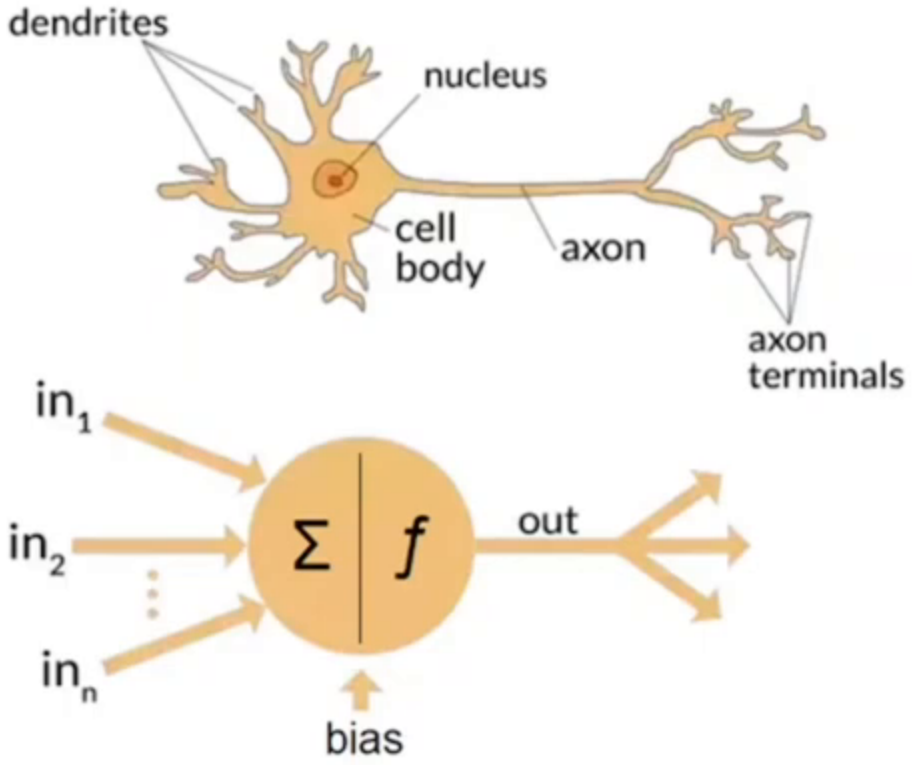
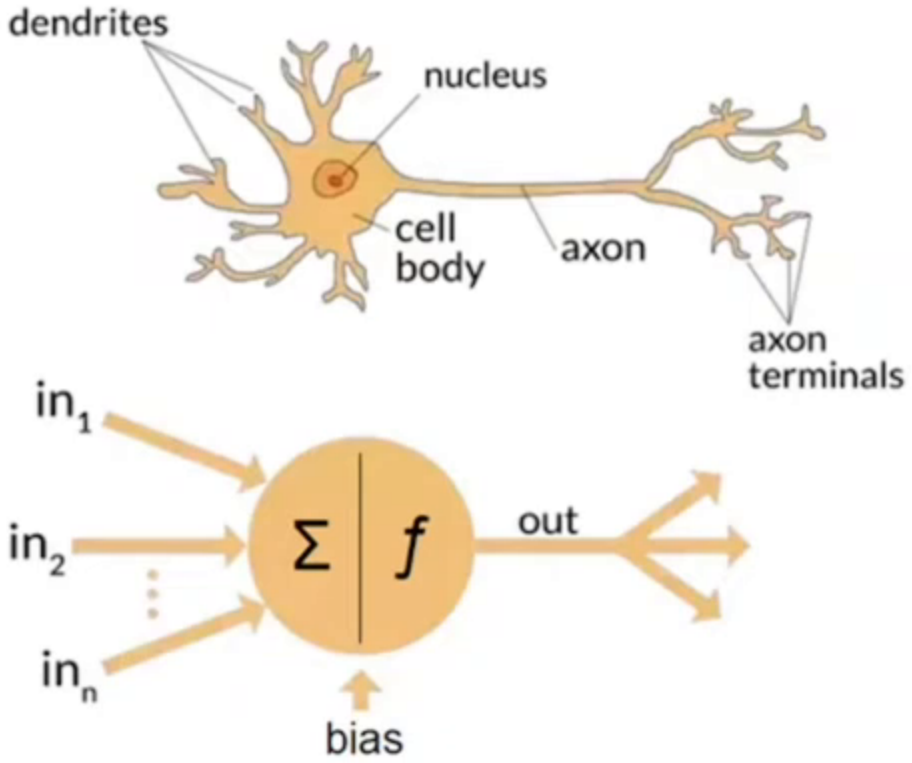
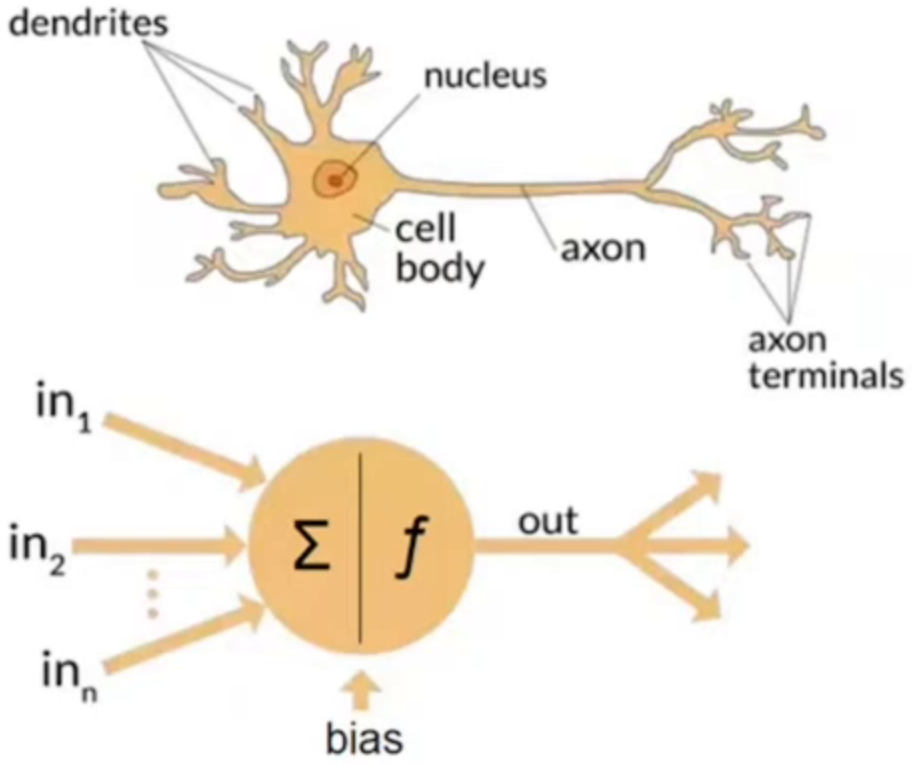
Neural Networks from Scratch



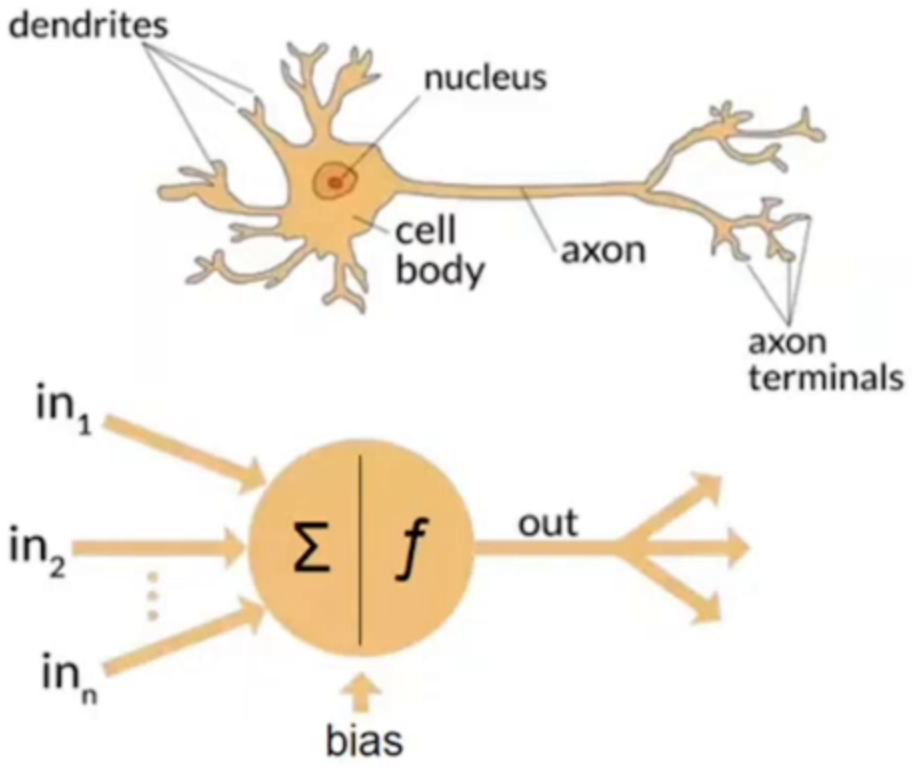
Neural Networks from Scratch



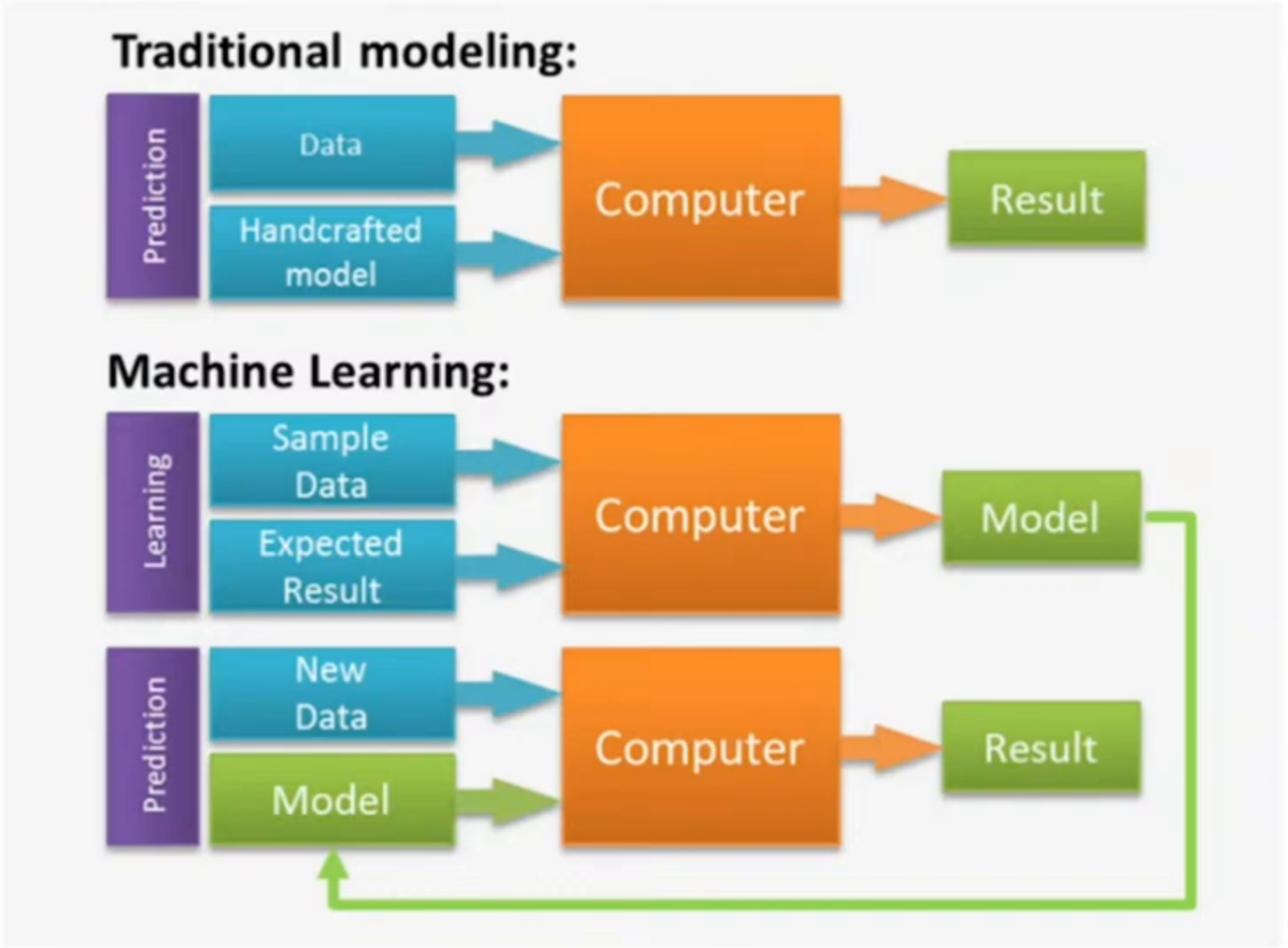
Neural Networks from Scratch



Neural Networks from Scratch



Introduction



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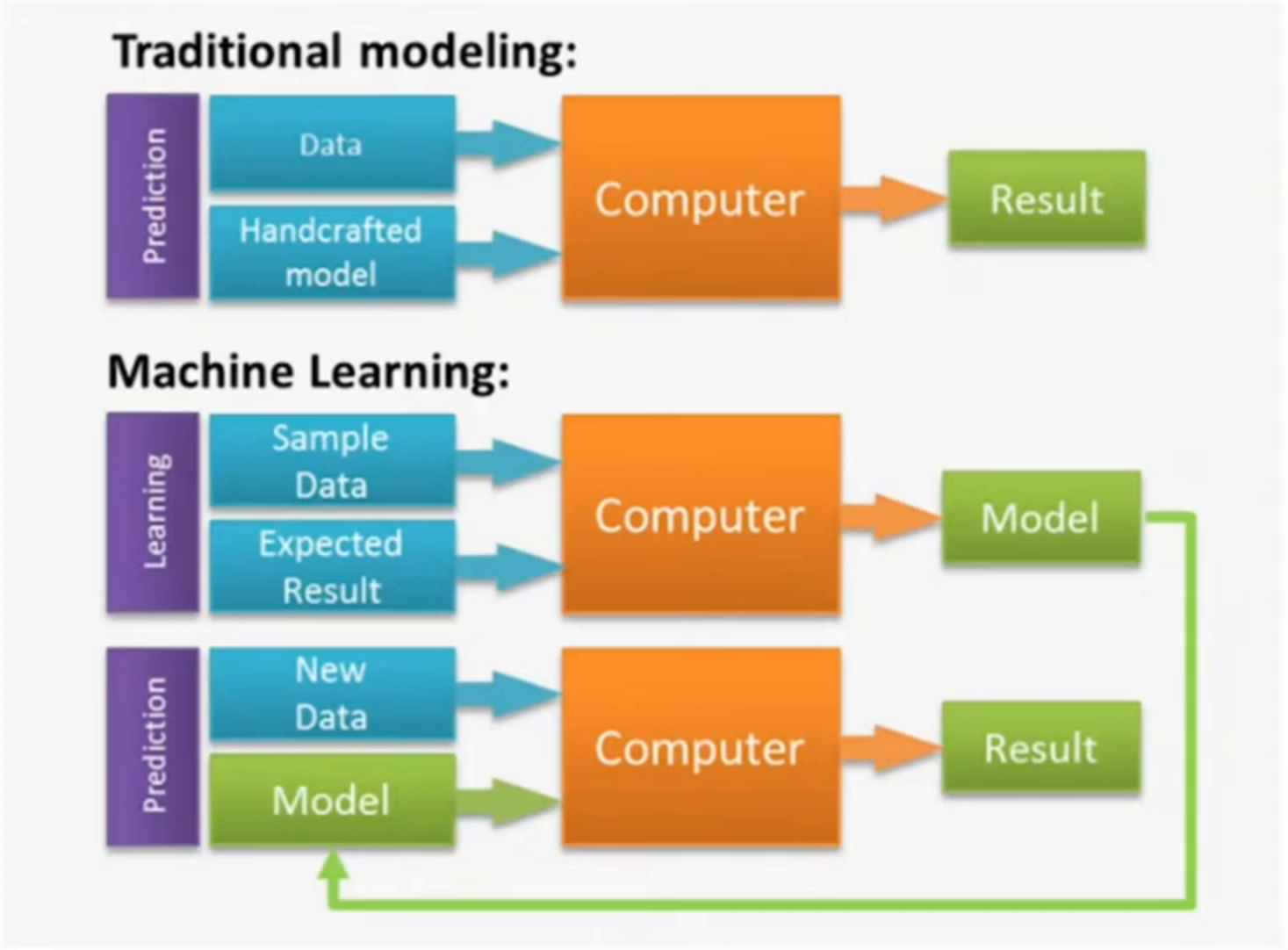
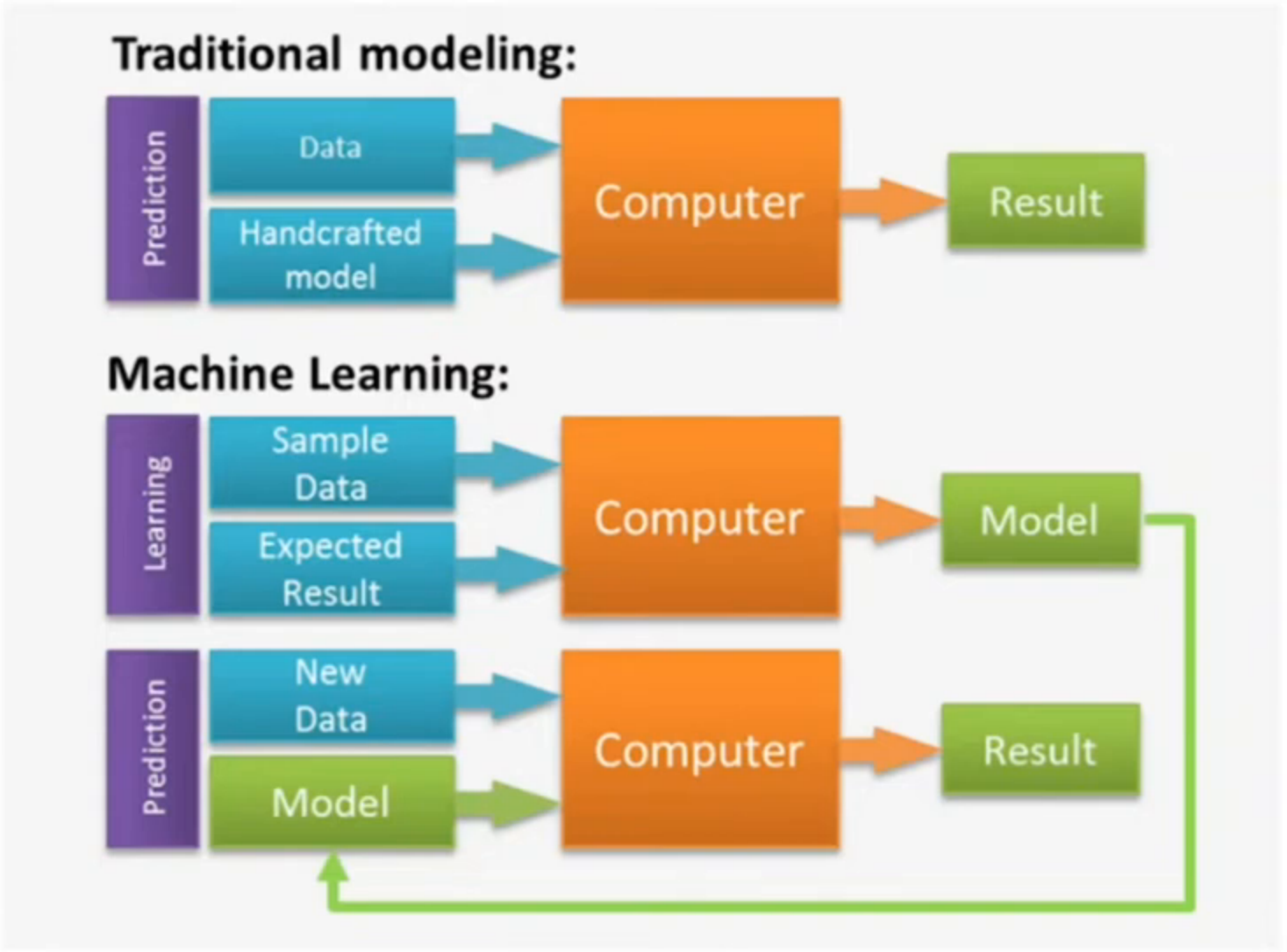


Introduction



Example

Machine Learning:

Sample

Label

dog

cat

horse

Human Learning:

We learn through

Examples

Long Ear Black nose

dog

Diagrams

Comparisons

Example

Machine Learning:

Sample

Label

dog

cat

horse

Human Learning:

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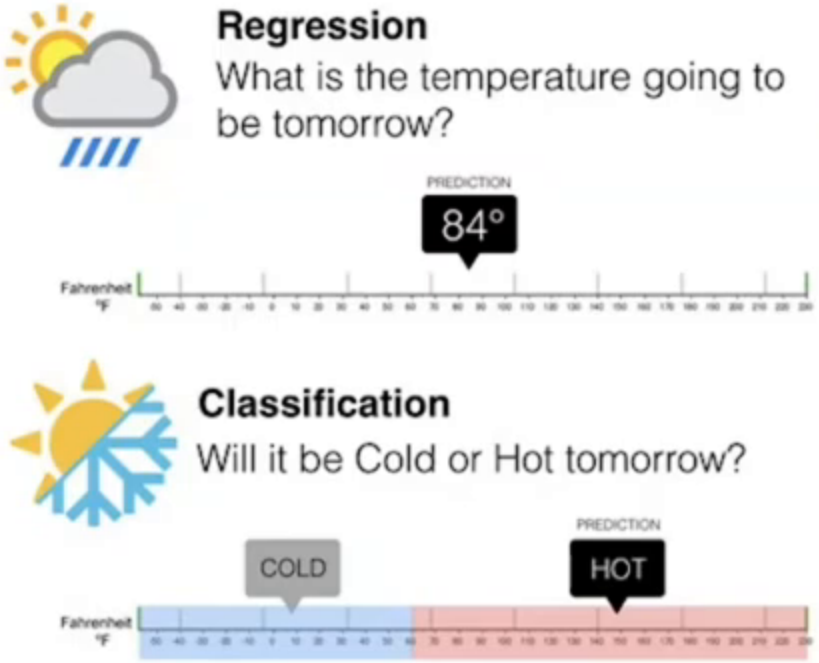
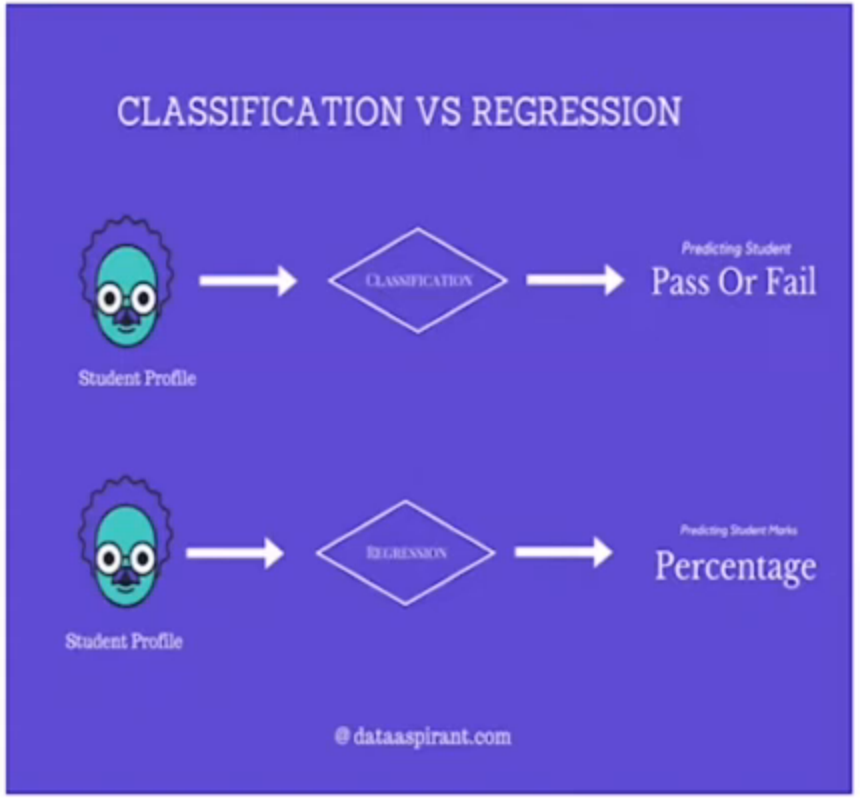
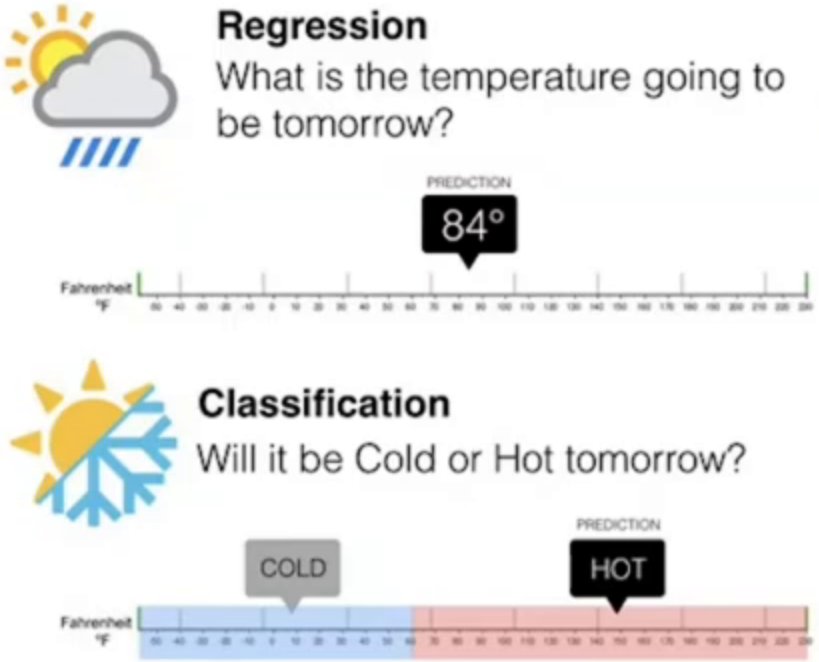
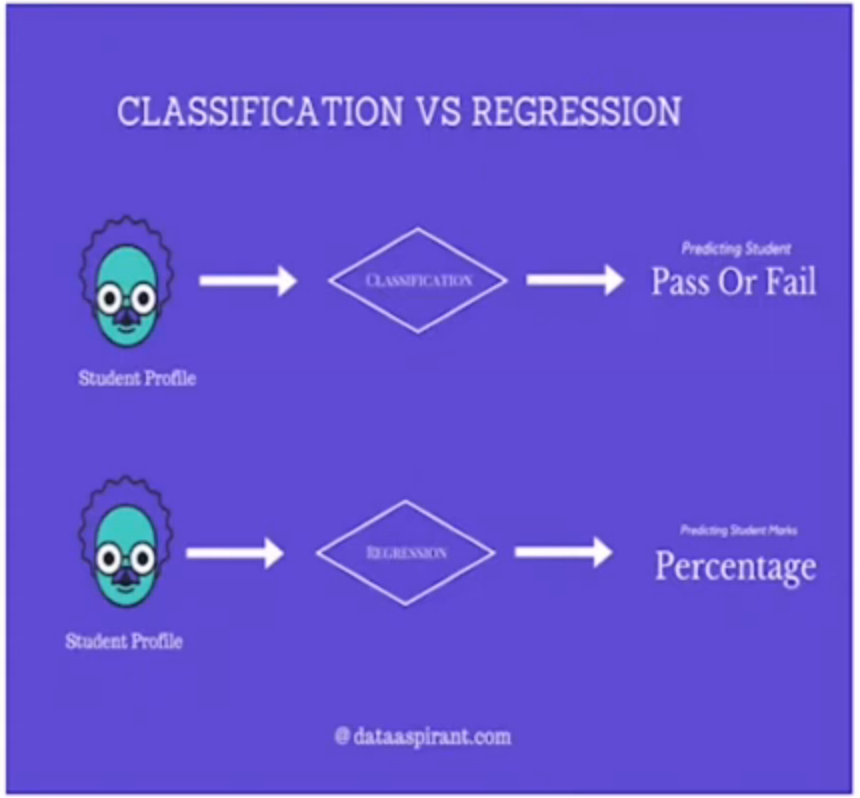
Common Tasks





Common Tasks

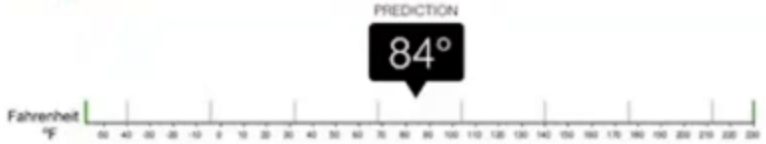




Common Tasks

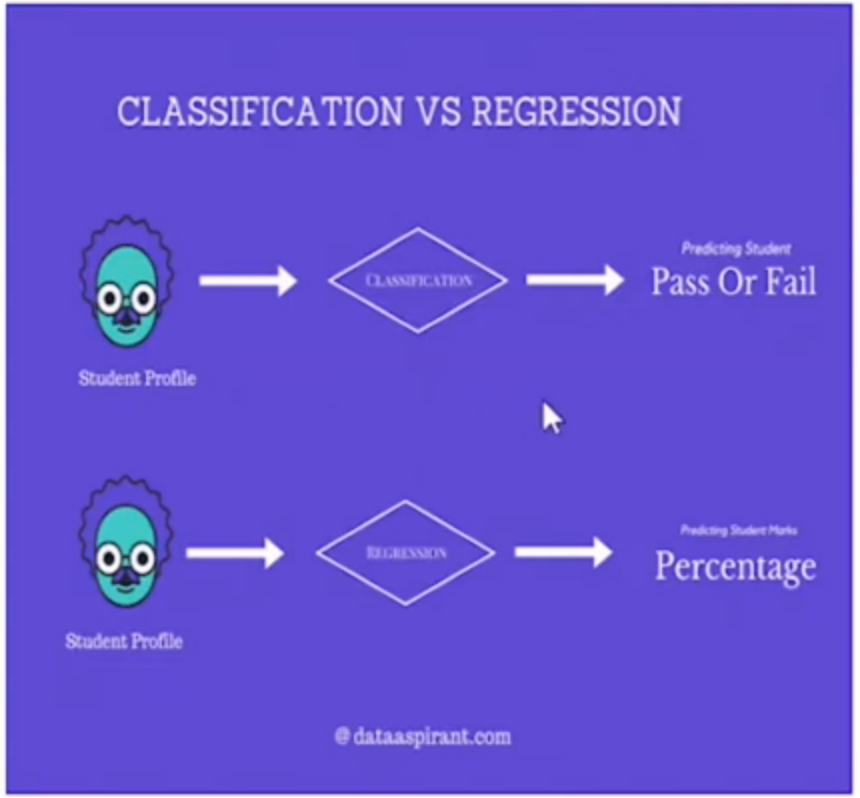
Regression

What is the temperature going to be tomorrow?



Classification

Will it be Cold or Hot tomorrow?



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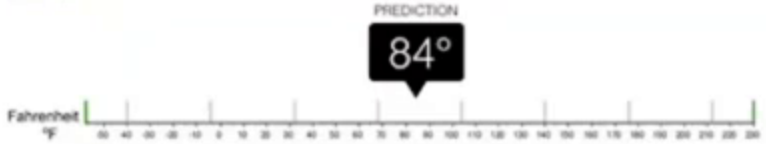

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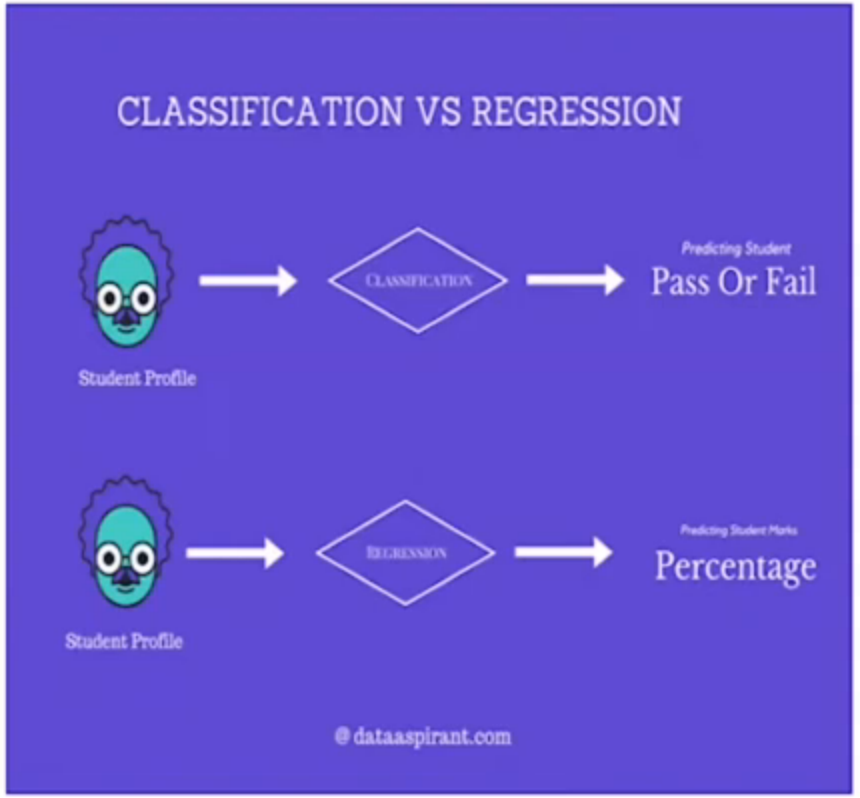

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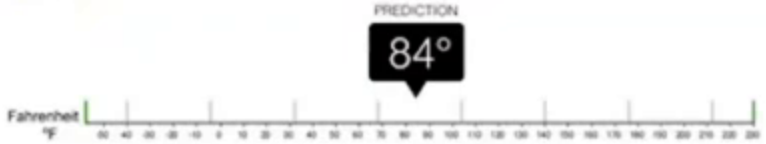

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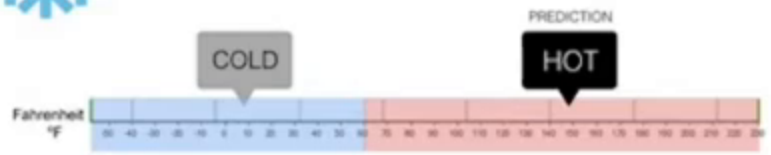
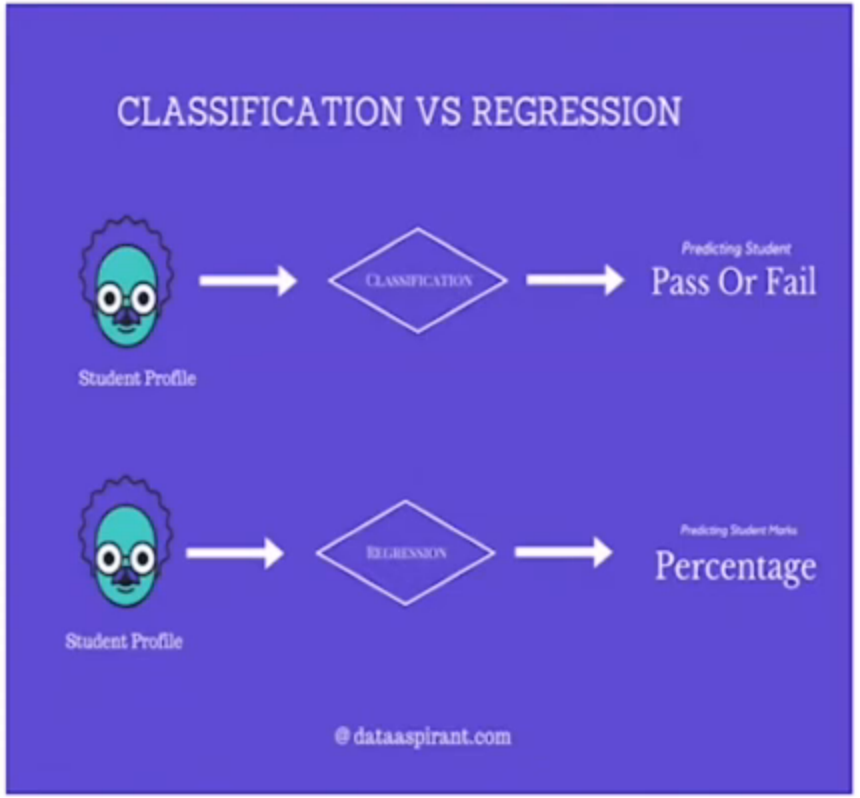
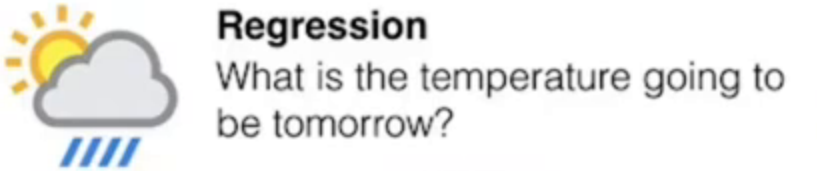




Common Tasks



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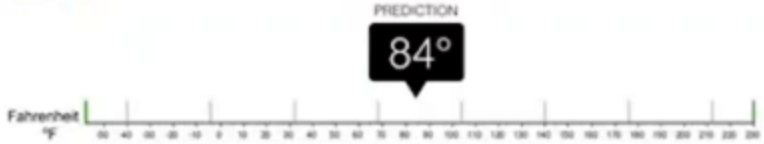

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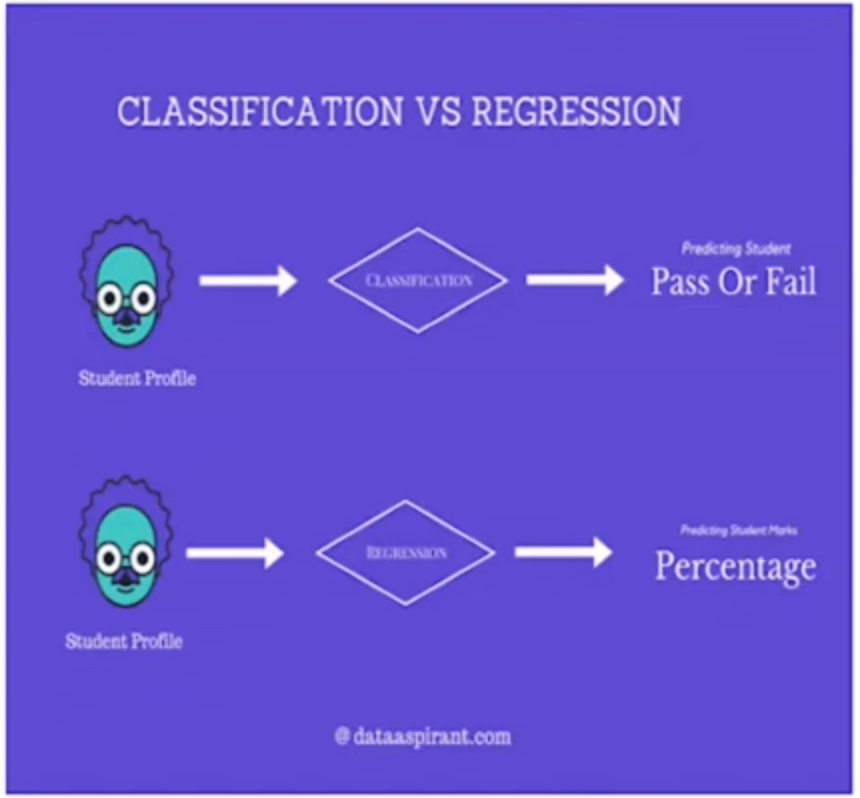

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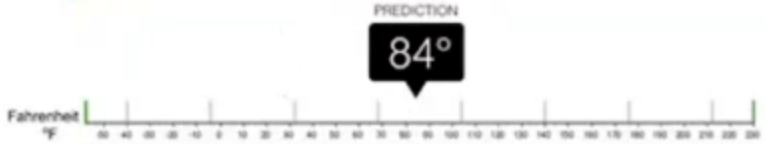

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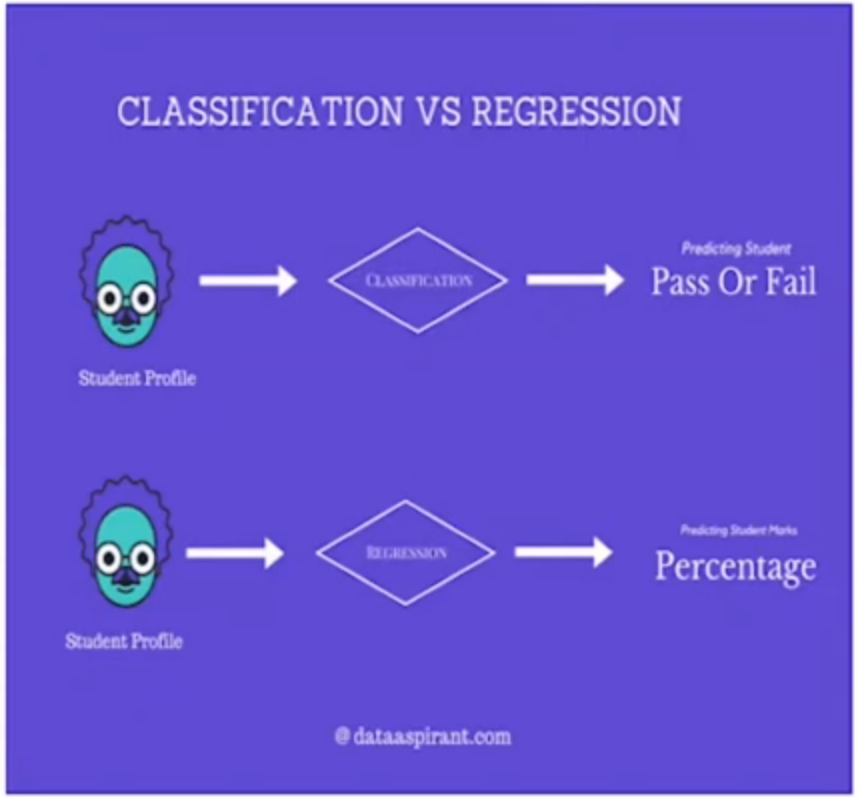
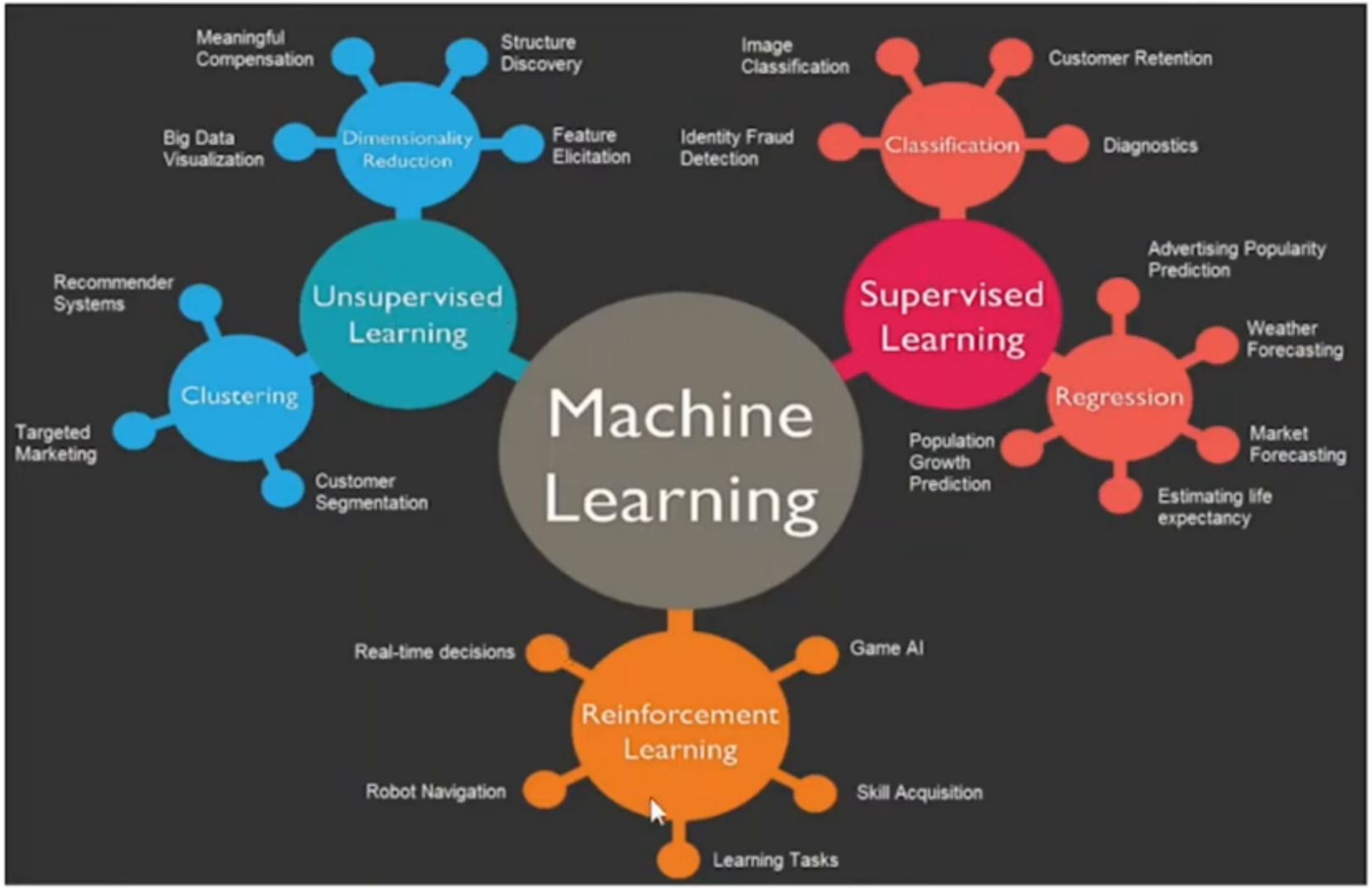
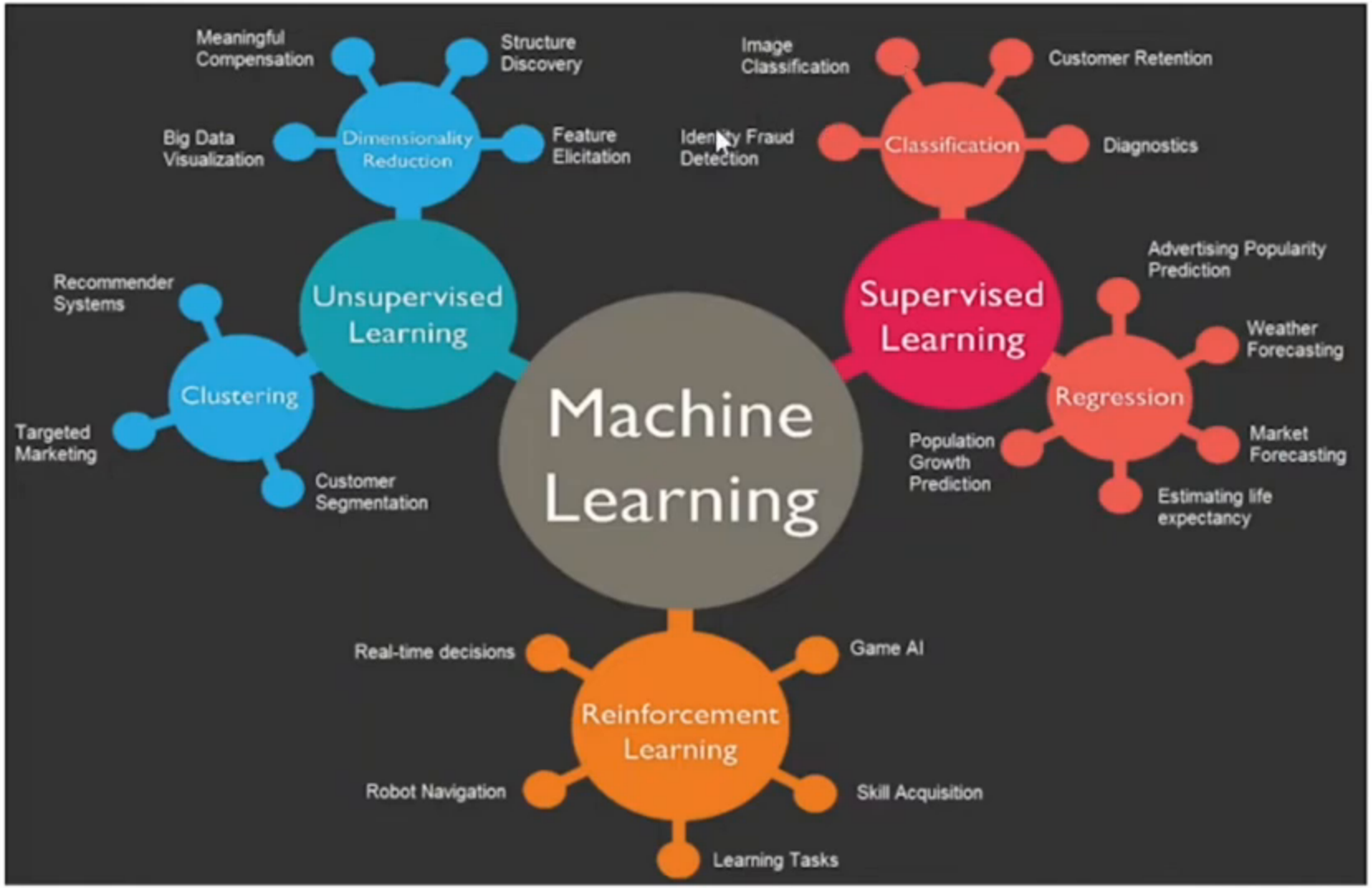


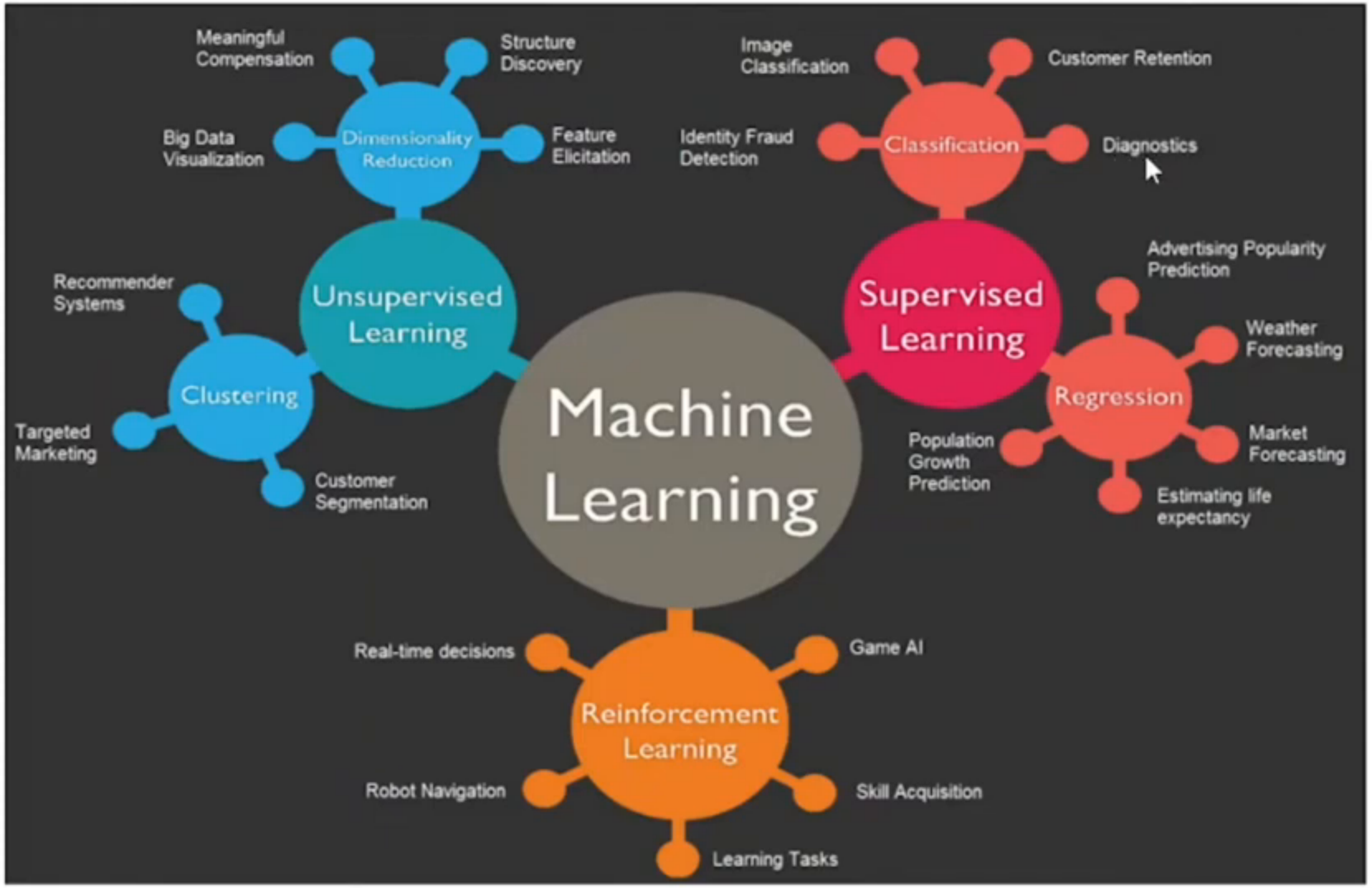
Machine Learning



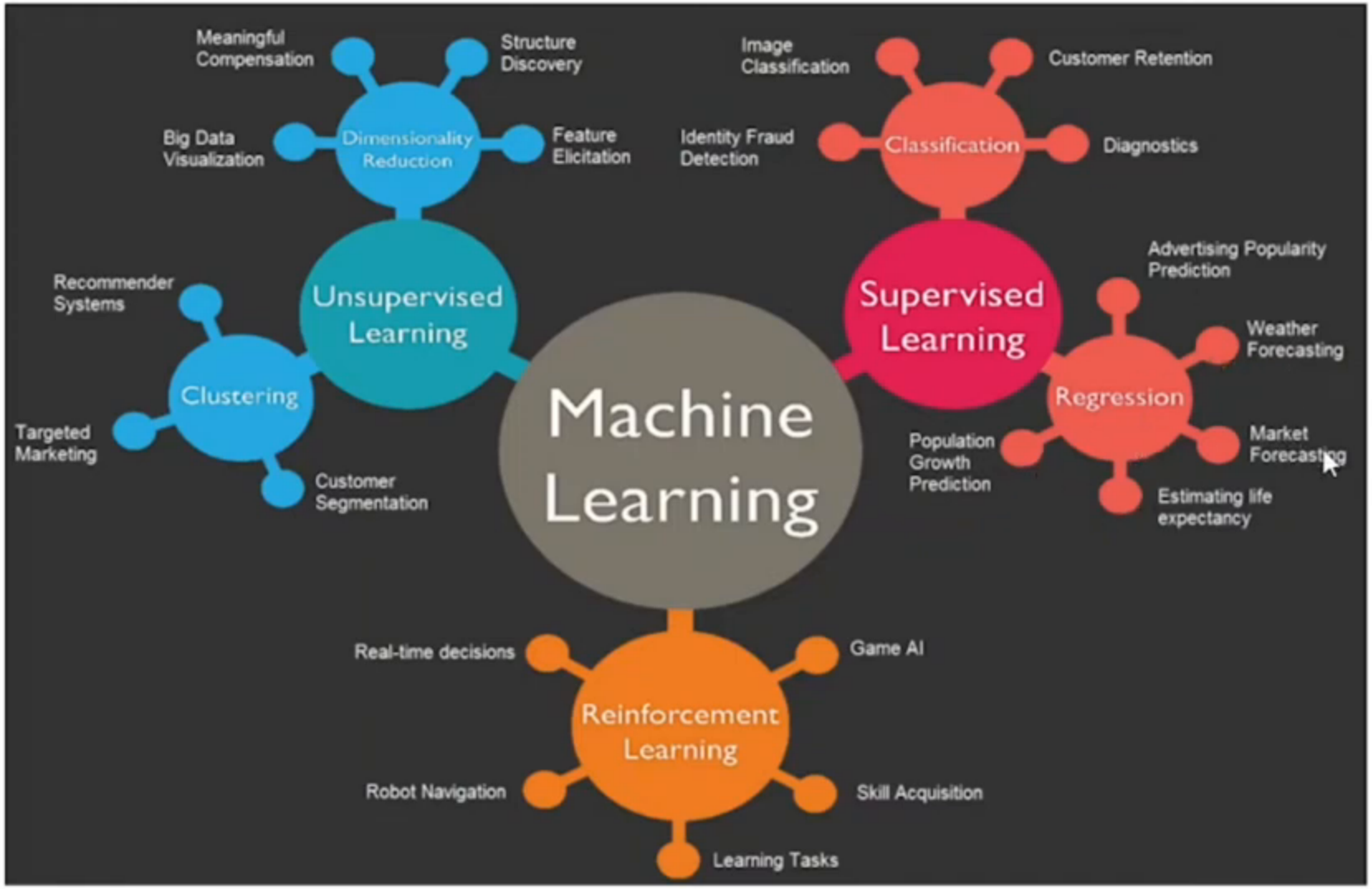
Machine Learning



Machine Learning



Machine Learning



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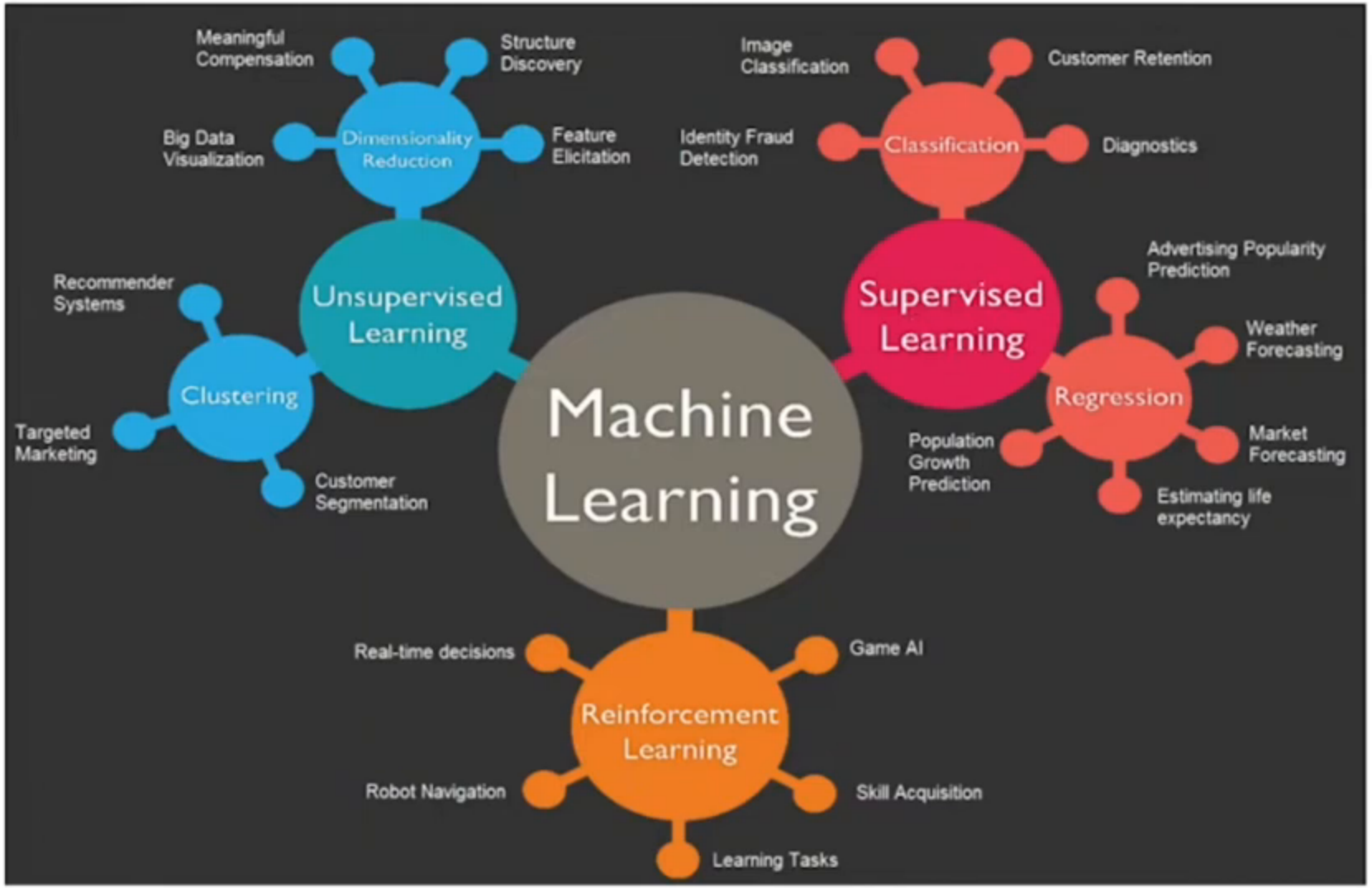
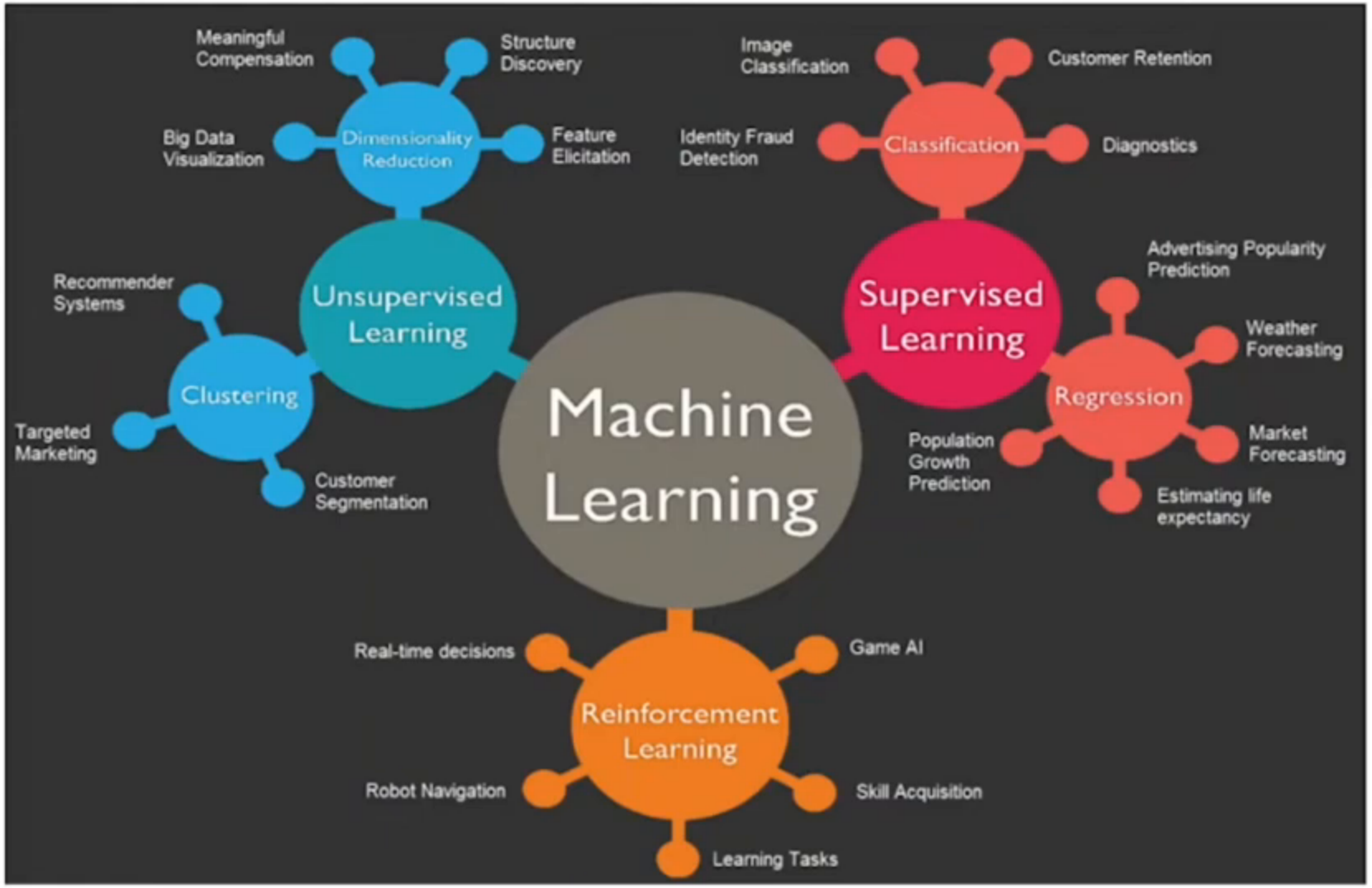
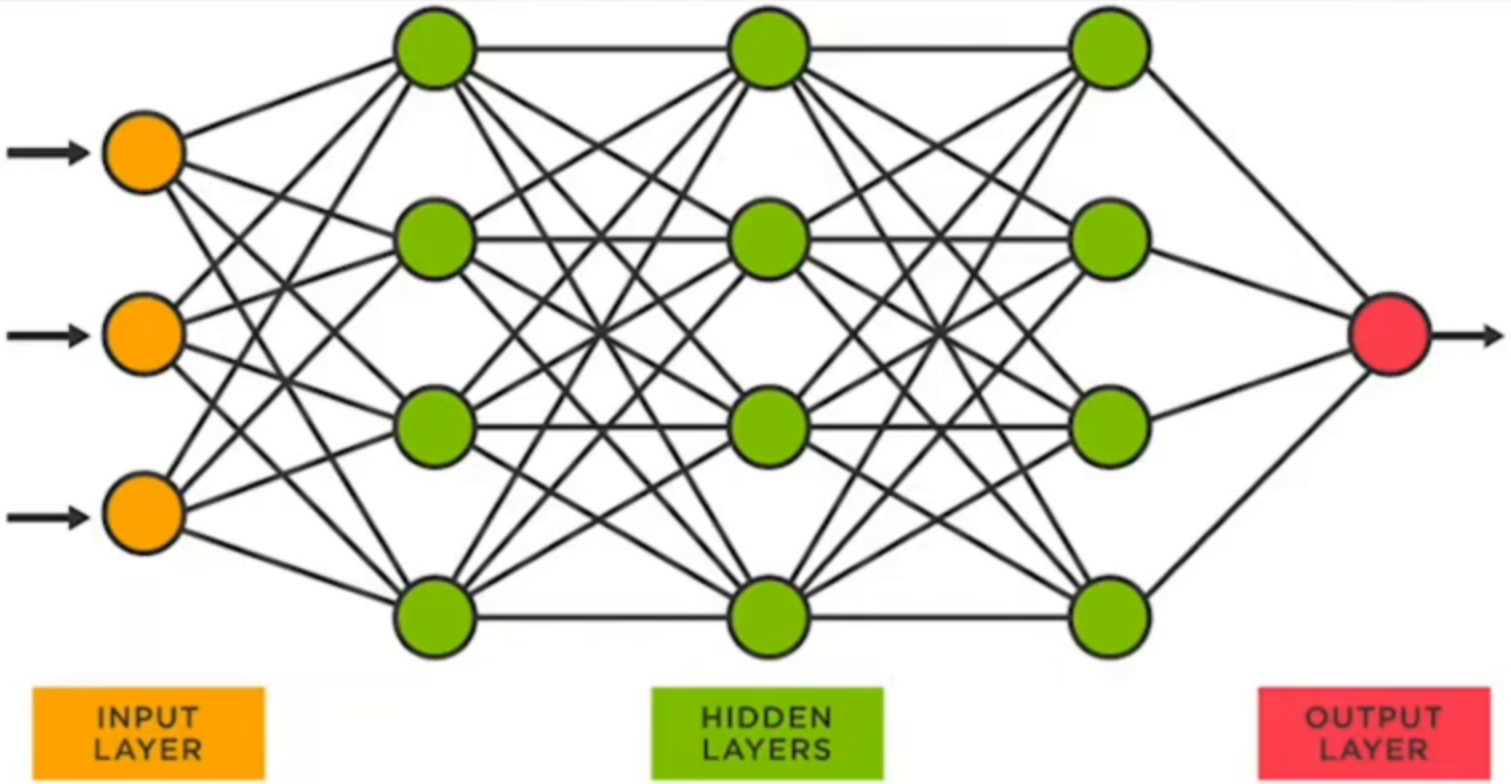


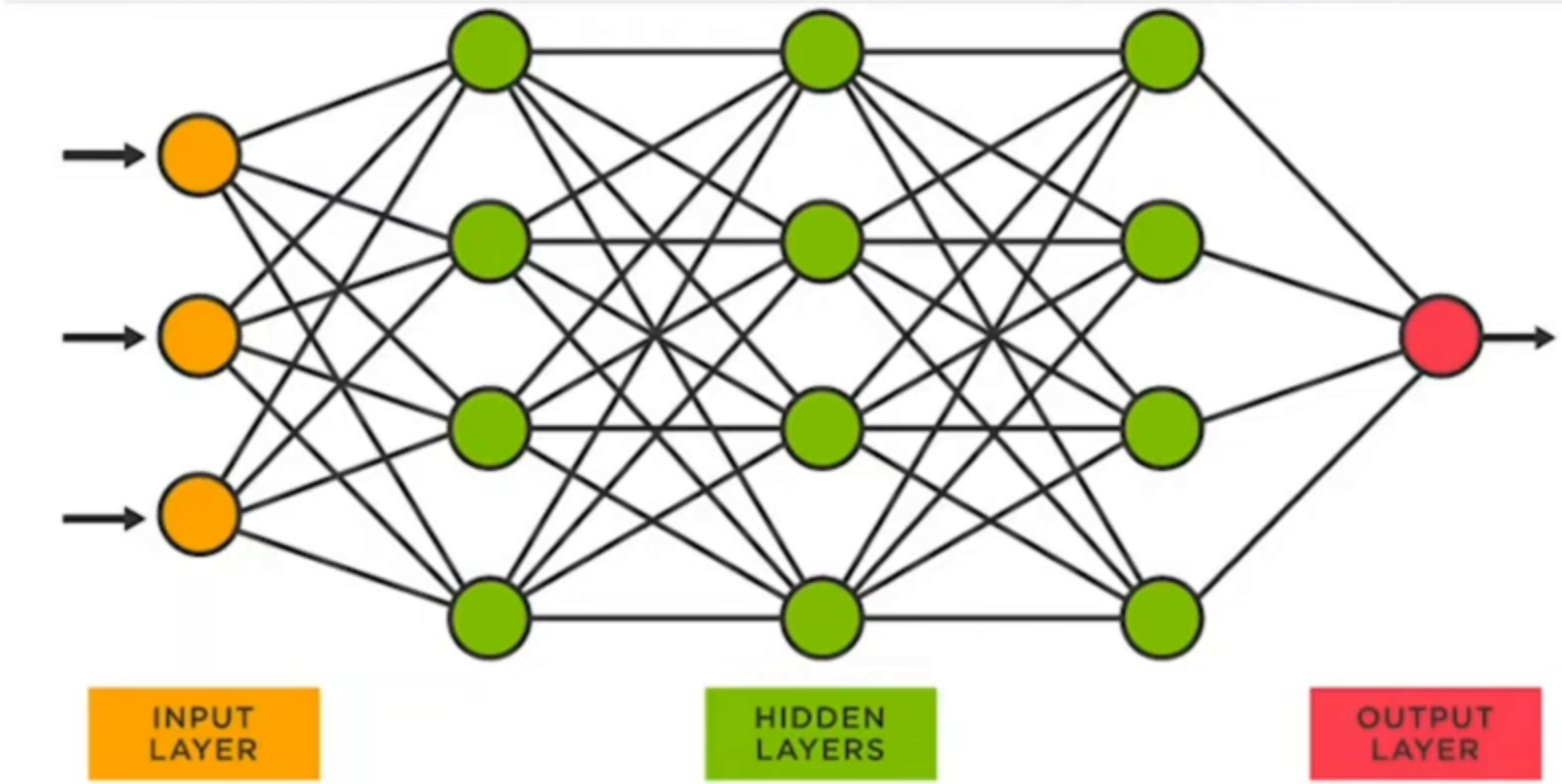
Machine Learning



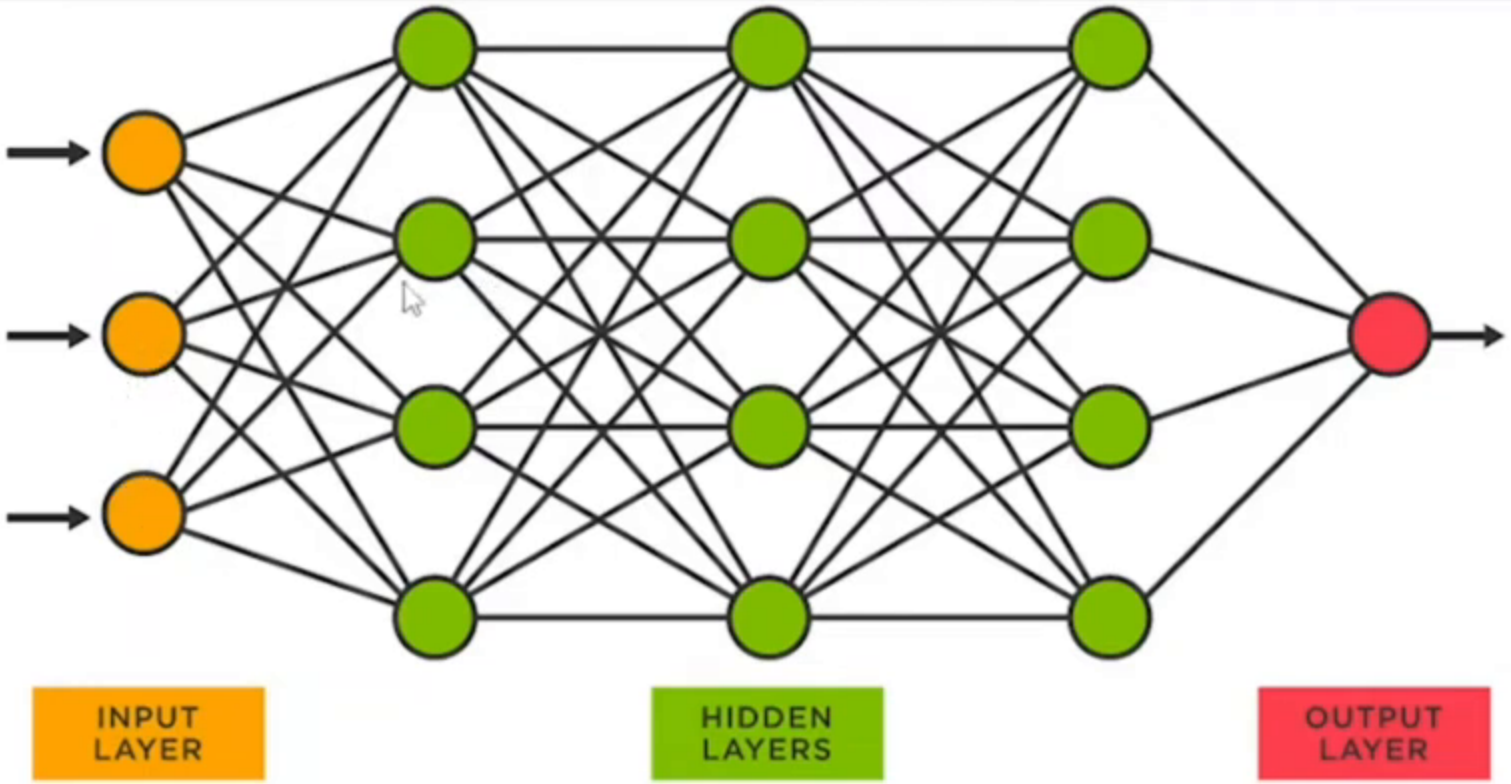
Neural Networks



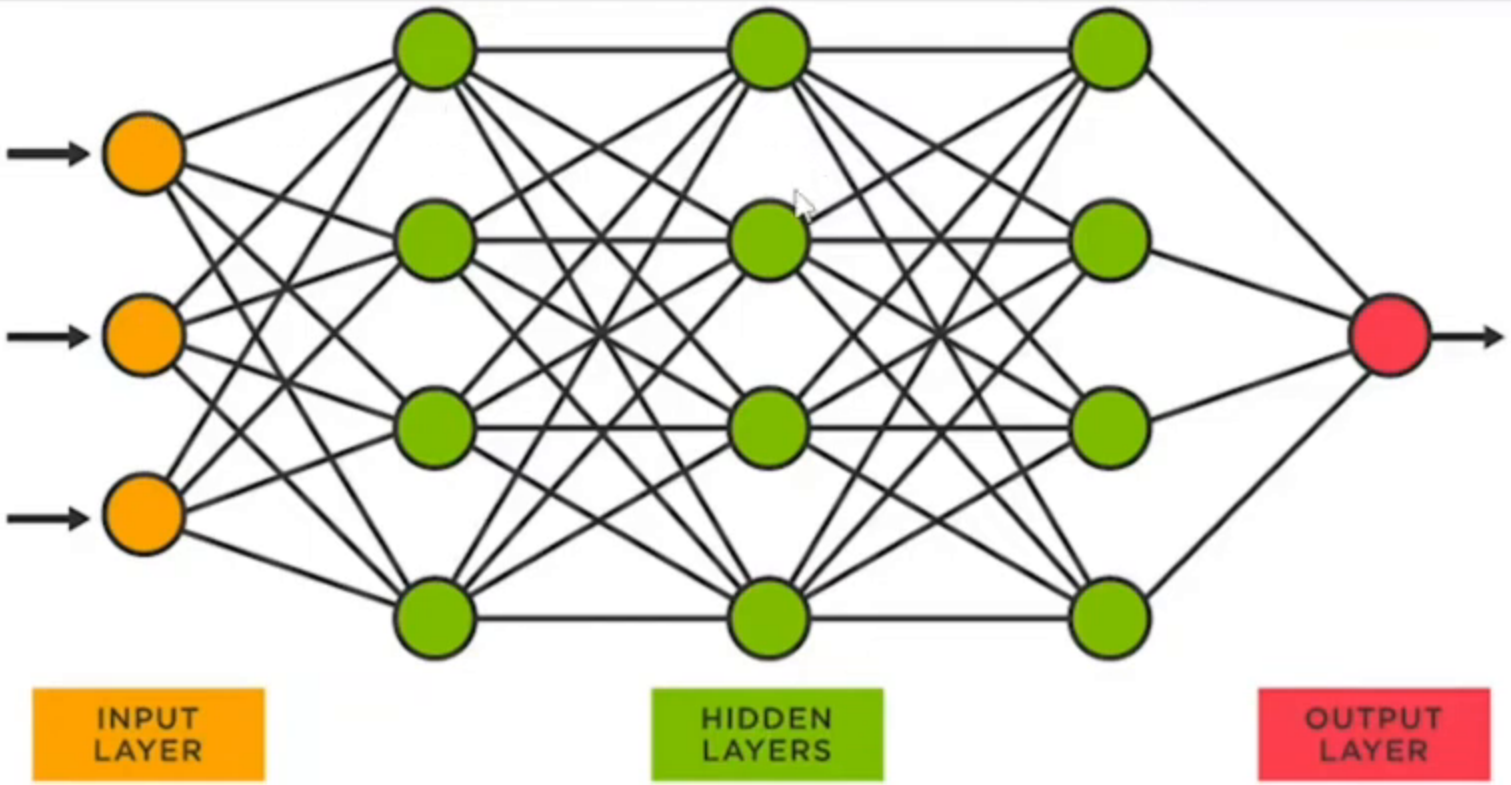
Neural Networks



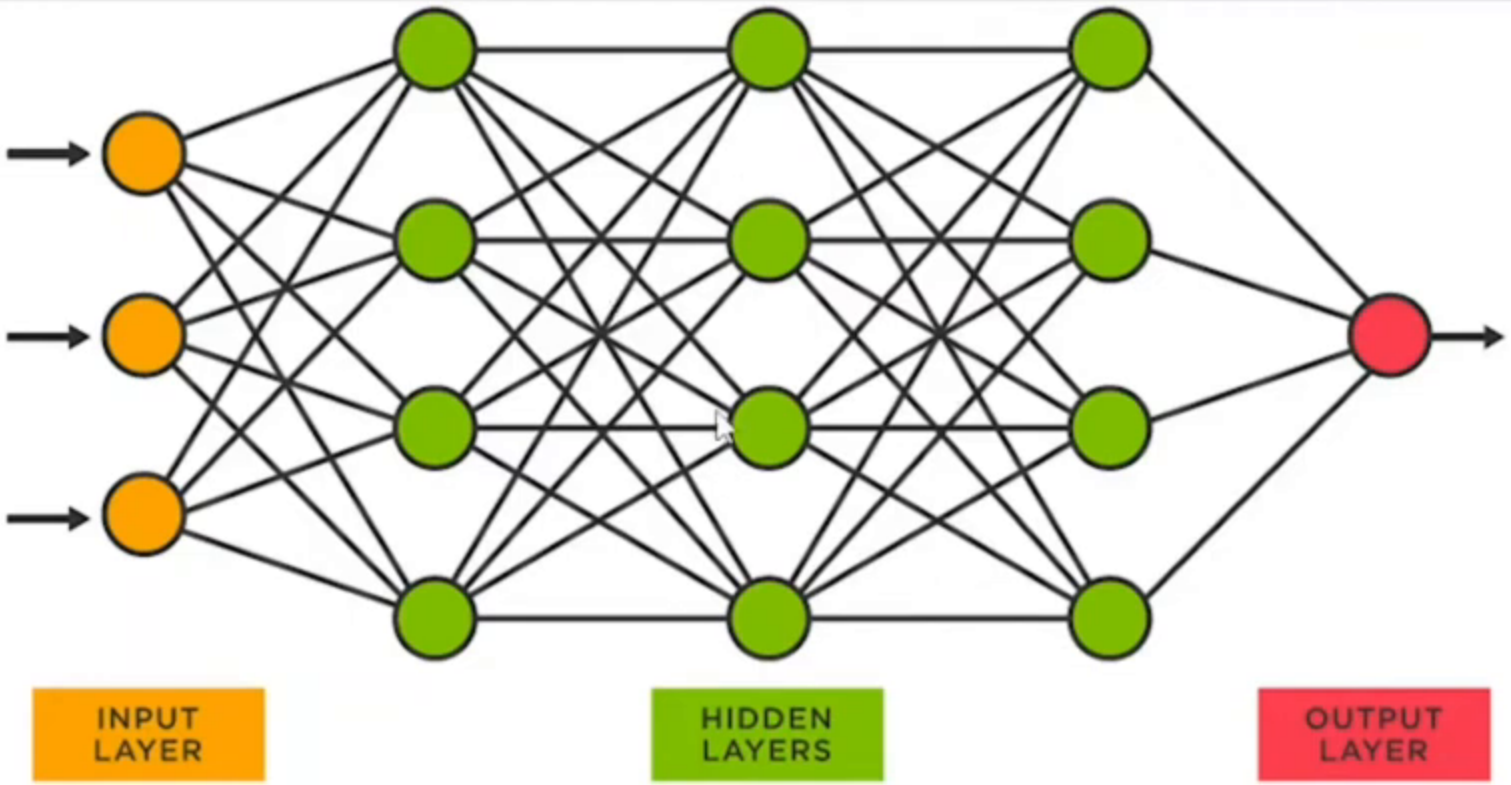
Neural Networks



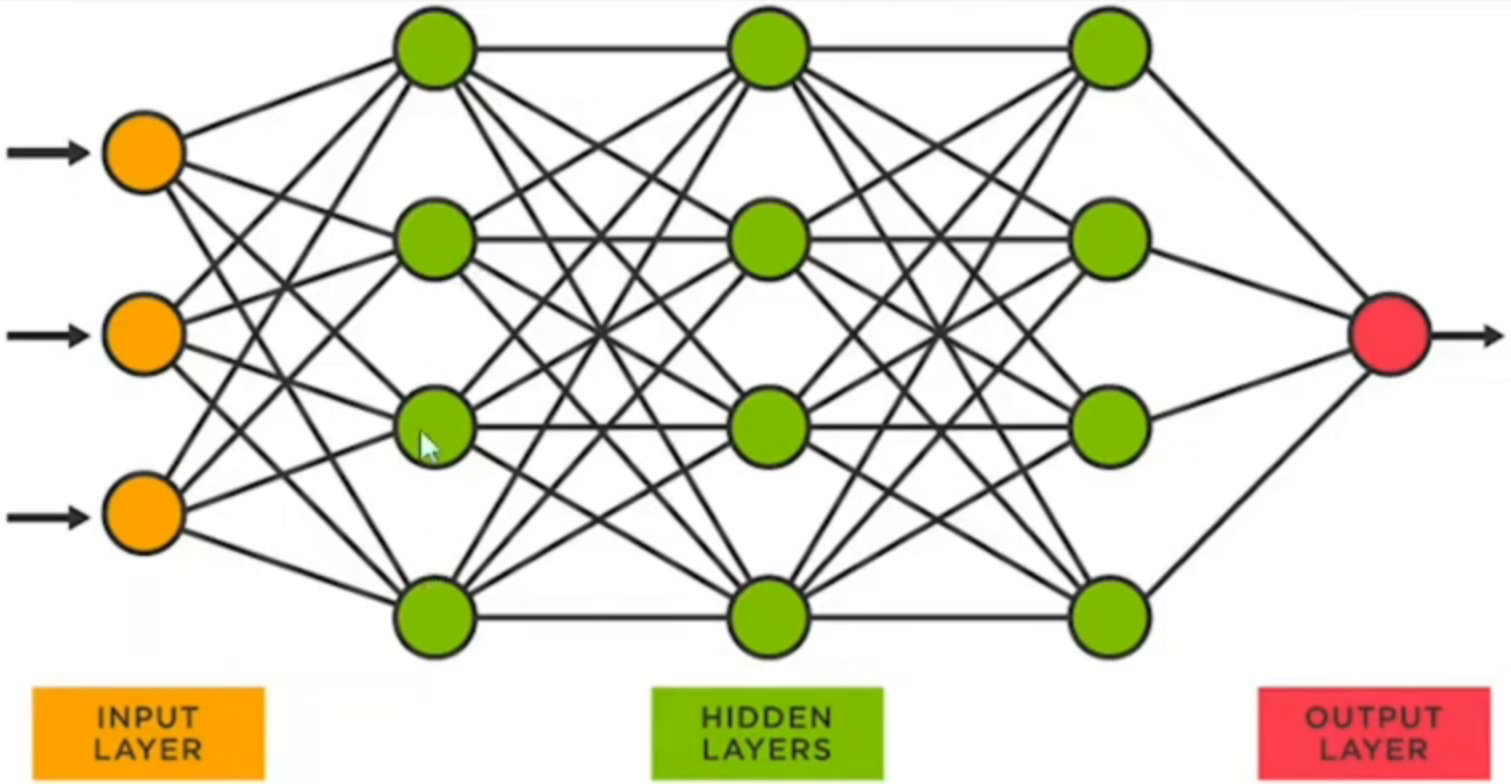
Neural Networks



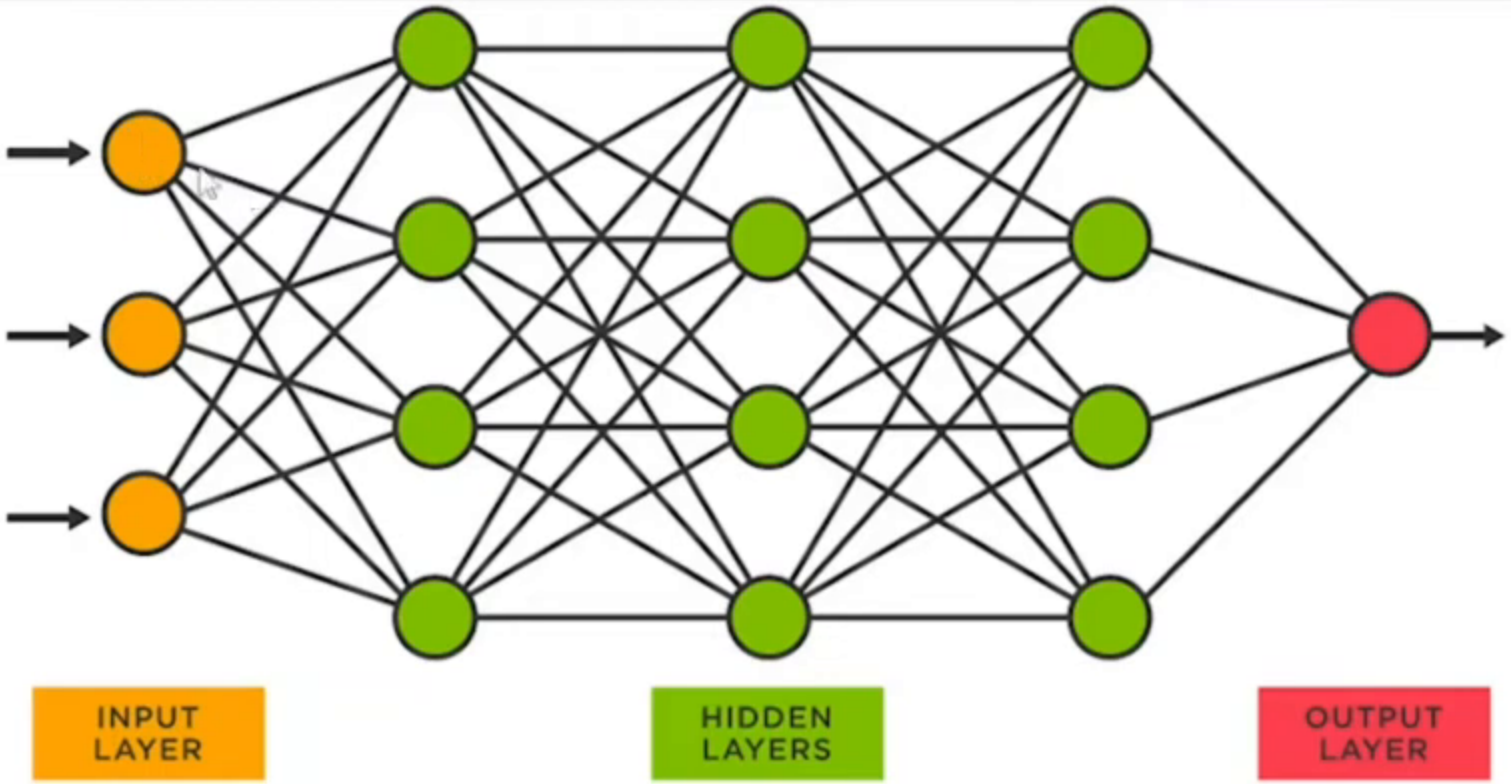
Neural Networks



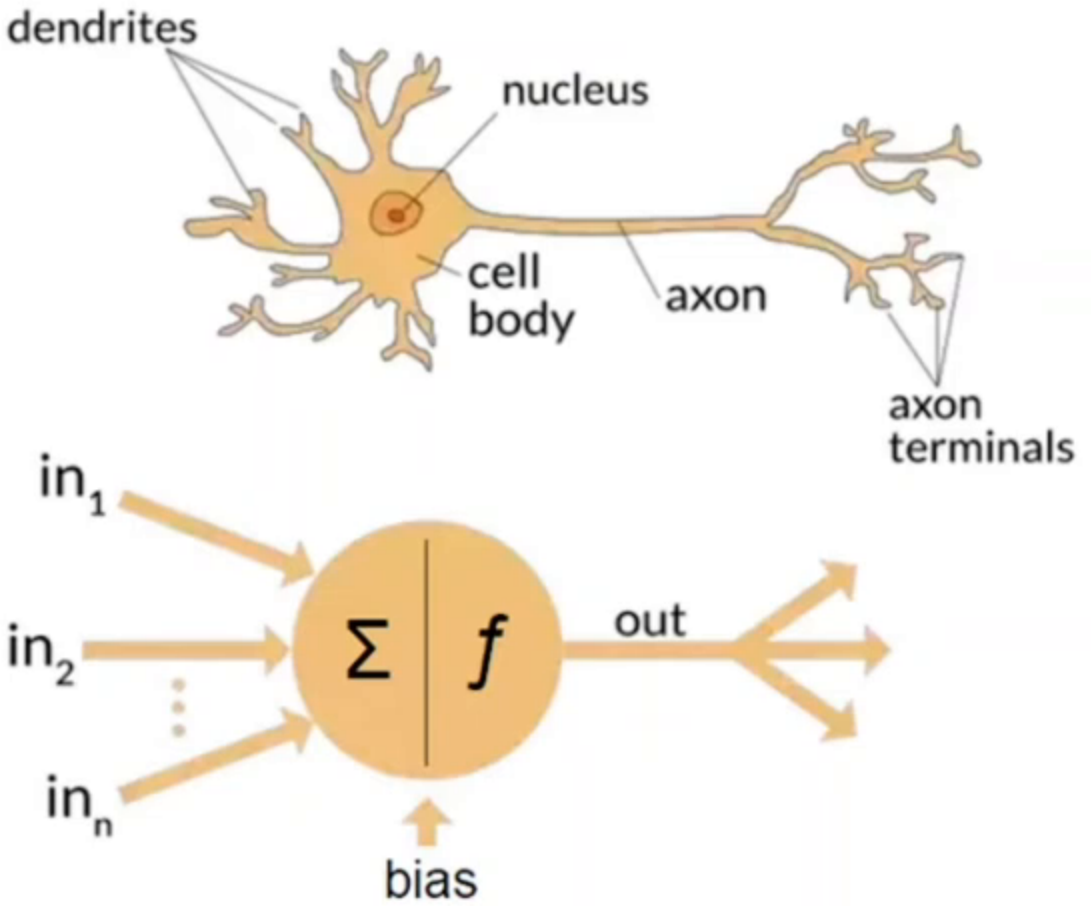
Neural Networks



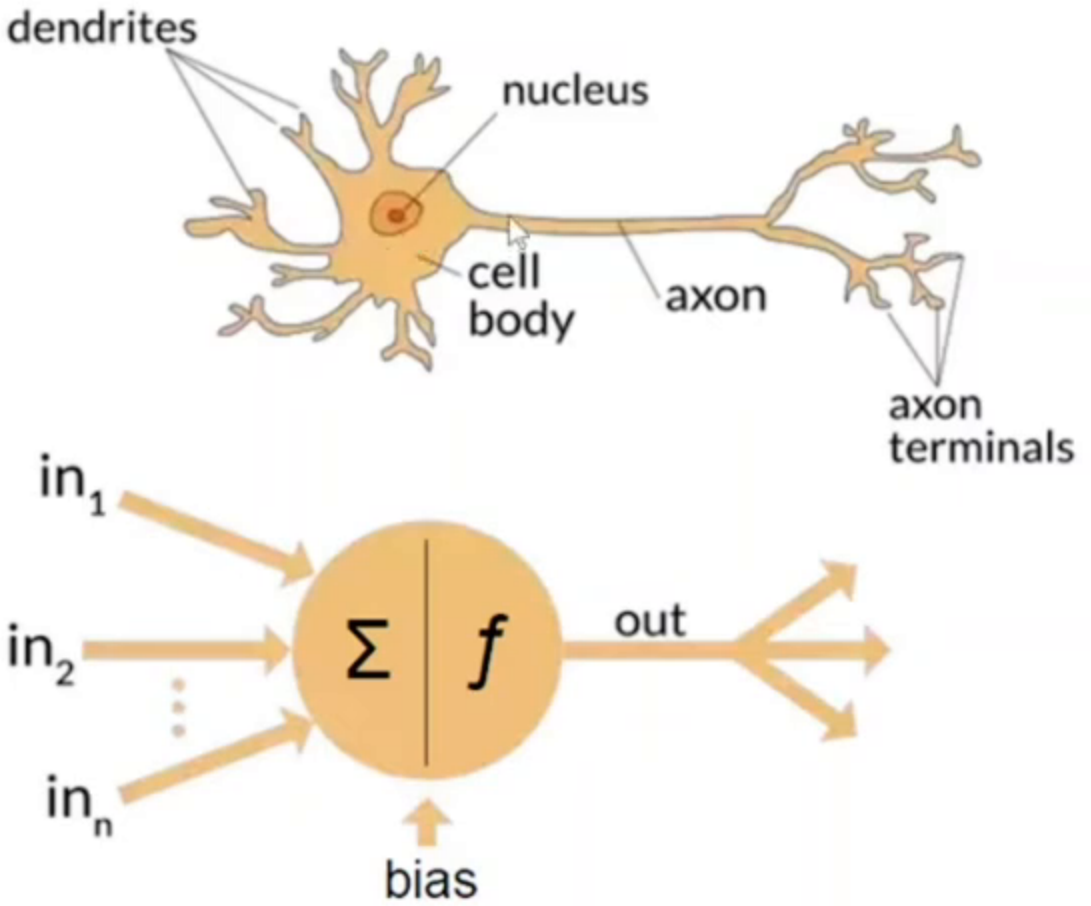
Neural Networks



Neuron


dendrites
nucleus
cell body
axon
axon terminals
in1
in2
inn
Σ
f
out
bias

Neuron


dendrites
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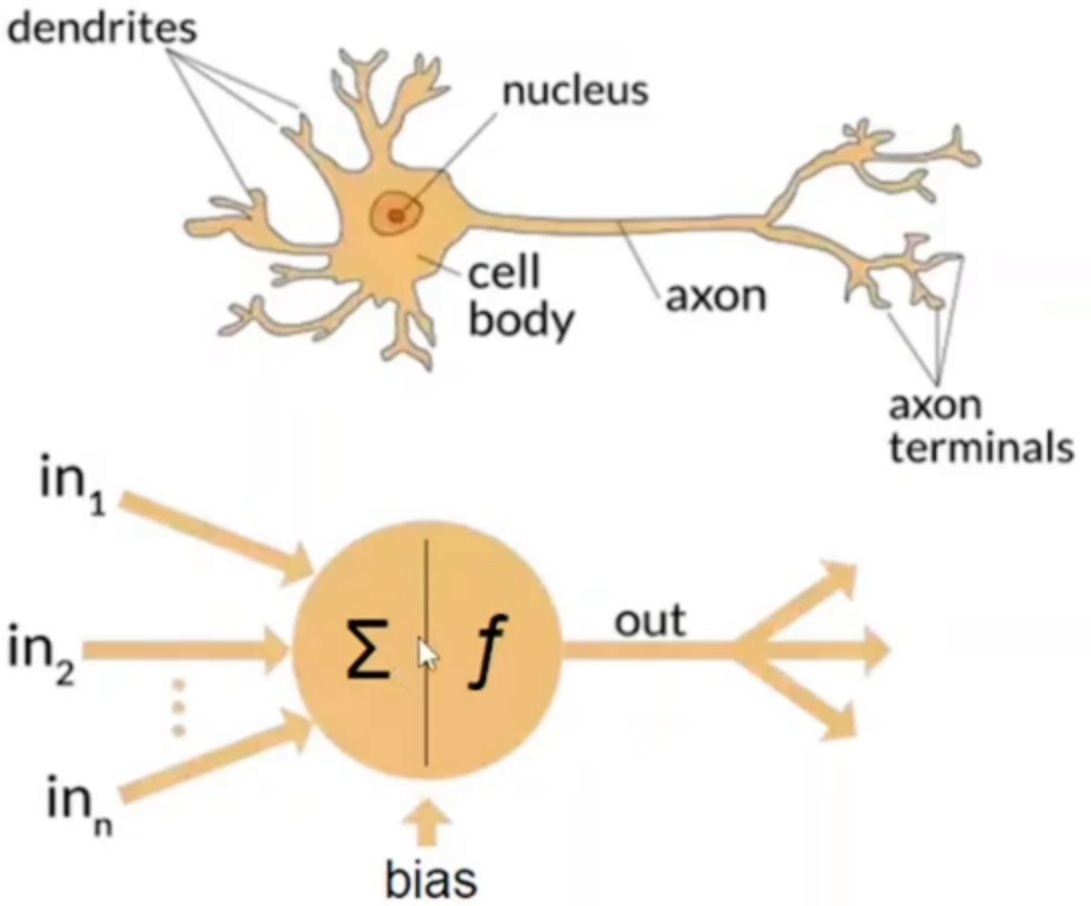
dendrites
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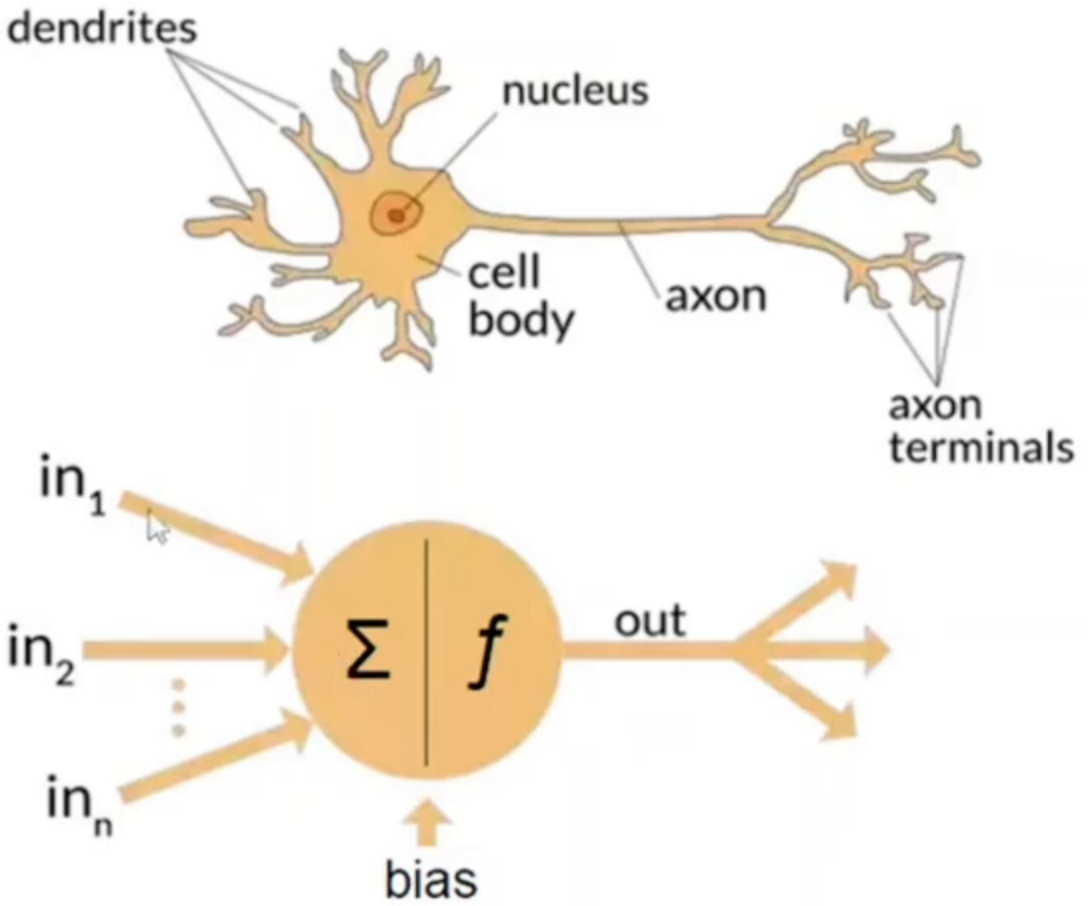
dendrites
nucleus
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in_1
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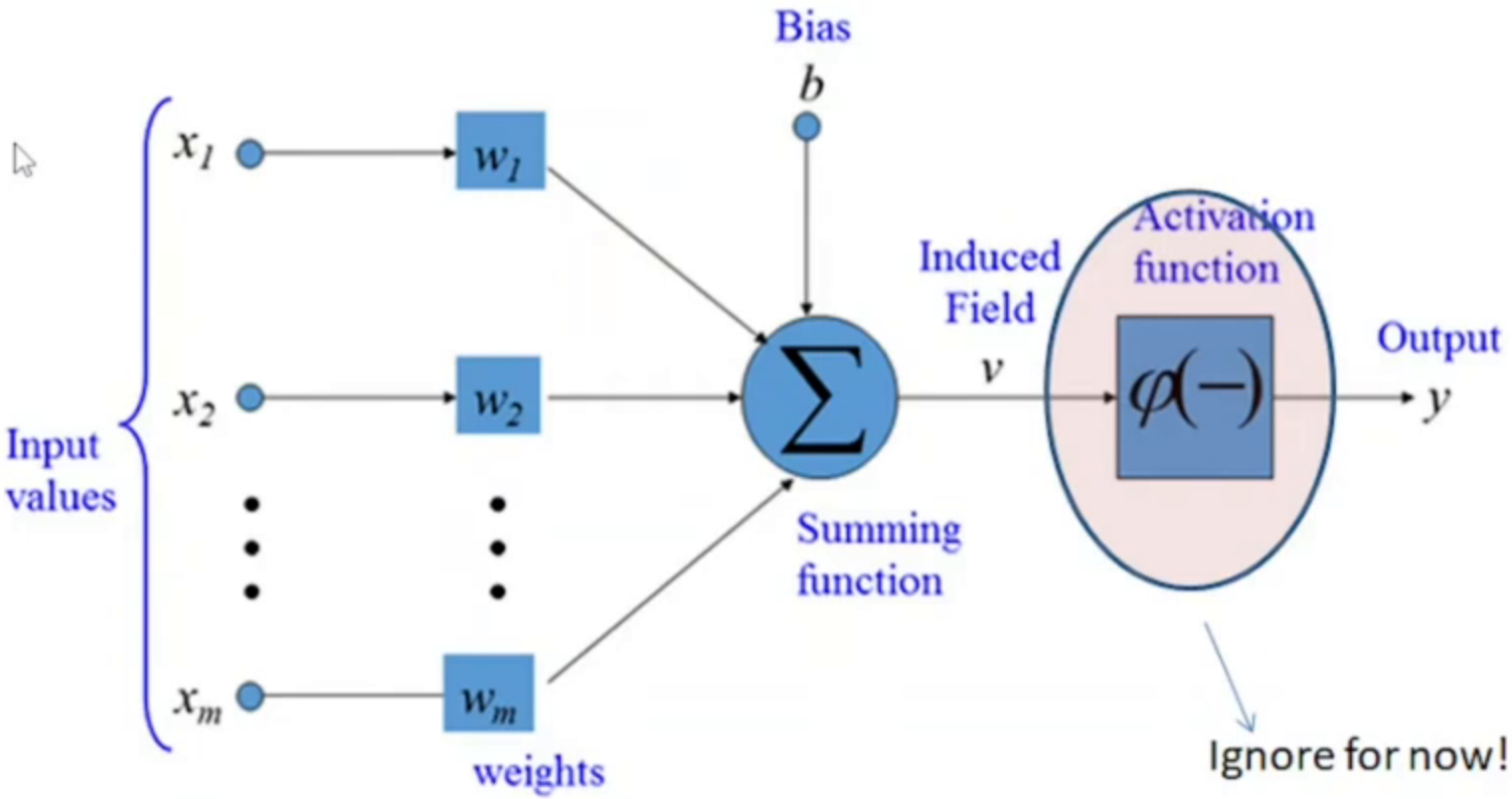
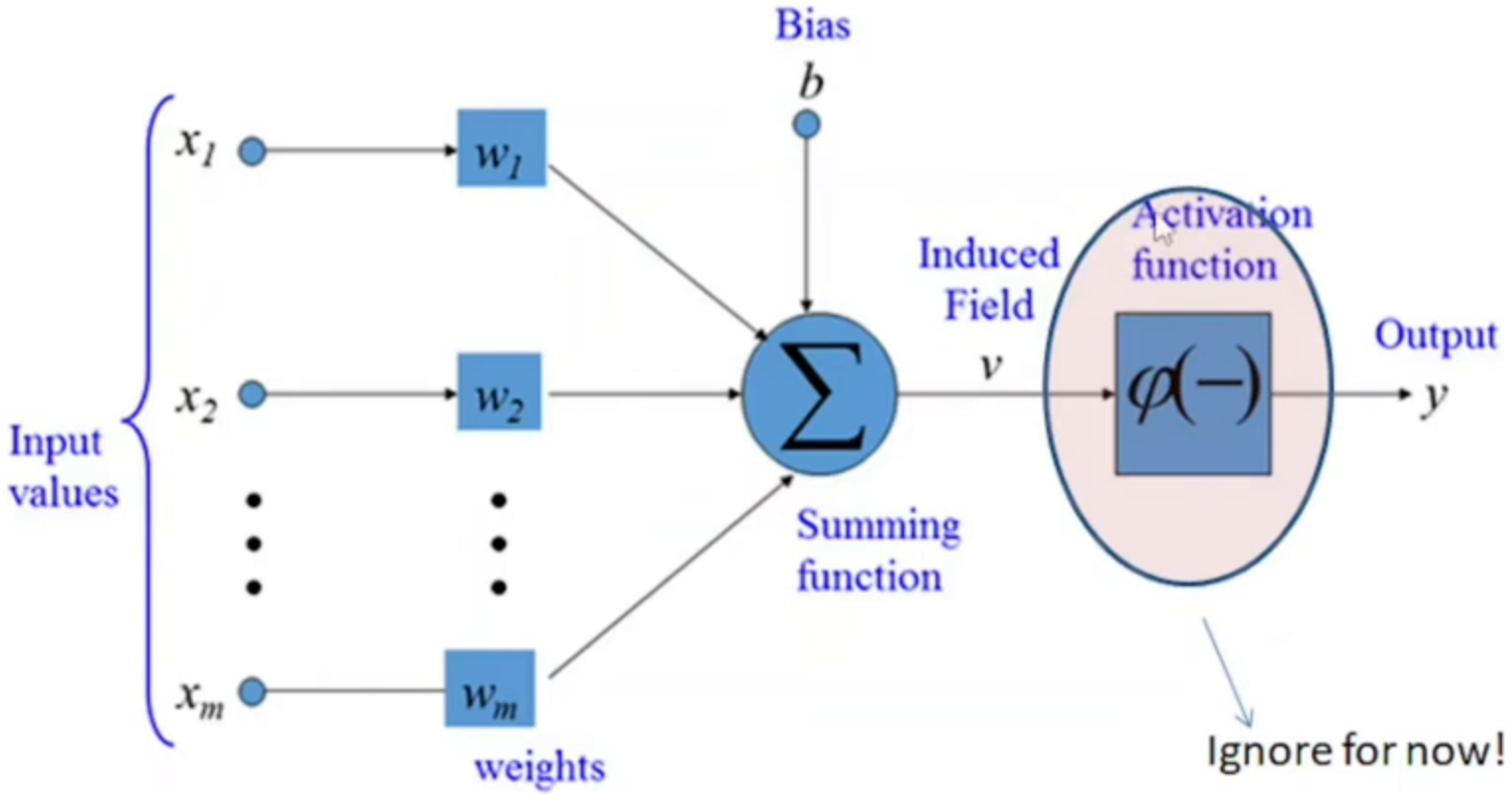
Σ
f
out
bias

Artificial Neuron



Output = x1*w1 + x2*w2 + … + b

Artificial Neuron



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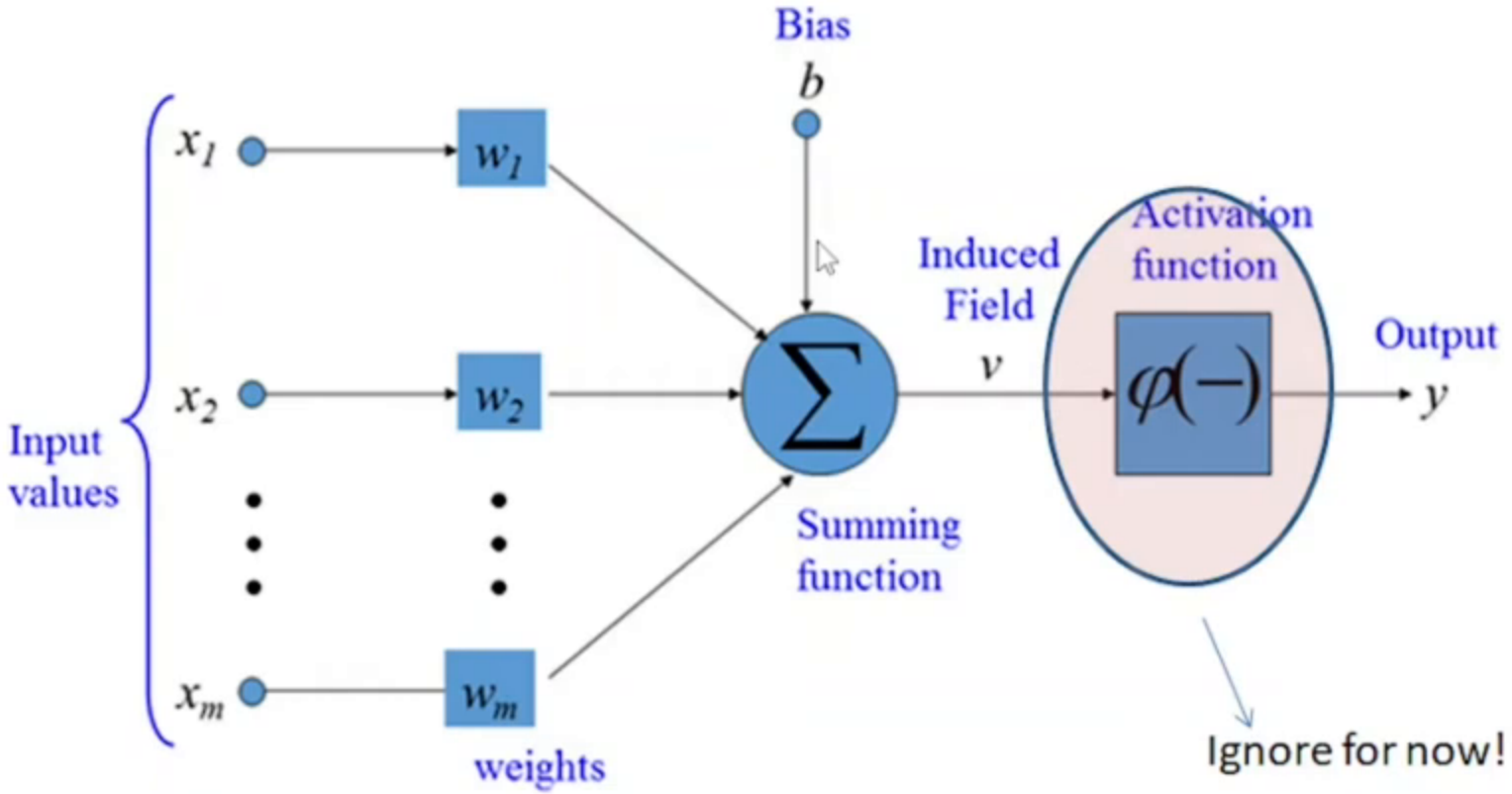

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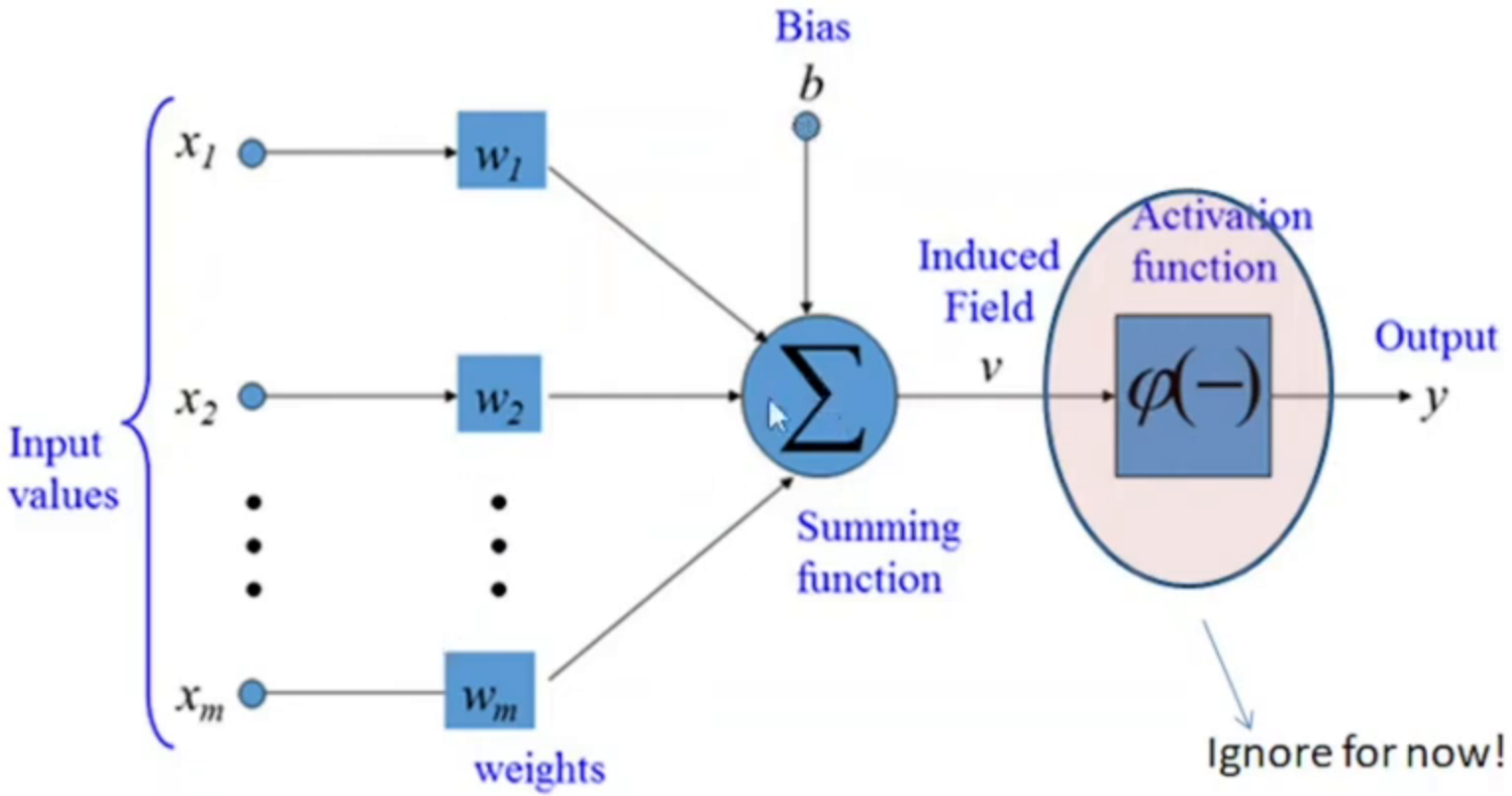

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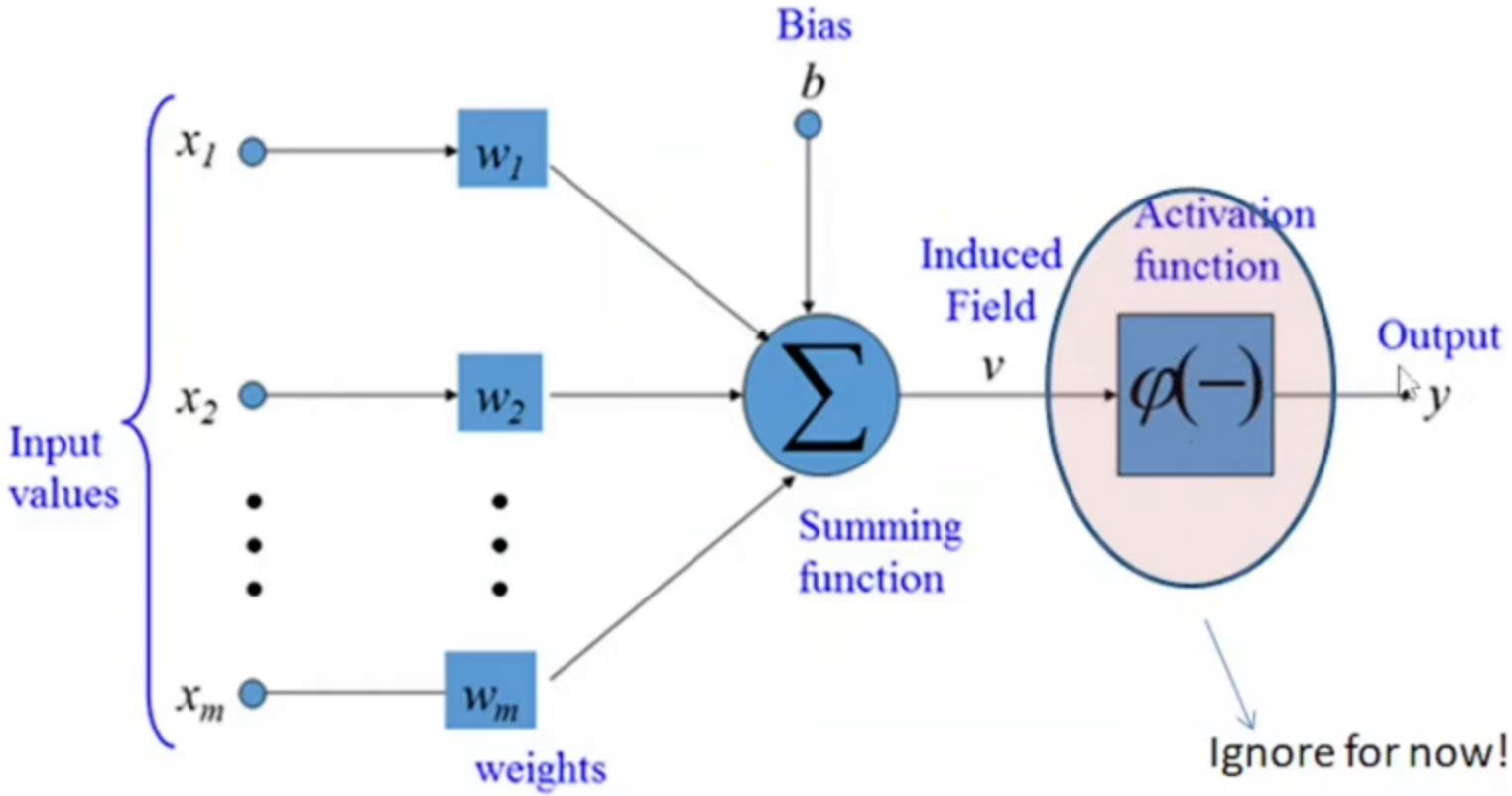

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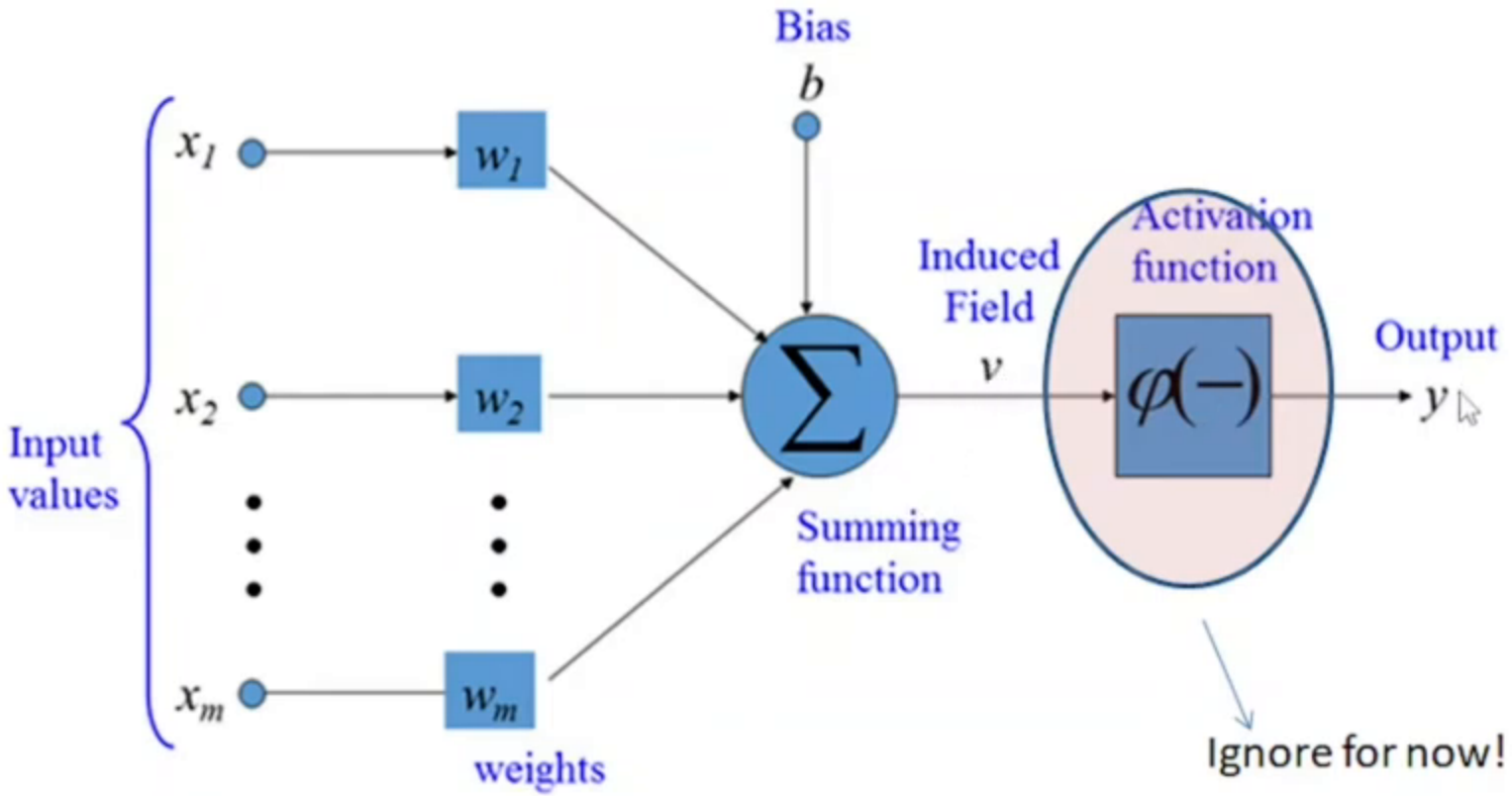

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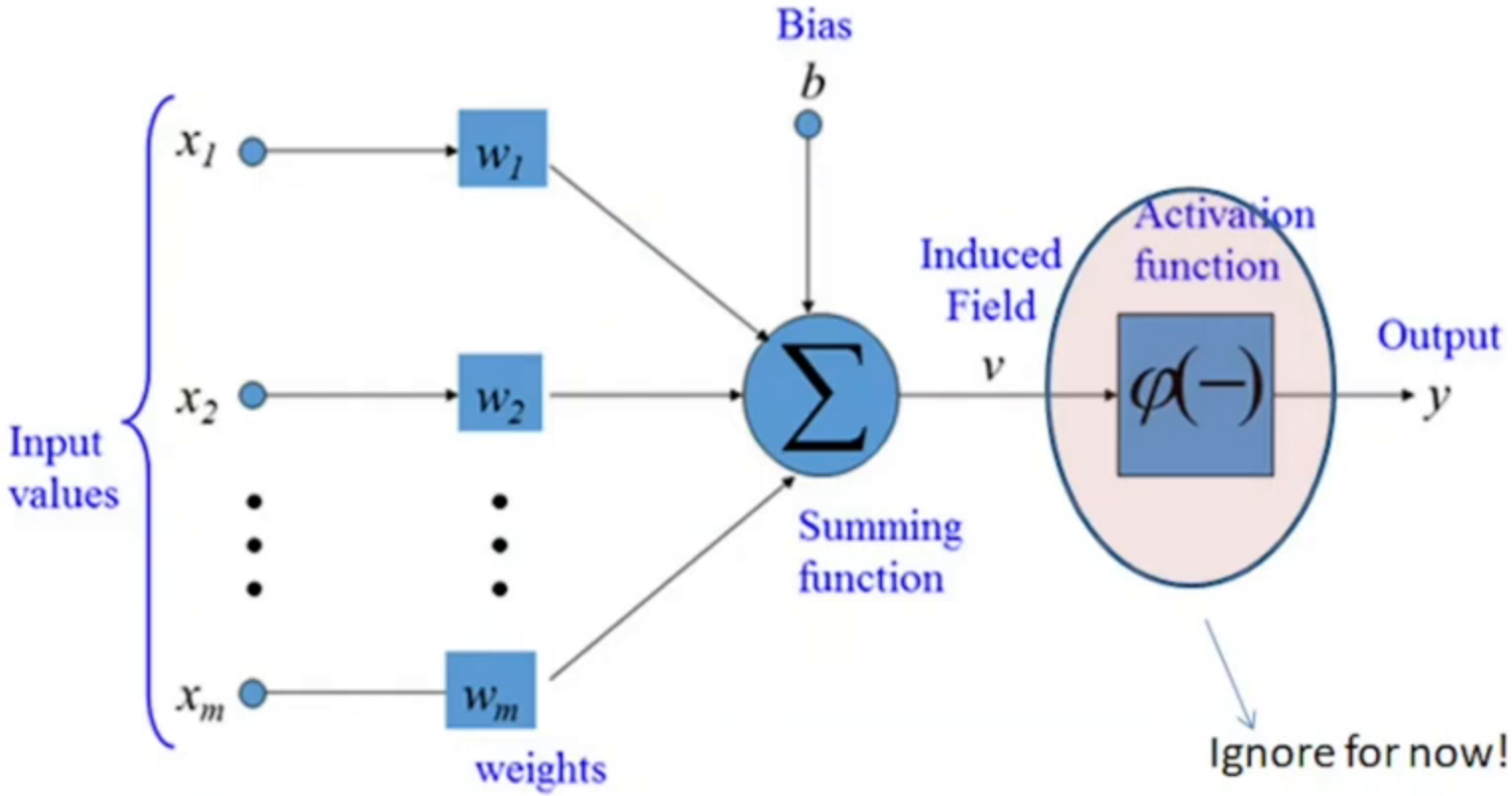


Output = x1*w1 + x2*w2 + … + b

System of linear equations

$$\begin{cases} a_1 x + b_1 y = c_1 \\ a_2 x + b_2 y = c_2 \end{cases}$$

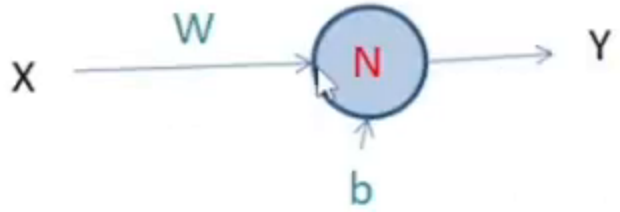
Weights

Bias

Ex:

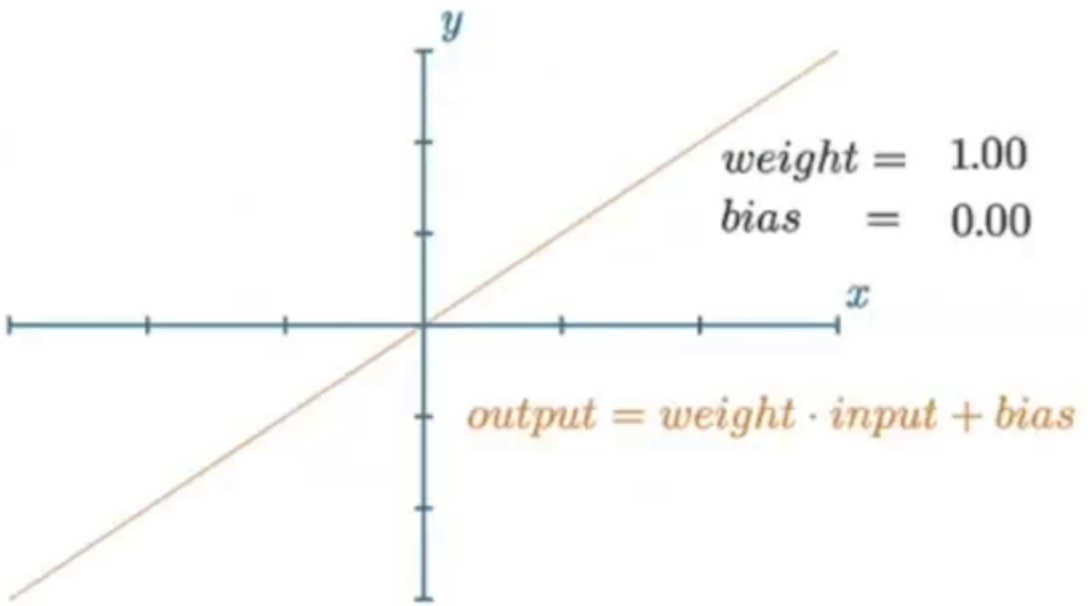
$$\begin{aligned} -5x+3y&=10 \\ -3x+\ y&=\ 6 \end{aligned}$$

Geometric view



Y = W*X + b

Ex: y = x ; w=1, b=0



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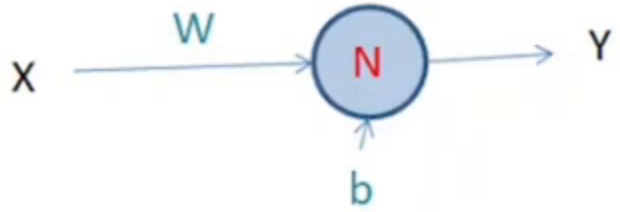

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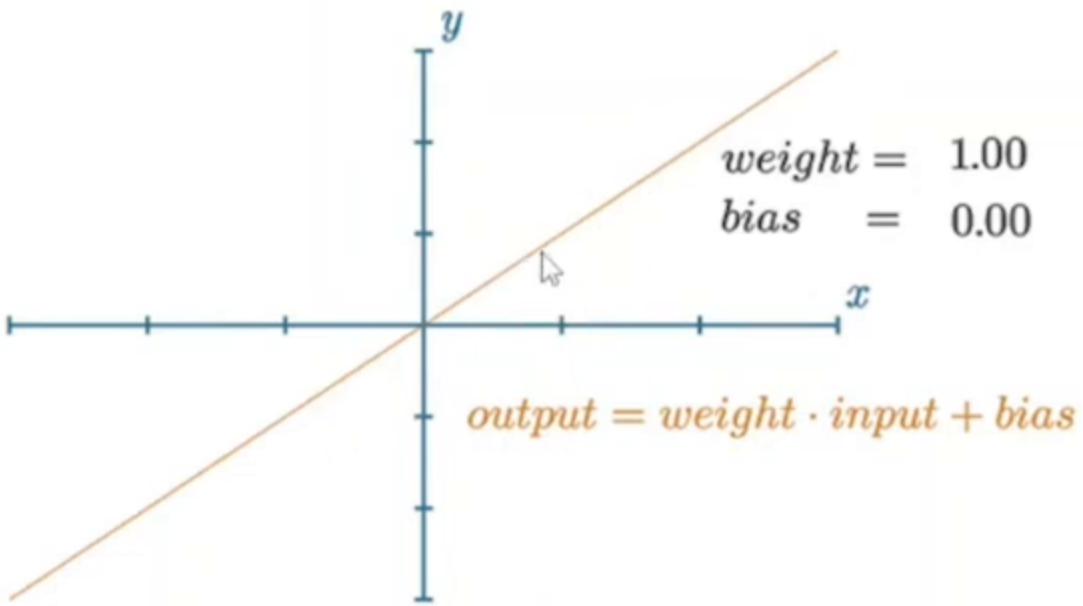

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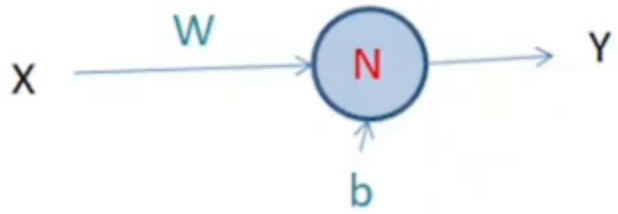

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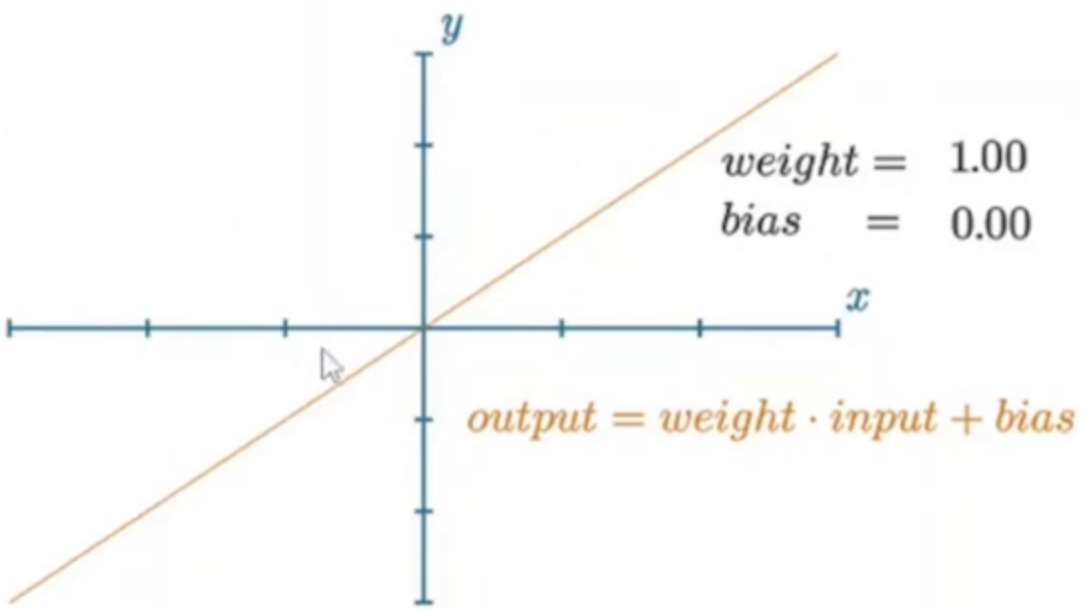
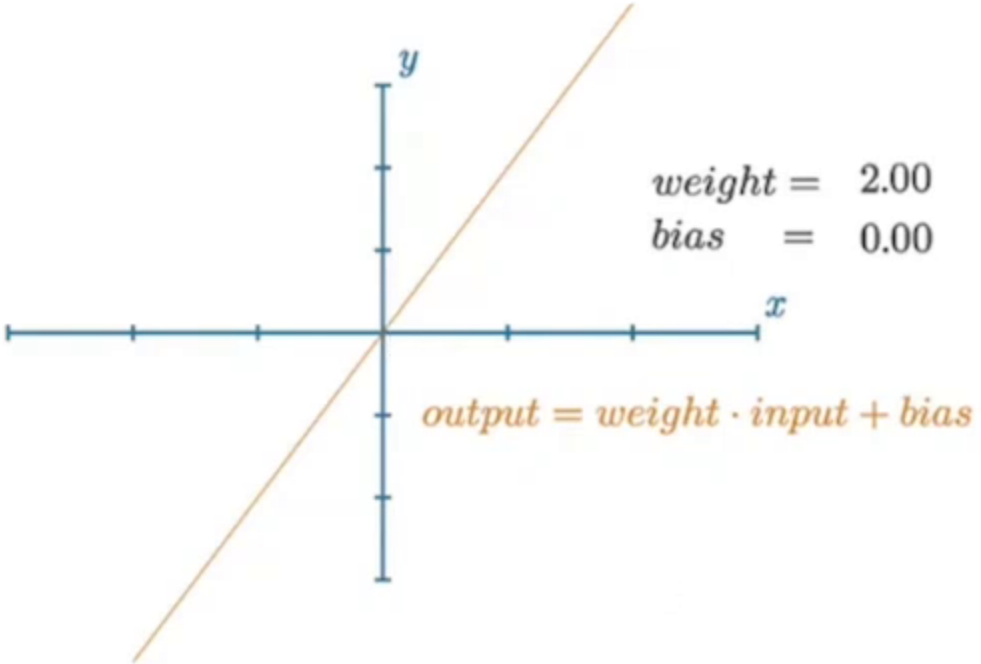
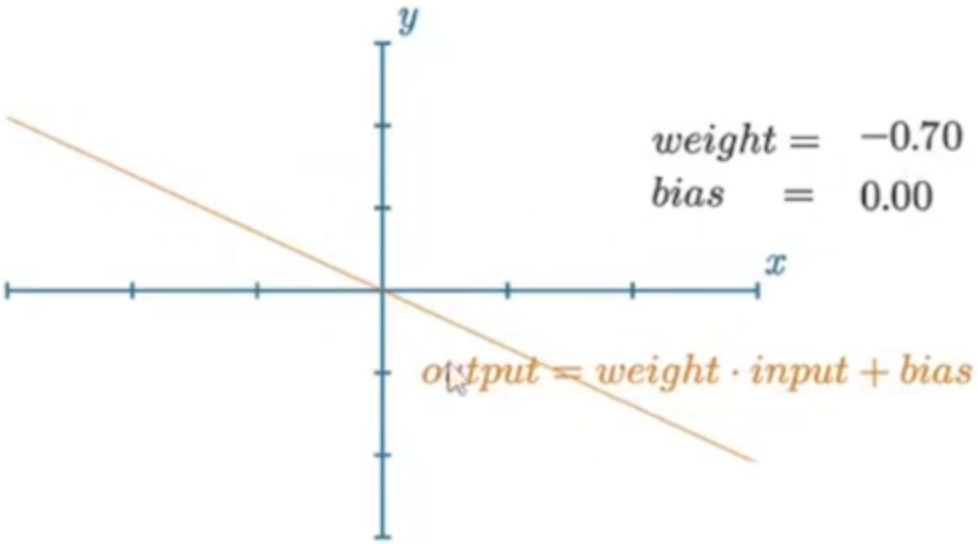


Examples



$$weight = 2.00$$
$$bias = 0.00$$

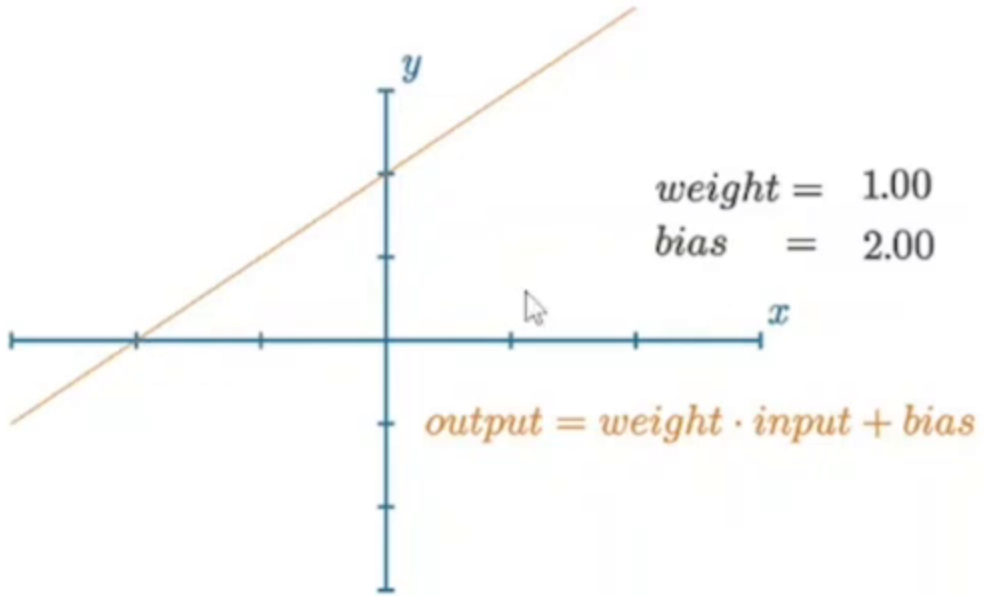
$$output = weight \cdot input + bias$$



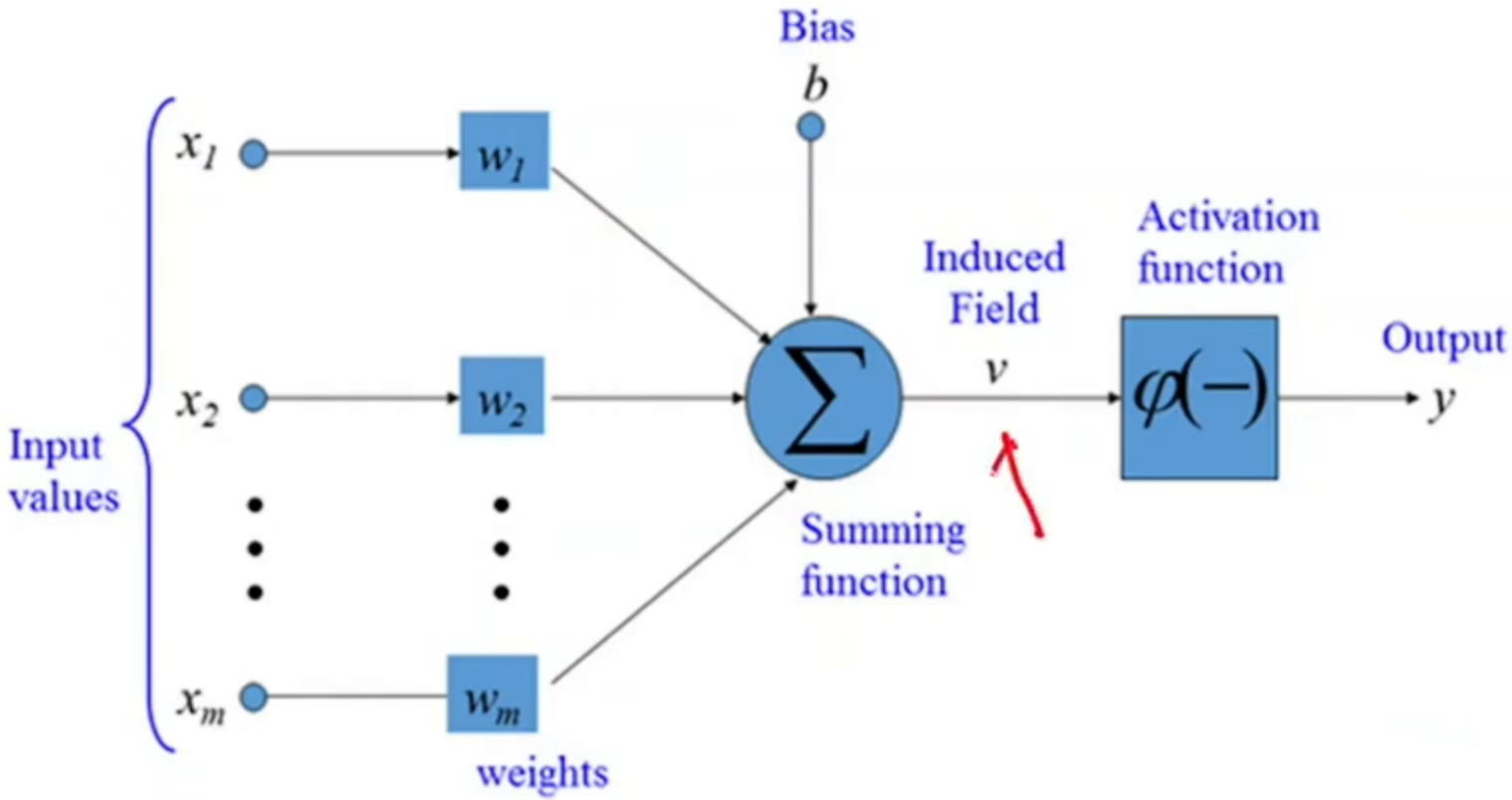
$$weight = -0.70$$
$$bias = 0.00$$

$$output = weight \cdot input + bias$$

Examples

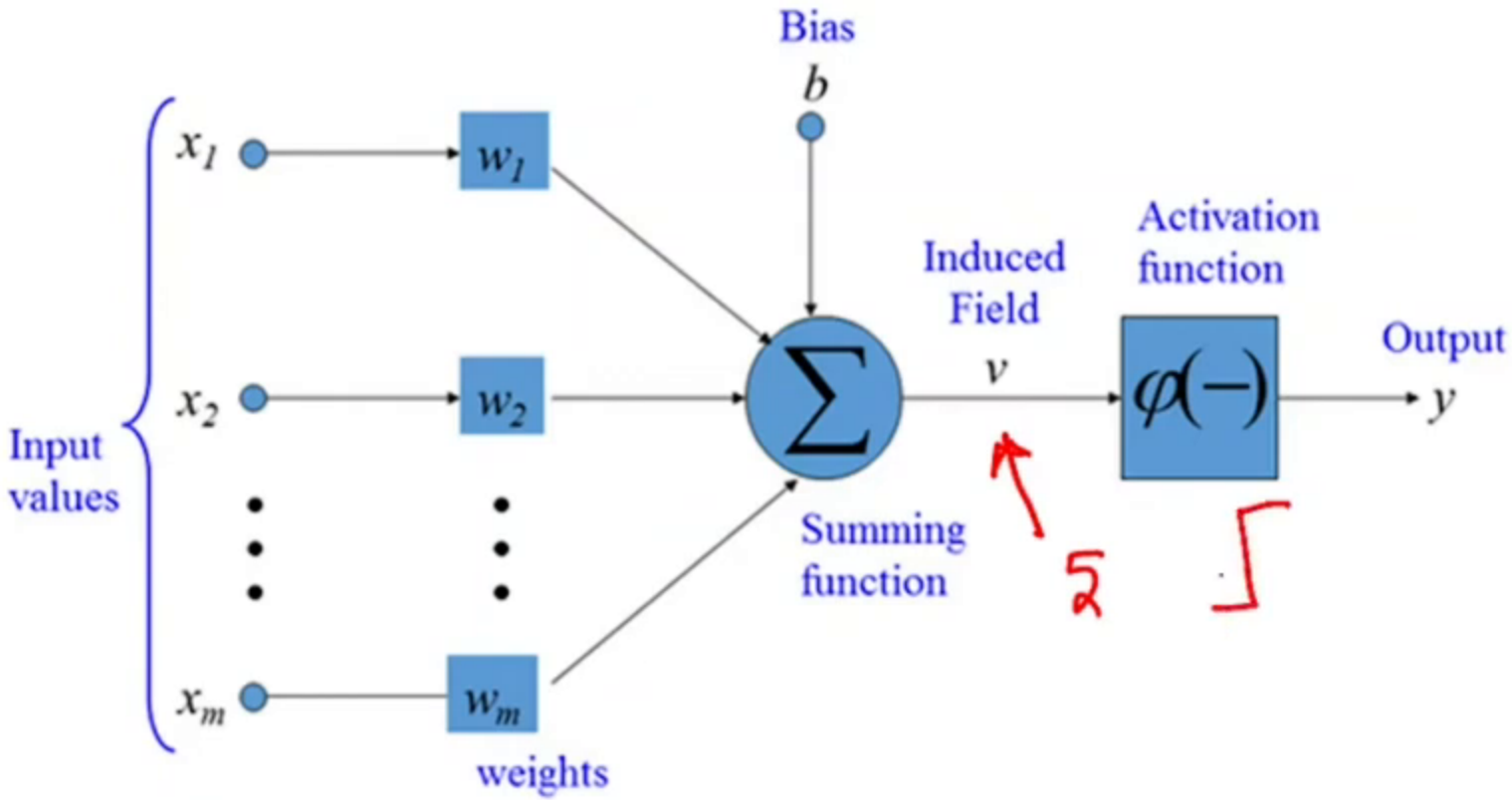


Activation Function



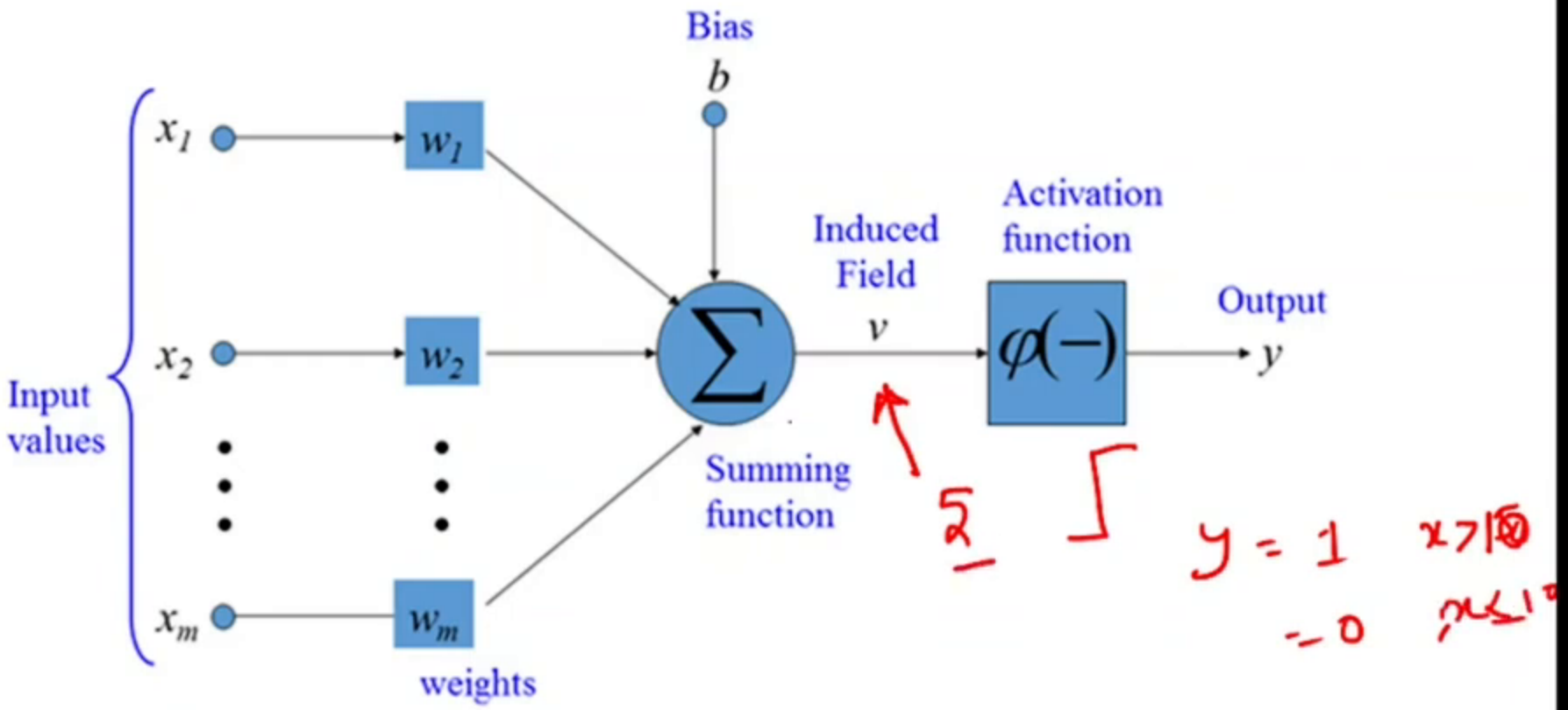
Output Y = Ø (w1*x1+w2*x2+…+b)

Activation Function



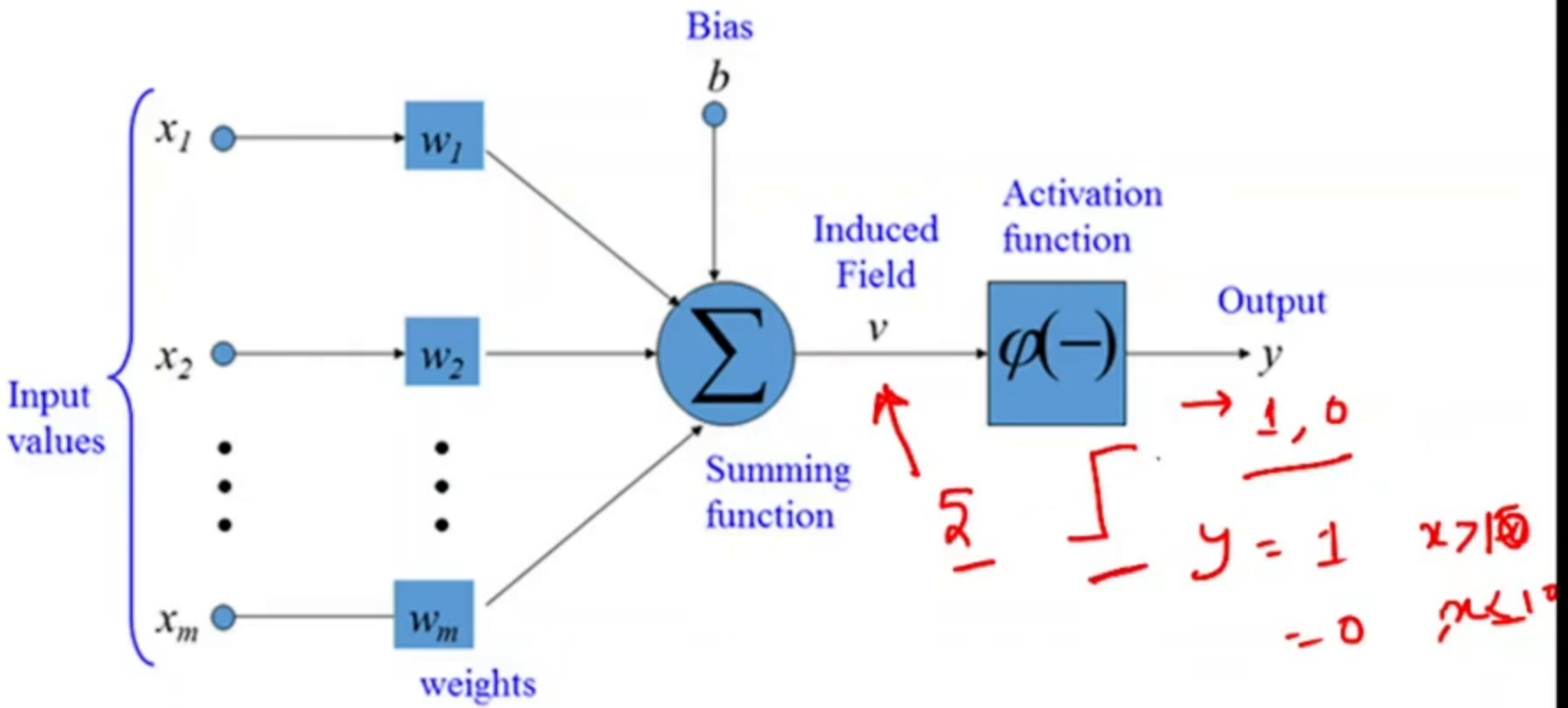
Output Y = Ø (w1*x1+w2*x2+…+b)

Activation Function



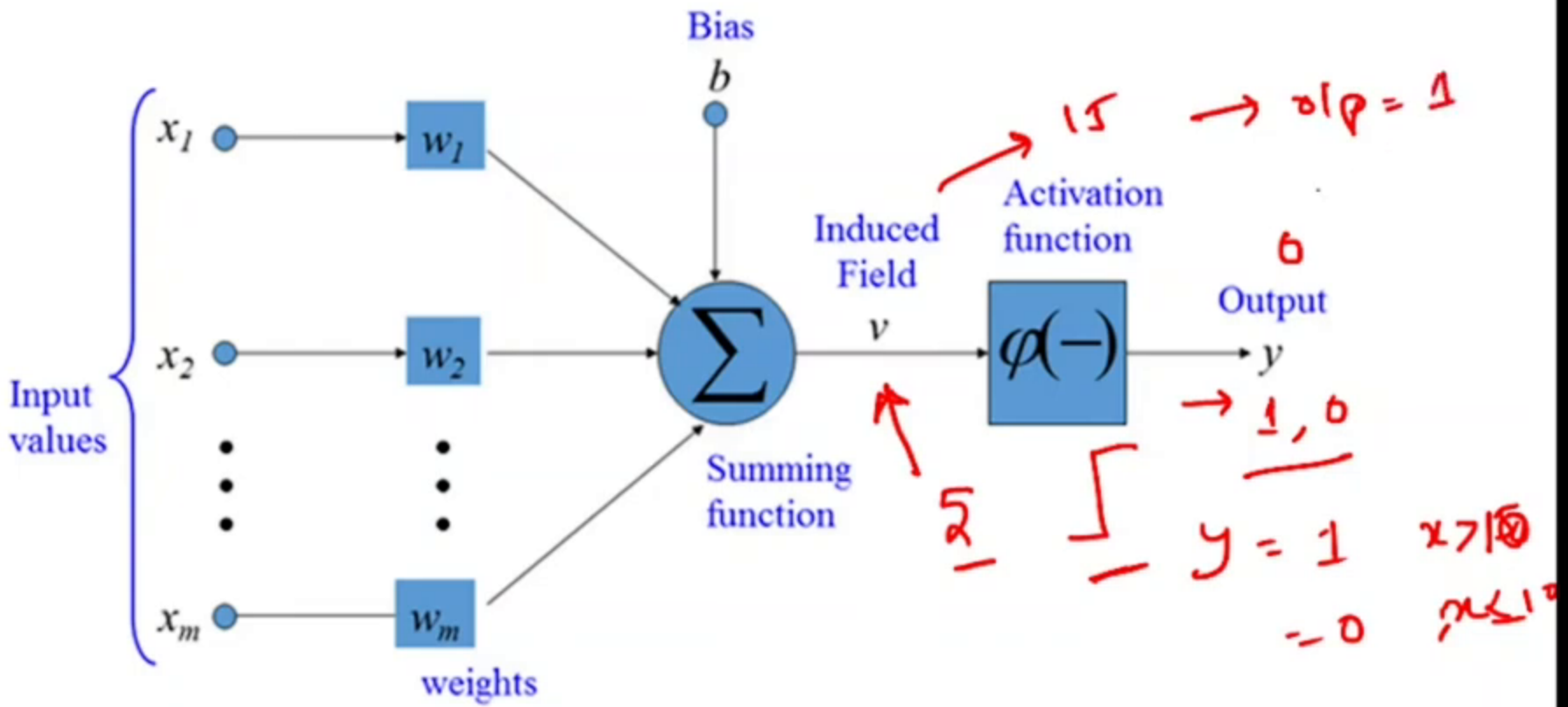
Output Y = Ø (w1*x1+w2*x2+…+b)

Activation Function



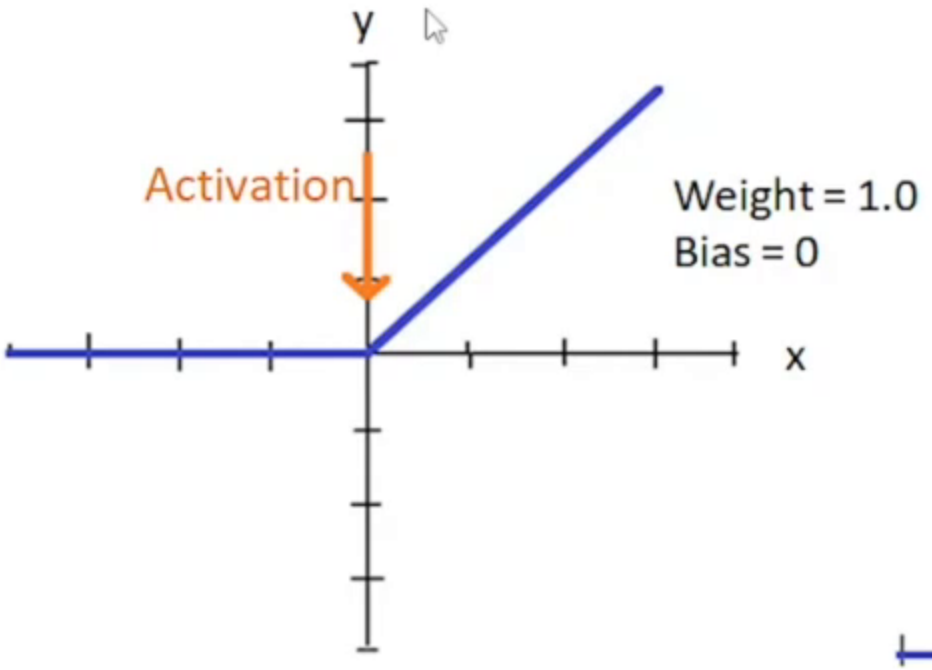
Output Y = Ø (w1*x1+w2*x2+…+b)

Activation Function

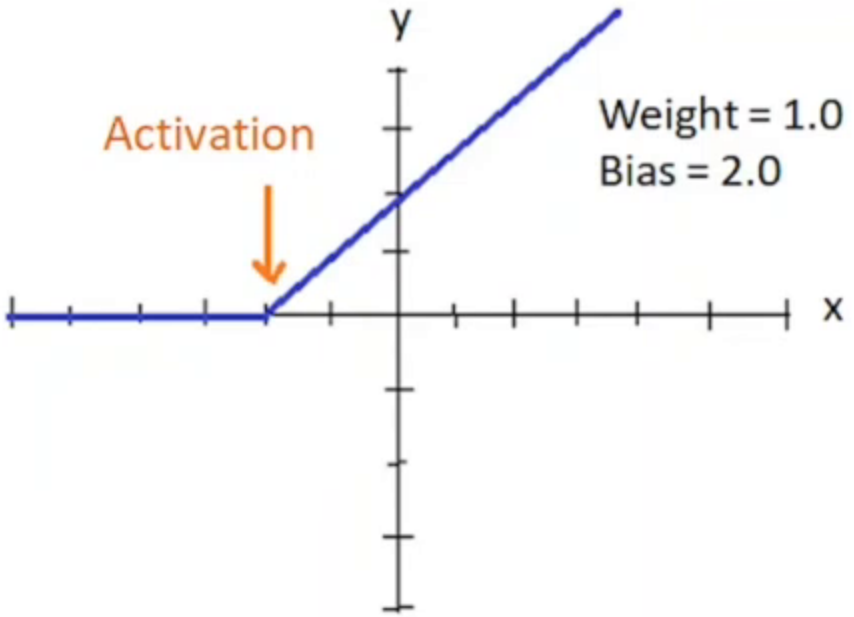


Output Y = Ø (w1*x1+w2*x2+…+b)

ReLU – Rectified Linear Unit



Weight = 1.0
Bias = 0

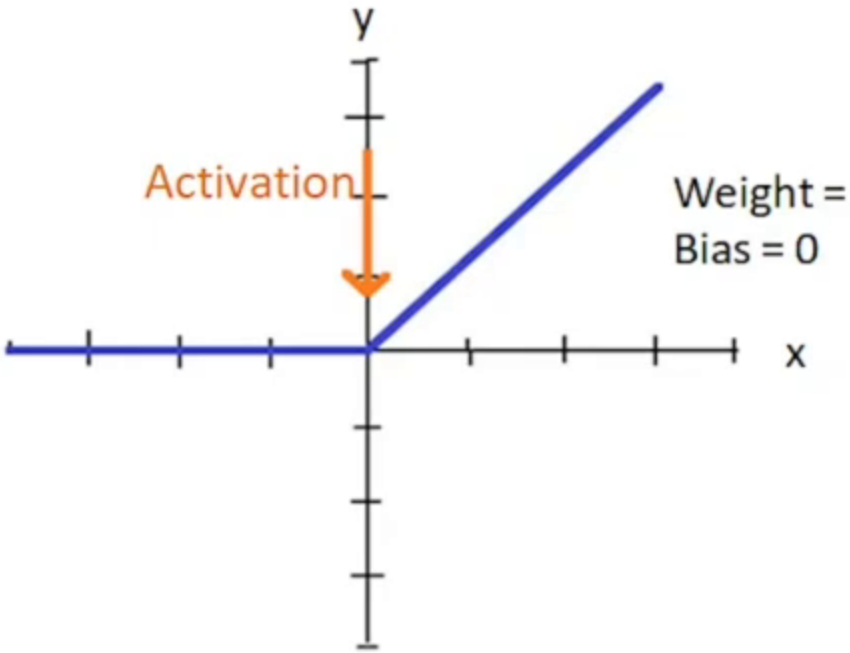


Weight = 1.0
Bias = 2.0

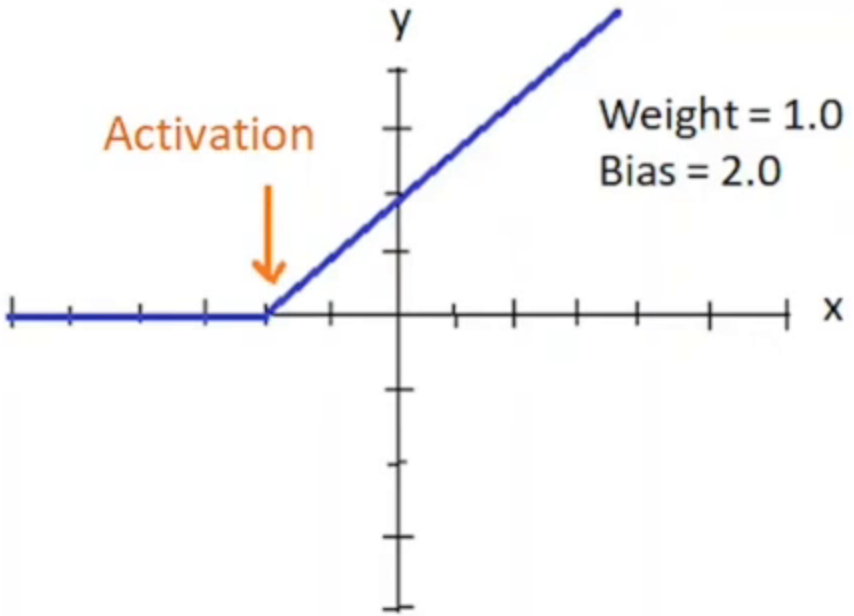
$Y = \max(0, x)$

ReLU activation

ReLU – Rectified Linear Unit



Weight = 1.0
Bias = 0

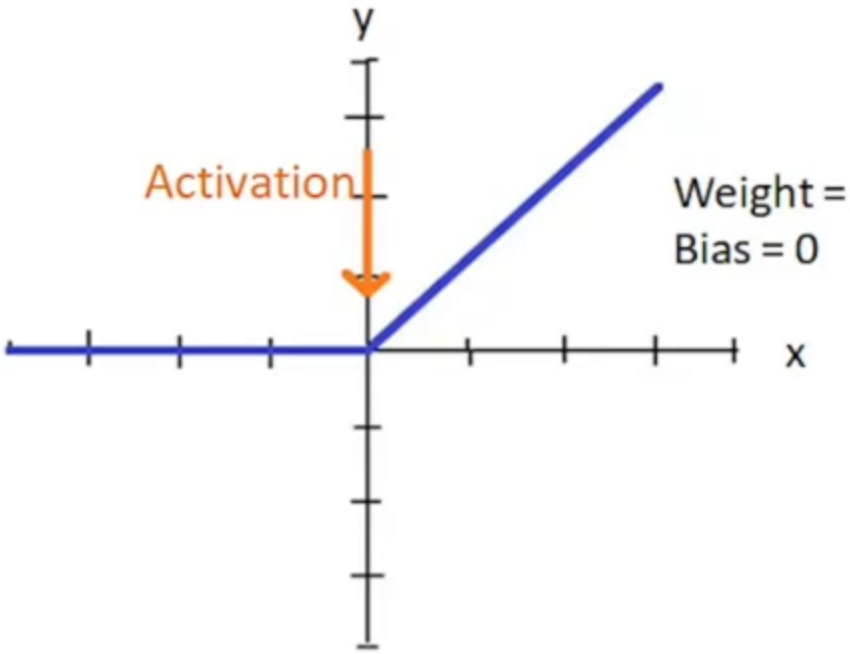


Weight = 1.0
Bias = 2.0

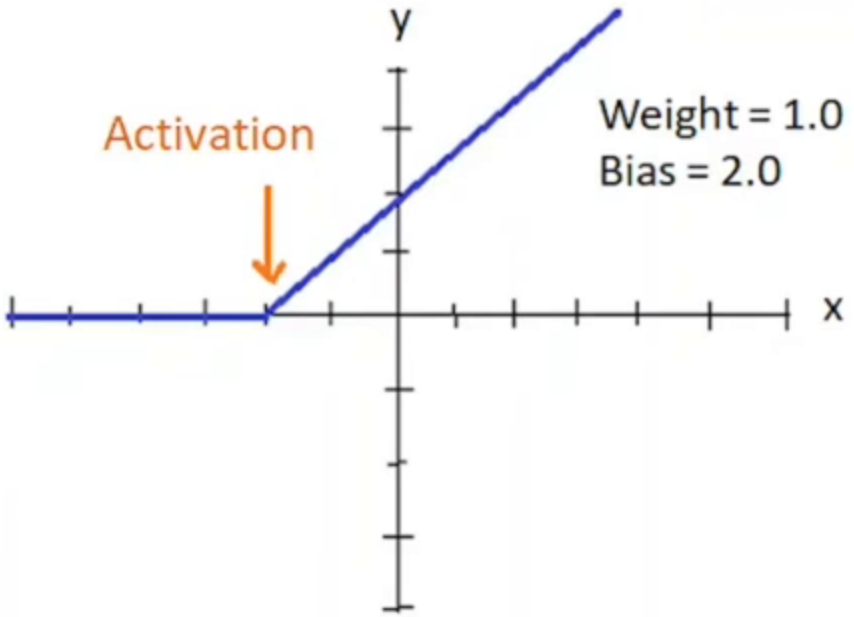
$Y = \max(0, x)$

ReLU activation

ReLU – Rectified Linear Unit



Weight = 1.0
Bias = 0

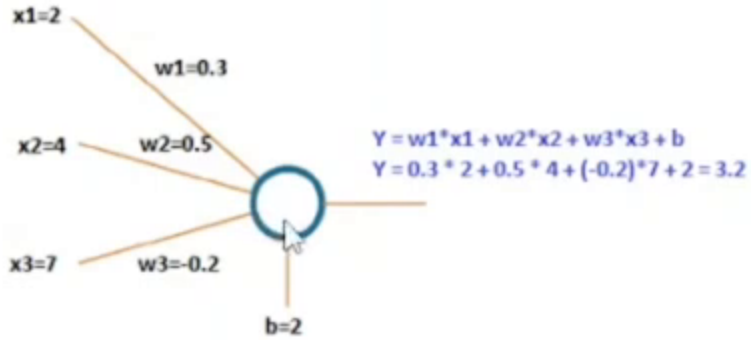


Weight = 1.0
Bias = 2.0

$Y = \max(0, x)$

ReLU activation

Let's code a basic neuron




```
[ ]
```

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Neuron.ipynb

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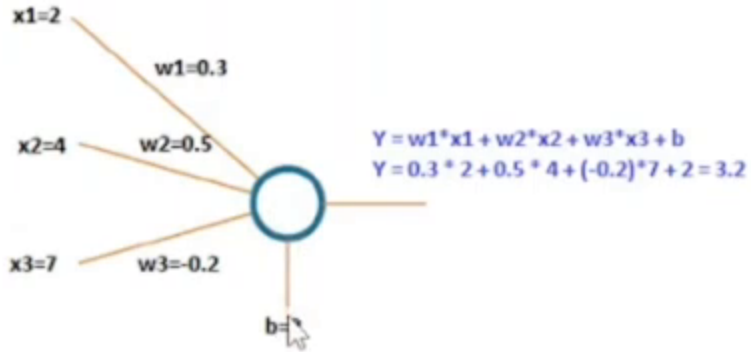
Let's code a basic neuron



[ ]

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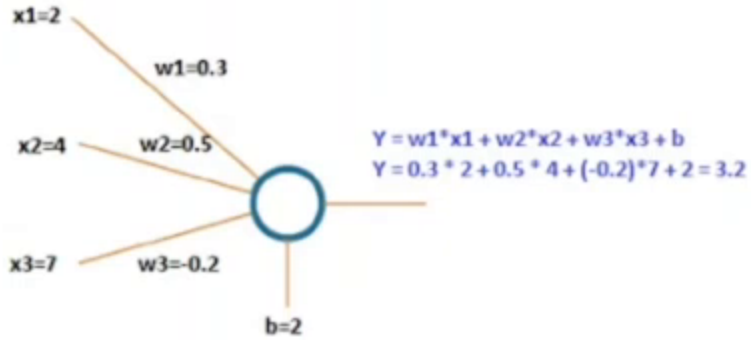
Let's code a basic neuron




```
inputs = []
```

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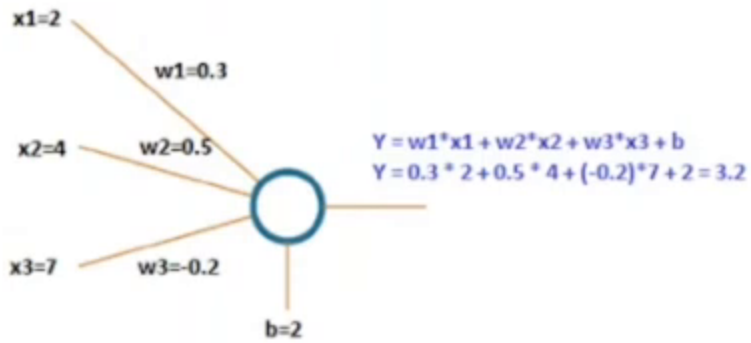
Let's code a basic neuron



$Y = w1*x1 + w2*x2 + w3*x3 + b$

$Y = 0.3 * 2 + 0.5 * 4 + (-0.2)*7 + 2 = 3.2$

```
inputs = [2,4,7]
weights = [0.3, 0]
```

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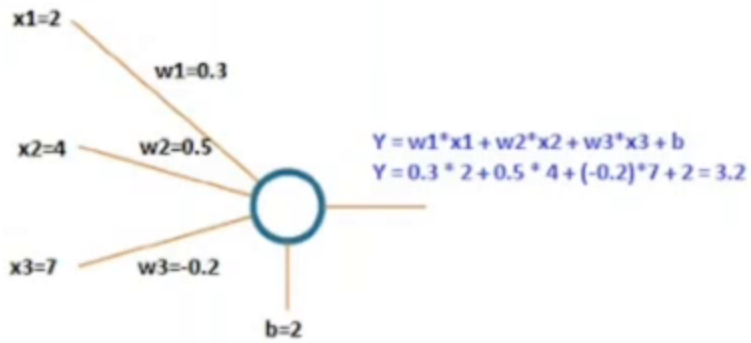
Let's code a basic neuron




```
inputs = [2,4,7]
weights = [0.3, 0.5, -0.2]
bias = 2

output
```

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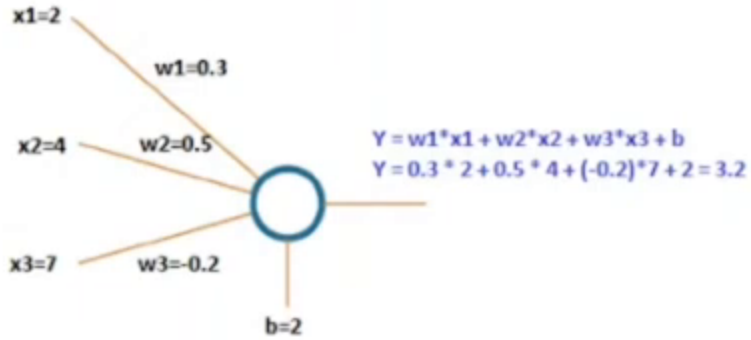
Let's code a basic neuron




```
inputs = [2,4,7]
weights = [0.3, 0.5, -0.2]
bias = 2

output = inputs[0]*weights
```

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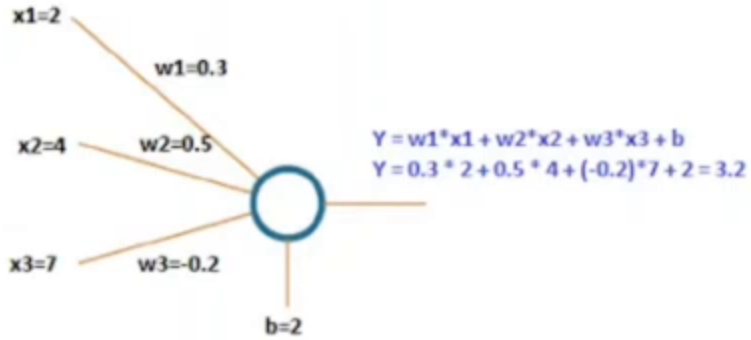
Let's code a basic neuron




```
inputs = [2,4,7]
weights = [0.3, 0.5, -0.2]
bias = 2

output = inputs[0]*weights[0] + inputs[1]*weights[1]
```

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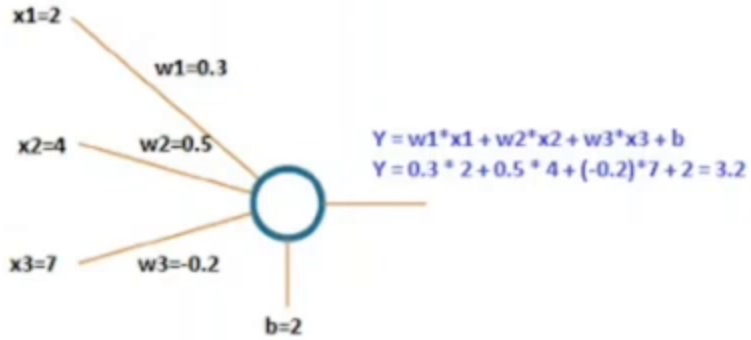
Let's code a basic neuron




```
inputs = [2,4,7]
weights = [0.3, 0.5, -0.2]
bias = 2

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2]
```

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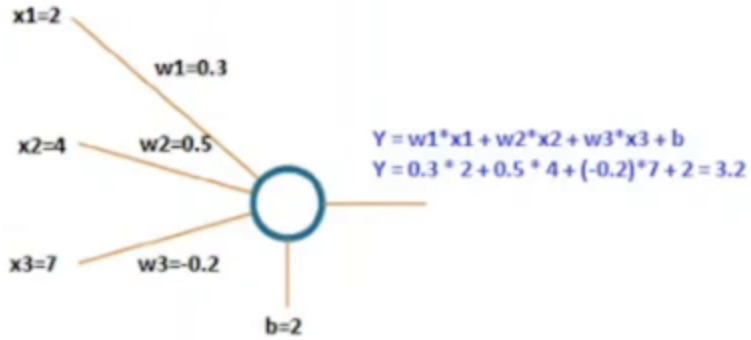
Let's code a basic neuron




```
inputs = [2,4,7]
weights = [0.3, 0.5, -0.2]
bias = 2

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
```

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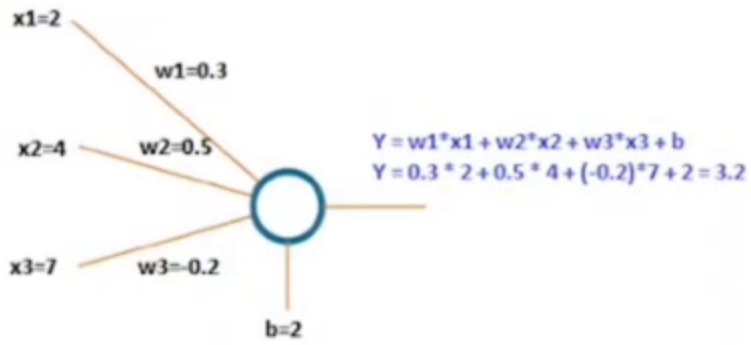


```
inputs = [2,4,7]
weights = [0.3, 0.5, -0.2]
bias = 2

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
print(output)
```

```
3.2
```

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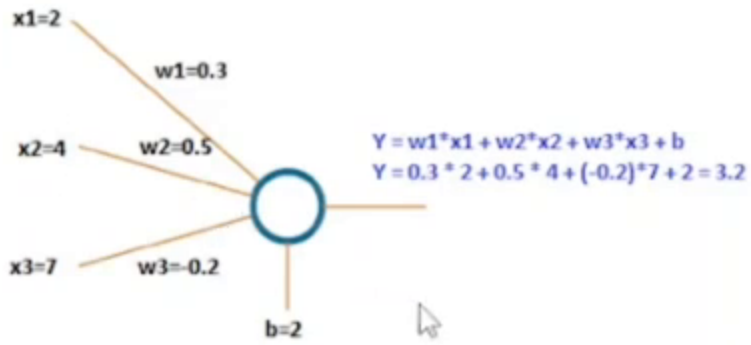

[15]
```
inputs = [2,4,7]
weights = [0.3, 0.5, -0.2]
bias = 2

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
print(output)
```

```
3.2
```

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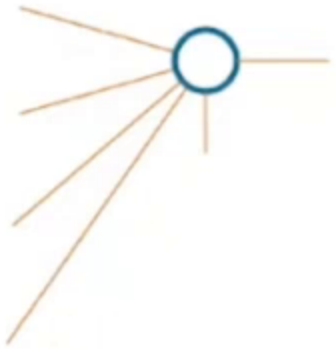
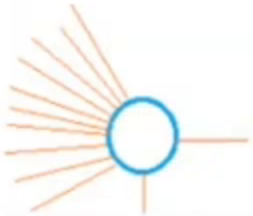
```
[15] bias = 2

     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
     print(output)
```

```
3.2
```



```
input
```



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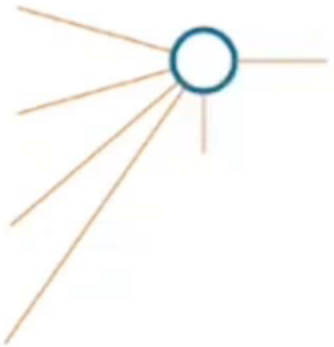
```
[15] bias = 2

     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
     print(output)
```

```
3.2
```



```
inputs = [1,2,3,4]
weights = [2,3,4,5]
bias
```

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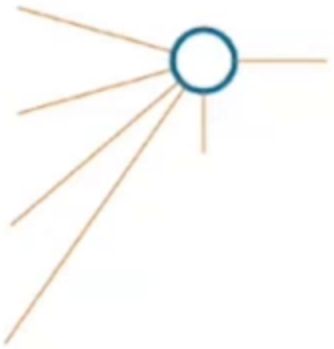
RAM Disk Editing

```
bias = 2

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
print(output)
```

```
3.2
```



```
[ ] inputs = [1,2,3,4]
    weights = [2,3,4,5]
    bias = 5

    output =
```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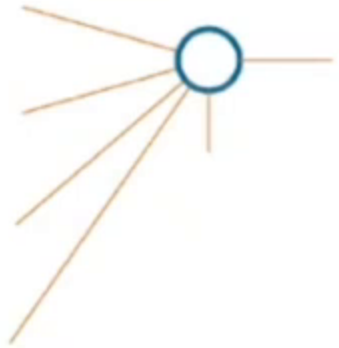
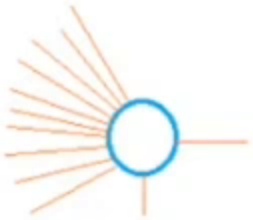


```
inputs = [1,2,3,4]
weights = [2,3,4,5]
bias = 5

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + inputs[3]* weights[3] + bias
print(output)
```

```
45
```



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colab.research.google.com/drive/109Wvb6_MPN9nDPOxf4wy2r6Ip7MZz4fs#scrollTo=E1LgW-xzC1ZE

Neuron.ipynb

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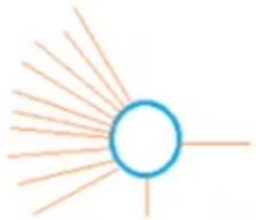
RAM Disk Editing

```
inputs = [1,2,3,4]
weights = [2,3,4,5]
bias = 5

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + inputs[3]* weights[3] + bias
print(output)
```

45



[ ]

With Numpy

[ ]

ReLU activation

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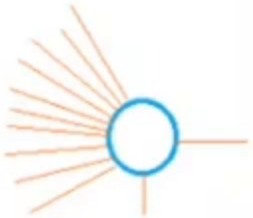
RAM Disk Editing

```
[16] inputs = [1,2,3,4]
     weights = [2,3,4,5]
     bias = 5

     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + inputs[3]* weights[3] + bias
     print(output)
```

```
45
```



```
inputts
```

With Numpy

```
[ ]
```

ReLU activation

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Neuron.ipynb

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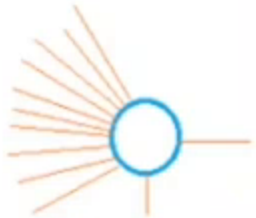
RAM Disk Editing

```
[16] inputs = [1,2,3,4]
     weights = [2,3,4,5]
     bias = 5

     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + inputs[3]* weights[3] + bias
     print(output)
```

```
45
```



```
inputs = weights = list(range())
```

With Numpy

```
[ ]
```

ReLU activation

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     bias = 5

     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + inputs[3]* weights[3] + bias
     print(output)
```

```
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```

```
inputs = weights = list(range(1,11))
bias =10
```

With Numpy

```
[ ]
```

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     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + inputs[3]* weights[3] + bias
     print(output)
```

```
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```

```
inputs = weights = list(range(1,11))
bias =10
output=0
for i in range(len(inputs)):
  ouput
```

With Numpy

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     weights = [2,3,4,5]
     bias = 5

     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + inputs[3]* weights[3] + bias
     print(output)
```

```
45
```

```
inputs = weights = list(range(1,11))
bias =10
output=0
for i in range(len(inputs)):
  output+=inputs[i]*
```

With Numpy

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     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + inputs[3]* weights[3] + bias
     print(output)
```

```
45
```

```
inputs = weights = list(range(1,11))
bias =10
output=0
for i in range(len(inputs)):
  output+=inputs[i]*weights[i]
output+=
```

With Numpy

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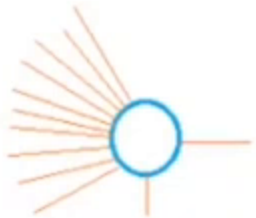
```
[16] print(output)
```

```
45
```



```
inputs = weights = list(range(1,11))
bias =10
output=0
for i in range(len(inputs)):
  output+=inputs[i]*weights[i]
output+=bias

print(output)
```

```
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```

With Numpy

```
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```

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```
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```

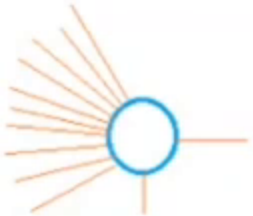

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inputs = weights = list(range(1,11))
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print(output)
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```
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```

With Numpy

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[ ]
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output=0
for i in range(len(inputs)):
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output+=bias

print(output)
```

```
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
395
```

With Numpy

```
[ ]
```

ReLU activation

```
[ ]
```

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inputs = weights = list(range(1,11))
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output+=bias

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```

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[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
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```

With Numpy

[ ]

ReLU activation

[ ]

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[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
395
```

With Numpy

[ ]

ReLU activation

[ ]

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RAM Disk Editing

```
[18] inputs = weights = list(range(1,11))
     print(inputs)
     print(weights)
     bias =10
     output=0
     for i in range(len(inputs)):
       output+=inputs[i]*weights[i]
     output+=bias

     print(output)
```

```
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
395
```

With Numpy

```
import numpy as np
```

() numpy as np

ReLU activation

```
[ ]
```

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RAM Disk Editing

```
inputs = weights = list(range(1,11))
print(inputs)
print(weights)
bias =10
output=0
for i in range(len(inputs)):
  output+=inputs[i]*weights[i]
output+=bias

print(output)
```

```
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
395
```

With Numpy

```
import numpy as np
```

ReLU activation

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RAM Disk Editing

```
[18] inputs = weights = list(range(1,11))
     print(inputs)
     print(weights)
     bias =10
     output=0
     for i in range(len(inputs)):
       output+=inputs[i]*weights[i]
     output+=bias

     print(output)
```

```
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
395
```

(a, b, out=None) -> tuple

dot(a, b, out=None)

Dot product of two arrays. Specifically,

- If both `a` and `b` are 1-D arrays, it is inner product of vectors (without complex conjugation).
- If both `a` and `b` are 2-D arrays, it is matrix multiplication, but using `matmul` or `a @ b` is preferred.

With Numpy

```
import numpy as np

output = np.dot(inputs, weights)
```

ReLU activation

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```
[18] inputs = weights = list(range(1,11))
     print(inputs)
     print(weights)
     bias =10
     output=0
     for i in range(len(inputs)):
       output+=inputs[i]*weights[i]
     output+=bias

     print(output)
```

```
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
395
```

With Numpy

```
import numpy as np

output = np.dot(inputs, weights) + bias
print(output)
```

```
395
```

ReLU activation

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RAM Disk Editing

```
[20] import numpy as np

     output = np.dot(inputs, weights) + bias
     print(output)
```

```
395
```

ReLU activation

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RAM Disk Editing

```
[20] import numpy as np

     output = np.dot(inputs, weights) + bias
     print(output)
```

```
395
```

ReLU activation

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```
# y=max(0,x)

Y = max()
```

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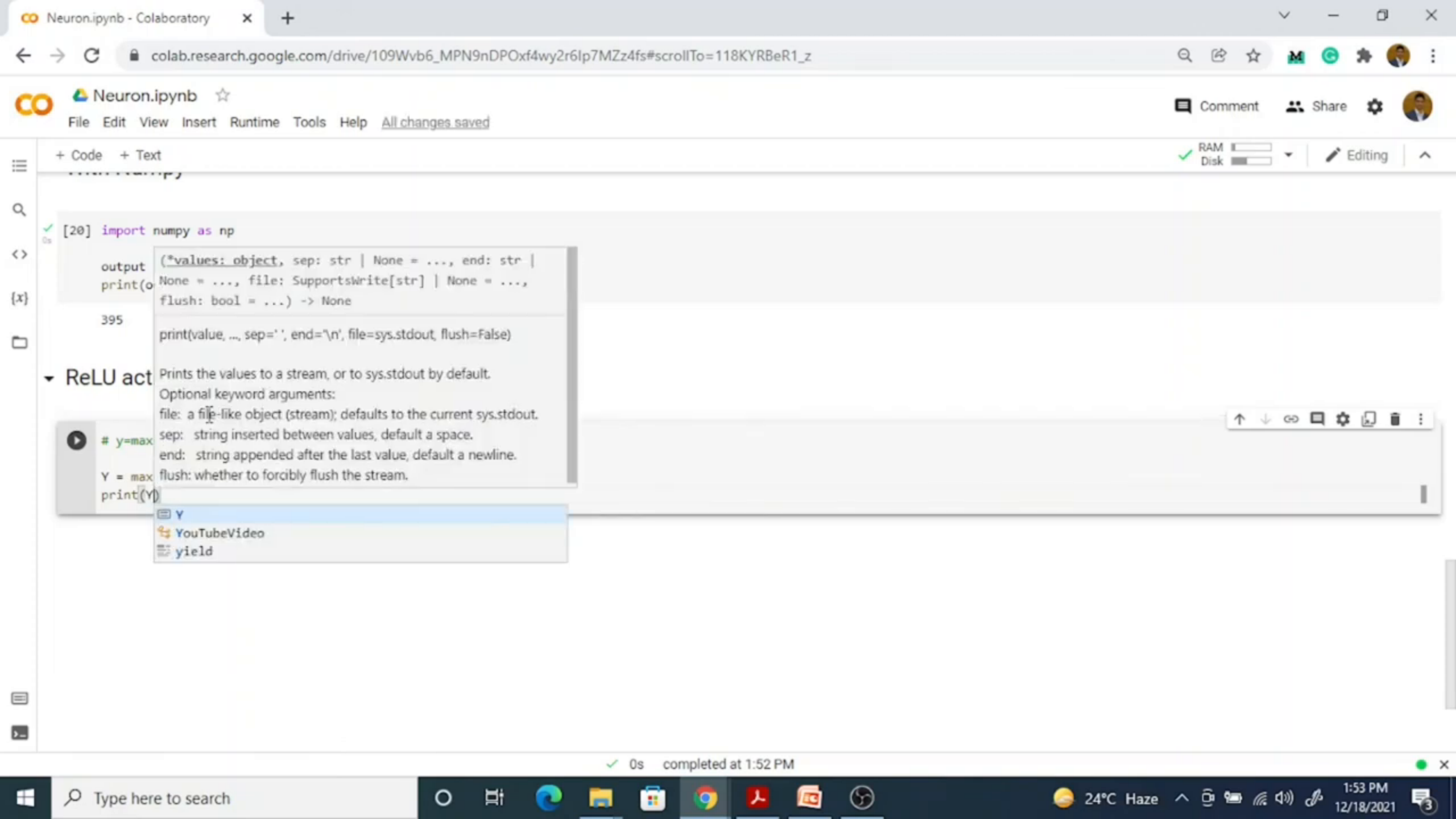
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Neuron.ipynb
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RAM
Disk
Editing
[20] import numpy as np
output
print(o
395
(*values: object, sep: str | None = ..., end: str | None = ..., file: SupportsWrite[str] | None = ..., flush: bool = ...) -> None
print(value, ..., sep=' ', end='\n', file=sys.stdout, flush=False)
Prints the values to a stream, or to sys.stdout by default.
Optional keyword arguments:
file: a file-like object (stream); defaults to the current sys.stdout.
sep: string inserted between values, default a space.
end: string appended after the last value, default a newline.
flush: whether to forcibly flush the stream.
ReLU act
# y=max
Y = max
print(Y)
Y
YouTubeVideo
yield
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RAM Disk Editing

ReLU activation

```
# y=max(0,x)

Y = max(0, output)
print(Y)
```

```
395
```

```
inputs = [-1,-2,-3]
weights = [0.2, 0.3, 0.4]
bias = -10

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
print(output)
```

```
[ ]
```

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ReLU activation

```
[21] # y=max(0,x)

     Y = max(0, output)
     print(Y)
```

```
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```

```
inputs = [-1,-2,-3]
weights = [0.2, 0.3, 0.4]
bias = -10

output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
print(output)
```

```
-12.0
```

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RAM Disk Editing

ReLU activation

```
[21] # y=max(0,x)

     Y = max(0, output)
     print(Y)
```

```
395
```

```
[22] inputs = [-1,-2,-3]
     weights = [0.2, 0.3, 0.4]
     bias = -10

     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
     print(output)
```

```
-12.0
```

```
Y = max(0, output)
prin
```

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```
[21] print(Y)

     395

[22] inputs = [-1,-2,-3]
     weights = [0.2, 0.3, 0.4]
     bias = -10

     output = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bias
     print(output)

     -12.0

     Y = max(0, output)
     print(Y)

     0

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RAM Disk Editing

```
import numpy as np
```

[20]

```
output = np.dot(inputs, weights) + bias
print(output)
```

```
395
```

ReLU activation

[21]

```
# y=max(0,x)

Y = max(0, output)
print(Y)
```

```
395
```

```
inputs = [-1,-2,-3]
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bias = -10

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print(output)
```

```
-12.0
```

```
Y = max(0, output)
print(Y)
```

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```

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