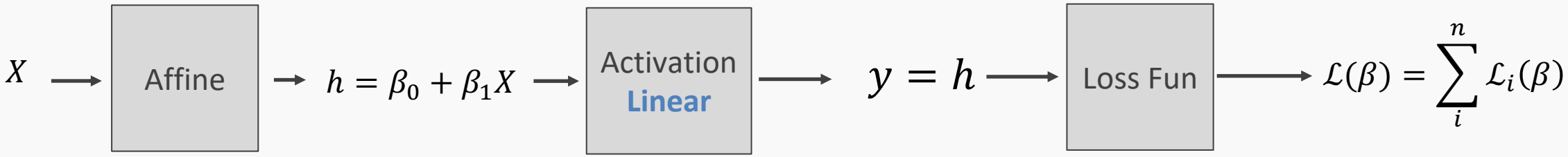
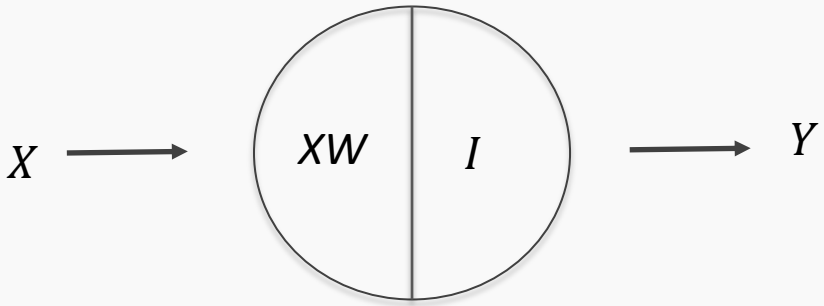
Up to this point we just re-branded logistic regression to look like a neuron.

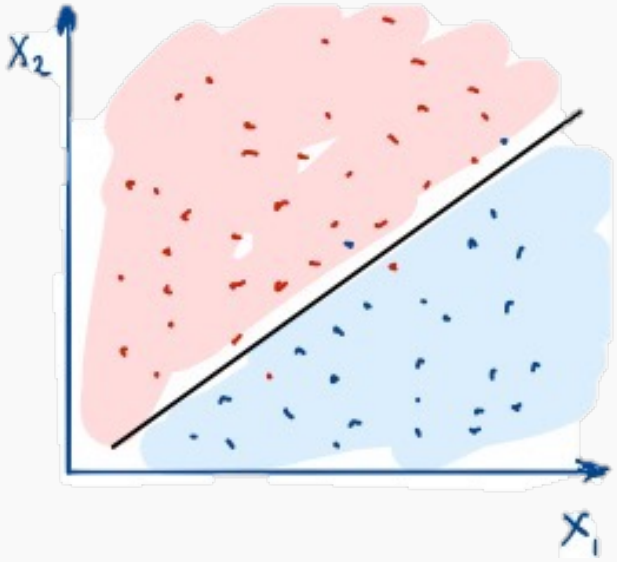
How about linear regression?

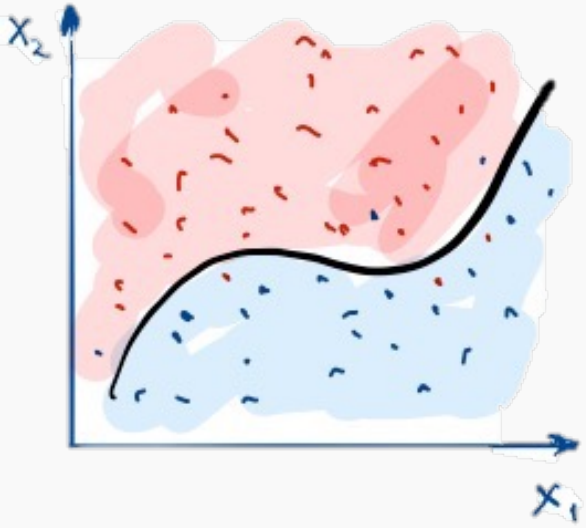


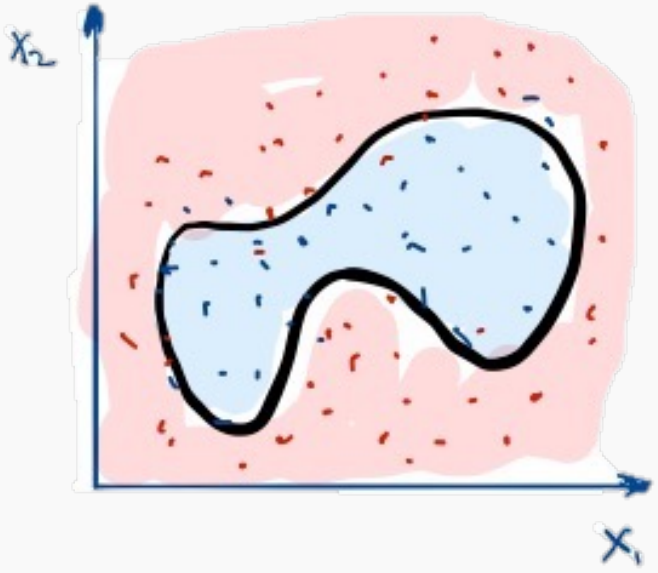


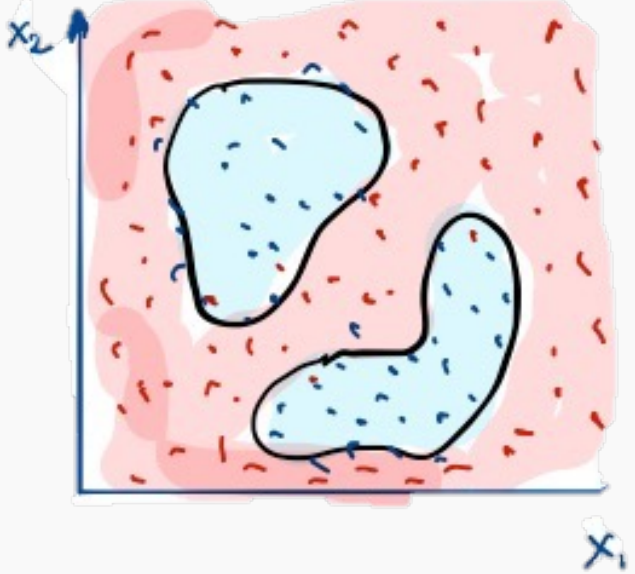
Where I is the identity function

So what's the big deal about Neural Networks?









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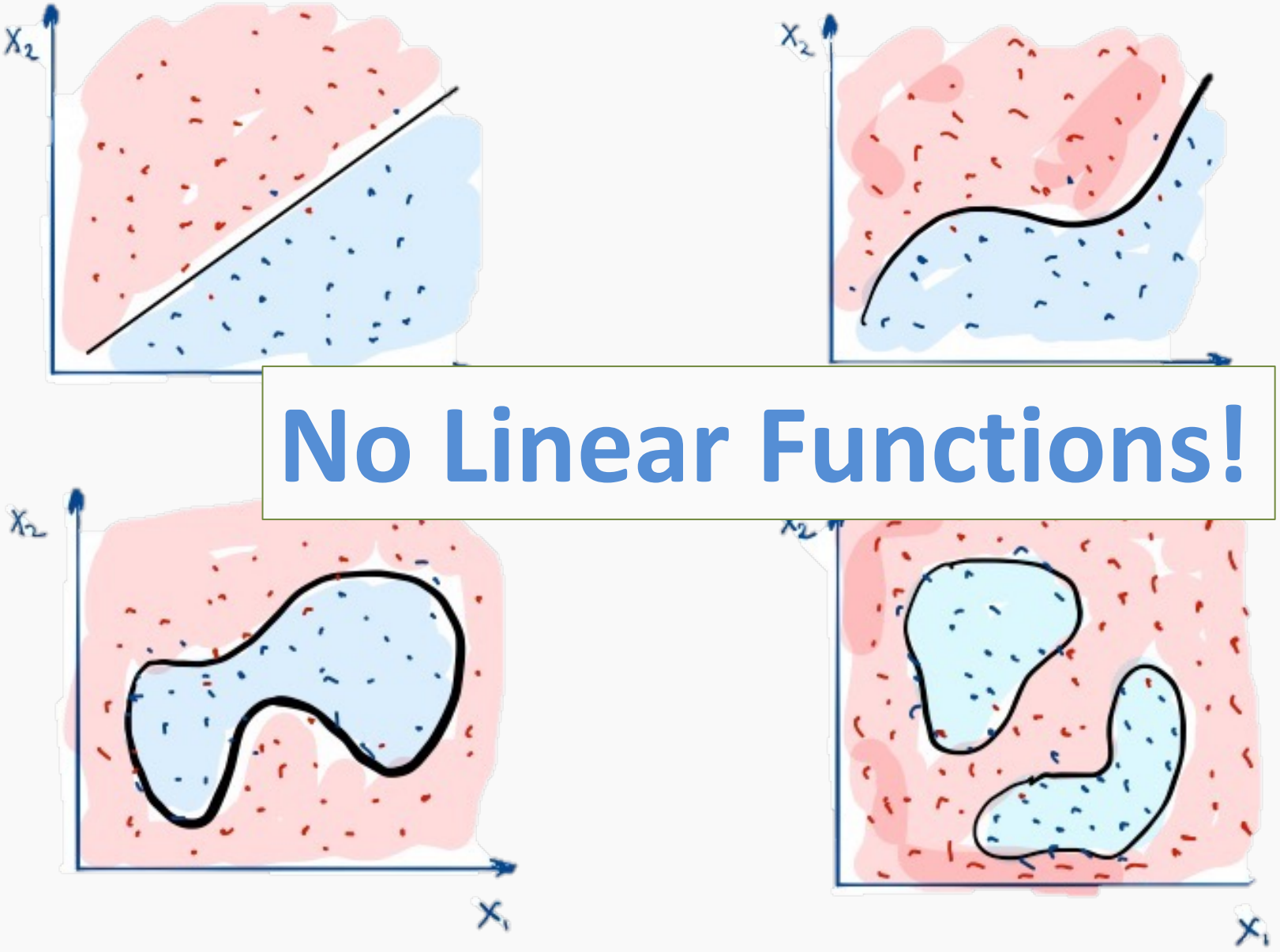
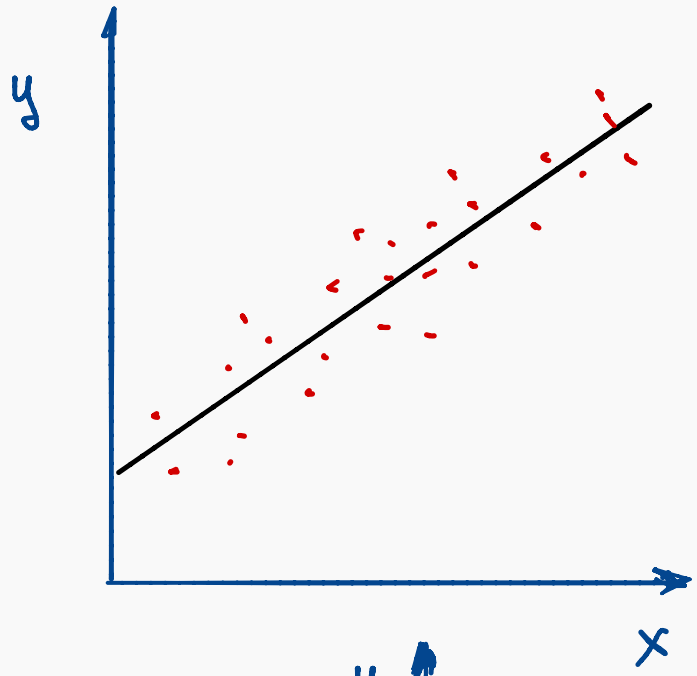
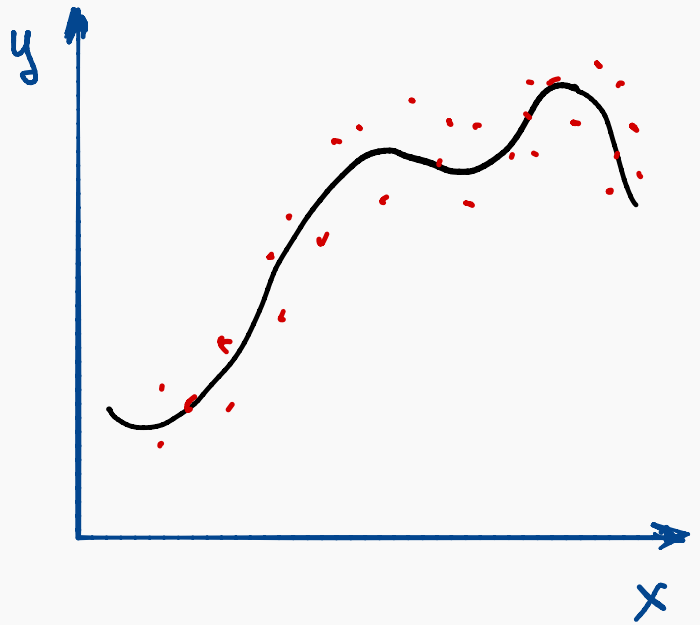
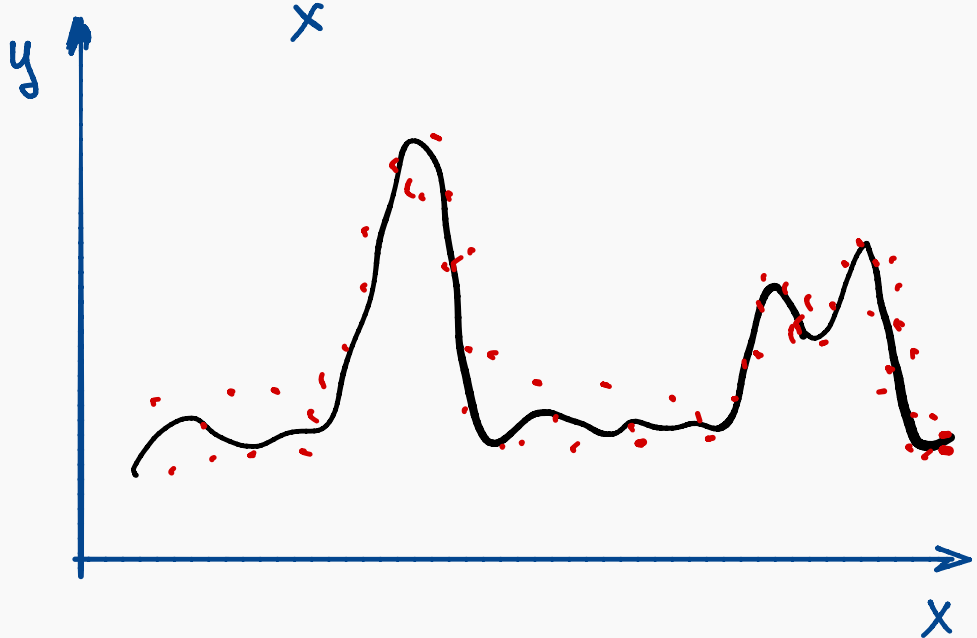


No Linear Functions!

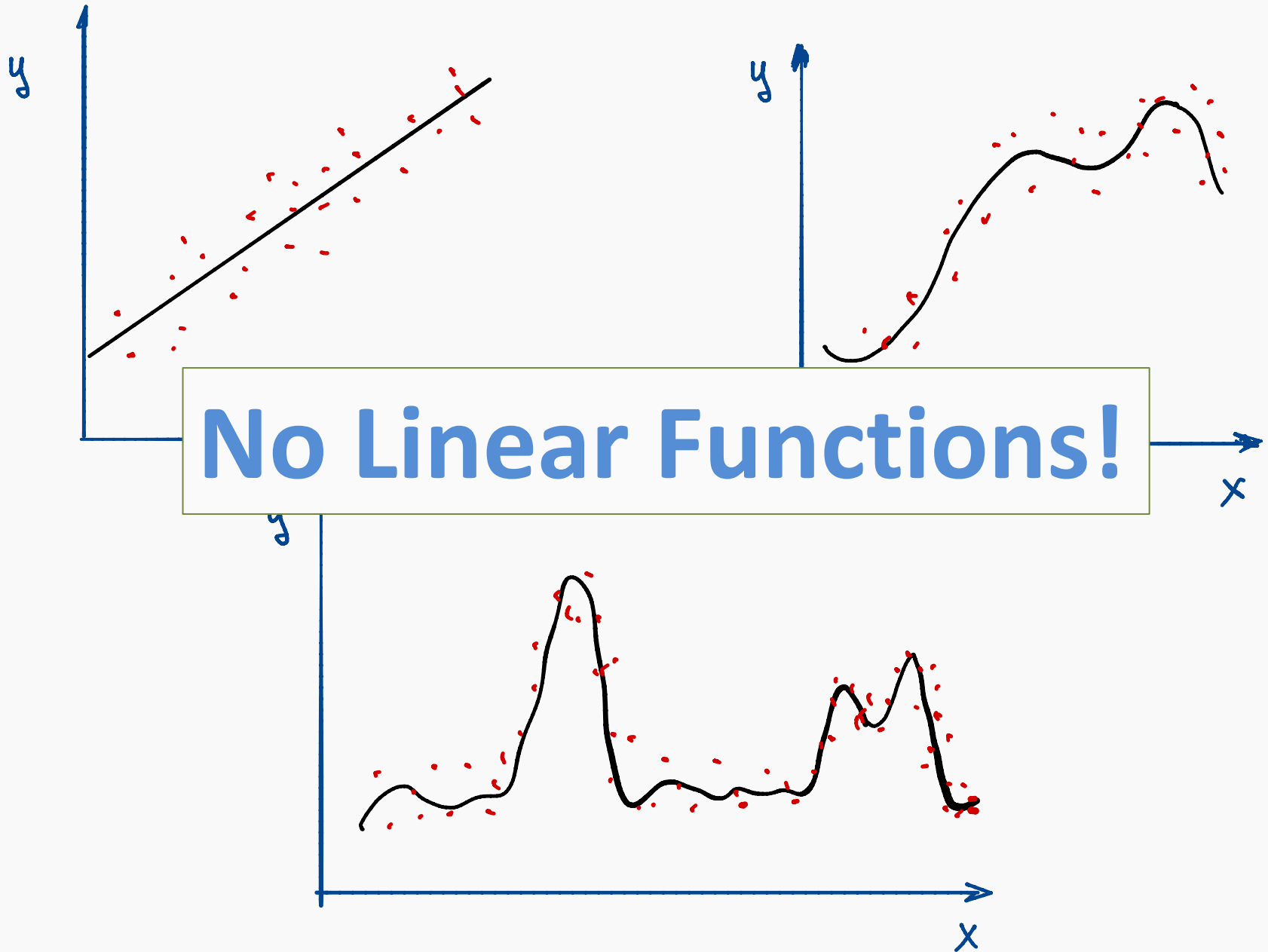
For regression?







For regression?



Outline

1. Introduction to Artificial Neural Networks
2. Review of Classification and Logistic Regression
3. Single Neuron Network (‘Perceptron’)
4. **Multi-Layer Perceptron (MLP)**

Example Using Heart Data

Slightly modified data to illustrate concepts.

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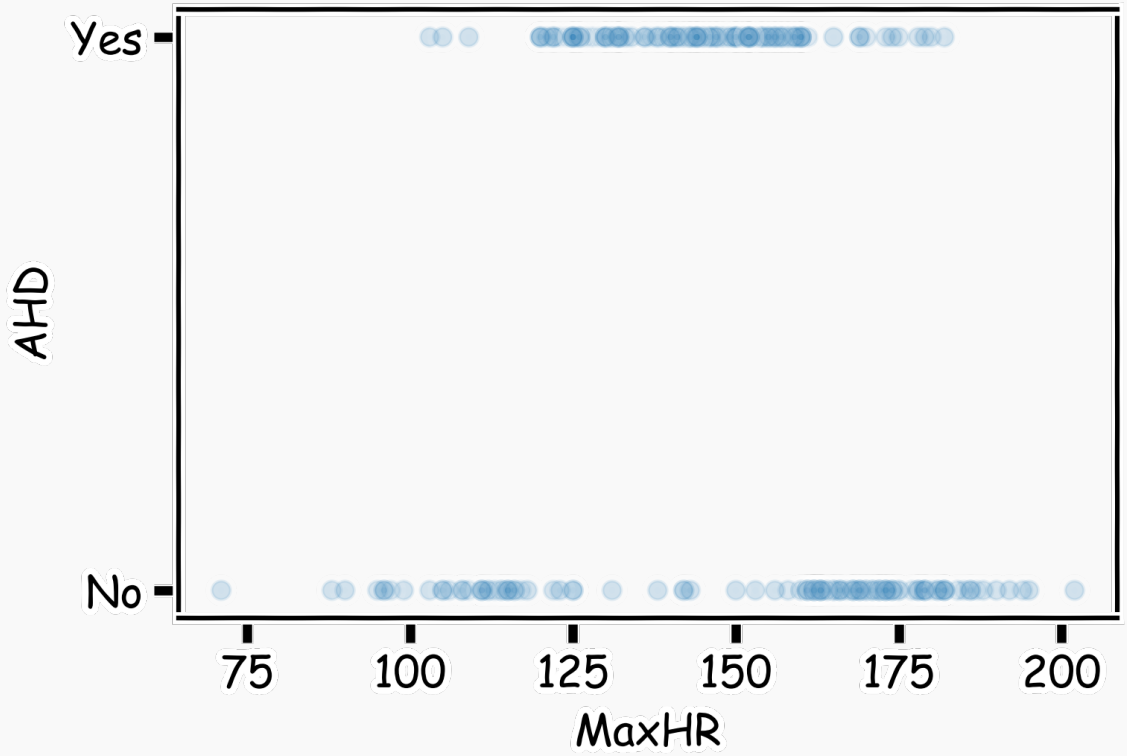
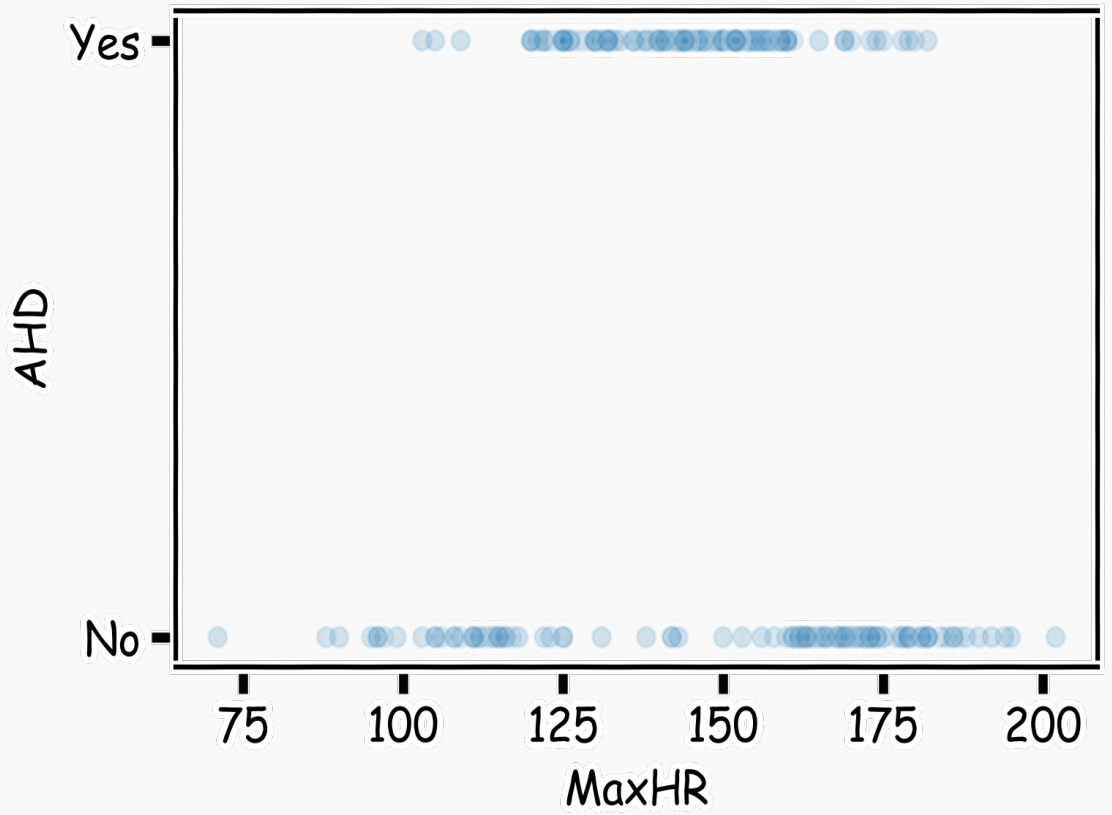
Slightly modified data to illustrate a point.



Example Using Heart Data



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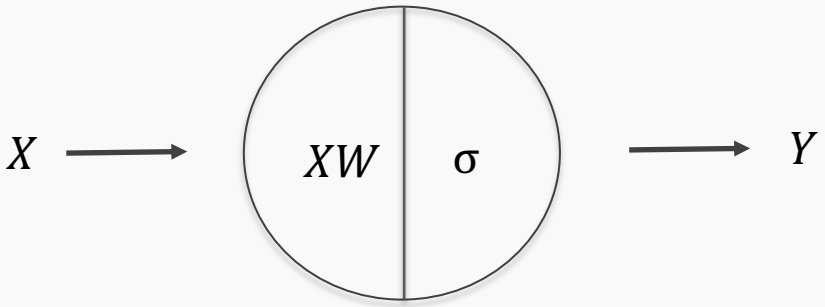
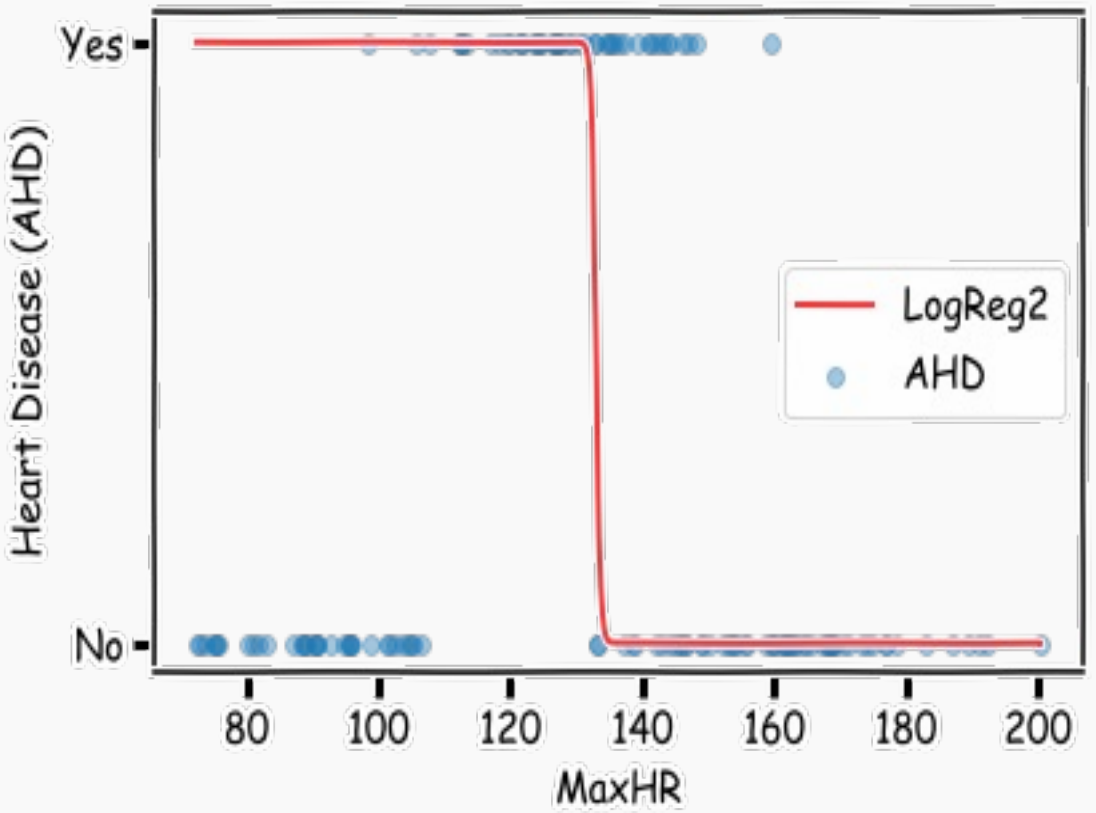


Choose W such as



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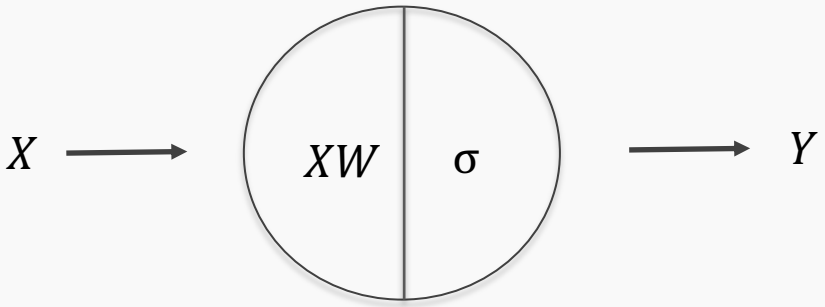

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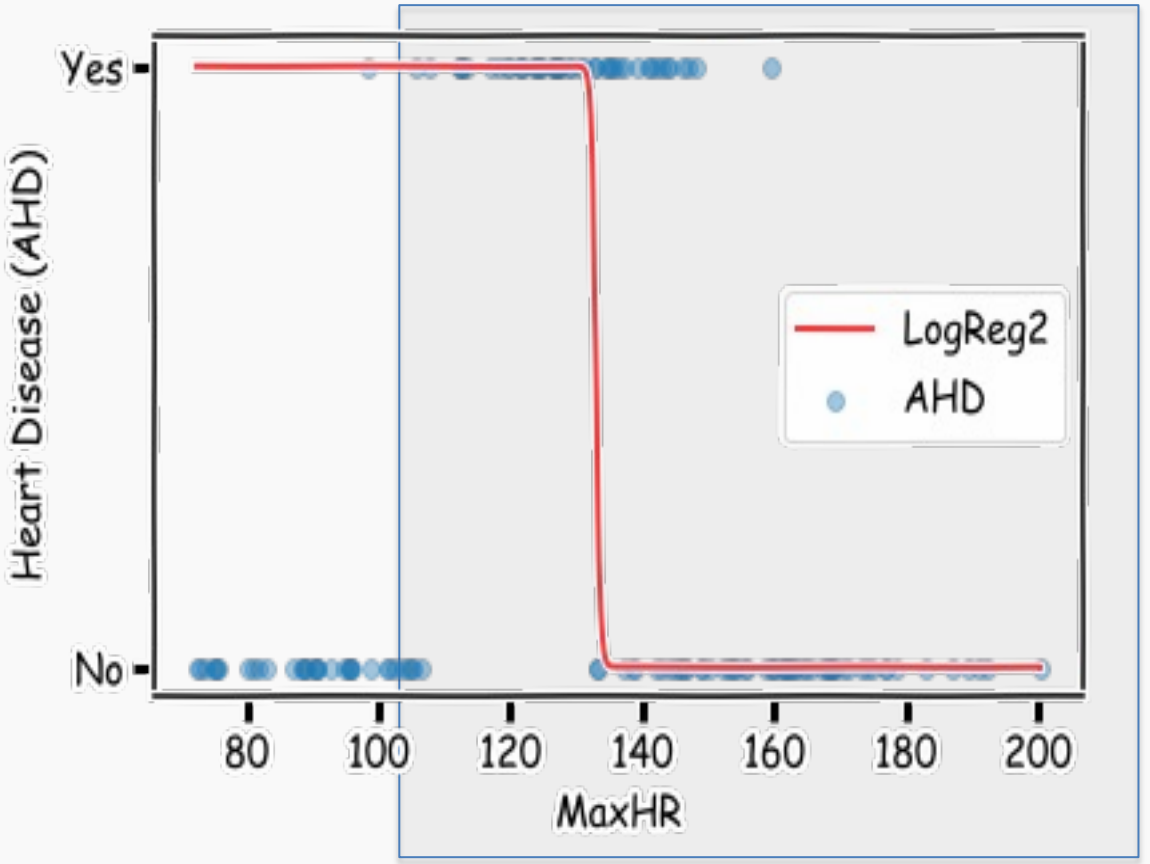
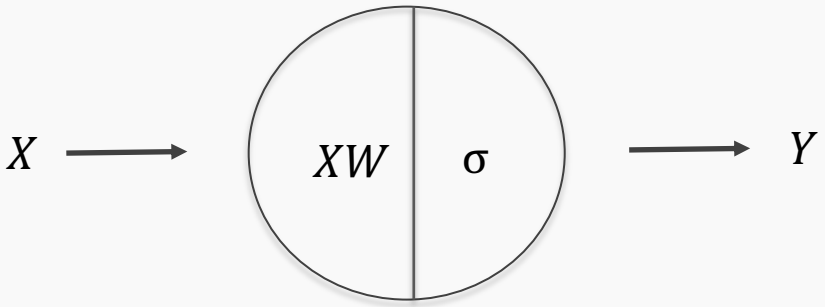
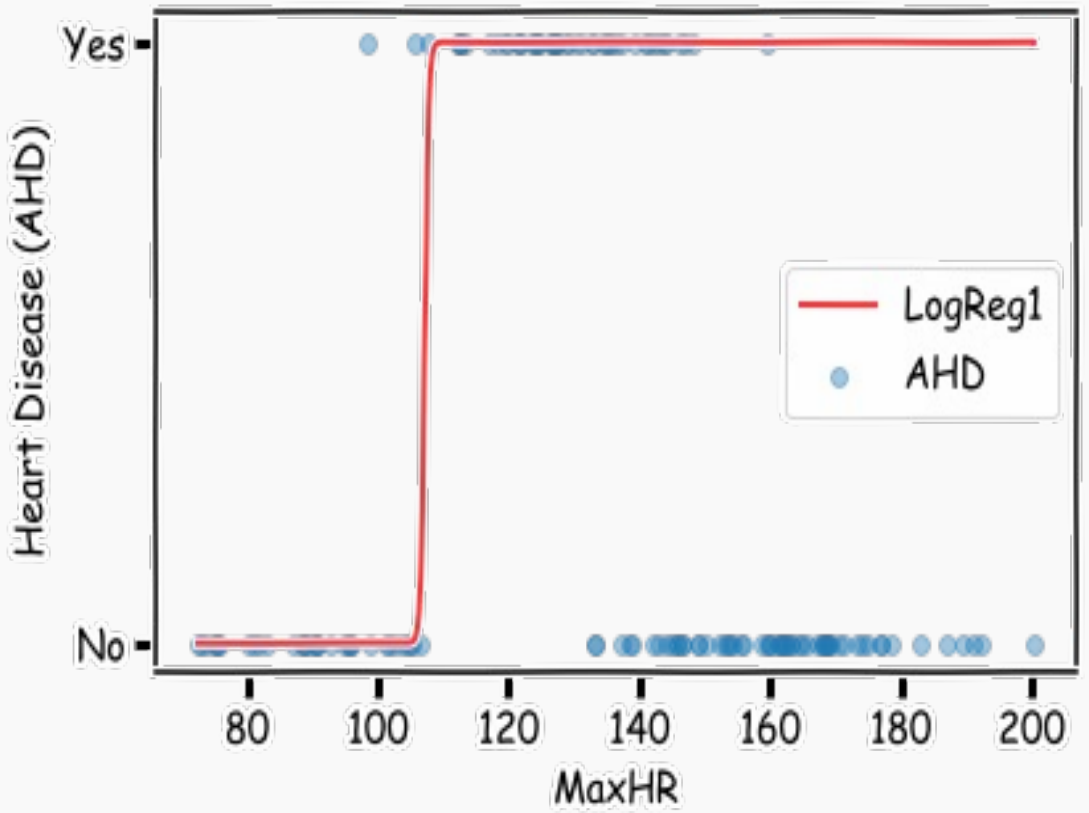


Right part of data is fitted well

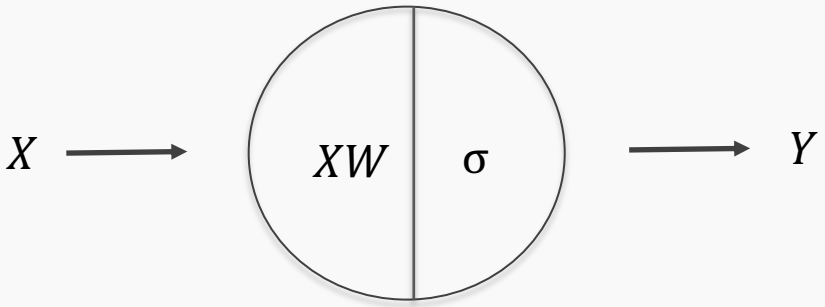
Example Using Heart Data



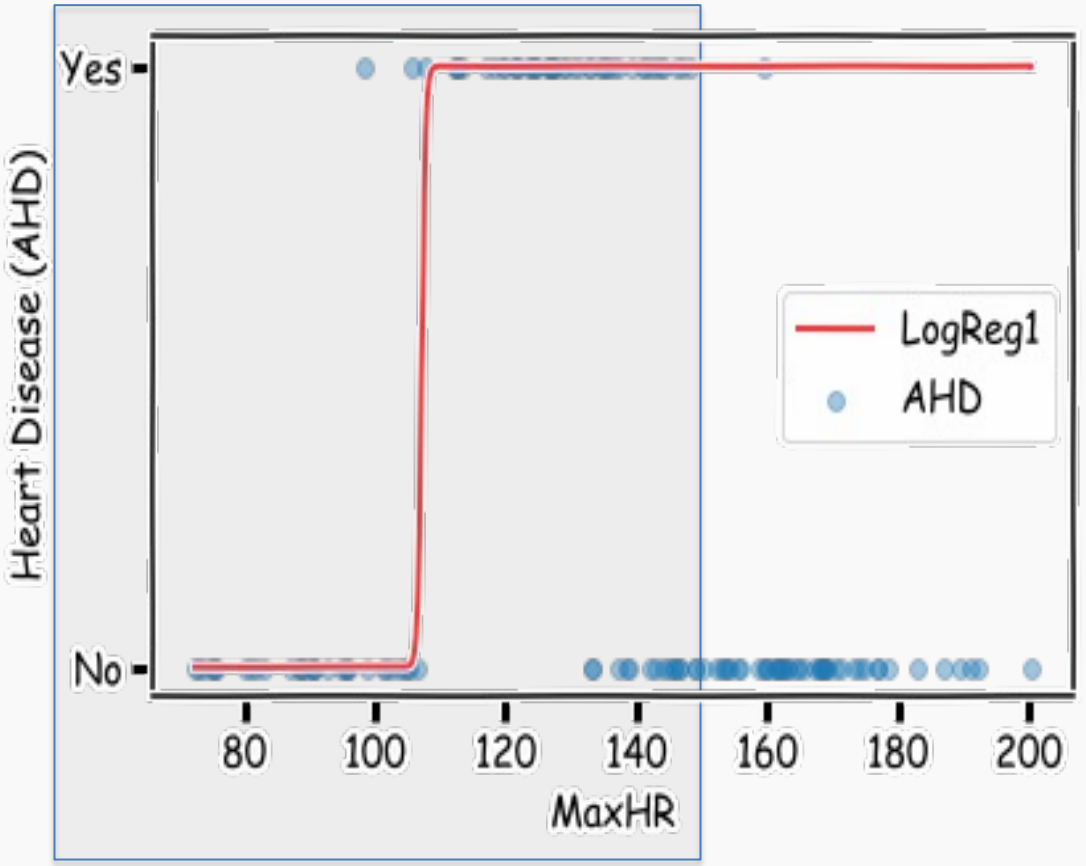
Choose W such as



Example Using Heart Data



Choose W such as

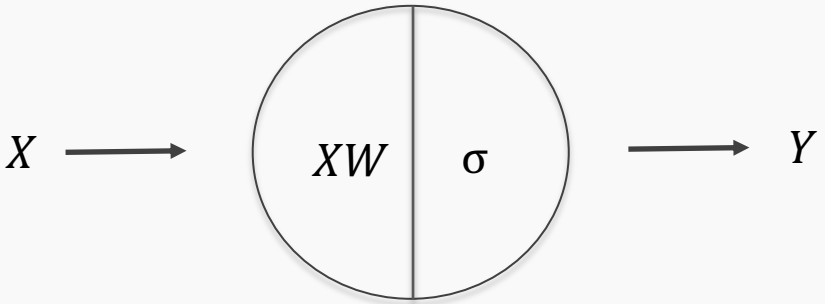


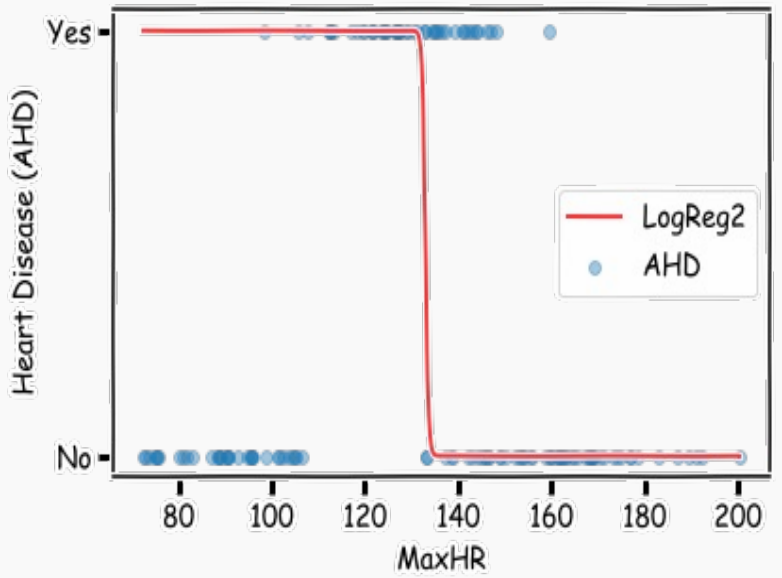
Left part of data is fitted well

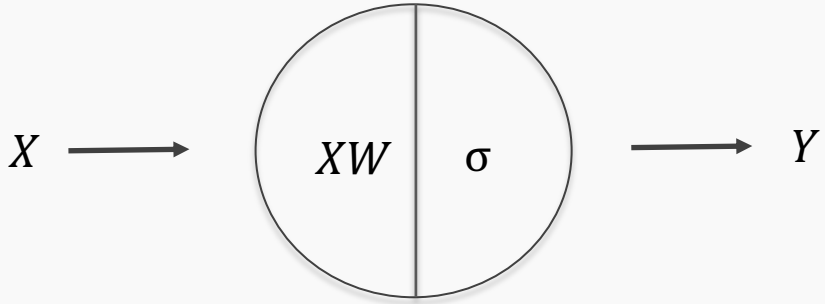
Example Using Heart Data

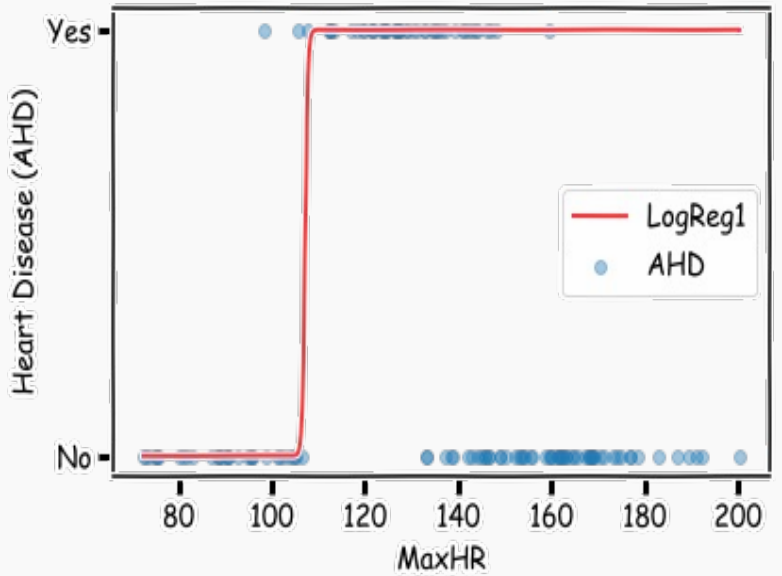
?

Two regions, two nodes

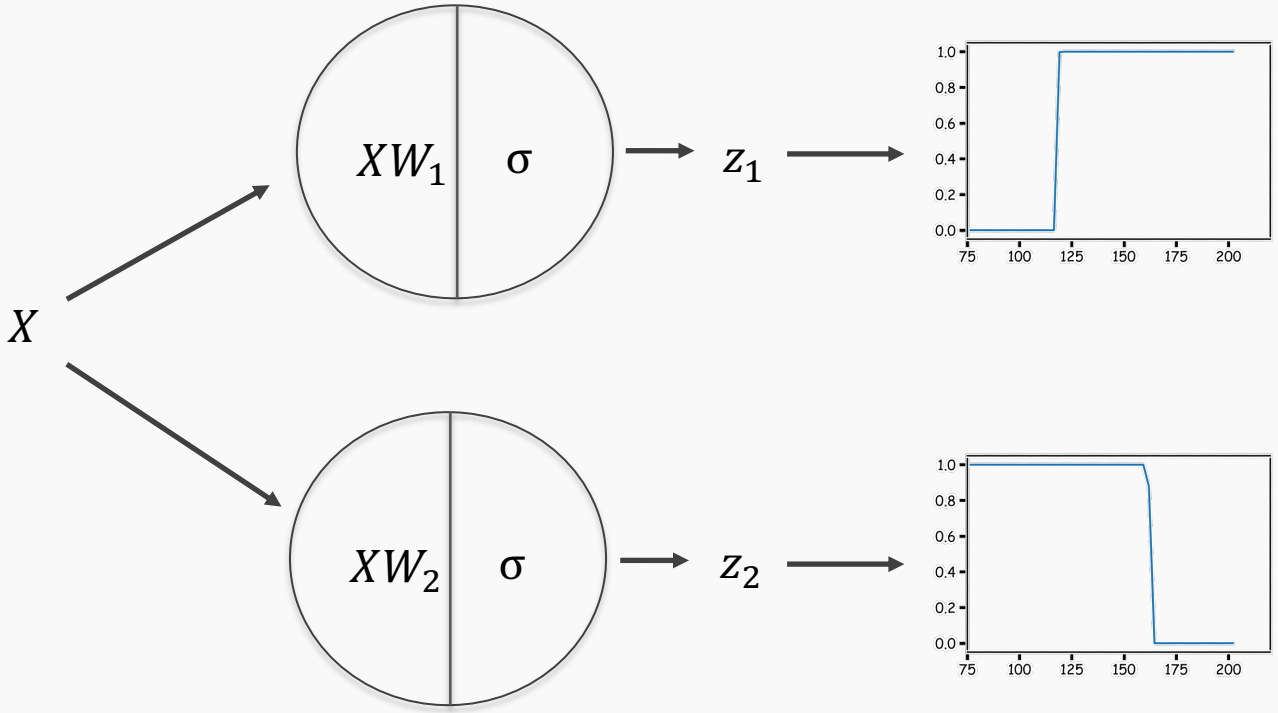








Combining Neurons



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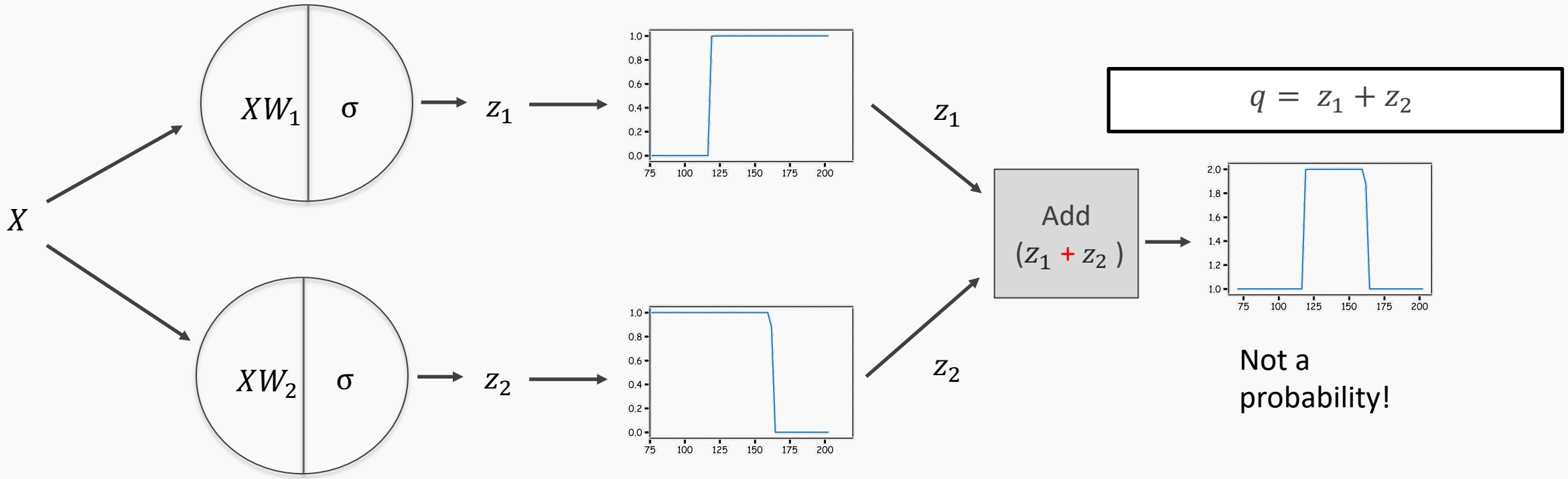

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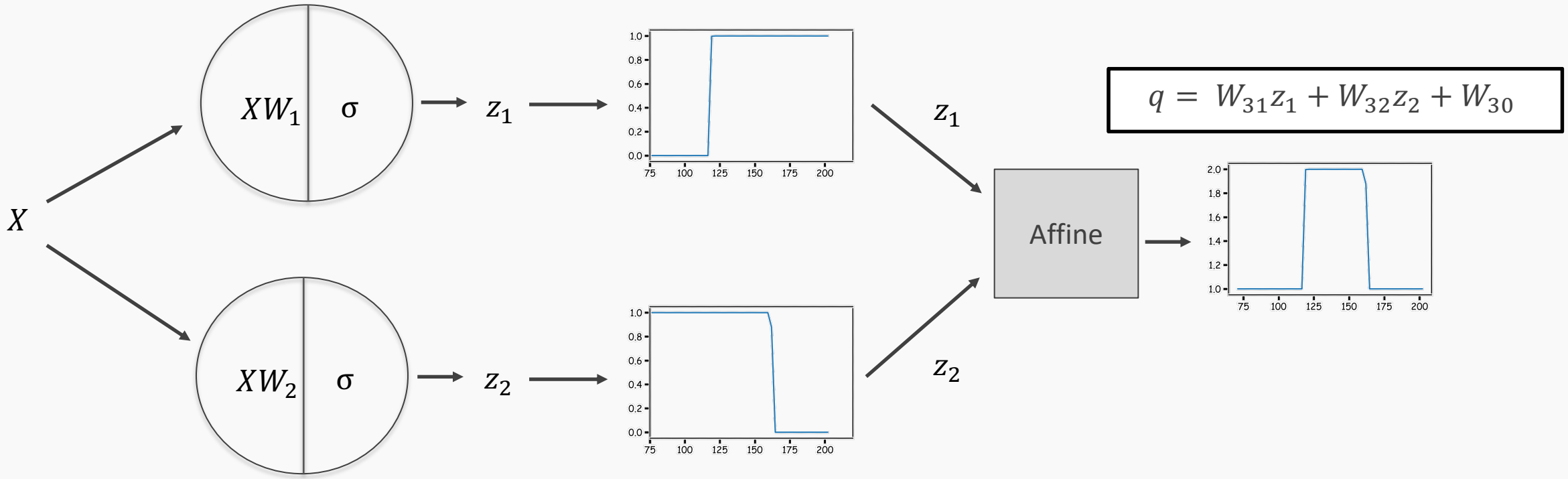

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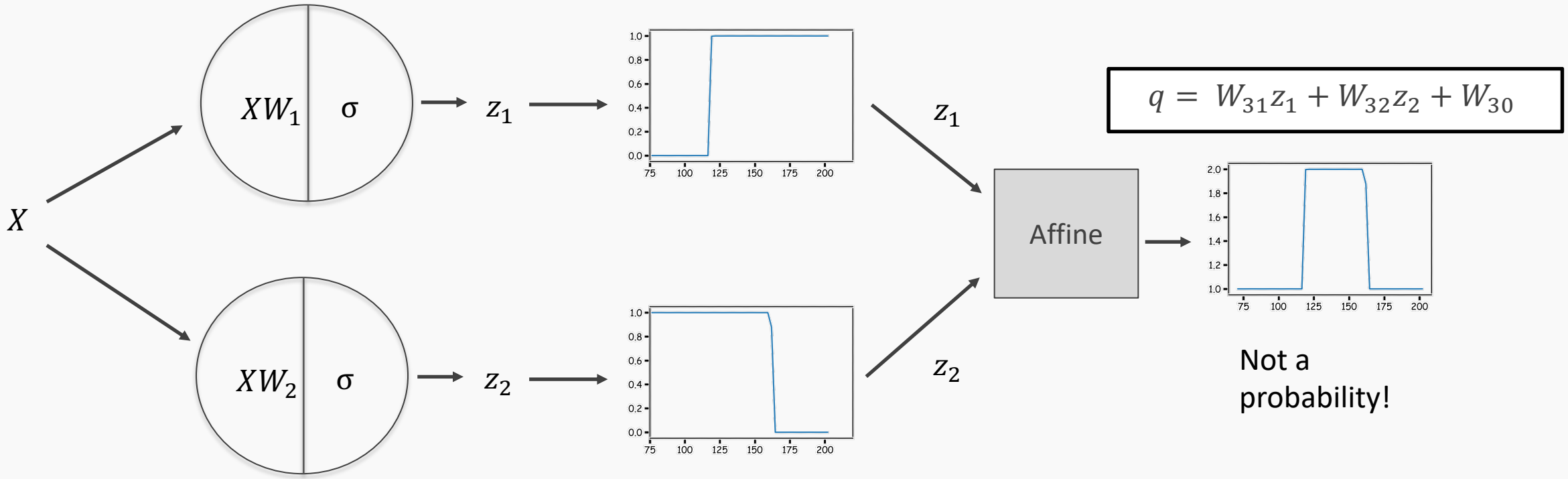

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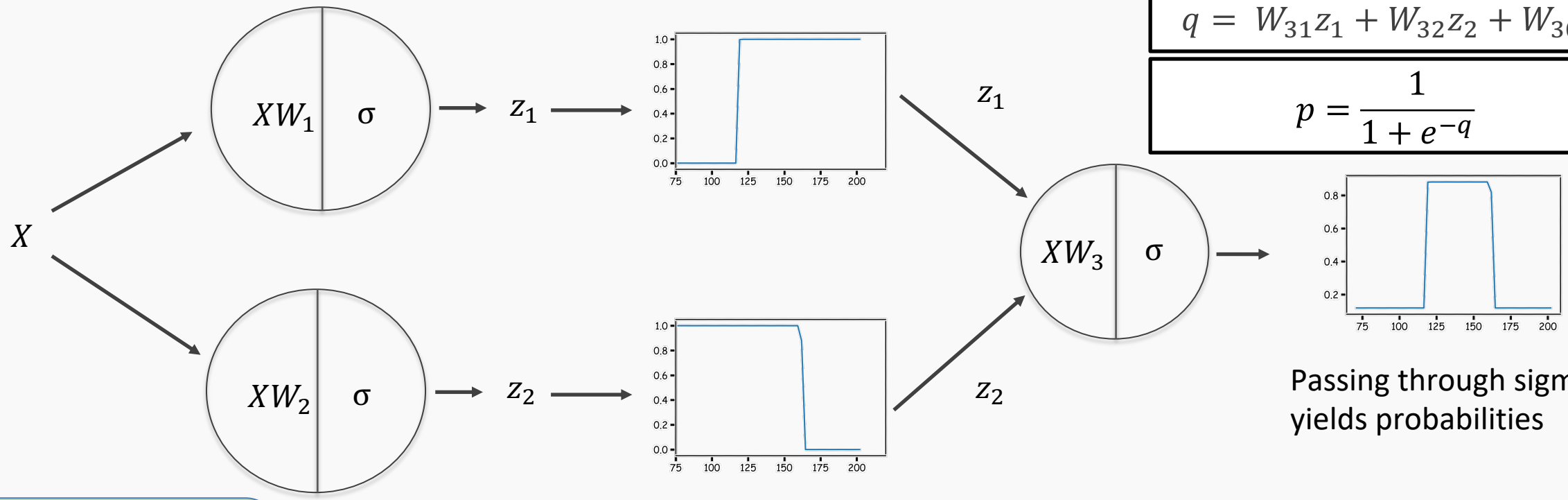


$$q = W_{31}z_1 + W_{32}z_2 + W_{30}$$

$$p = \frac{1}{1 + e^{-q}}$$

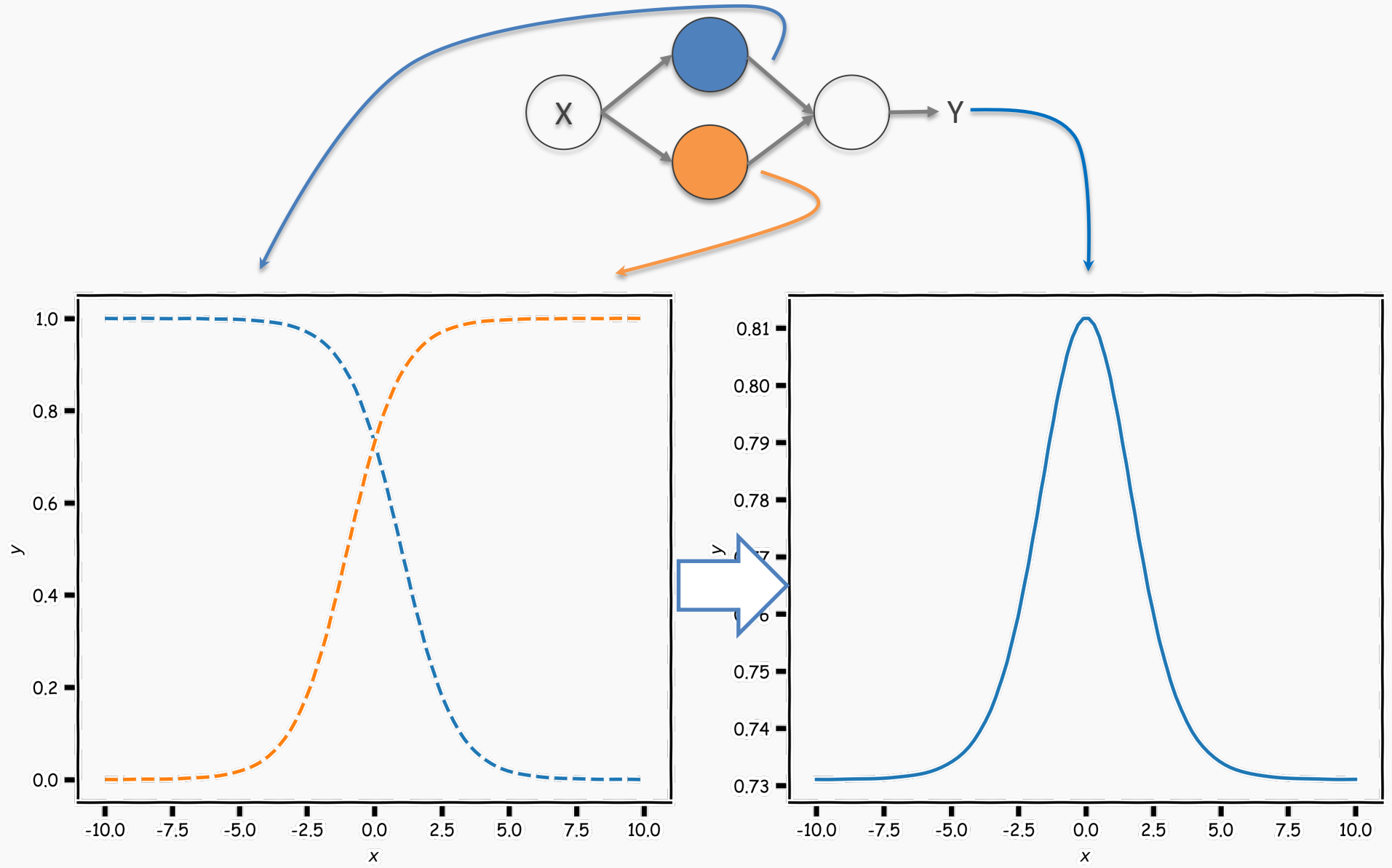
Passing through sigmoid yields probabilities

$$L = -y\ln(\mathrm{p}) - (1 - \mathrm{y})\ln(1 - \mathrm{p})$$

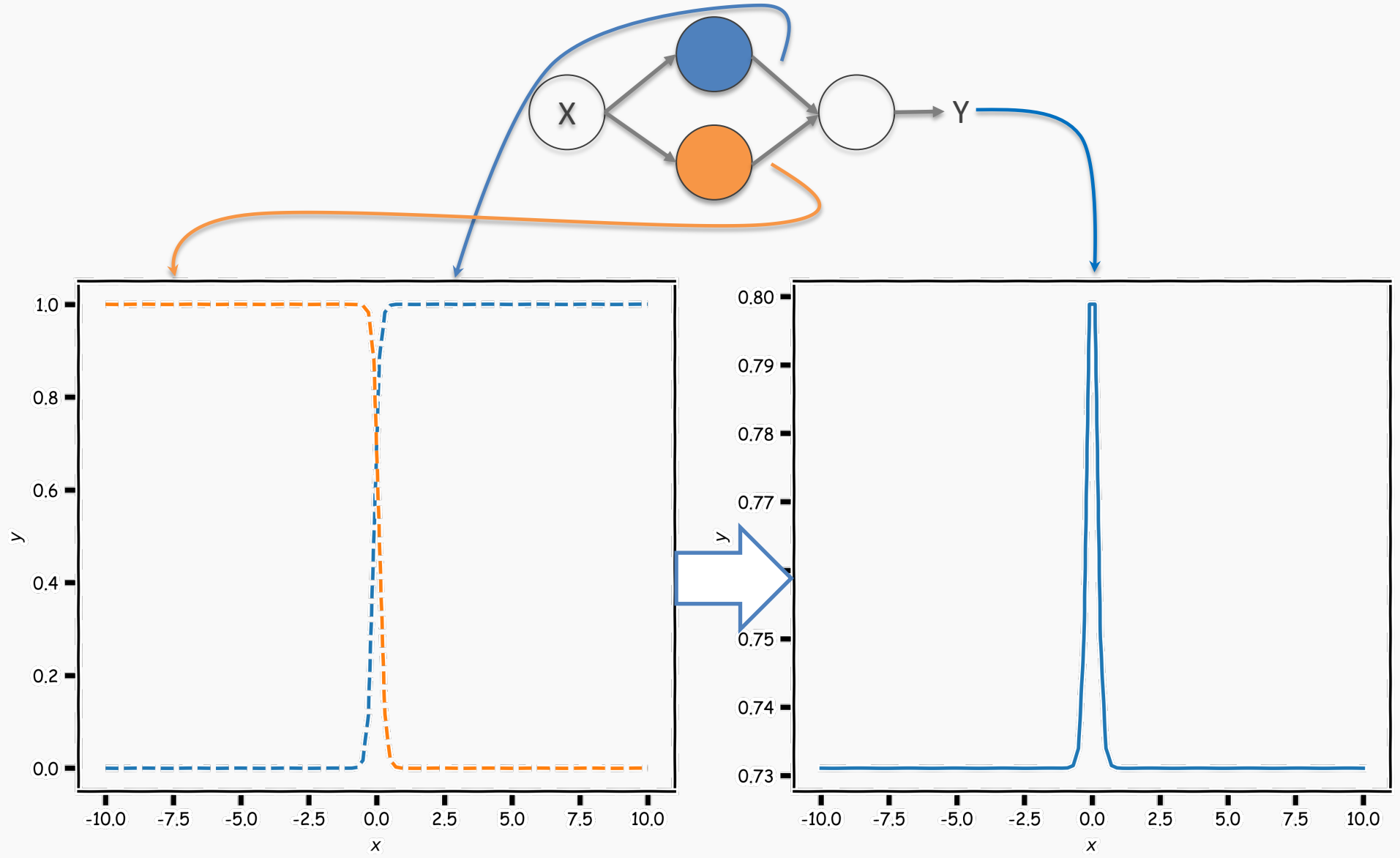
We will talk about about this in the coming lectures

Need to learn W_1, W_2 and W_3

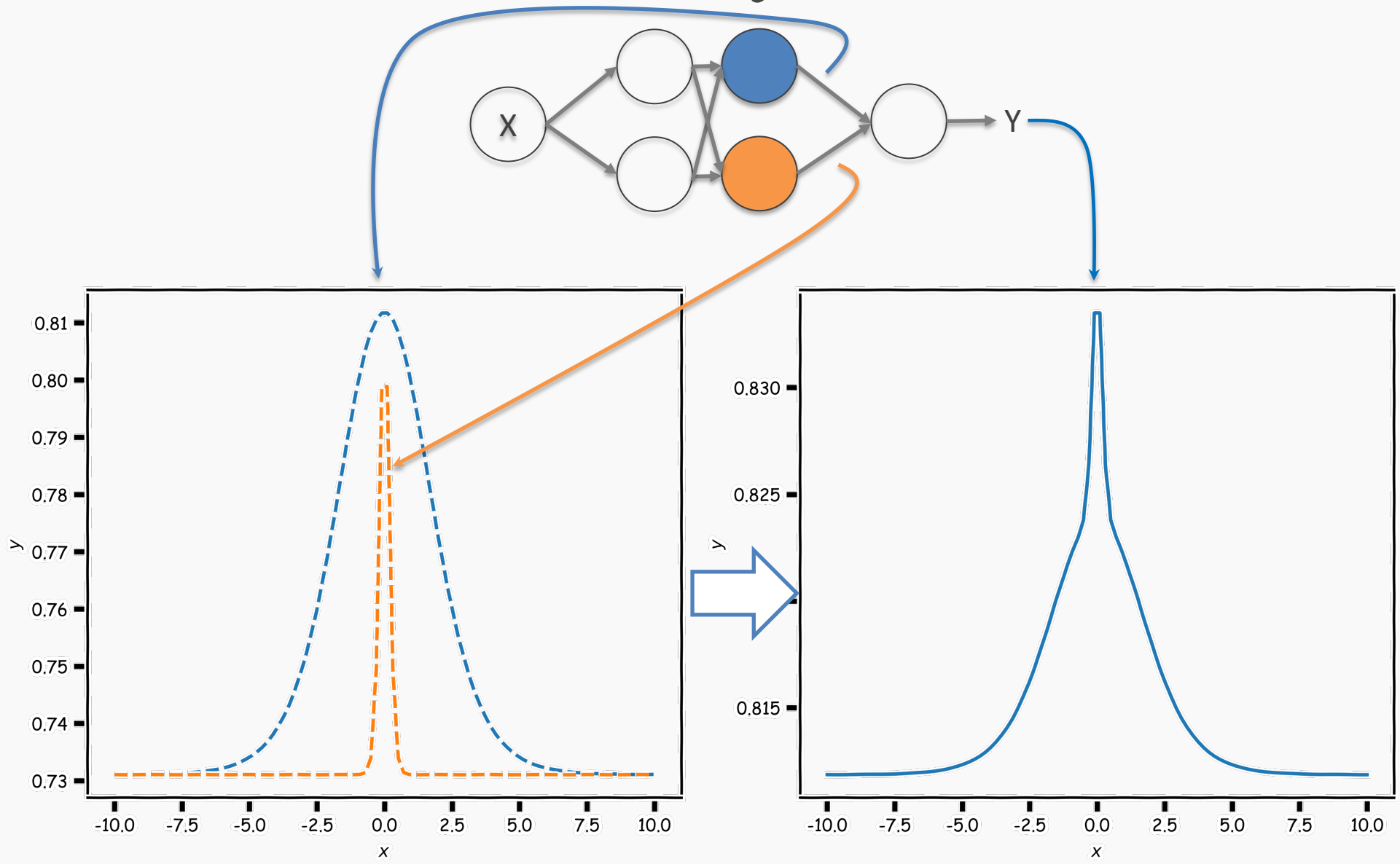
Combining neurons allows us to model interesting functions



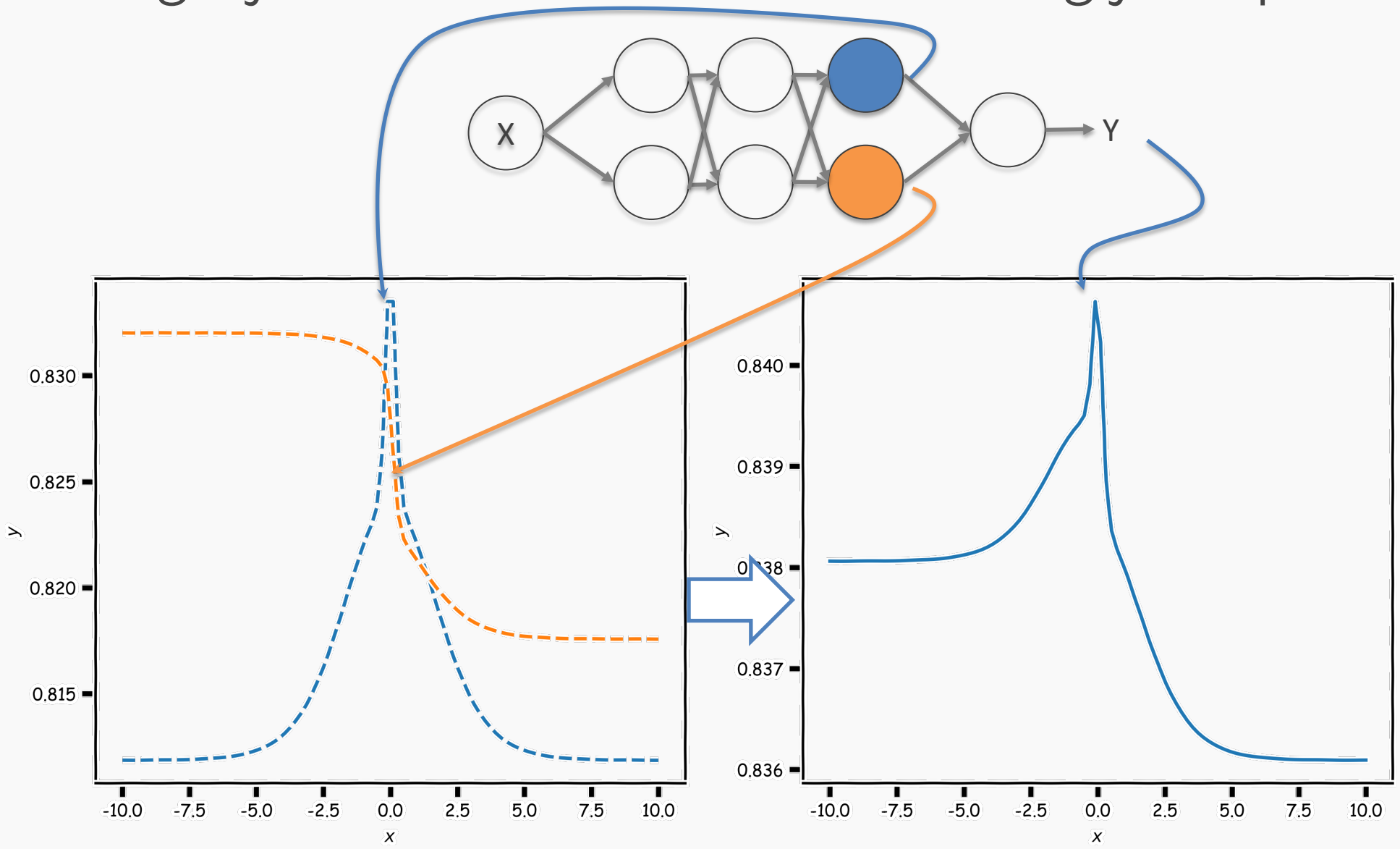
Different weights change the shape and position



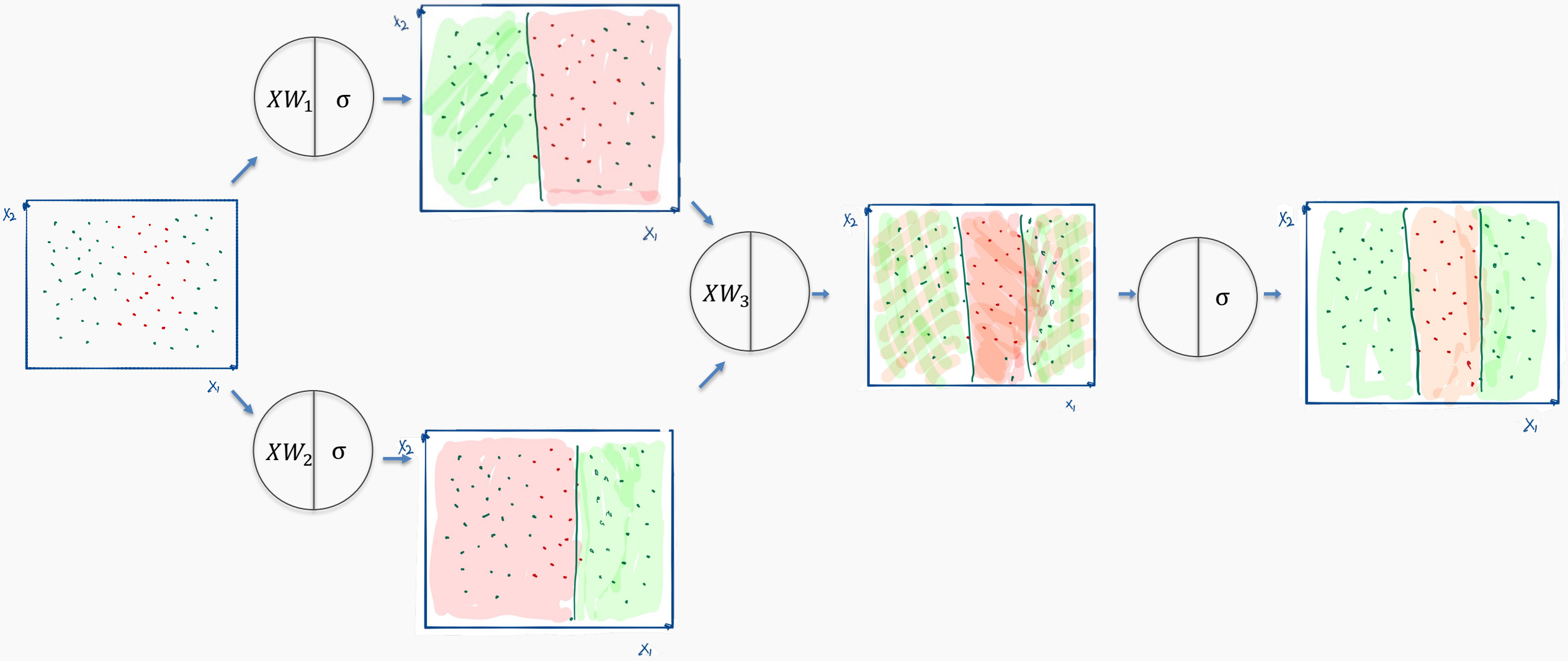
Neural networks can model *any* reasonable function



Adding layers allows us to model increasingly complex functions



For 2-D input the same idea applies.



Summary

So far:

- A single neuron can be a logistic regression or linear unit. We will soon see other choices of activation functions.
- A neural network is a combination of logistic regression (or other types) units.
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Following two lectures on NN:

- How do we estimate the weights and biases?
- How to regularize Neural Networks?