Artificial Intelligence: Machine Learning

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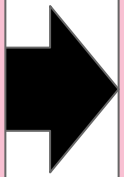
Traditional Programming

Traditional Code for "Is this picture a pig?"

Is it pink?
Does it have a tail?
Pointed ears?
Four legs?
And so on...



Rules for "Is this picture a pig?"

```
if (isPink(picture) and
hasTail(picture) and
hasPointedEars(picture)
and hasFourLegs(picture)
and …)
    print "Yes!"
else
    print "No!"
```

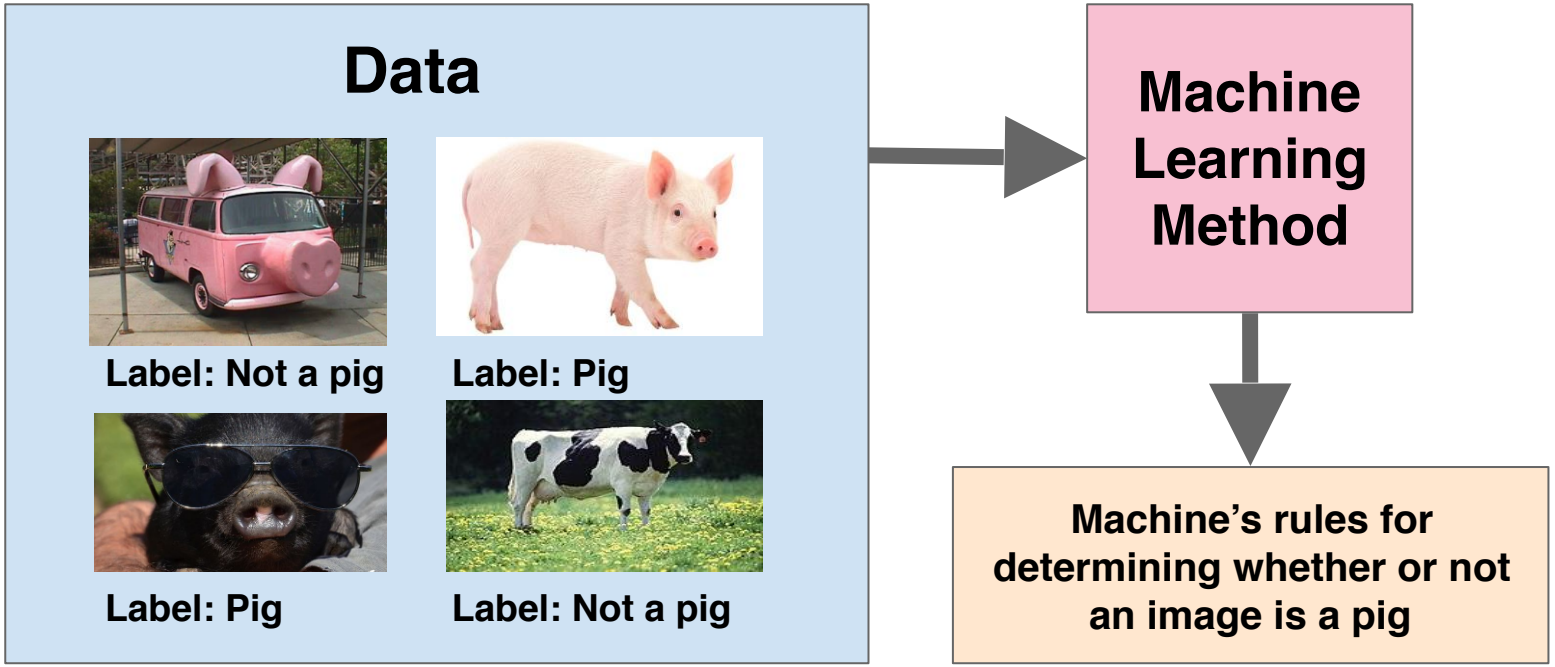
?

HOW DO YOU DECIDE WHAT THE RULES ARE?

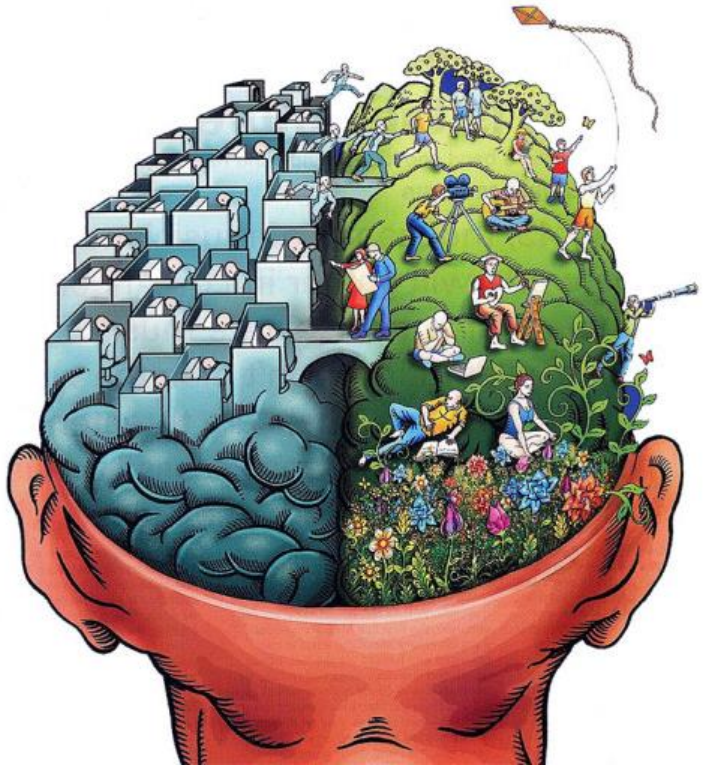
YOU DON'T!
LET THE COMPUTER DO IT WITH
MACHINE LEARNING!

Machine Learning

A machine learning method takes a bunch of data and “learns” from it!



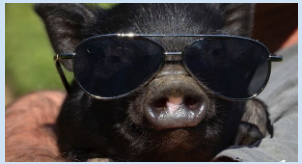
WHAT'S THE DIFFERENCE BETWEEN MEMORIZING AND LEARNING?



Did it “Learn” Something?

Label: Not a pig

Label: Pig



Label: Pig

Label: Not a pig

Training Data

The data we give to the machine learning method to learn from

Label: Not a pig

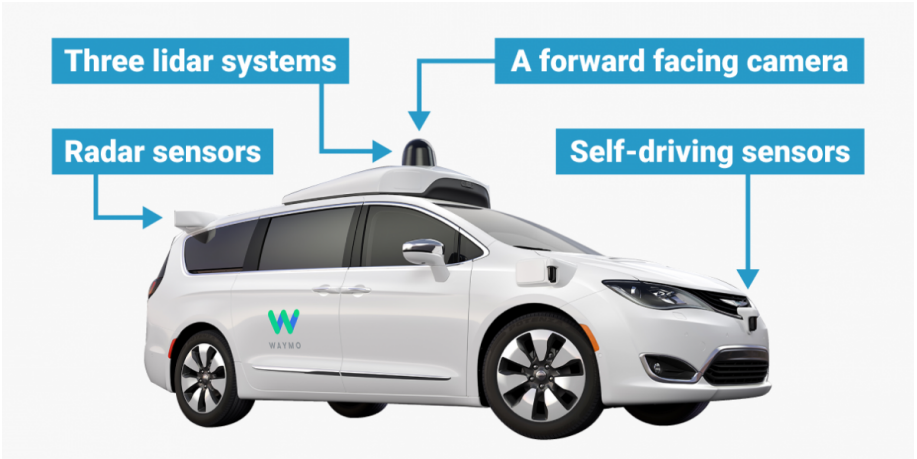
Label: Pig

Testing Data

The data we hold out and use to check to see if the method actually learned something!

Where is Machine Learning Used?

amazon Google



Why Does it Work?

Lots of Data

- 350 million new photos to Facebook every day
- 300 hours of video uploaded to YouTube every minute
- 500 million Tweets every day

Powerful Computers

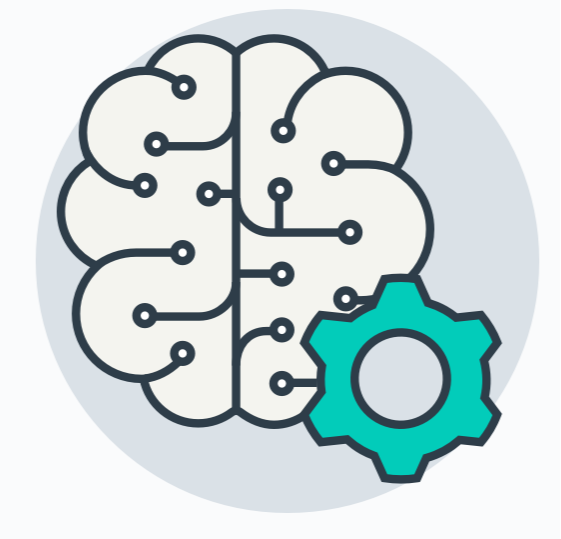
- Computers are faster and bigger than ever!

Let’s Play with Machine Learning

- Digit Classifier Tool
  - http://scs.ryerson.ca/~aharley/vis/fc/
- Drawing Completion Tool
  - https://magenta.tensorflow.org/assets/sketch_rnn_demo/index.html
- Quick Draw
  - https://quickdraw.withgoogle.com/
- Photos into art
  - https://deepart.io/

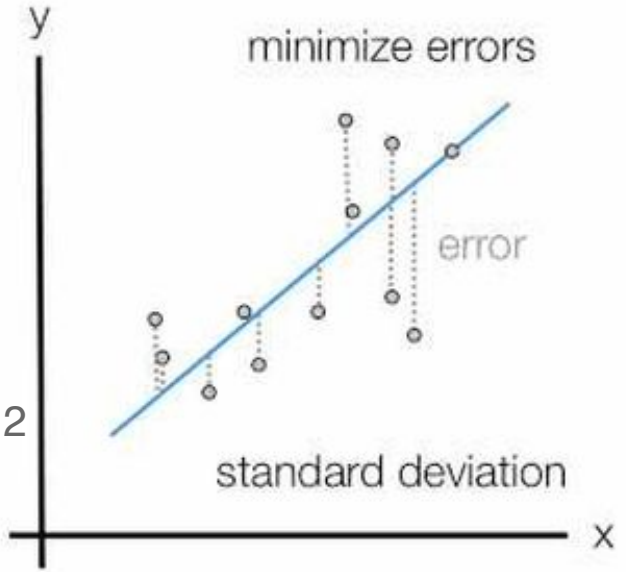
Ok, But How Does it Work?

- Think about data as lists of numbers -- even pictures!
- Machine Learning Techniques Examples:
  - Linear Regression
  - Logistic Regression
  - Artificial Neural Networks

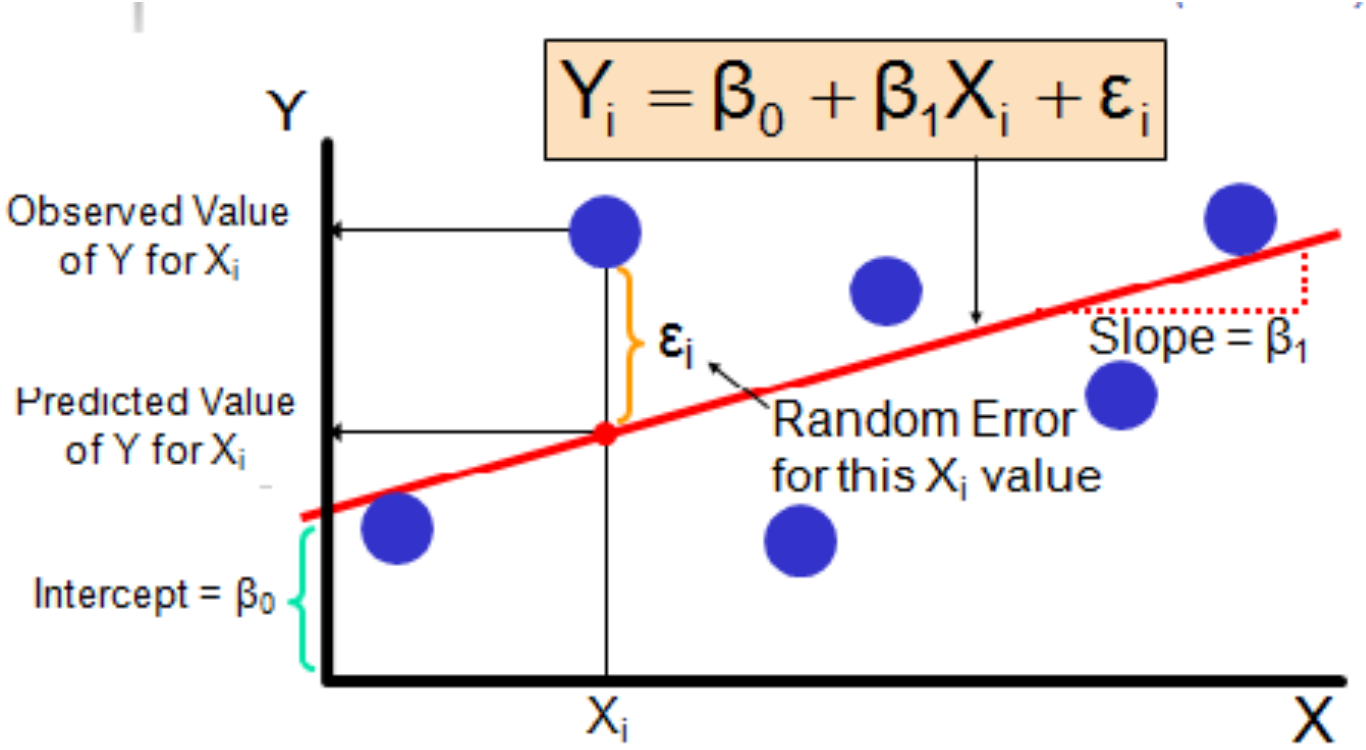


Linear regression

- X represent continuous numerical features
- Y represent continuous numerical result
- Example:
  - X = size of the house
  - Y = price of the house
- **Goal:** Create a line that would be the best fit for data (minimize the errors)
- $Y_i = \beta_0 + \beta_1 * X_i + \epsilon_i$
- Different error measures are possible
- Most common: standard deviation $(y_{ip}-y_i)^2$



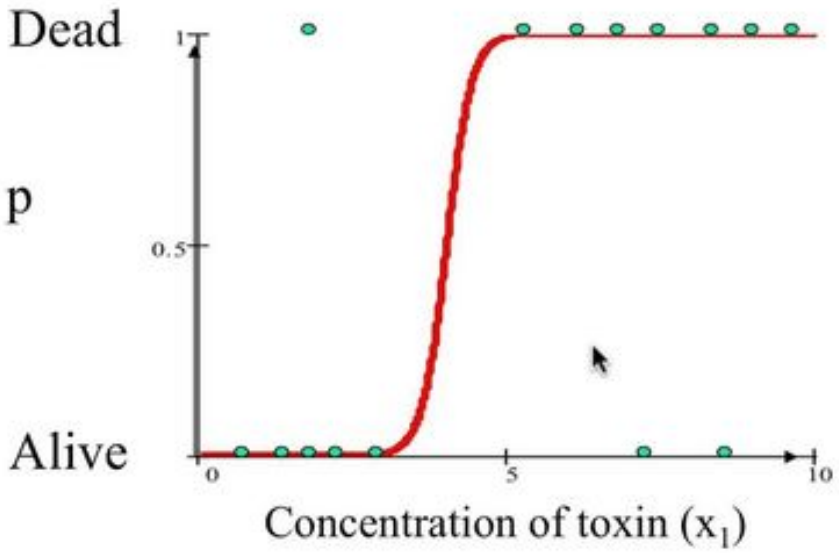
Linear regression



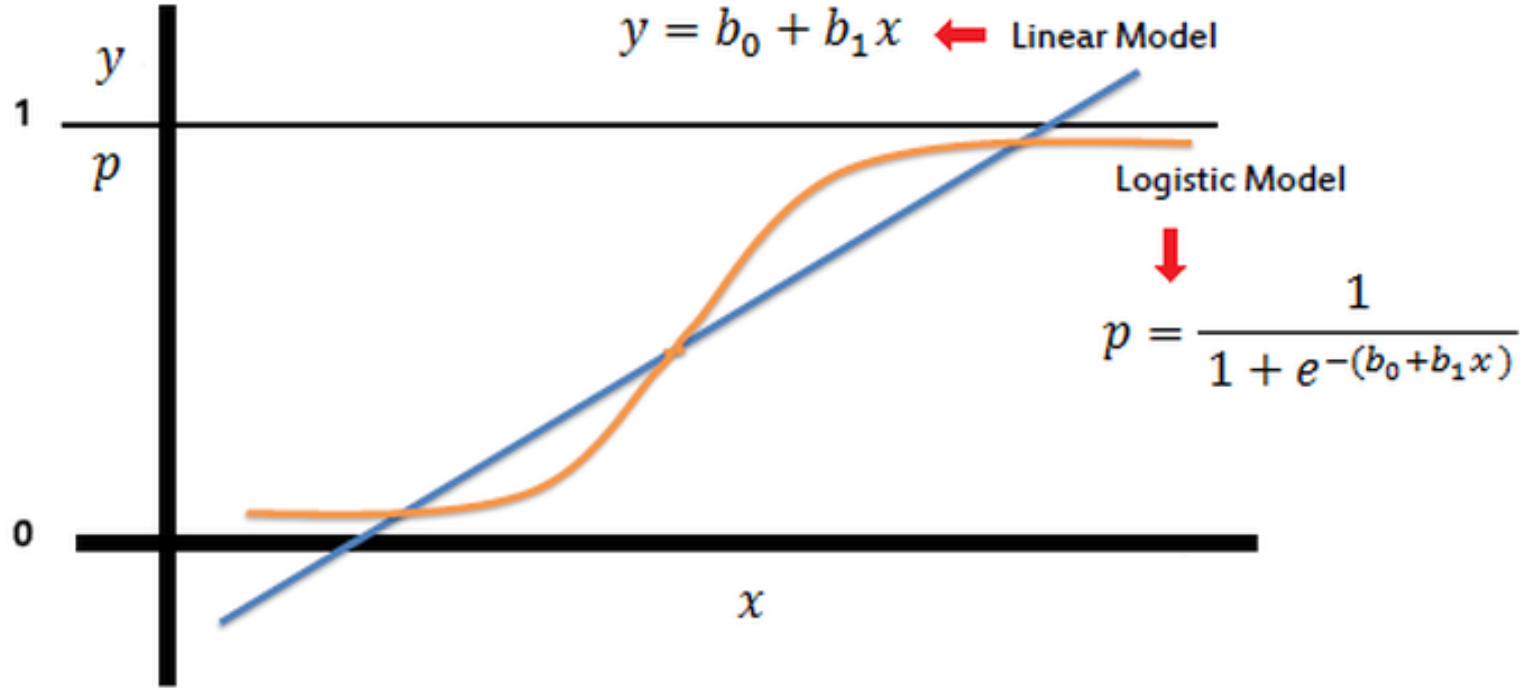
Example!

Logistic regression (classification)

- X represent continuous numerical features
- Y represent classes
- Example:
  - X = average score at games
  - Y = won/lost
- **Goal:** Separate examples in two classes to minimize number of wrongly classified examples

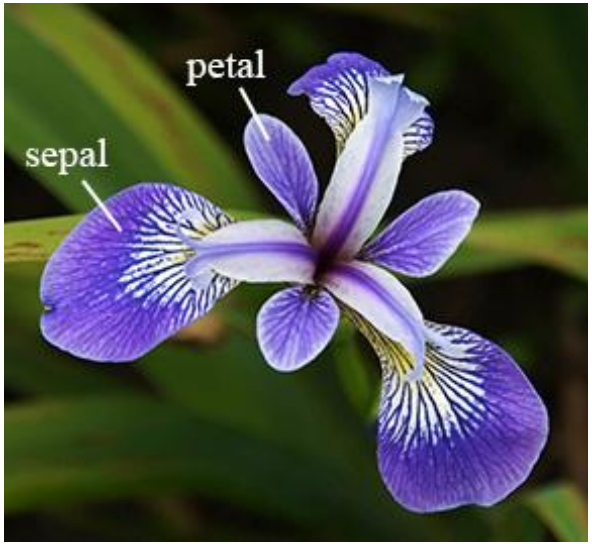


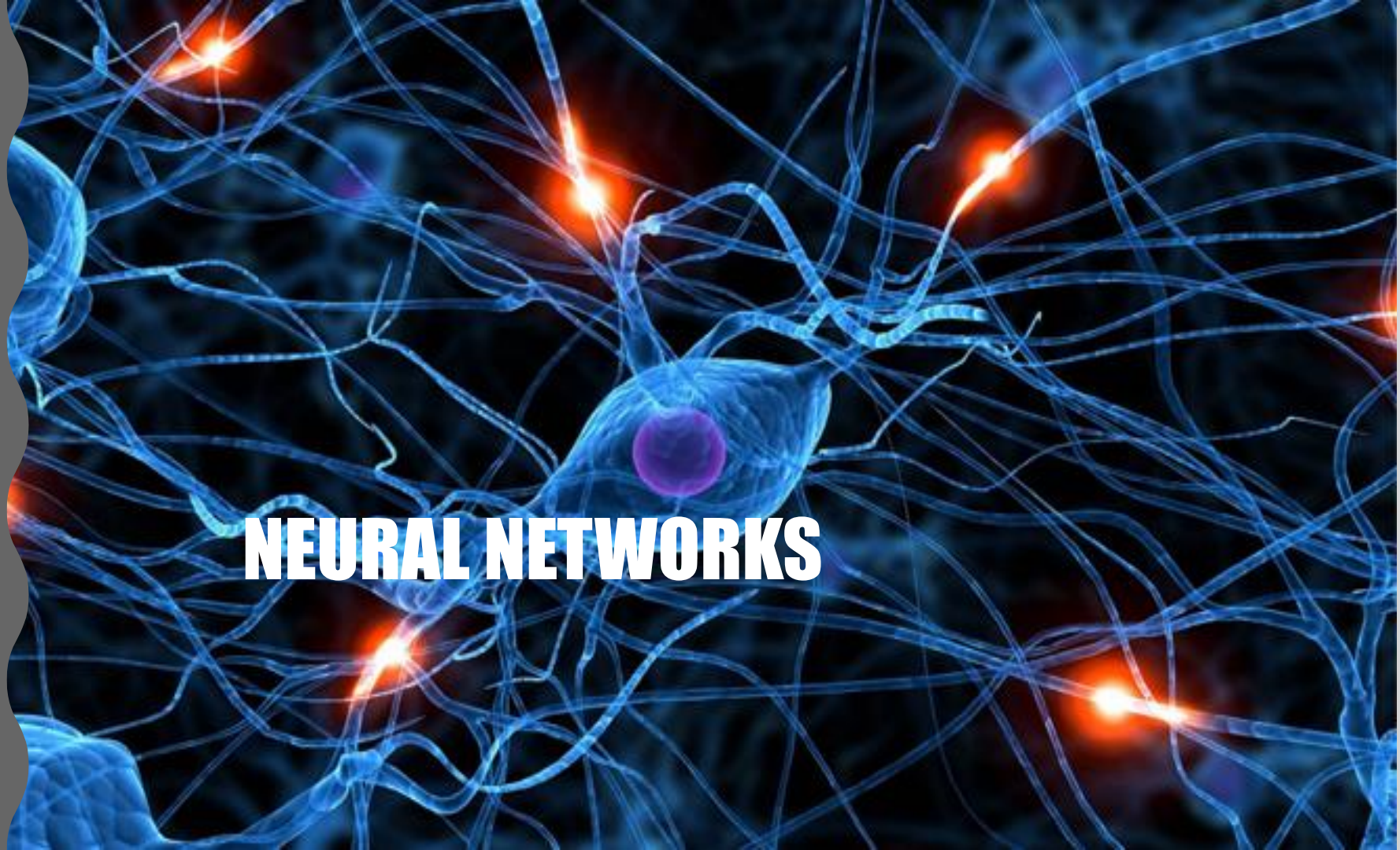
Logistic regression



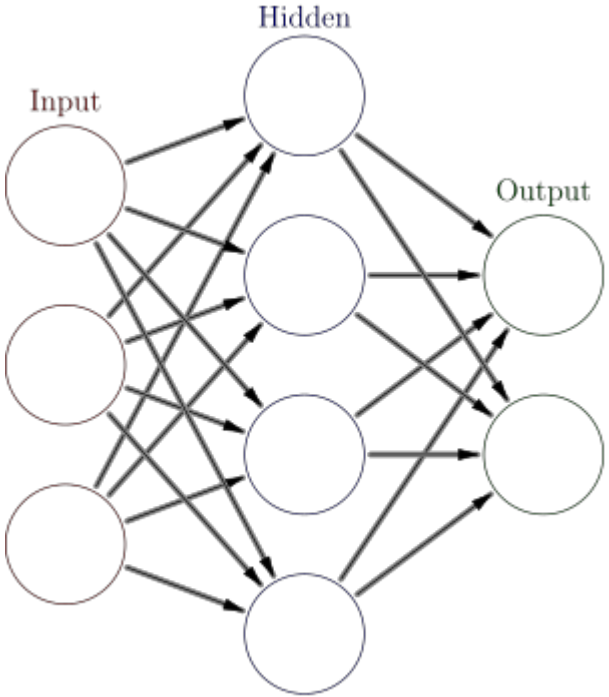
Example!

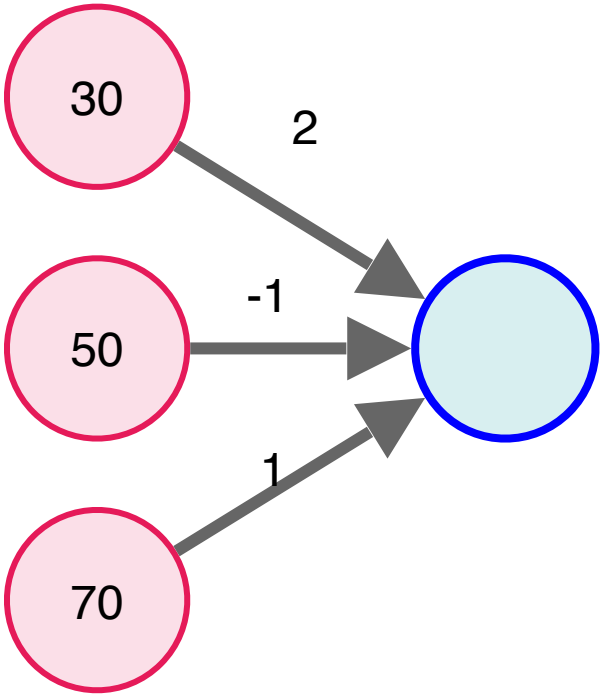
- 150 different iris flowers
- Three different types:
  - Versicolor
  - Setosa
  - Virginica
- For each flower, we know:
  - Petal length and width
  - Sepal length and width
- Can you guess which type based on that information?
- We’re going to use machine learning to train the computer how to do it!



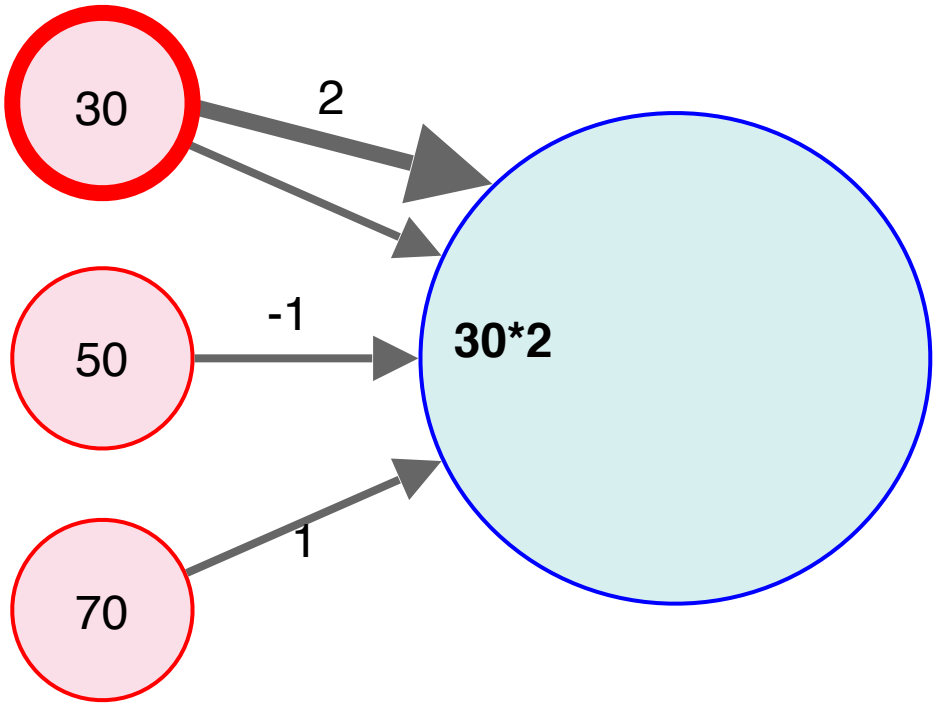

NEURAL NETWORKS

Neural Network Explanation





Neural Network Explanation



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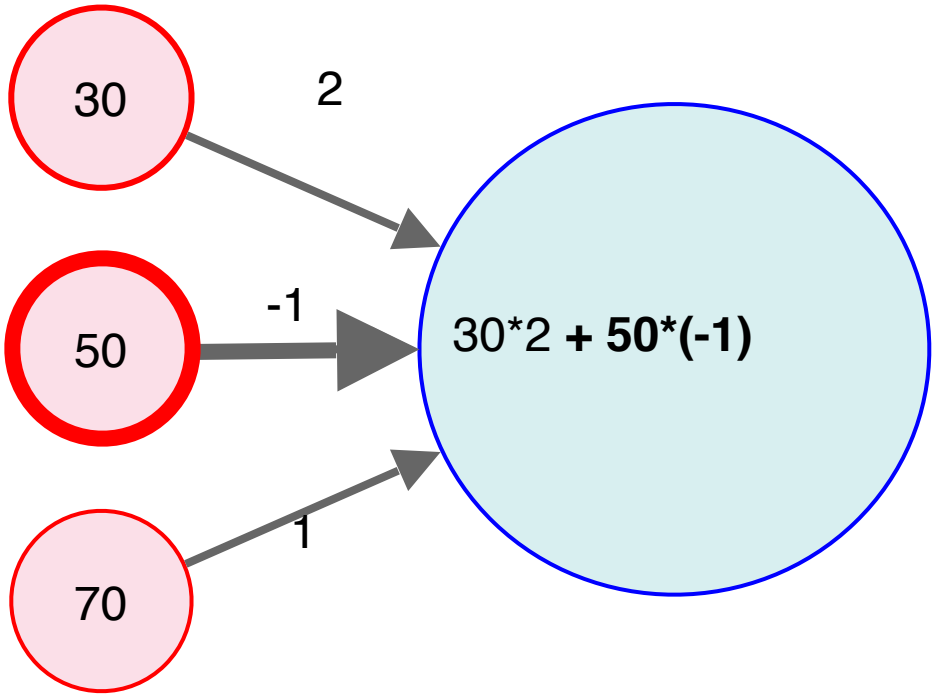

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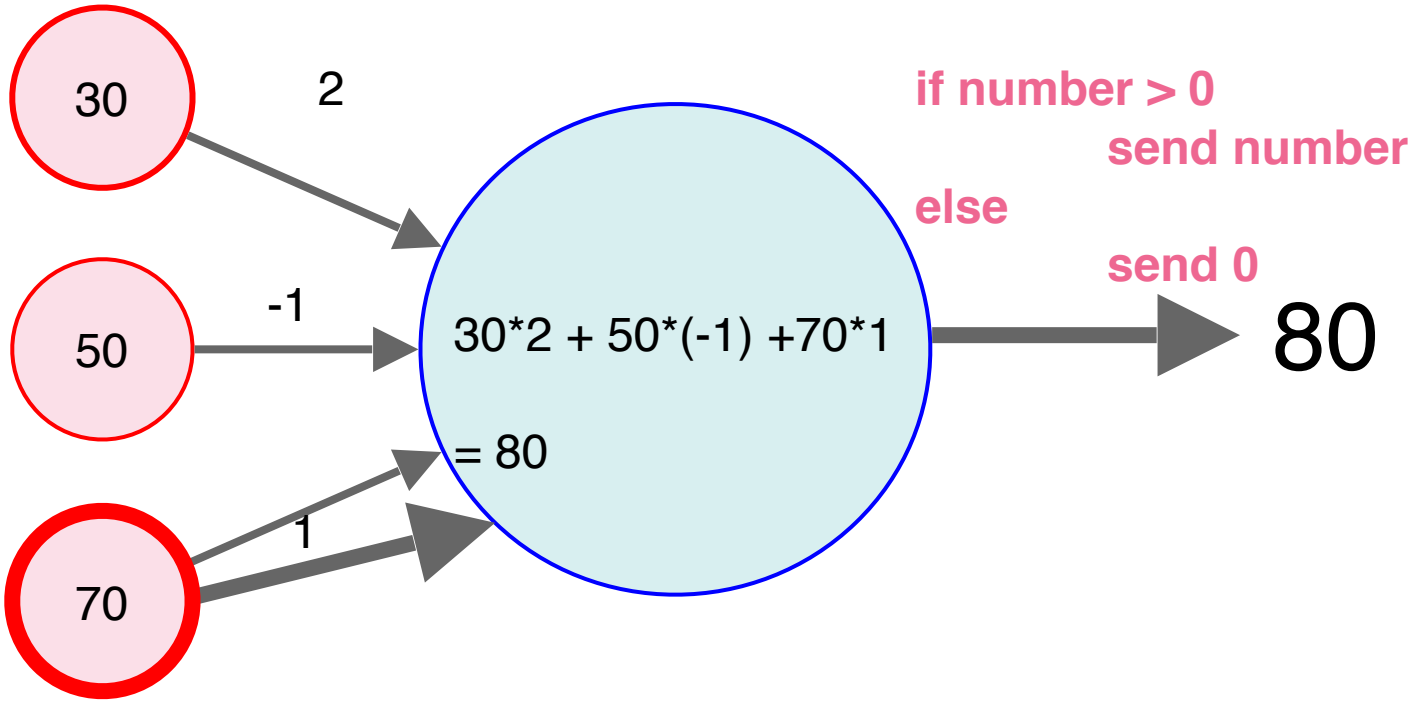
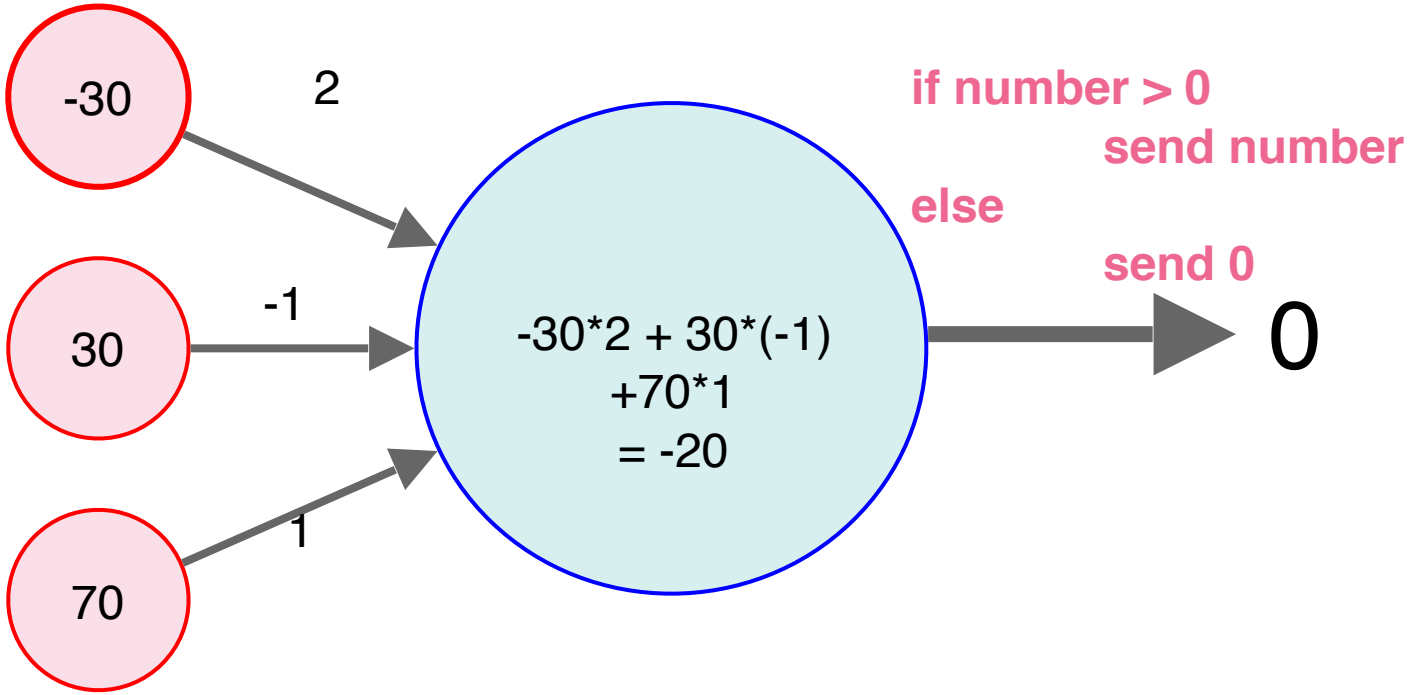


Neural Network Explanation



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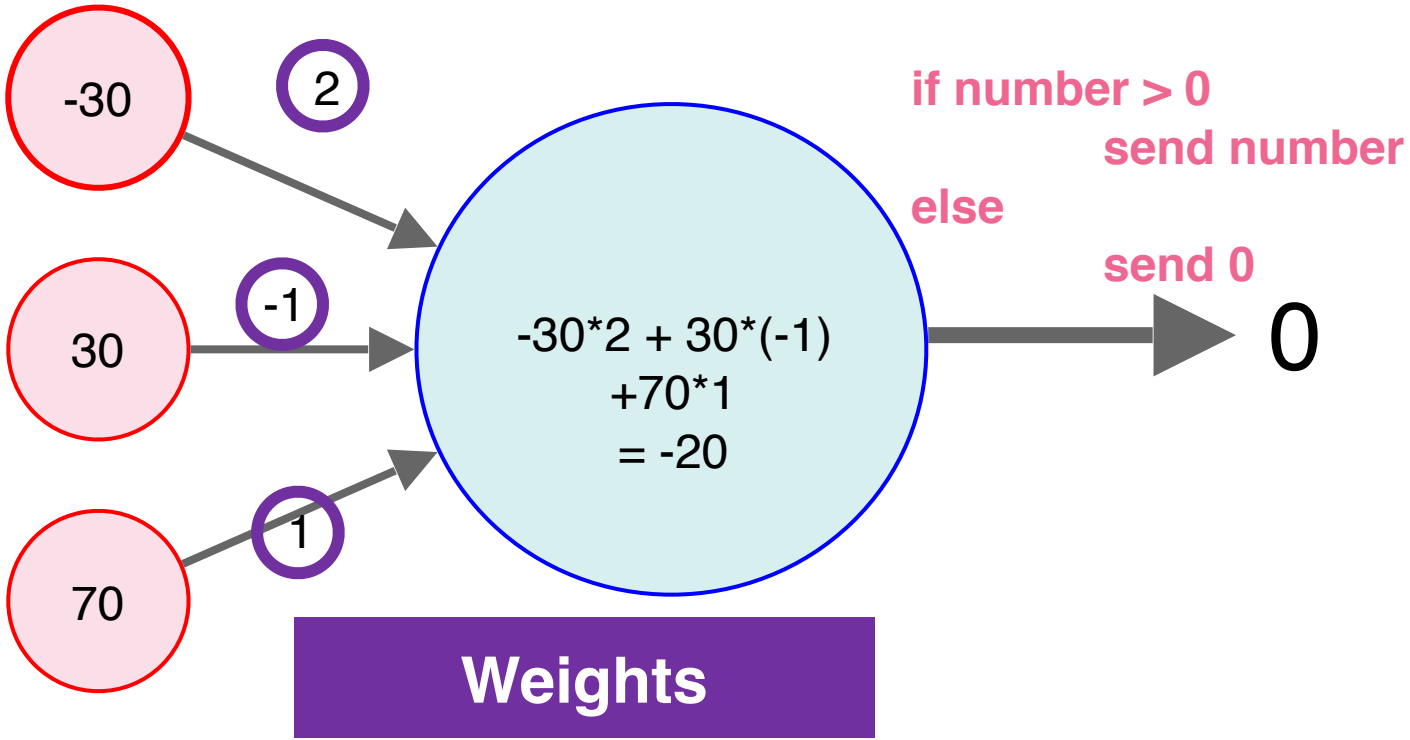
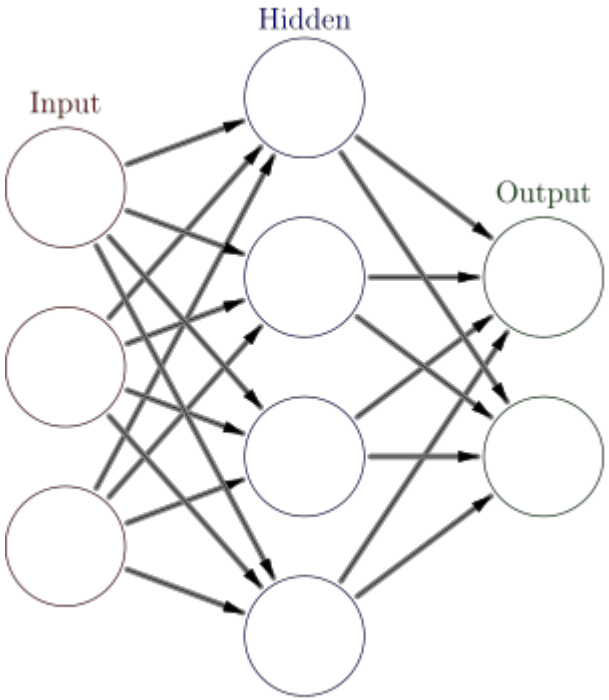
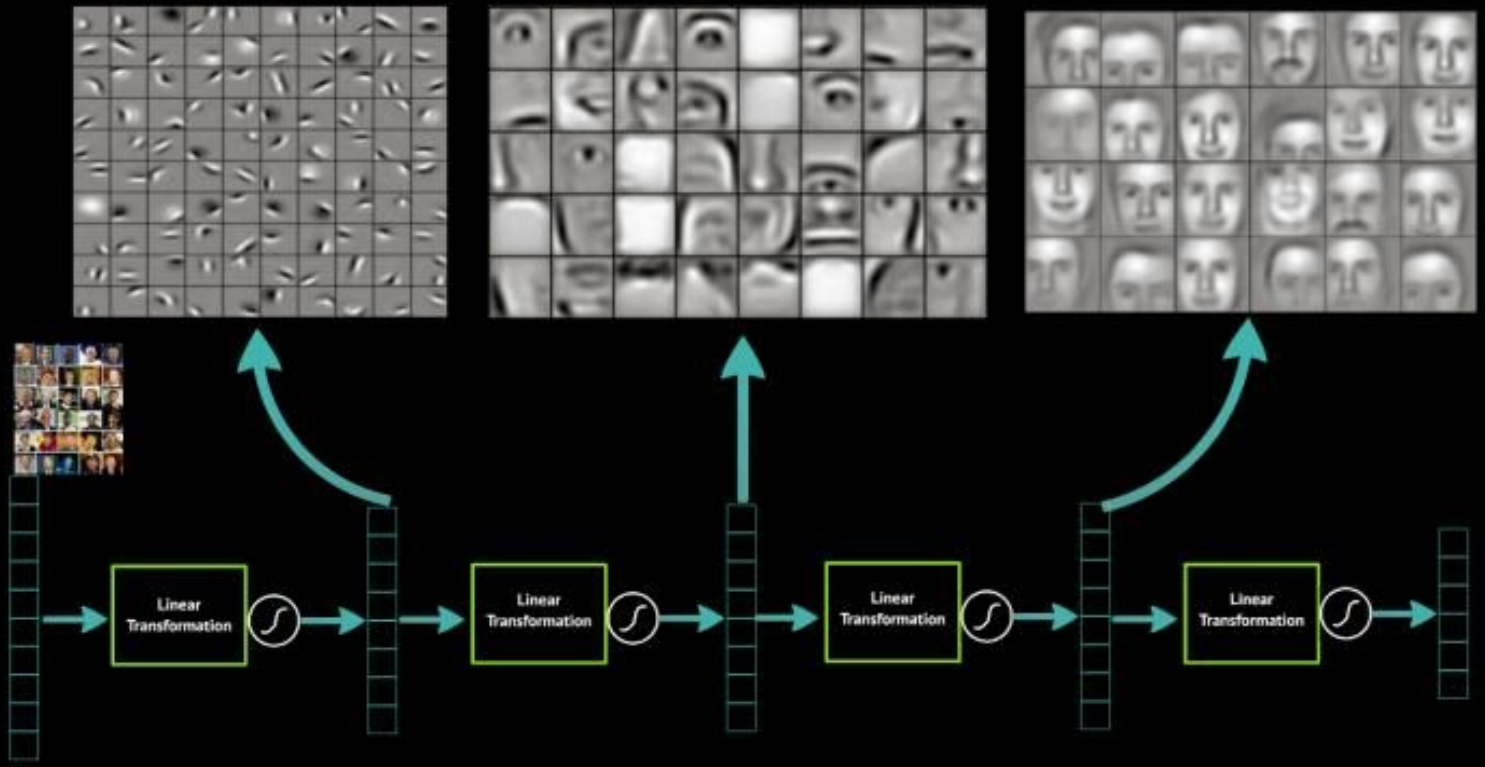


Neural Network Explanation



- “Backpropagation” is used to figure out what all of the weights should be!
- We start with a random guess, and feed the answer through the network, and see how far away it is from the right answer.
- Backpropagation uses the “error” to figure out how to change the weights so that the error gets smaller.

Deep Learning learns layers of features



www.datarobot.com/blog/a-primer-on-deep-learning/

Examples

[Train computer to play a game](http://playground.tensorflow.org/)

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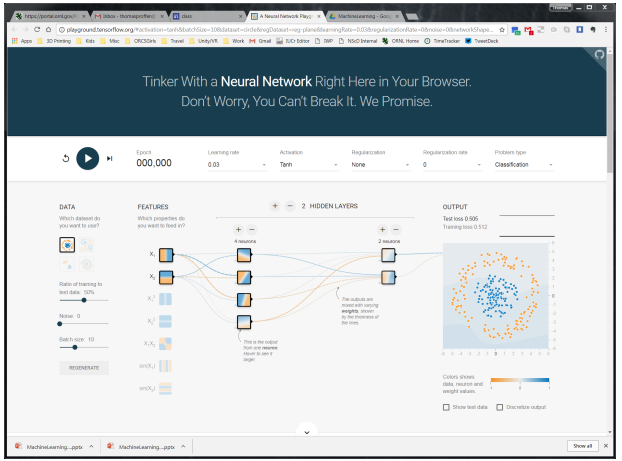

Things to play with

- **Different data sets**
  - Which ones are hard to do and which ones are easy?
- **Different number of layers or different number of hidden neurons per layer**
  - What happens for the different data sets if you remove all of the hidden layers?
  - What happens as you add more hidden layers or more neurons per layer?

Example!

Classifying digits with CNN with Keras

Example!

Classifying digits with CNN with Keras