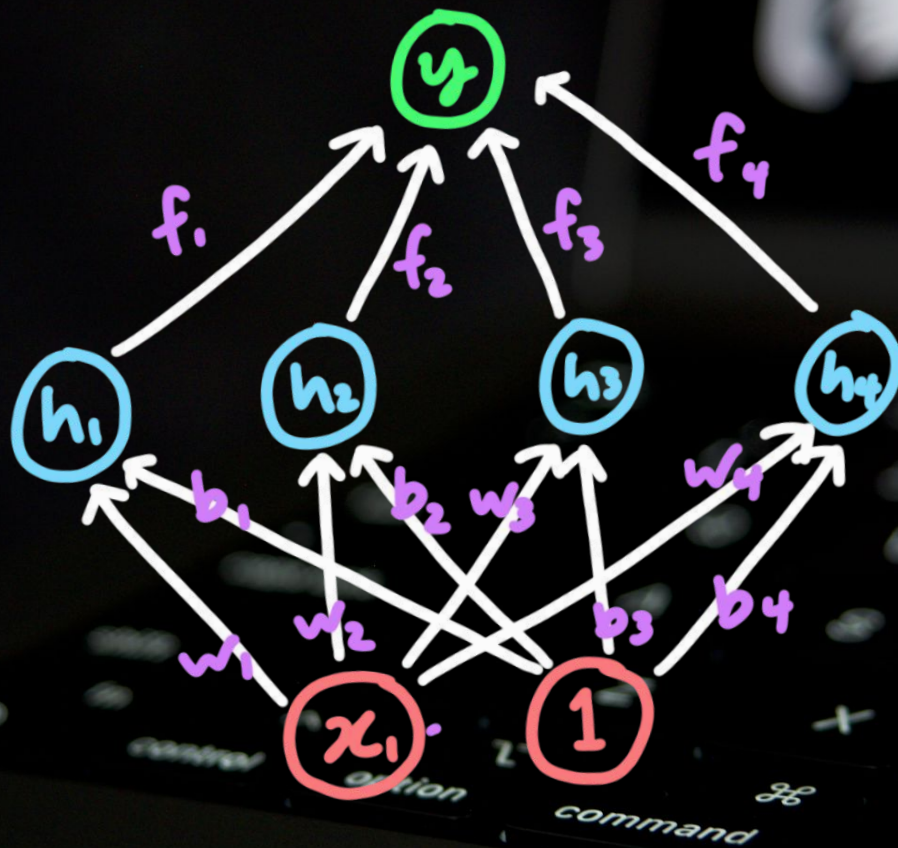
**Usage:**

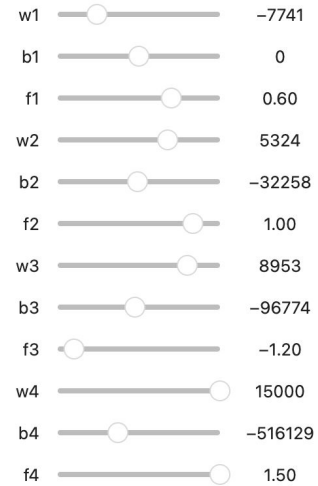
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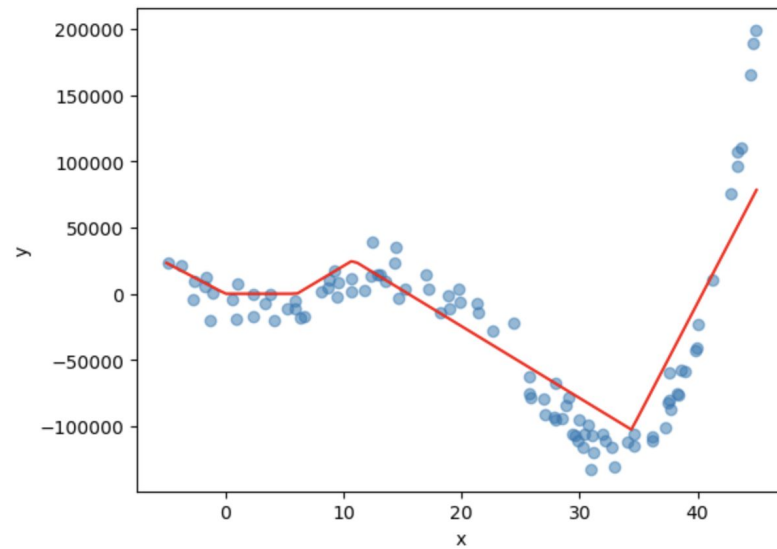
Use your **personal** gmail account.

## > MLP Structure





Mean Squared Error = 0.00



## > Socials

**Website:** [hhscs.club](https://hhscs.club)

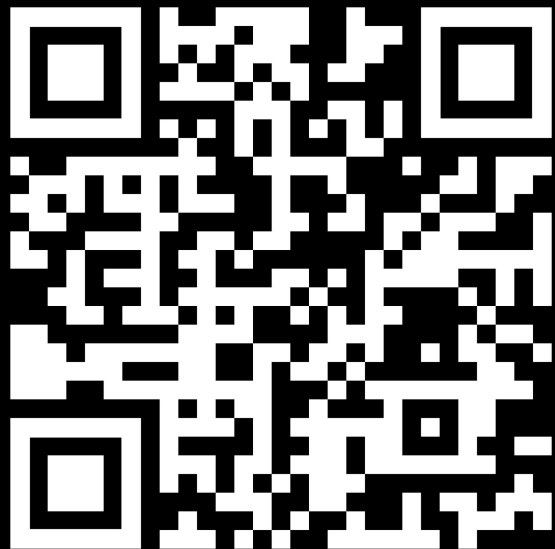
**Email List:**



**Insta:**

**@hhscomputerscience**

**Discord:**





Next Meeting:  
Tuesday (9/26) Lunch