Neural Networks - I

Understand the need for Deep Learning

Introduction to TensorFlow

Building a Model using TensorFlow

Using Keras with TensorFlow

Day - I

Classification in TensorFlow Keras

Understanding Deep Learning

Building Deep Neural Network

Model Prediction in TensorFlow Keras

Day - II

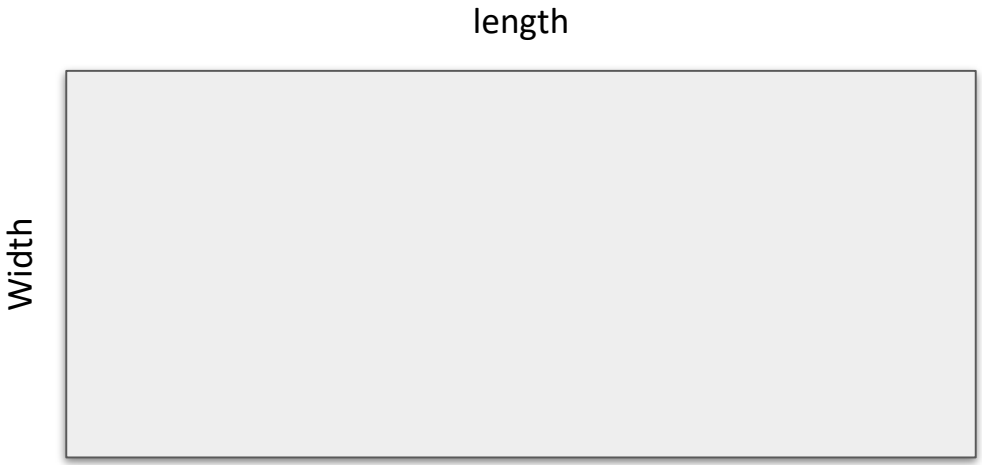
Working with

Machines

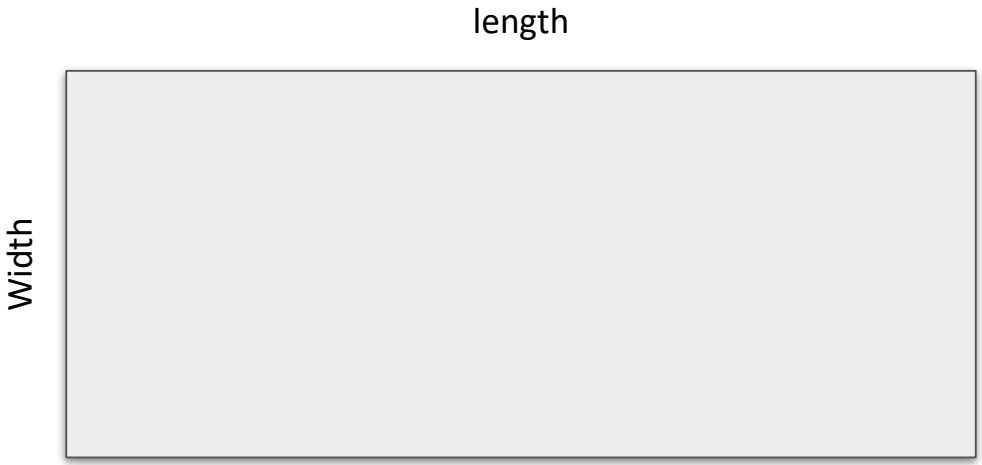
How do we make Computer do things?

Requirement

Area of a Rectangle



Area of a Rectangle



$$Area = L * W$$

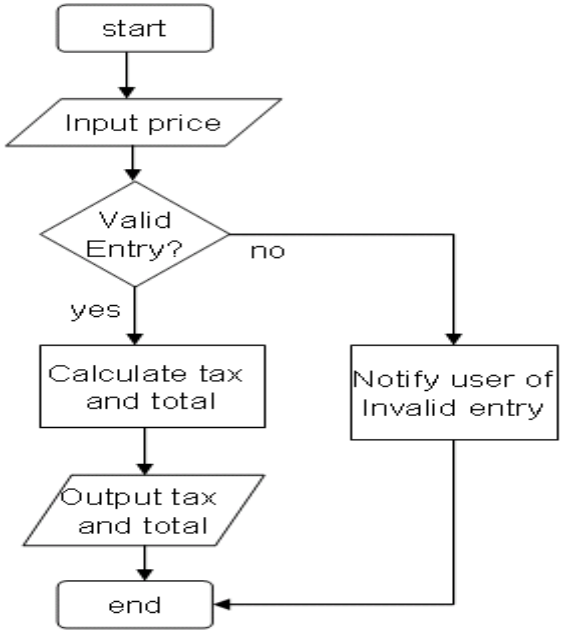
Write down steps (Algorithm)

```
START
    DISPLAY "Enter length of side one: "
    GET side1
    DISPLAY "Enter length of side two: "
    GET side2
    area = side1 * side2
    DISPLAY area
END
```

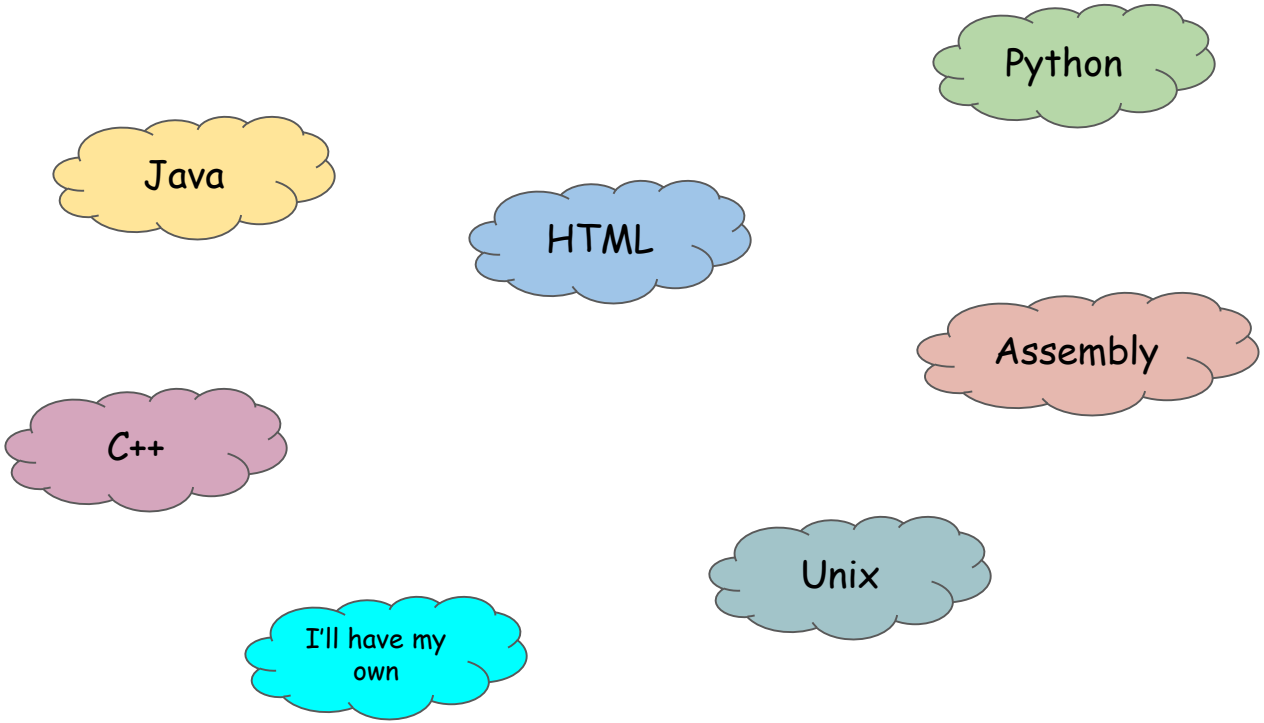
Feed it to the Computer

Calculate Sales Tax

Algorithm


start
Input price
Valid Entry?
no
yes
Calculate tax and total
Notify user of Invalid entry
Output tax and total
end

Write code!



WOOHOO!!!

Working with Machines

- Get the **requirement**

Working with Machines

- Get the **requirement**
- Build the **Logic**

Working with Machines

- Get the **requirement**
- Build the **Logic**
- Convert logic into a **Program**

Working with Machines

- Get the **requirement**
- Build the **Logic**
- Convert logic into a **Program**
- Give it to Computer

What do you see?

How about this?

Is it same?

This is very easy :)

Let’s write down the Steps…to recognize Elephant

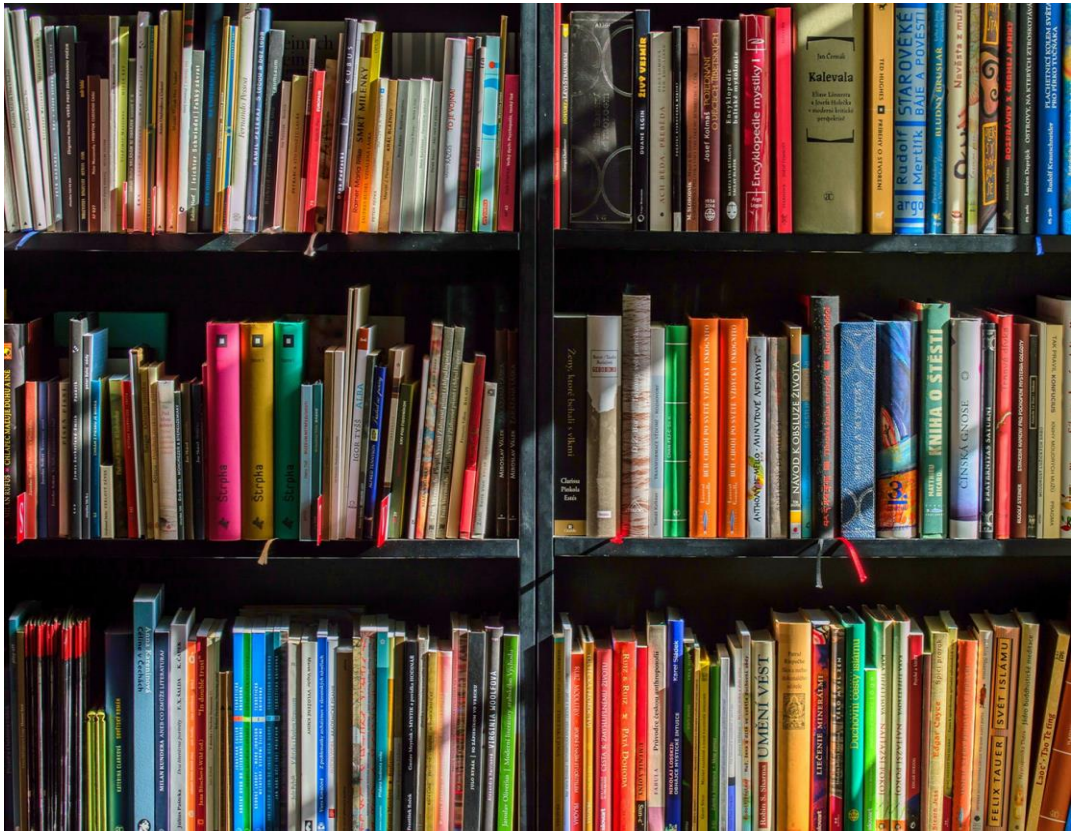
- ✔ Get the **requirement**
- ✘ Build the **Logic**
- ? Convert logic into a **Program**
- ? Give it to Computer

How does our brain understand it?

Can a machine
have

Vision?

Case Study: Google Photos



Can a machine understand

Natural Language?

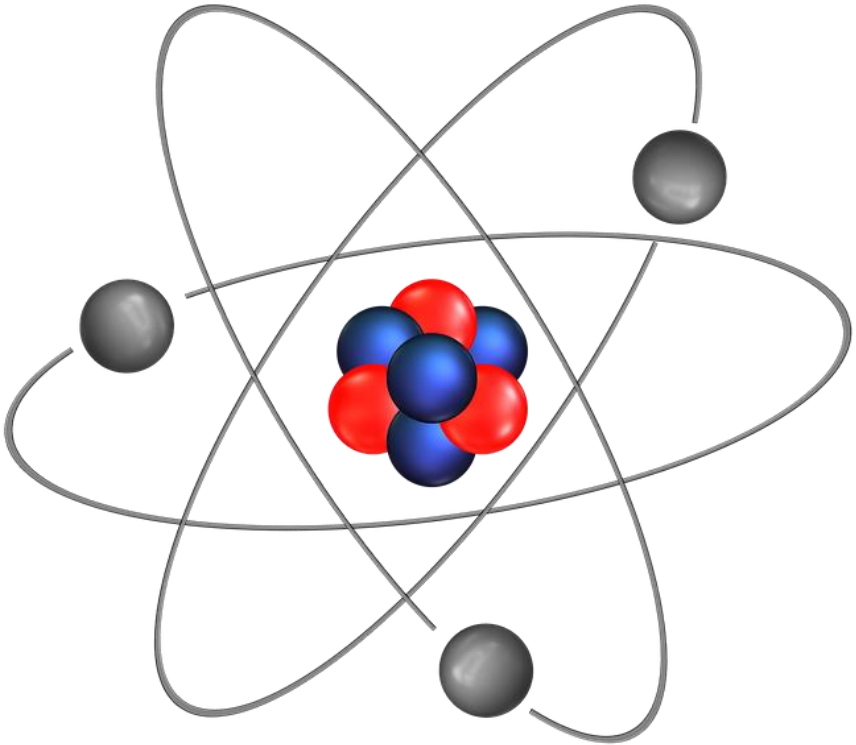
Case Study: Google Translate

Sometime even having logic …

may not help

Possible moves in Chess

10^{123}



Possible atoms in
Observable Universe

10^{80}

In 1997, IBM’s Deep Blue machine defeated Gary Kasparov

In 1997, IBM's Deep Blue machine defeated Gary Kasparov

…using huge computing capacity.

Possible moves in Go

10^{360}

Possible moves in Go

10^{360}

We can not apply brute computing capacity :(

In Mar 2016, Google's AlphaGo defeated Lee Sedol

In Mar 2016, Google's AlphaGo defeated Lee Sedol

…by 'learning' to play 'Go'

Recognize objects

Understand Language

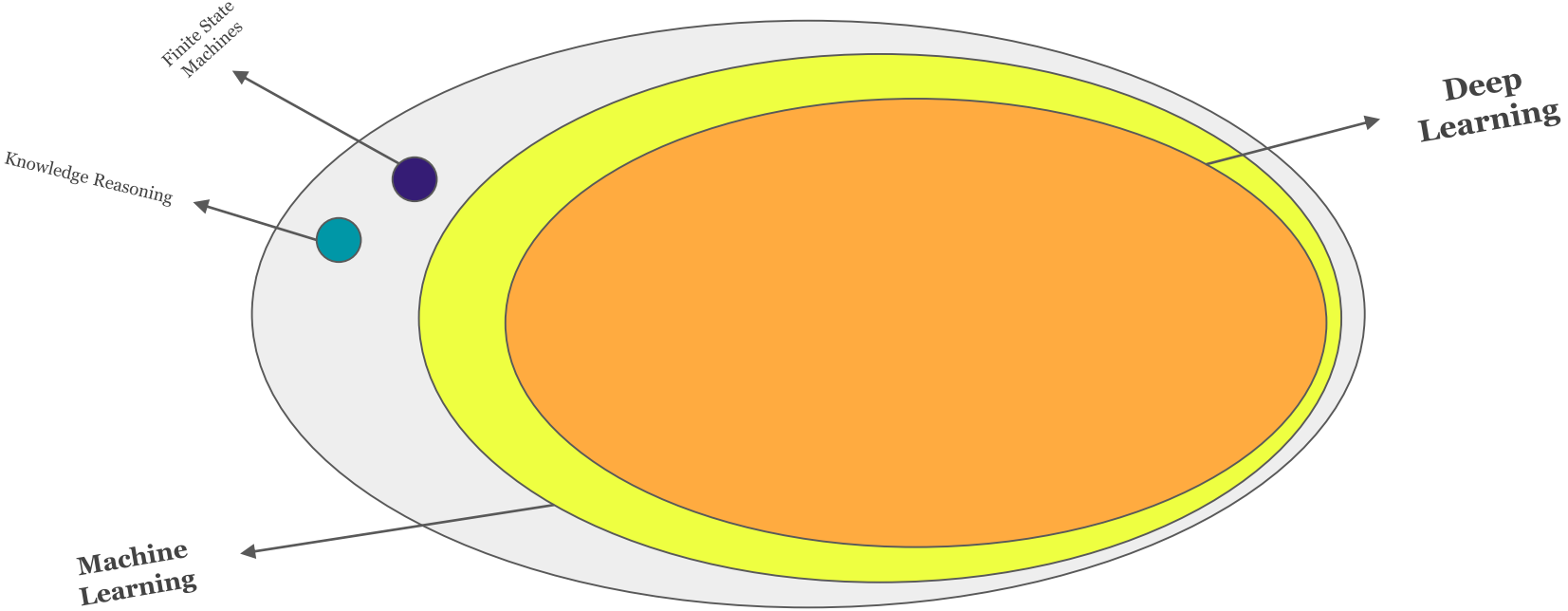
Play complex games

Machine demonstrates an ability to…
Think, Reason

Artificial Intelligence

How do we build AI?

AI World


Finite State Machines
Knowledge Reasoning
Machine Learning
Deep Learning

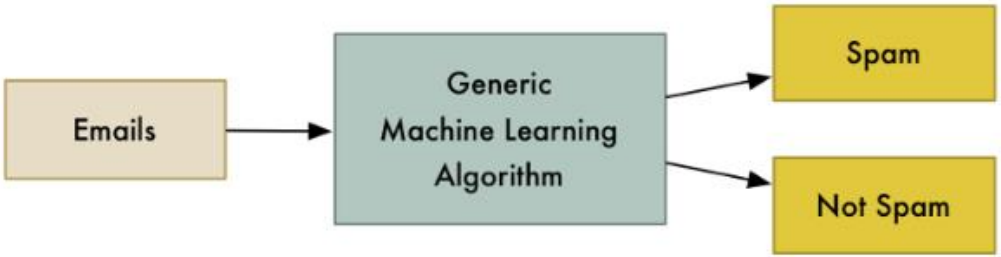
What is
Machine Learning?

Machine learning (ML) allows computers to do things....

without our logic

Computer program themselves

Instead of writing code, we feed the data to the Generic algorithms



...and it builds its own logic based on the data.

How did we 'humans' learn to recognize Elephants?

How Machine builds logic

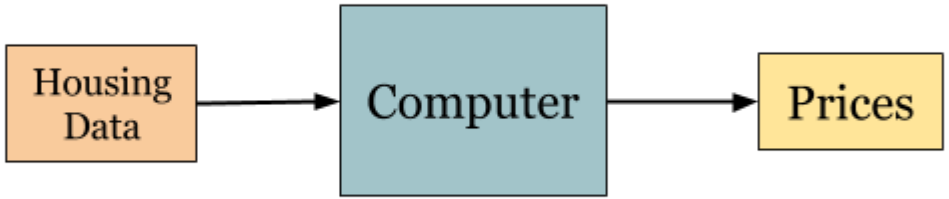
Sq. Ft	Neighbourhood	Bedrooms	Price (‘000)
2000	Gachibowli	3	180
1750	Jubilee Hills	3	210
1100	Kukatpally	2	55
900	Gachibowli	2	72
1245	KPHB	3	60
…	…	…	…
…	…	…	…

Real-Estate Data

Requirement

Sq. Ft	Neighbourhood	Bedrooms	Price (‘000)
1250	Gachibowli	3	???

Machine to build its own program



What will Machine try to build?

$$\text{Price} = W_1 * \text{Sq. Ft.} + W_2 * \text{Bedrooms} + W_3 * \text{Neighbourhood}$$

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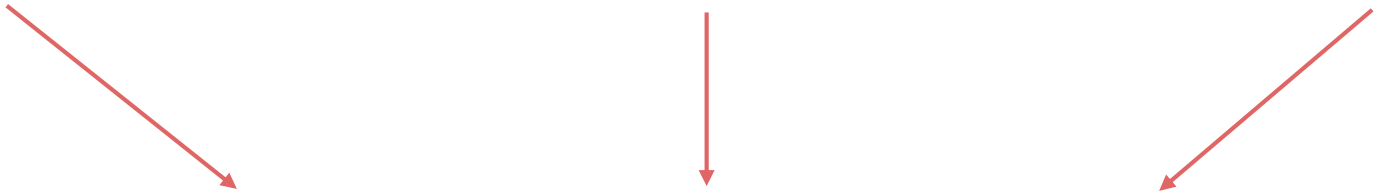


$$y = W_1 * x_1 + W_2 * x_2 + W_3 * x_3$$

ML Terminology

- Weights : W_1, W_2, W_3
- Features : x_1, x_2, x_3
- Target / Prediction / Output : y

Handling bias in Data

$$y = W_1 x_1 + W_2 x_2 + W_3 x_3 + b$$

How do I choose
Weights and bias?

$$y = W_1 x_1 + W_2 x_2 + W_3 x_3 + b$$

Pick random values

Sq. Ft	Bedrooms	Neighbourhood	Actual Price	Machine Price	Loss
2000	3	Gachibowli	160	118	42
1750	3	Jubilee Hills	230	269	-39
1100	2	Kukatpally	55	67	-12
900	2	Gachibowli	92	83	9
1245	3	KPHB Colony	60	60	0
		Total			**0**

Is machine's logic good?

Another way to calculate Loss

$$Loss = \frac{\sum_{i=1}^{m} (Prediction_i - Actual_i)^2}{2 \times m}$$

$m \rightarrow number\ of\ examples$

$$J(\theta) = \frac{1}{2m} \sum_{i=1}^{m} \left(h_\theta(x^{(i)}) - y^{(i)} \right)^2$$

More complex way :)

Sq. Ft	Bedrooms	Neighbourhood	Actual Price	Machine Price	Loss
2000	3	Gachibowli	160	118	$(42)^2$
1750	3	Jubilee Hills	230	269	$(-39)^2$
1100	2	Kukatpally	55	67	$(-12)^2$
900	2	Gachibowli	92	83	$(9)^2$
1245	3	KPHB Colony	60	60	$(0)^2$
		Total			**3510**

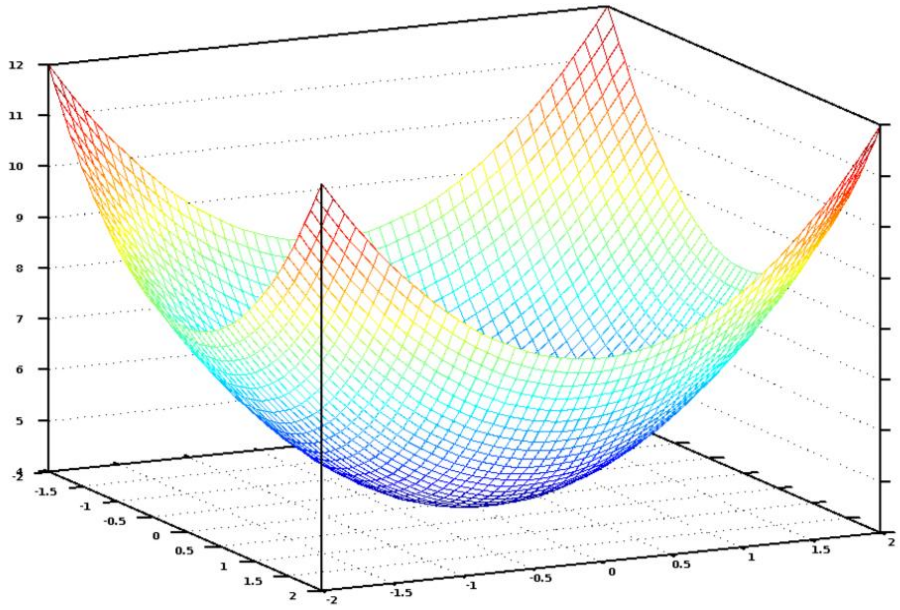
$$Loss = 3510 / (2 * 5) = 351$$

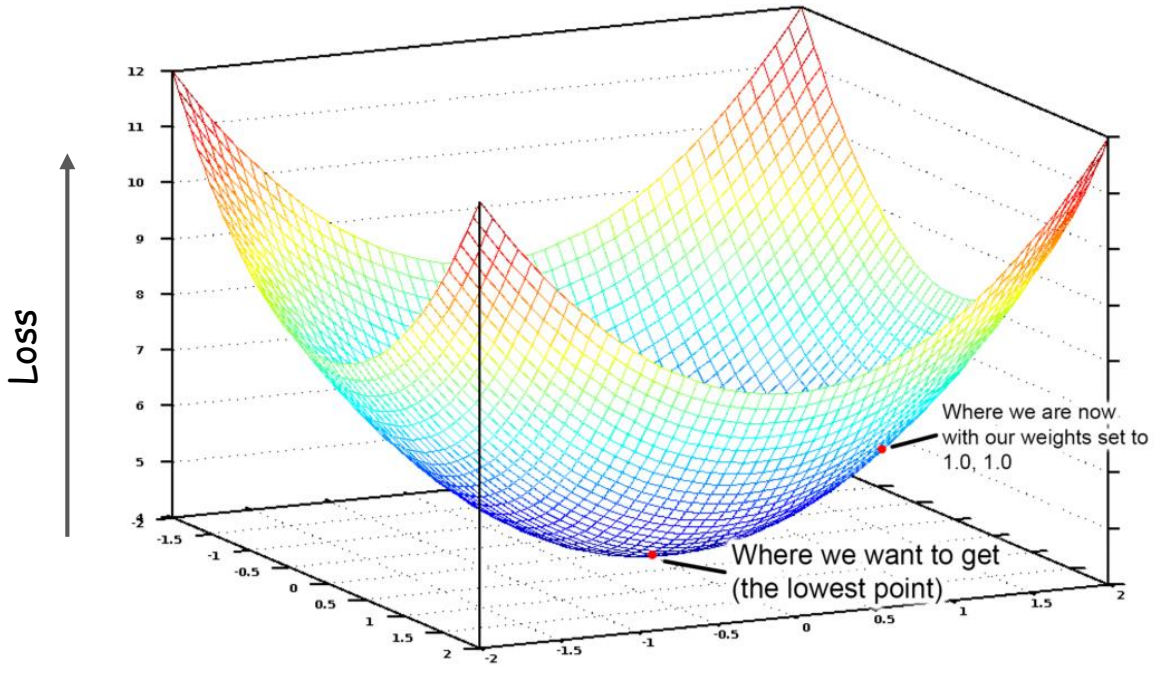
What is the machine’s goal?

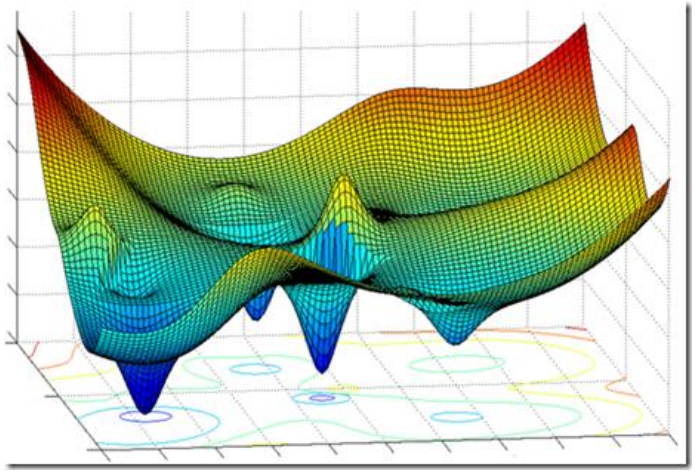
Find weights and bias to minimize ‘Loss’

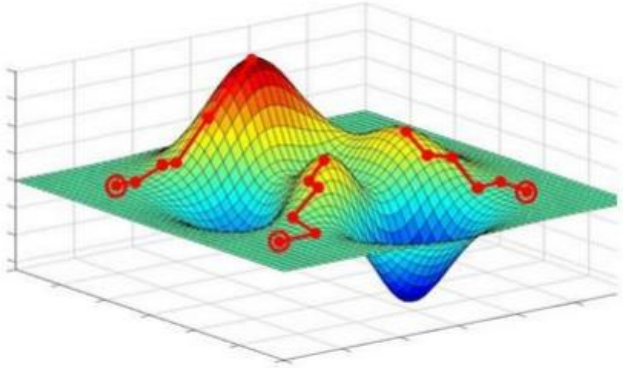
How do I decide on next set of weights?

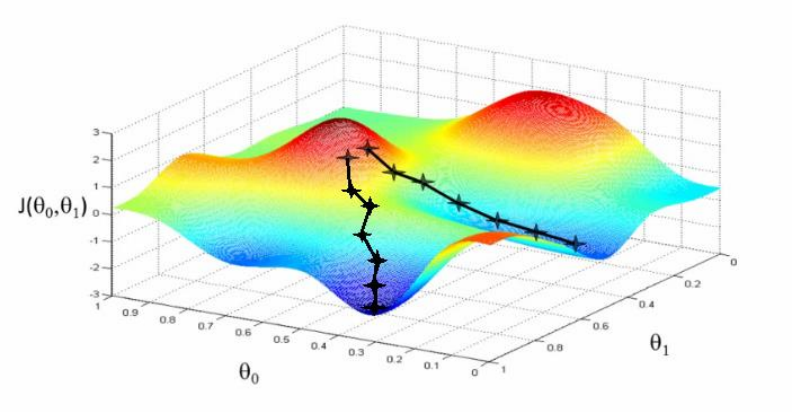
The world of Gradient Descent


12
11
10
9
8
7
6
5
4
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2


Loss
Where we are now
with our weights set to
1.0, 1.0
Where we want to get
(the lowest point)







Usually it's not pretty

What is Gradient?

$$\frac{d}{dx} f(x_0) = \lim_{h \to 0} \frac{f(x_0+h) - f(x_0)}{h}$$

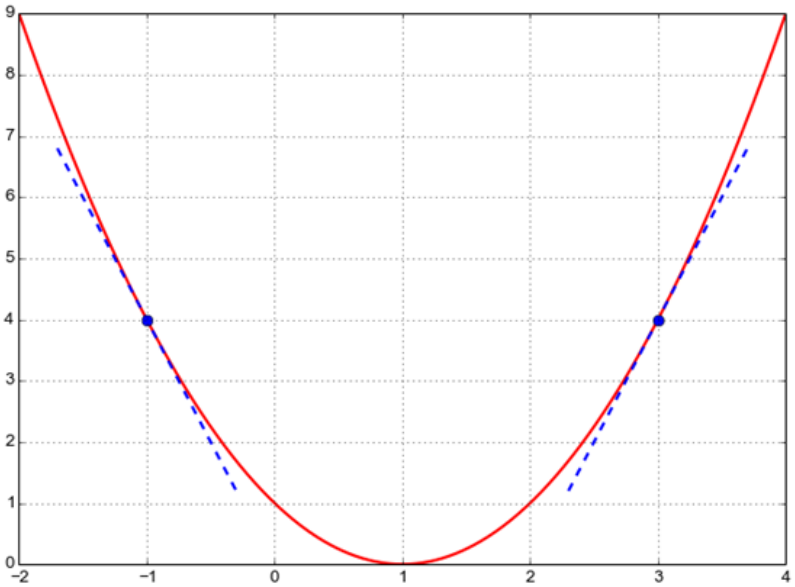
Derivative of a function

$$Loss = \frac{\sum_{i=1}^{m} (Prediction_i - Actual_i)^2}{2 \times m}$$

What function we want to minimize?

Visualizing a simple function

$$f(x) = (x-1)^2$$



Derivative when X = 3

$$\frac{d}{dx}f(3) = \lim_{h\to 0}\frac{f(3+h)-f(3)}{h}$$

$$= \lim_{h\to 0}\frac{(3+h-1)^2-(3-1)^2}{h}$$

$$= \lim_{h\to 0}\frac{h^2+4h}{h}$$

$$= \lim_{h\to 0} h + 4 = 4$$

Derivative when X = 3

$$\frac{d}{dx}f(3) = \lim_{h\to 0}\frac{f(3+h)-f(3)}{h}$$

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$$= \lim_{h\to 0}\frac{h^2+4h}{h}$$

$$= \lim_{h\to 0} h + 4 = 4$$

A **positive** derivative indicates that function f(x) is increasing.

Derivative when X = -1

$$\frac{d}{dx}f(-1) = \lim_{h\to 0}\frac{f(-1+h)-f(-1)}{h}$$

$$= \lim_{h\to 0}\frac{(-1+h-1)^2-(-1-1)^2}{h}$$

$$= \lim_{h\to 0}\frac{h^2-4h}{h}$$

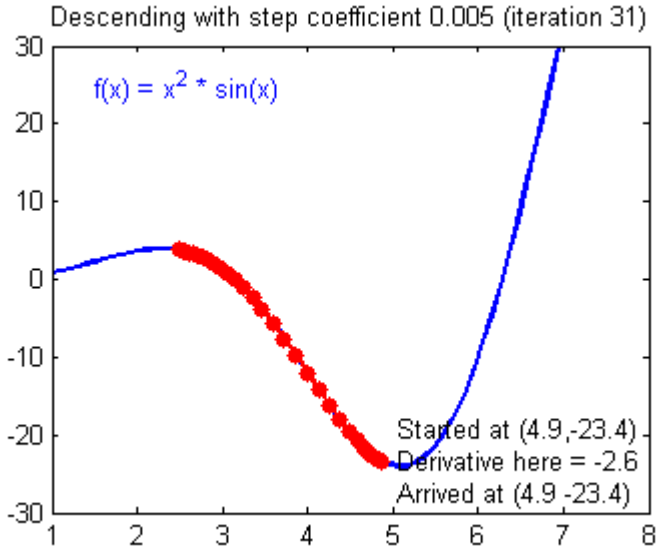
$$= \lim_{h\to 0} h-4 = \quad -4$$

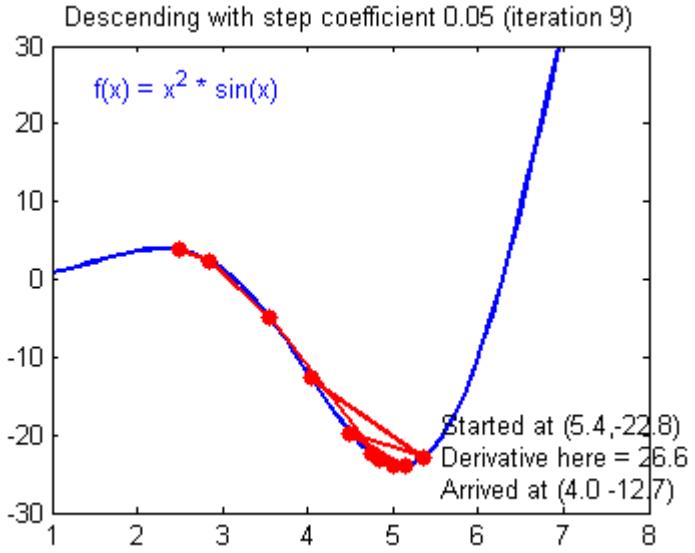
A **negative** derivative indicates that function f(x) is decreasing.

New value of X

$$x_{new} = x_{old} - \eta \frac{d}{dx} f(x_{old})$$

Example: Gradient Descent





New value of weight

$$w_{new} = w_{old} - \eta \frac{d}{dw} J(w_{old})$$

Loss function

Individual weights

$$w_{1(new)} = w_{1(old)} - \eta \frac{d}{dw_1} J(w_{1(old)})$$

$$w_{2(new)} = w_{2(old)} - \eta \frac{d}{dw_2} J(w_{2(old)})$$

$$w_{3(new)} = w_{3(old)} - \eta \frac{d}{dw_3} J(w_{3(old)})$$

What about bias?

$$b_{new} = b_{old} - \eta \frac{d}{db} J(b_{old})$$

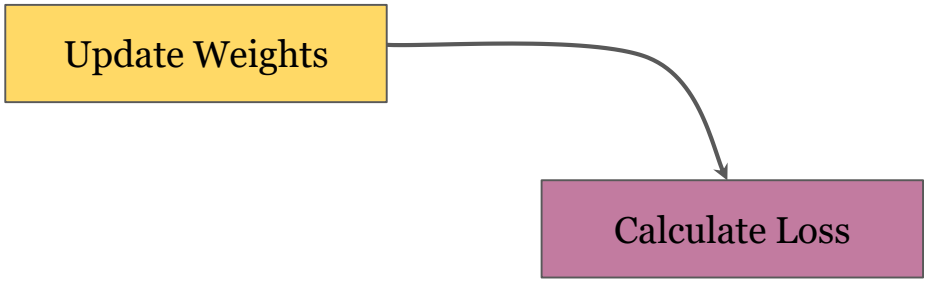
Learning Rate

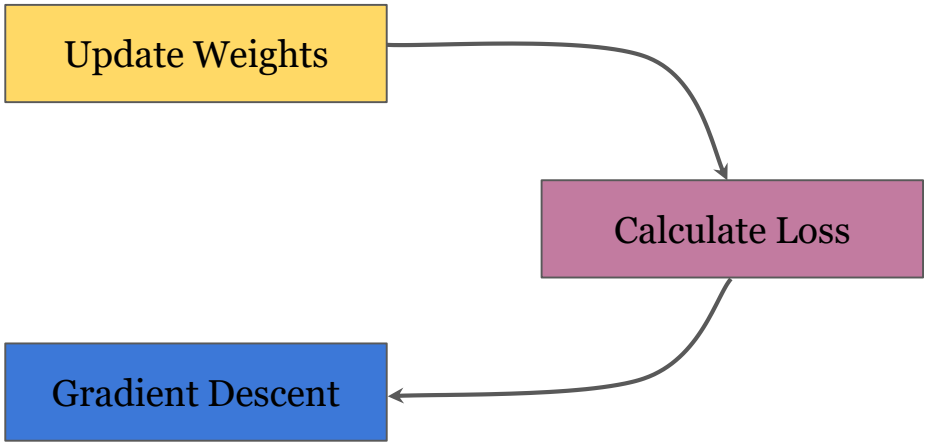
$$w_{new} = w_{old} - \eta \frac{d}{dw} J(w_{old})$$

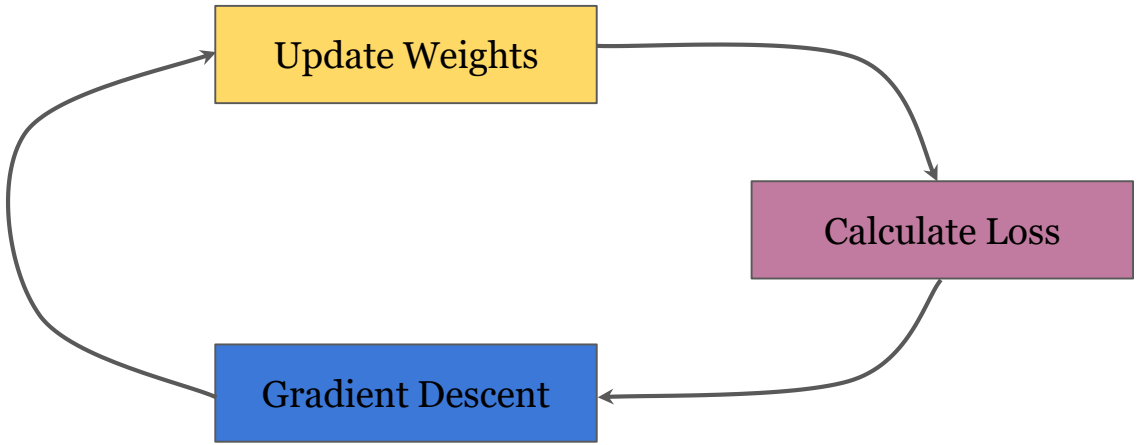
What should be value of learning rate?

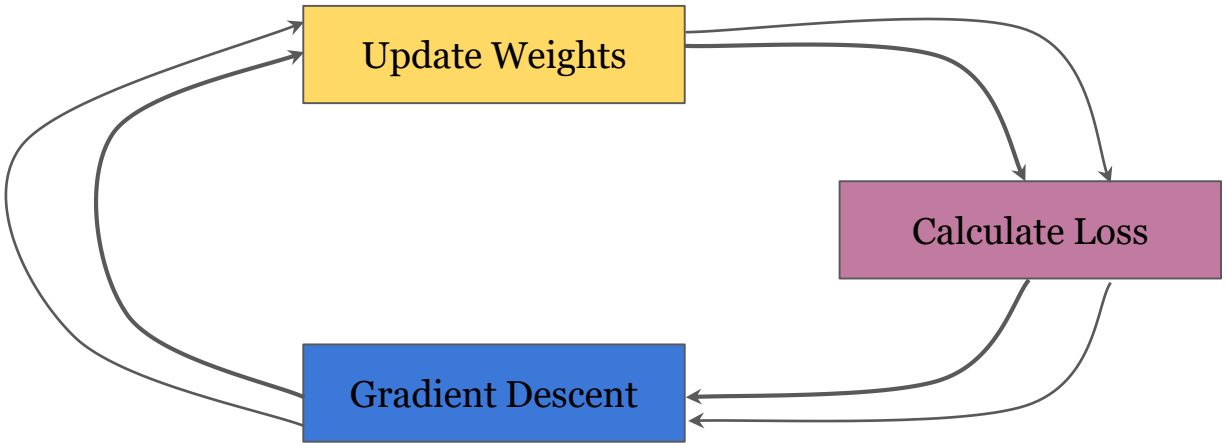
What's Next?

Update Weights

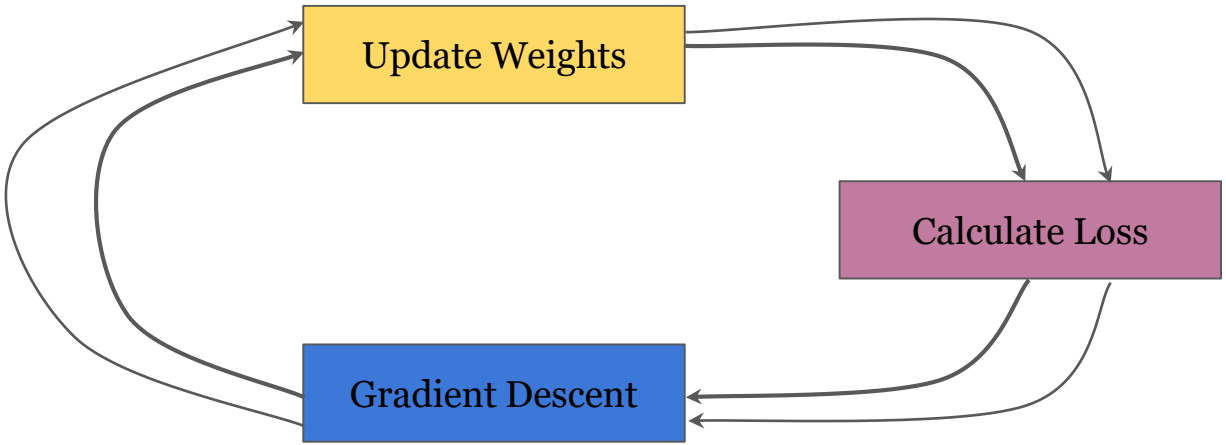

Update Weights
Calculate Loss


Update Weights
Calculate Loss
Gradient Descent


Update Weights
Calculate Loss
Gradient Descent



Do this multiple times...



Do this multiple times...

After lot of iterations…

$$y = 8369.175 * x_1 + 1.84732 * x_2 - 23.65543 * x_3 + 22.121977$$