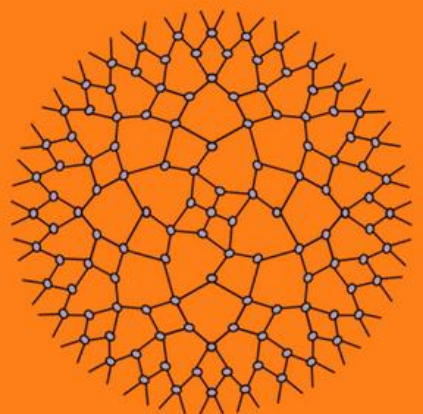
ML Algorithms

NEURAL NETWORKS



Class

A Detailed Look At Neural Networks

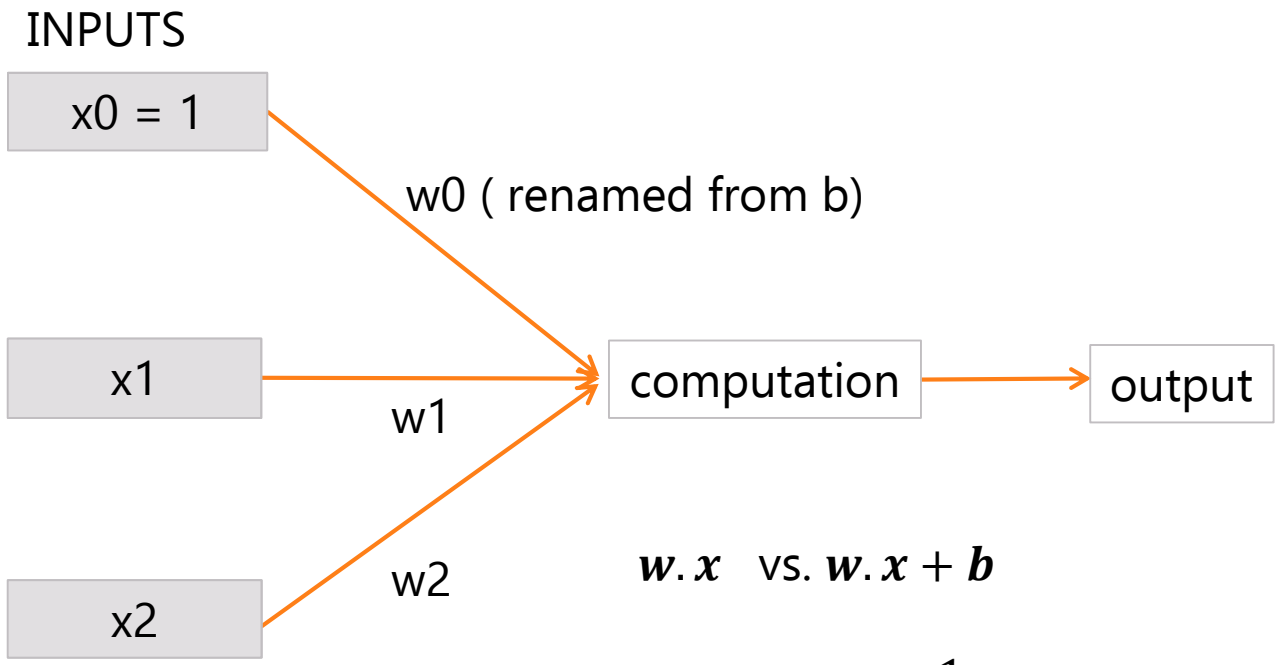
Topic

Mathematical Representation

Multi-layered Networks

To find their weights, modify how each neuron is represented mathematically

- The intercept term b is the weight for an input that is always 1



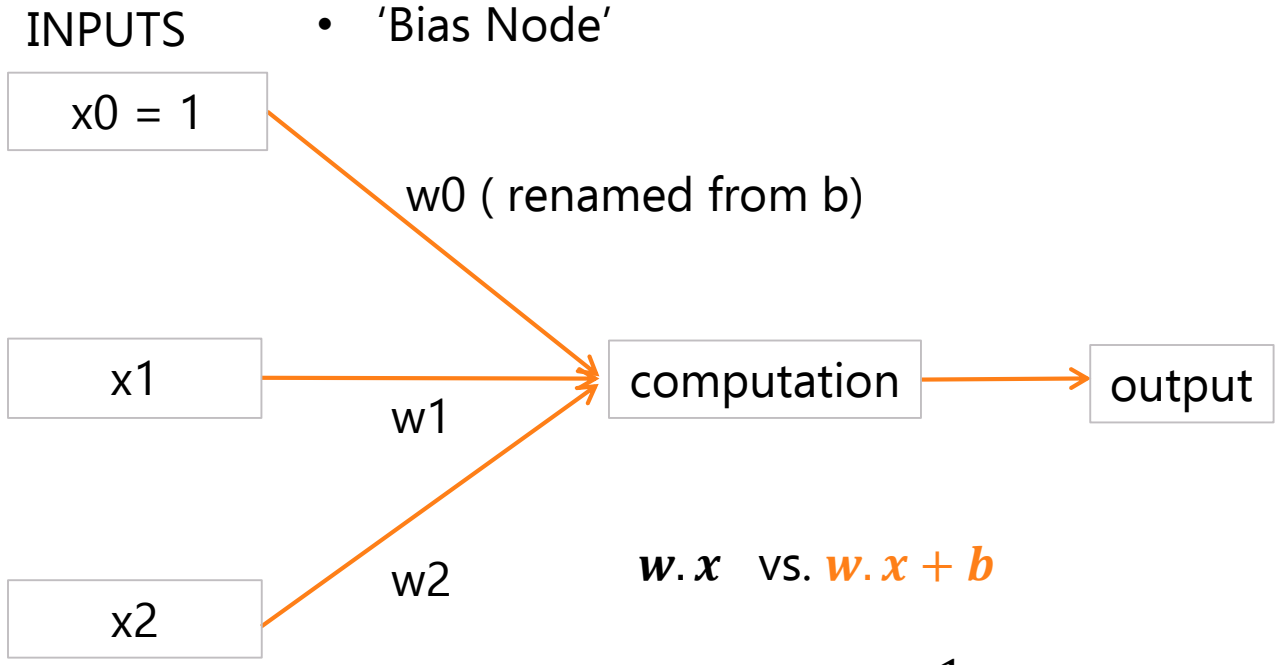
$\boldsymbol{w}.\boldsymbol{x}$ vs. $\boldsymbol{w}.\boldsymbol{x} + \boldsymbol{b}$

$$h(x) = \frac{1}{1+e^{-\boldsymbol{w}.\boldsymbol{x}}}$$

Multi-layered Networks

To find their weights, modify how each neuron is represented mathematically

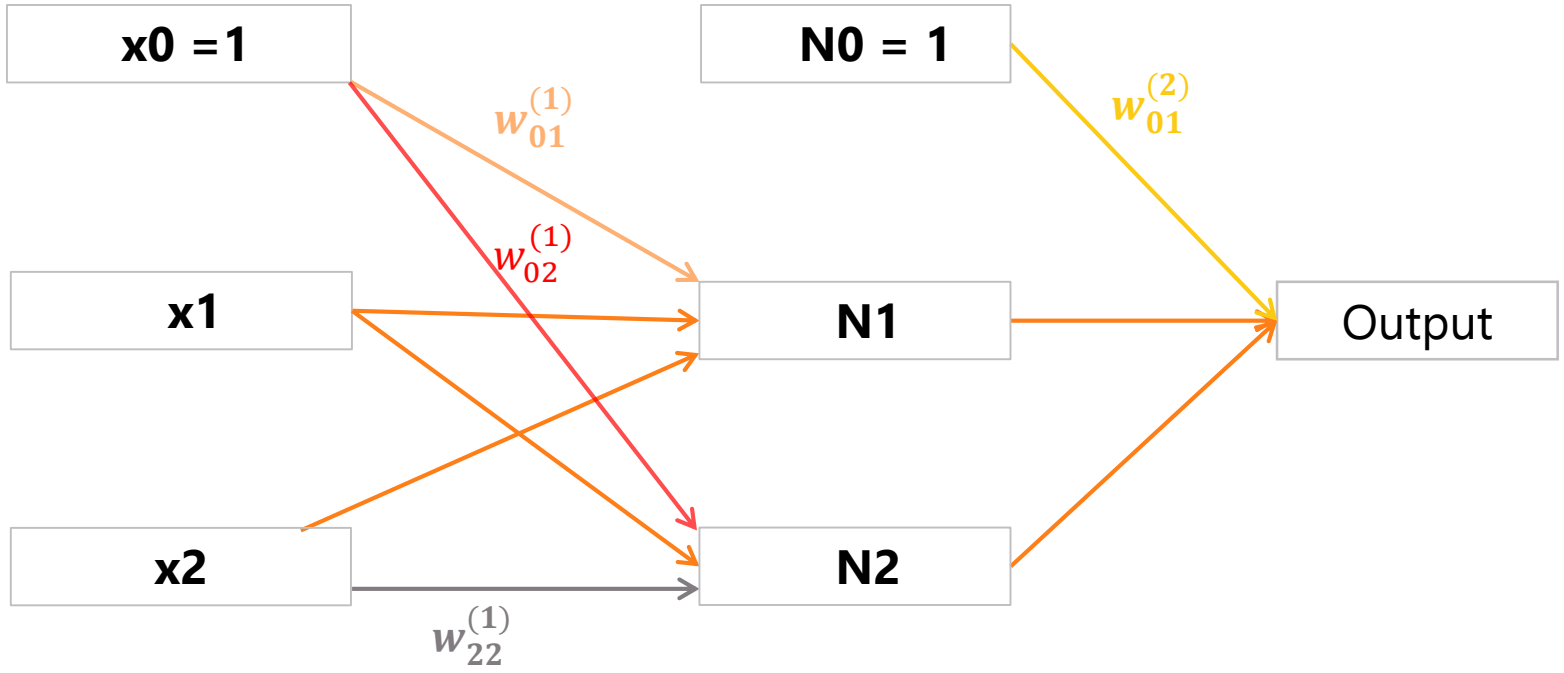
- The intercept term b is the weight for an input that is always 1
- 'Bias Node'



$\boldsymbol{w.x}$ vs. $\boldsymbol{w.x + b}$

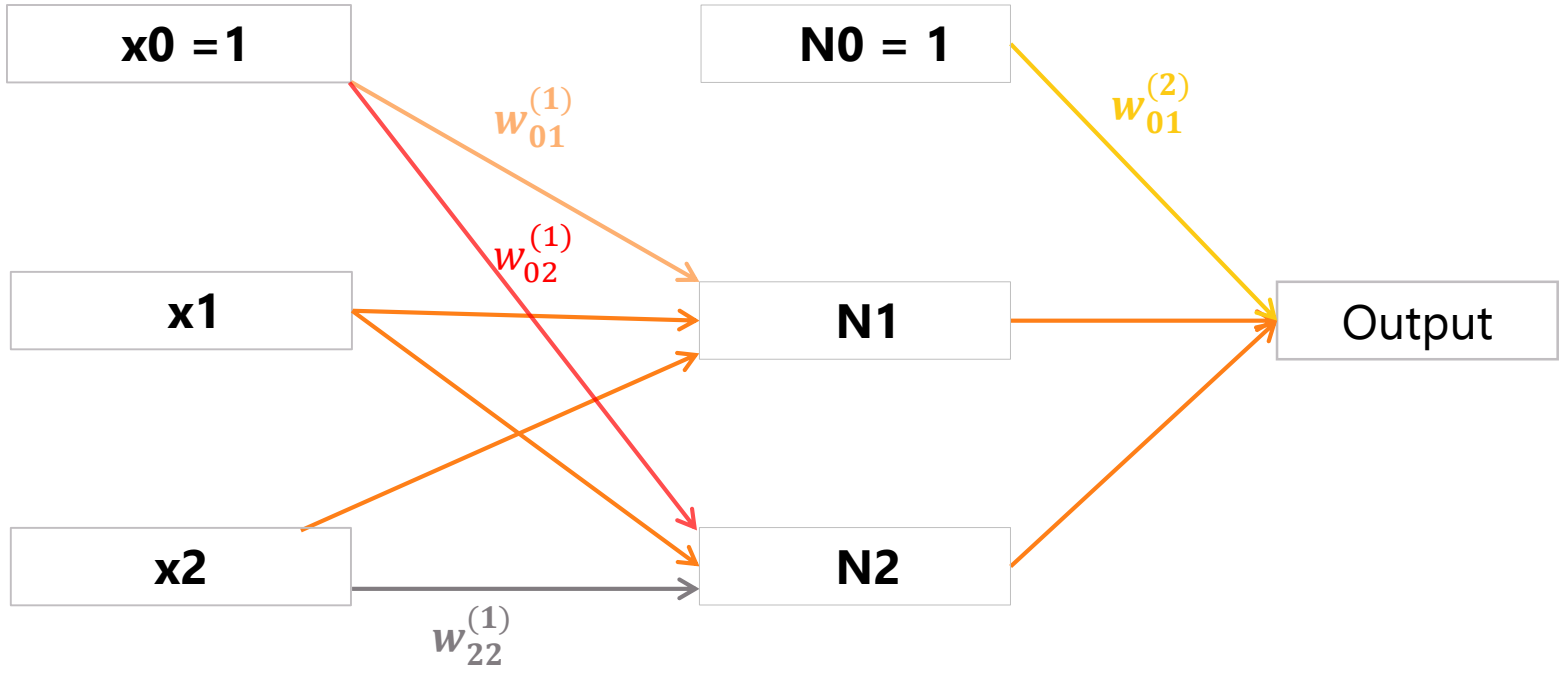
$$h(x) = \frac{1}{1+e^{-\boldsymbol{w.x}}}$$

Multi-layered Networks



- In multi layered networks, you can have multiple layers
- Each layer would have a different number of nodes than the others
- This neural net has three layers

Multi-layered Networks



Input Layer : 0
Dimension (number of nodes) : $d^{(0)} = 3$

Hidden Layer : 1
Dimension (number of nodes) : $d^{(1)} = 3$

Output Layer : 2
Dimension (number of nodes) : $d^{(2)} = 1$

Mathematical Representation

- We have already seen the **w**'s in
  - ❑ Single neurons
  - ❑ Networks

- Now that things are more complex, we need an indexing scheme to keep track of the **w**'s

- Weights should have 3 indices
  - ❑ I1: Destination layer index
  - ❑ I2: Identifies the origin input in the origin layer
  - ❑ I3: Identifies the destination node in the destination layer

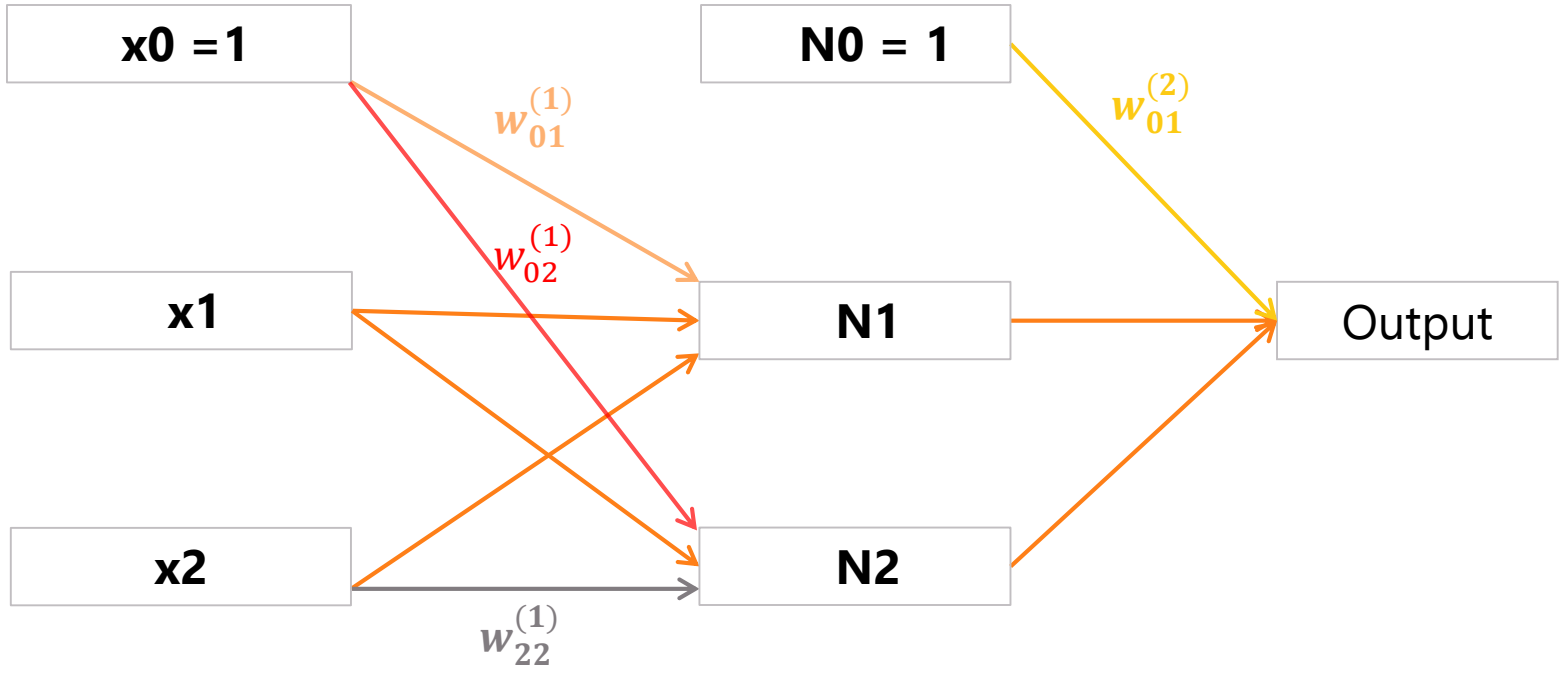
- The layer index is written in superscript

- The number thus displayed indicates which layer you're working with

- The two remaining indices are written in subscript

- **I2** identifies the **origin node** and **I3** identifies the **destination node**

Mathematical Representation



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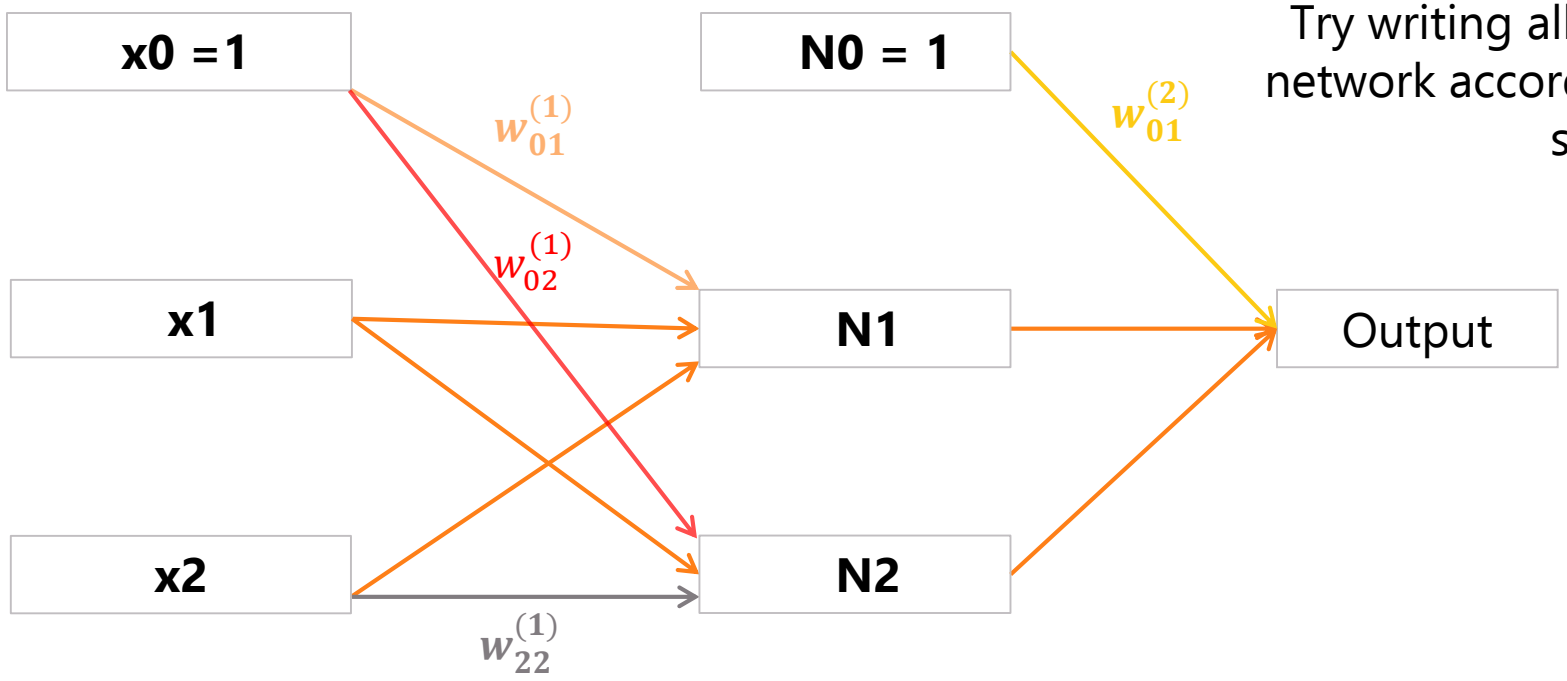
Mathematical Representation



Try writing all the weights in this network according to this indexing scheme

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Hidden Layer : 1
Dimension (number of nodes) : $d^{(1)} = 3$

Output Layer : 2
Dimension (number of nodes) : $d^{(2)} = 1$

Neural Networks: Summary

- L layers (L – 2 hidden layers)
- $d^{(l)}$ nodes in Layer l, $0 \leq l \leq L$
- Weights: $w_{ij}^{(l)}$, $i \leq d^{(l-1)}$ & $j \leq d^{(l)}$

Neural Networks: Summary

- L layers (L – 2 hidden layers)
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- The weight vector for such a neural network is a long vector
- Each element of the vector is the weight of a connection between a neuron in one layer to a neuron in the immediate next layer

Recap

- Machine Learning
- Different kinds of tasks in machine learning
- The workings of neurons
- How does a neuron make a decision?
- How does a group of neurons make a decision ?
- Mathematical formulation

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