Modelos de Clasificación

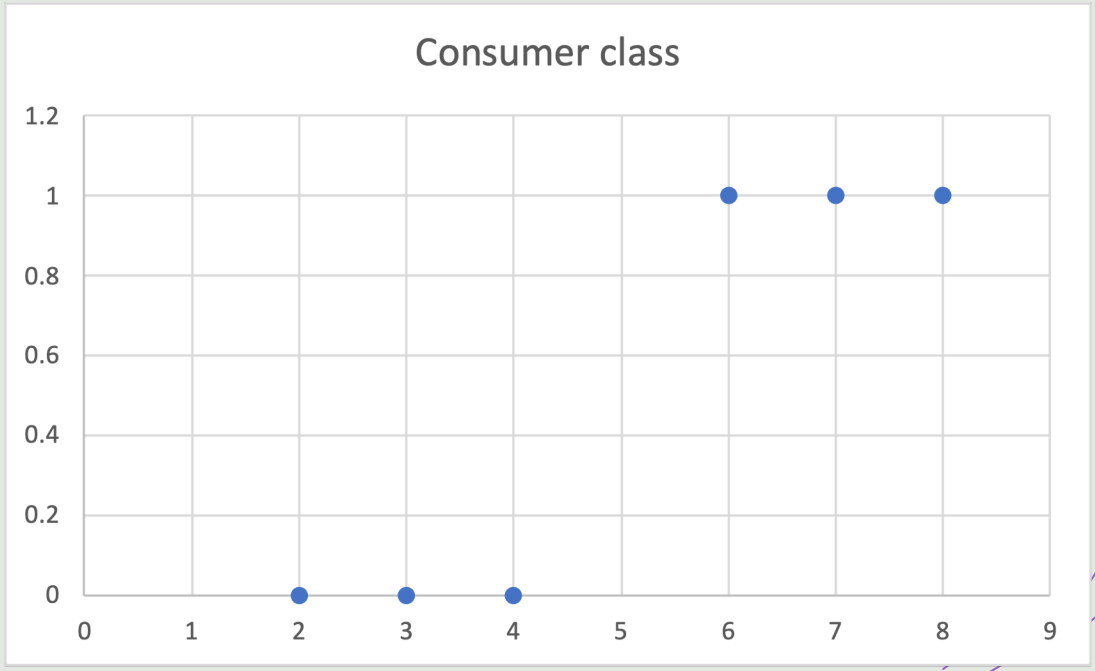
Regresión Logística

TC3006C

Linear regression?

+With the following data use linear regression

CPUs	Consumer Class
2	0
3	0
4	0
6	1
7	1
8	1



Linear regression?...

Can your model correctly predict the Consumer Class when we have 5 CPUs?

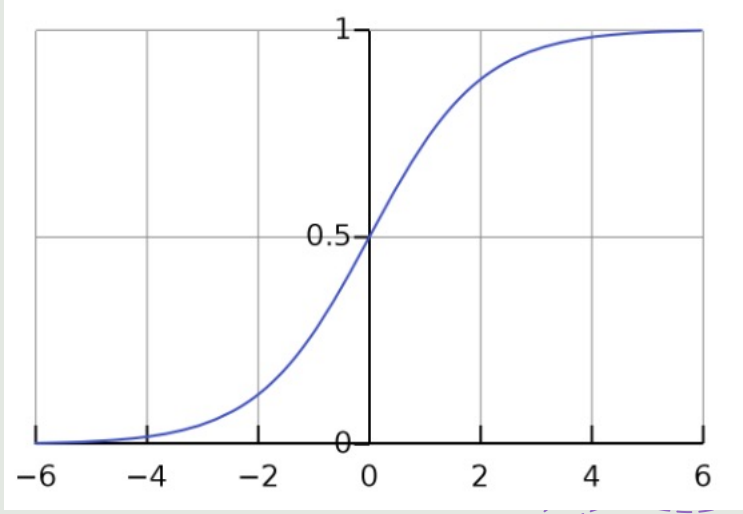
Logistic Regression

Sigmoid function

- Data cannot be linearly separated

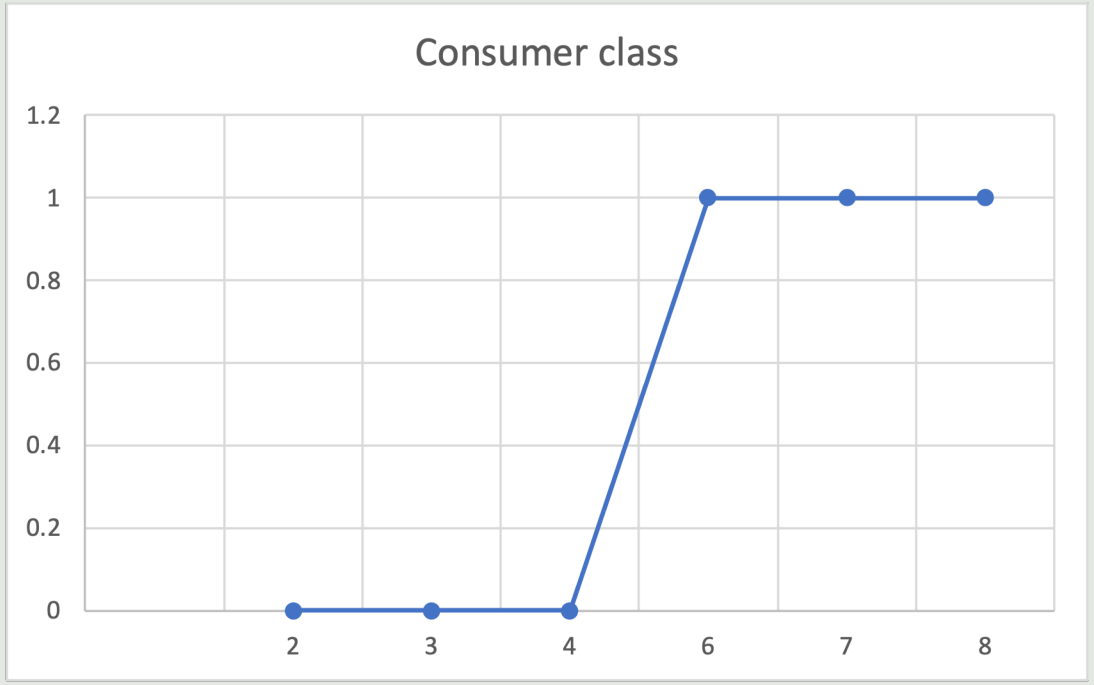
- A non-linear transformation is needed to fit data

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

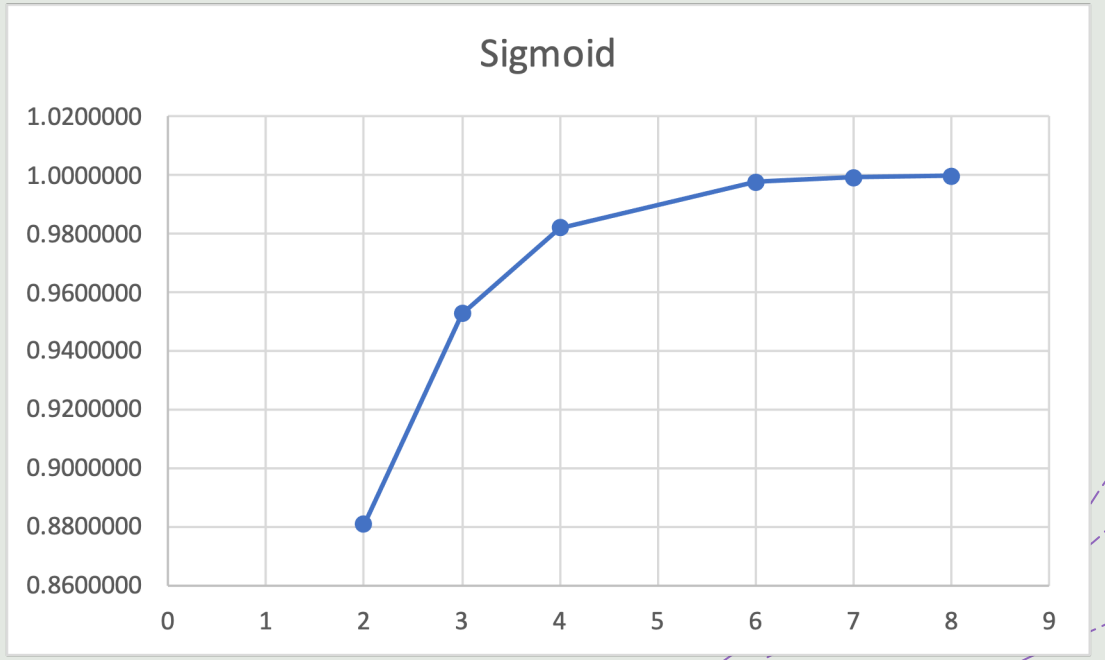


How to use the sigmoid function?

We want

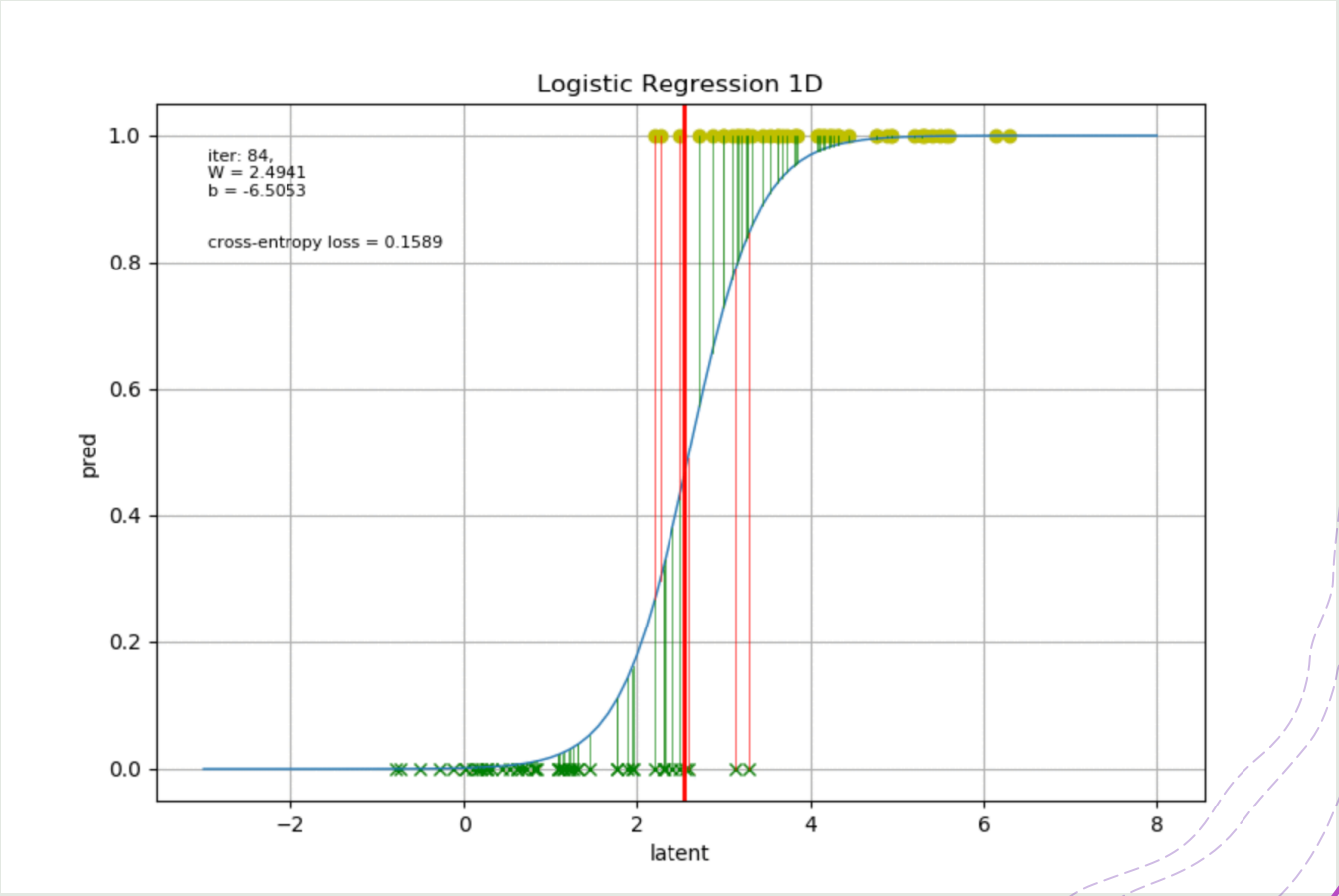


We get



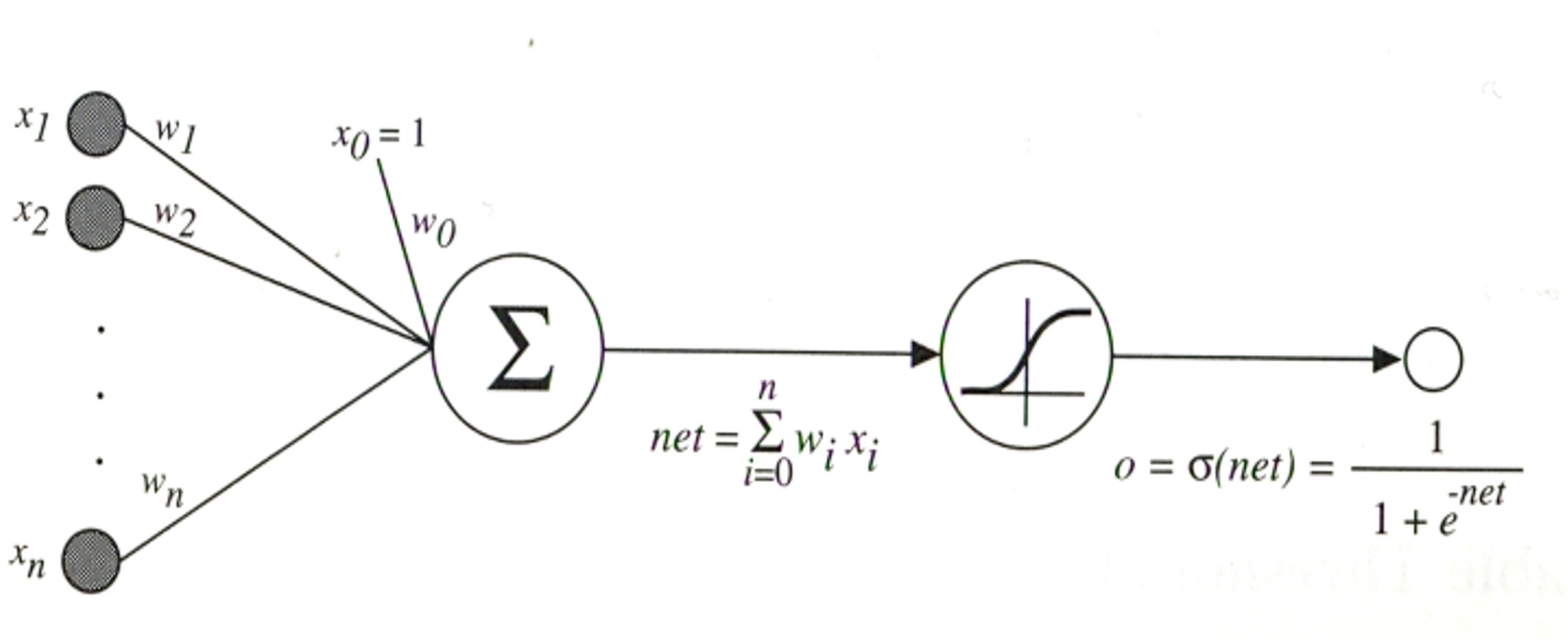
Logistic Regression

- Type of Supervised Learning
- Method that allows us to discriminate (classify) between 2 classes
- Predicts the probability of a binay event occuring
- Basis for neural networks



Animation

Logistic Regression…



Class example

- Data

CPUs	Consumer Class
2	0
3	0
4	0
6	1
7	1
8	1

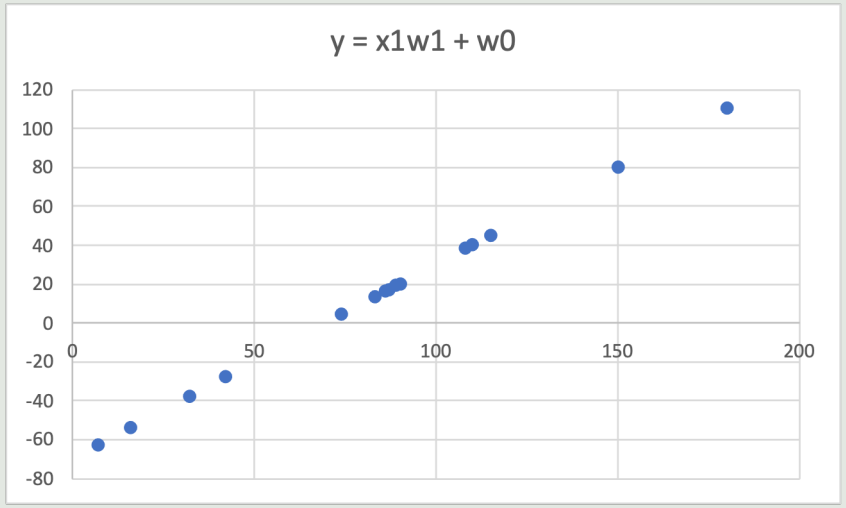
- Draw the logistic regression model
- Make a manual run of logistic regression

Class exercise

- Make a manual run of logistic regression for this data
- Use the following model
  - y = **w1***x1 + **w0**
  - Did you get **w1** is **1** and **w0** is **-70** ?

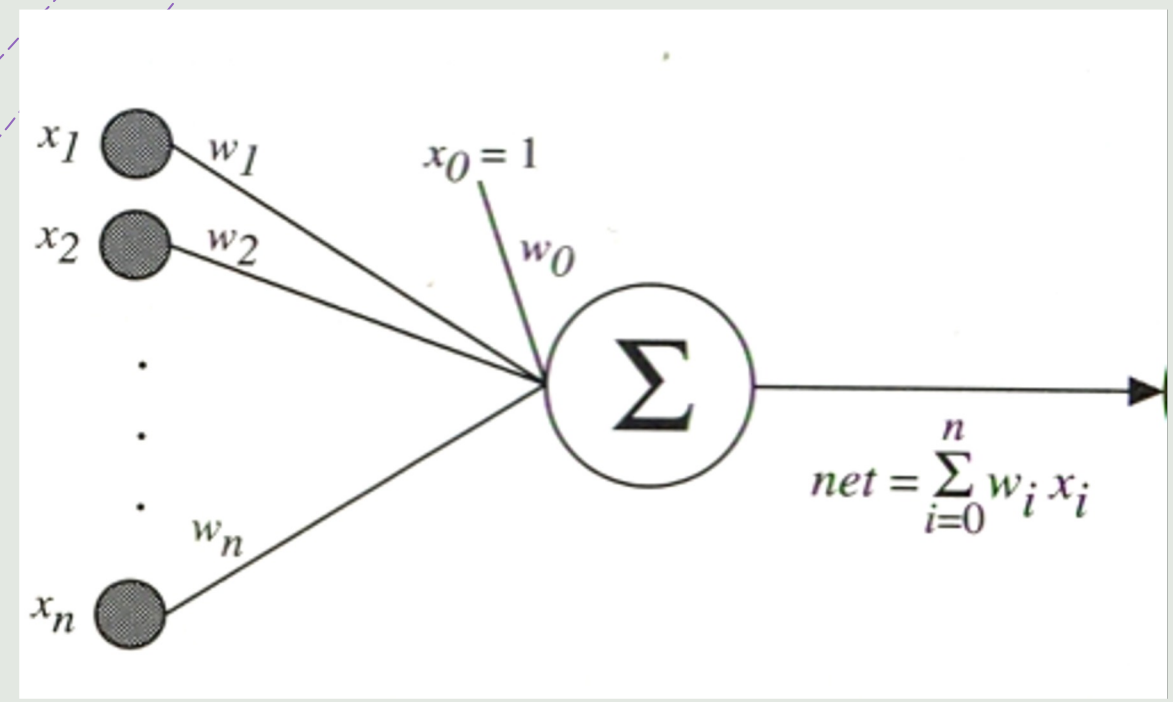
Score Exam	Passed
90	1
89	1
16	0
87	1
86	1
42	0
74	1
83	1
32	0
7	0
110	1
108	1
115	1
180	1
150	1

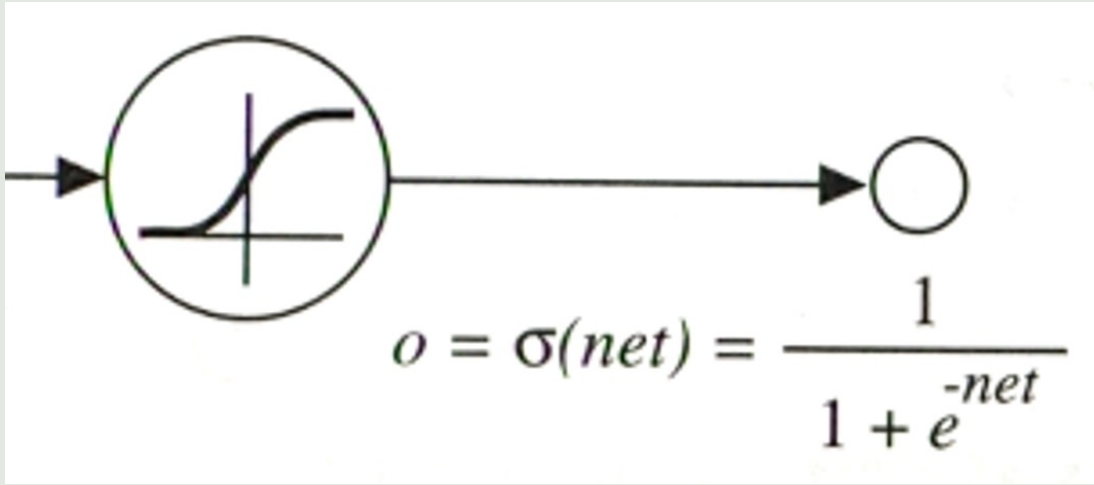
Class exercise…



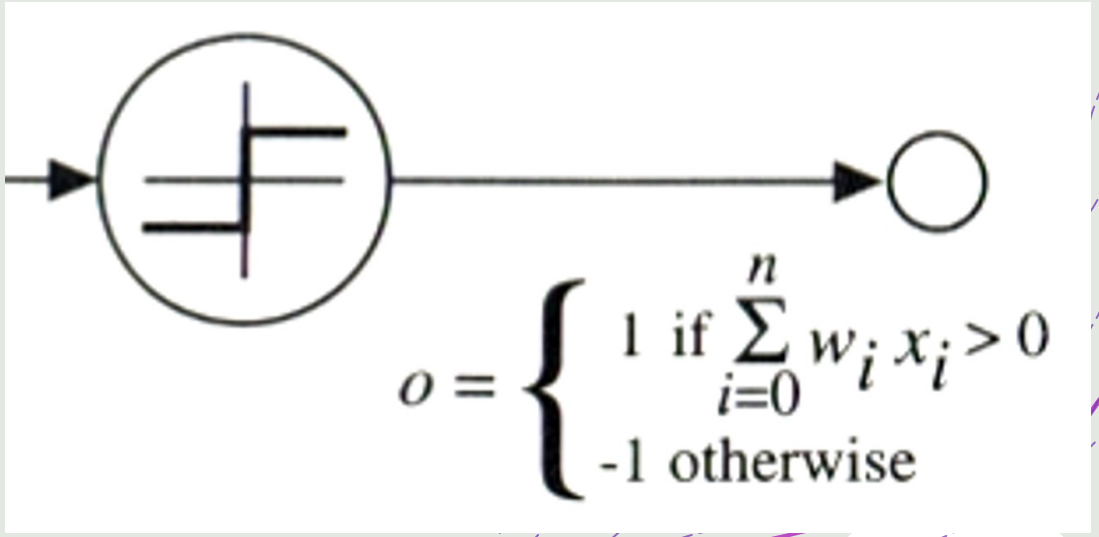
		w1	1	
		w0	-70	
Score Exam	**Passed**	**y = x1w1 + w0**	**Sigmoid**	**Error**
90	1	20	1.00	0.0000000
89	1	19	1.00	0.0000000
16	0	-54	0.00	0.0000000
87	1	17	1.00	0.0000000
86	1	16	1.00	0.0000001
42	0	-28	0.00	0.0000000
74	1	4	0.98	0.0179862
83	1	13	1.00	0.0000023
32	0	-38	0.00	0.0000000
7	0	-63	0.00	0.0000000
110	1	40	1.00	0.0000000
108	1	38	1.00	0.0000000
115	1	45	1.00	0.0000000
180	1	110	1.00	0.0000000
150	1	80	1.00	0.0000000

Activation functions





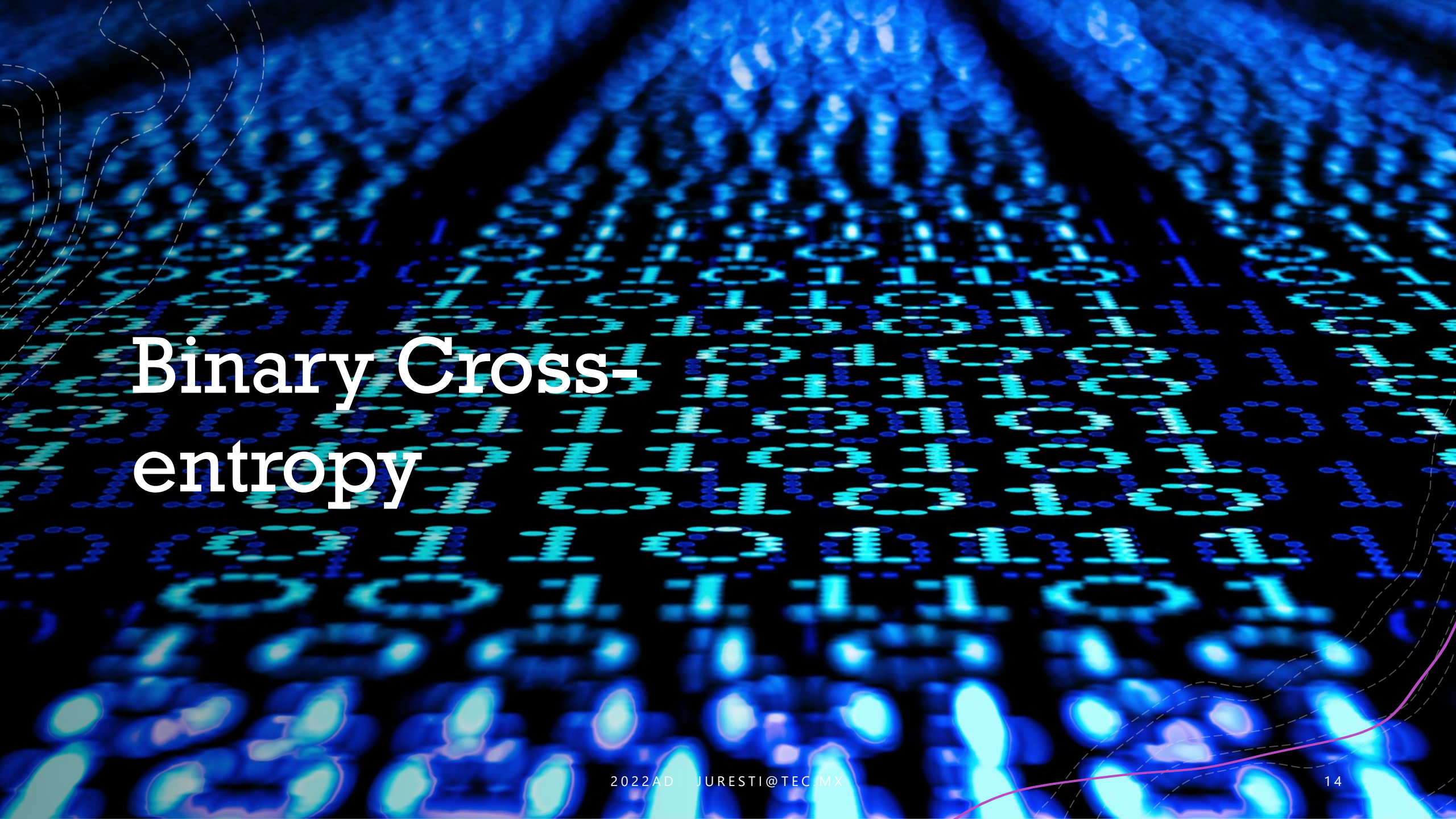
Sigmoidal



Sign

How do we get the correct parameters?

- Parameters of the Net part must be decided for a correct classification
- Parameters can be manually defined
- A training algorithm would need loss function
- MSE measures difference between real numbers
- Logistic regression is used for binary classes (discrete values)
  - Which loss function?



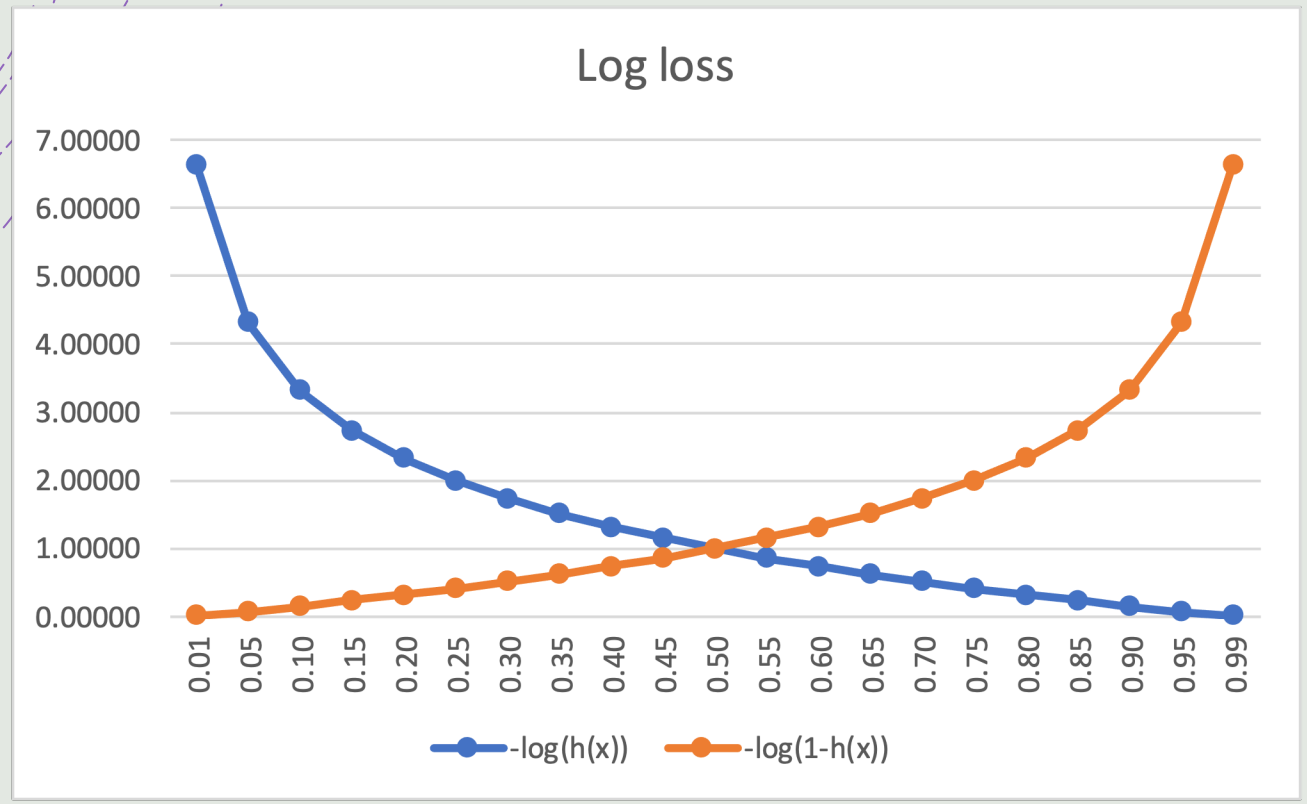
Binary Cross-entropy

Binary Cross-entropy (logistic loss/log loss)

- Loss/cost function usually used in binary classification
- Based on the idea of information theory entropy
- Measures the difference between two probability distributions for a given random variable/set of events

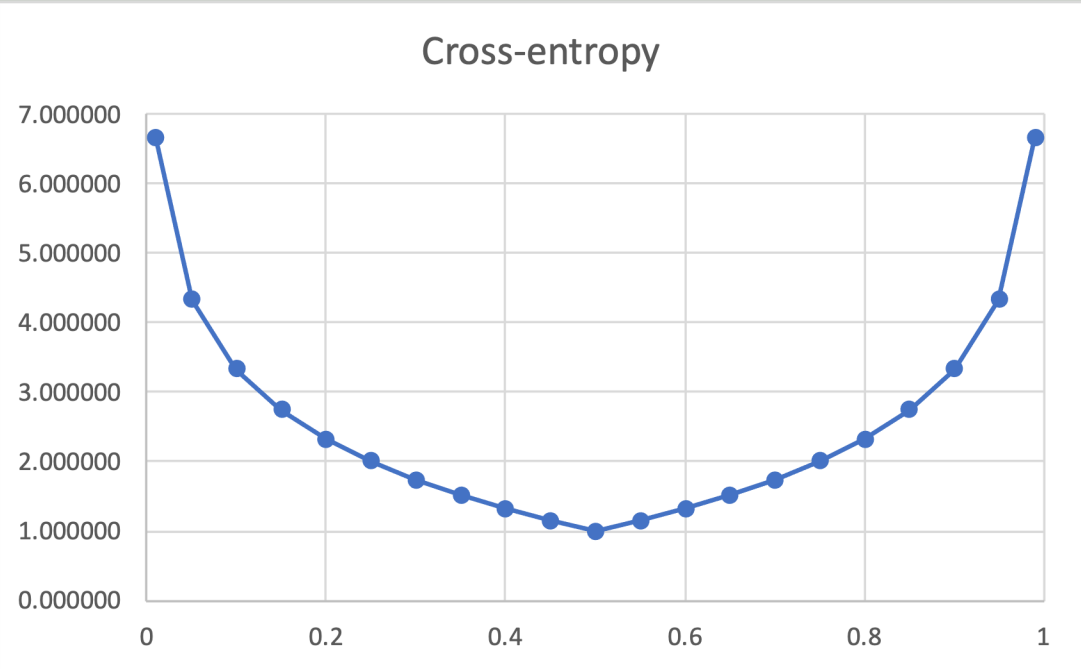
$$H_p(q) = -\frac{1}{N}\sum_{i=1}^{N} y_i \cdot log(p(y_i)) + (1 - y_i) \cdot log(1 - p(y_i))$$

Log loss



h(x)	-log(h(x))	-log(1-h(x))
0.01	6.64386	0.01450
0.05	4.32193	0.07400
0.10	3.32193	0.15200
0.15	2.73697	0.23447
0.20	2.32193	0.32193
0.25	2.00000	0.41504
0.30	1.73697	0.51457
0.35	1.51457	0.62149
0.40	1.32193	0.73697
0.45	1.15200	0.86250
0.50	1.00000	1.00000
0.55	0.86250	1.15200
0.60	0.73697	1.32193
0.65	0.62149	1.51457
0.70	0.51457	1.73697
0.75	0.41504	2.00000
0.80	0.32193	2.32193
0.85	0.23447	2.73697
0.90	0.15200	3.32193
0.95	0.07400	4.32193
0.99	0.01450	6.64386

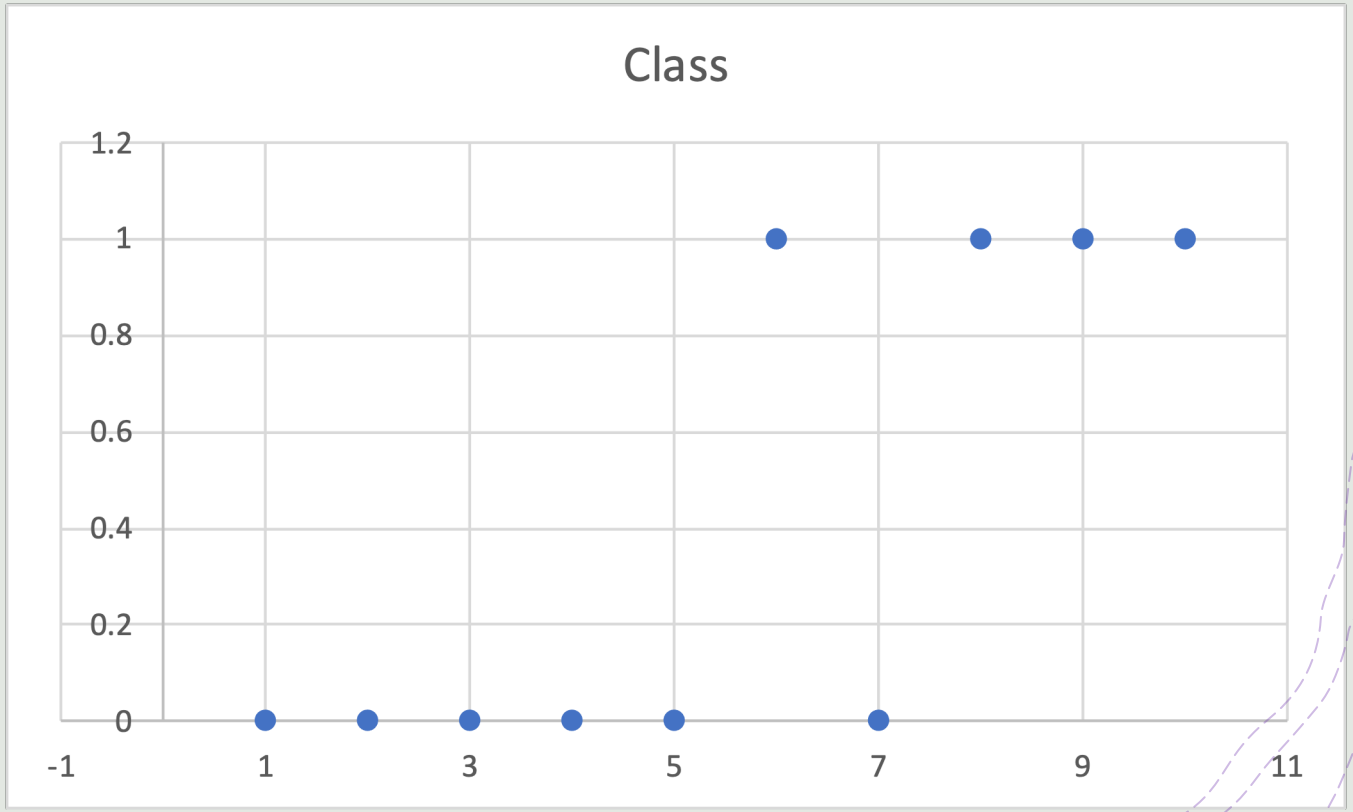
Both distributions



h(x)	Cross-entropy
0.01	6.643856
0.05	4.321928
0.10	3.321928
0.15	2.736966
0.20	2.321928
0.25	2.000000
0.30	1.736966
0.35	1.514573
0.40	1.321928
0.45	1.152003
0.50	1.000000
0.55	1.152003
0.60	1.321928
0.65	1.514573
0.70	1.736966
0.75	2.000000
0.80	2.321928
0.85	2.736966
0.90	3.321928
0.95	4.321928
0.99	6.643856

How does it work with logistic regression?

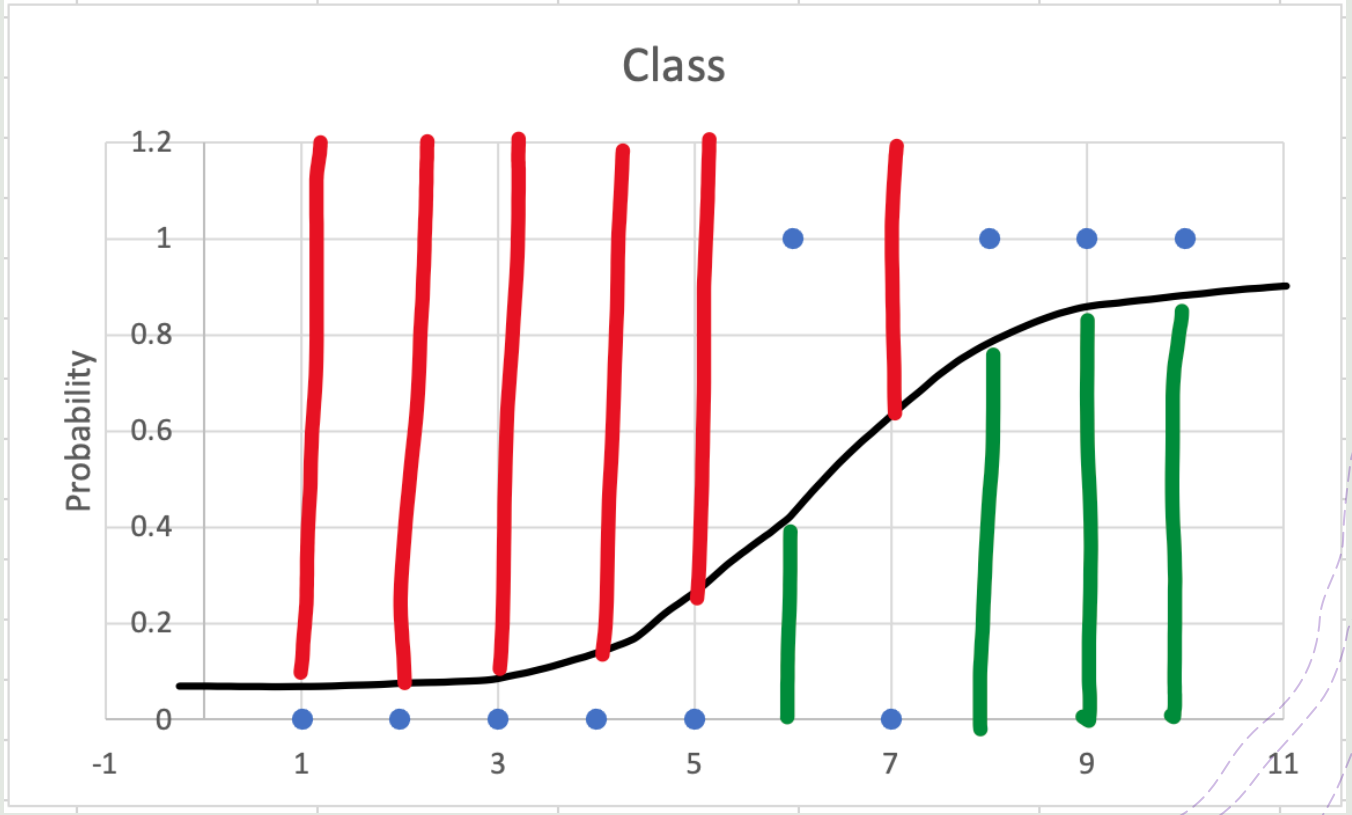
- A sigmoid function is fitted
- Probabilities are calculated for each point
- The loss is calculated for each data point
- All losses are sum together



How does it work with logistic regression?...

- Once the logistic regression is fitted, you can calculate the probability of being of a class

- With the probabilities given by the sigmoidal function, the cross-entropy of each instance is calculated



Optimization using Gradient Descent

- Same Gradient Descent used in Linear Regression
- Remember to scale features
- Main differences are:
  - Use of sigmoid function
  - Use of binary cross-entropy as loss function
- Class example
  - Code in Python
    - logistic_reg_gd.py
- Compare vs. linear regression code