CS 455 – Computer Security Fundamentals

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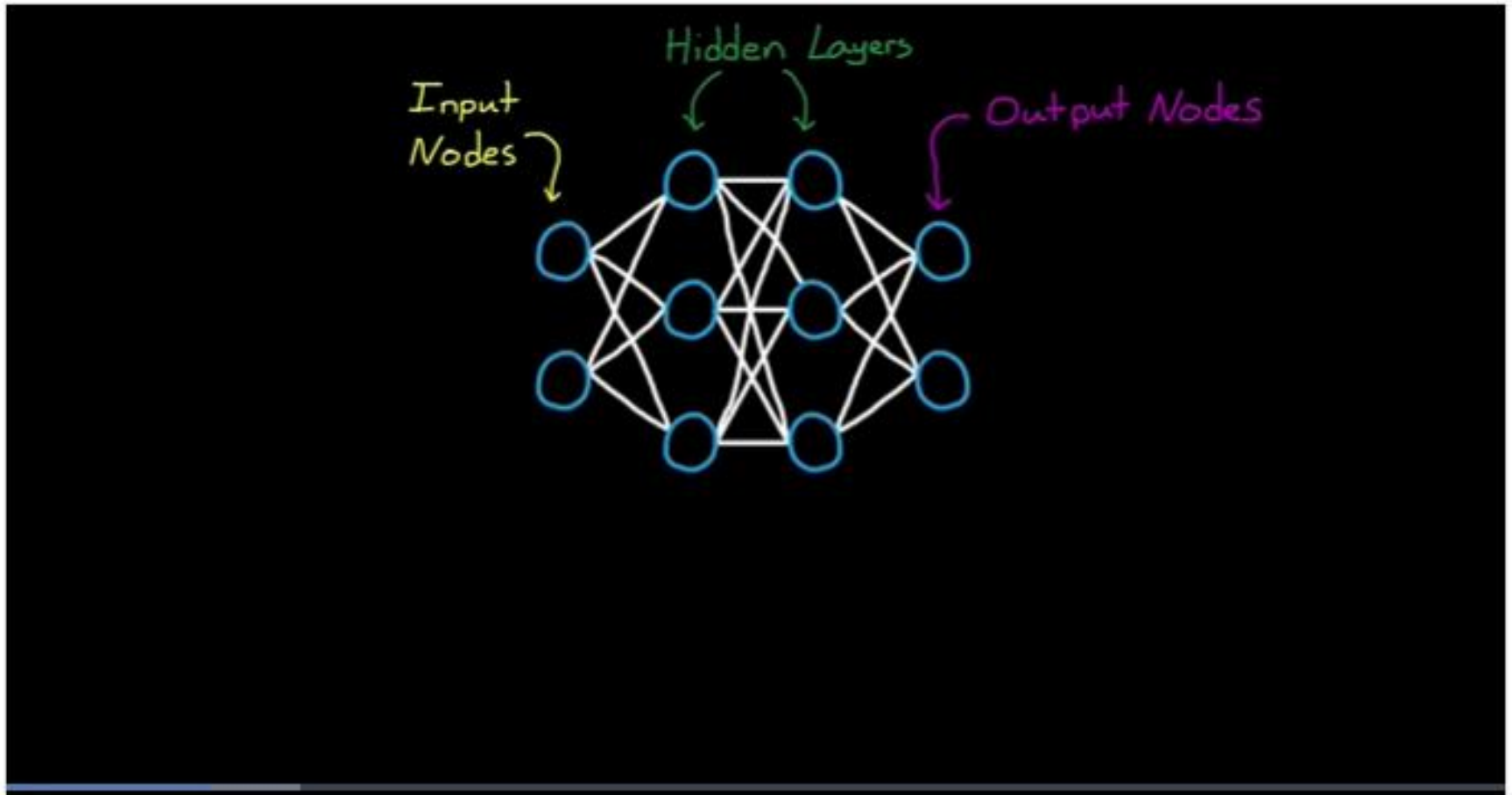
- Appendix Neural Network
  - Purpose: Prediction

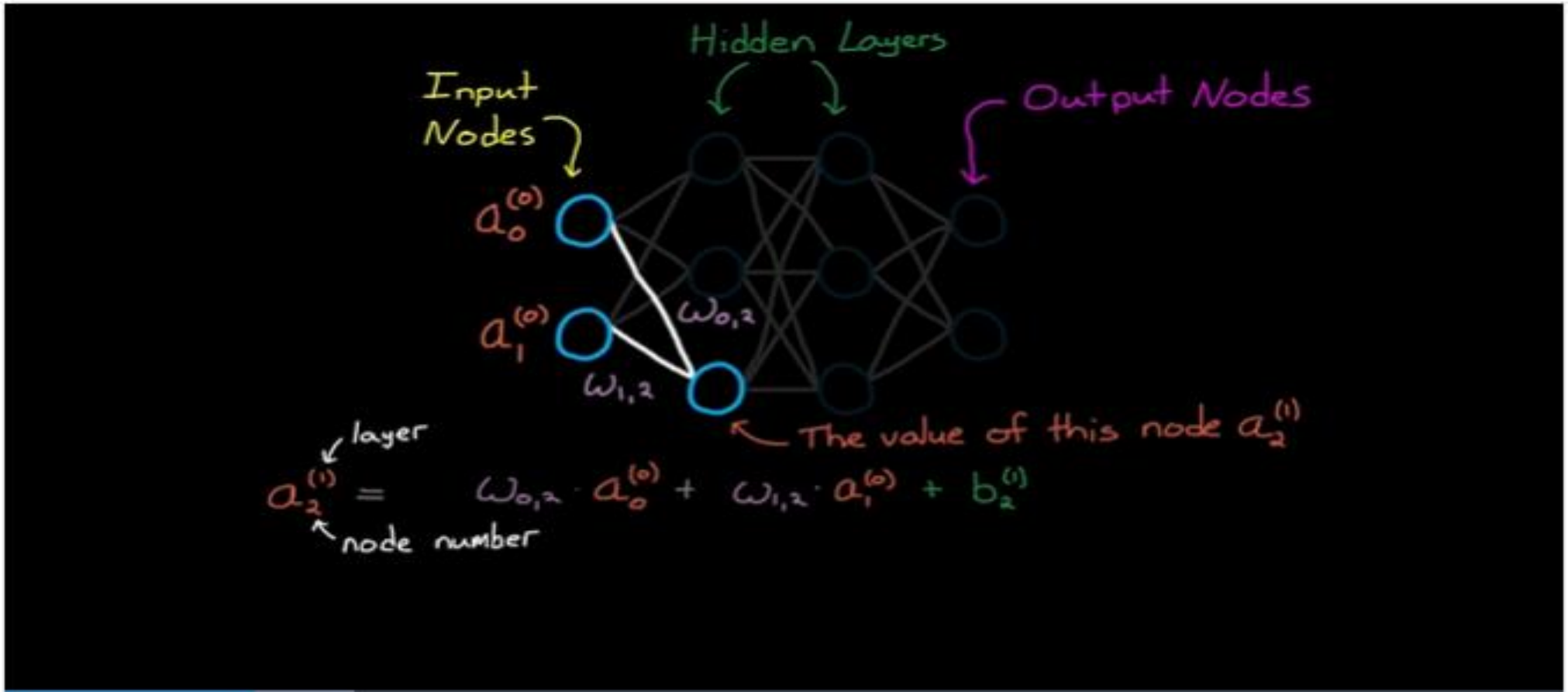
Appendix: Neural Network

- Let’s take a very simple example, a fully connected network



Appendix: Neural Network

- In this way, we can easily compute a node's value, the blue on in the bottom of the 1st hidden layer (or you can say on the bottom of the 2nd layer)
- W is the weight on the edges



Appendix: Neural Network

- Supposedly, in this way, we can compute all the values in the layer1 (numbering on layers starts from 0)
- What is the “b” item? Bias! There a is a gap between the predicted value and the realistic value

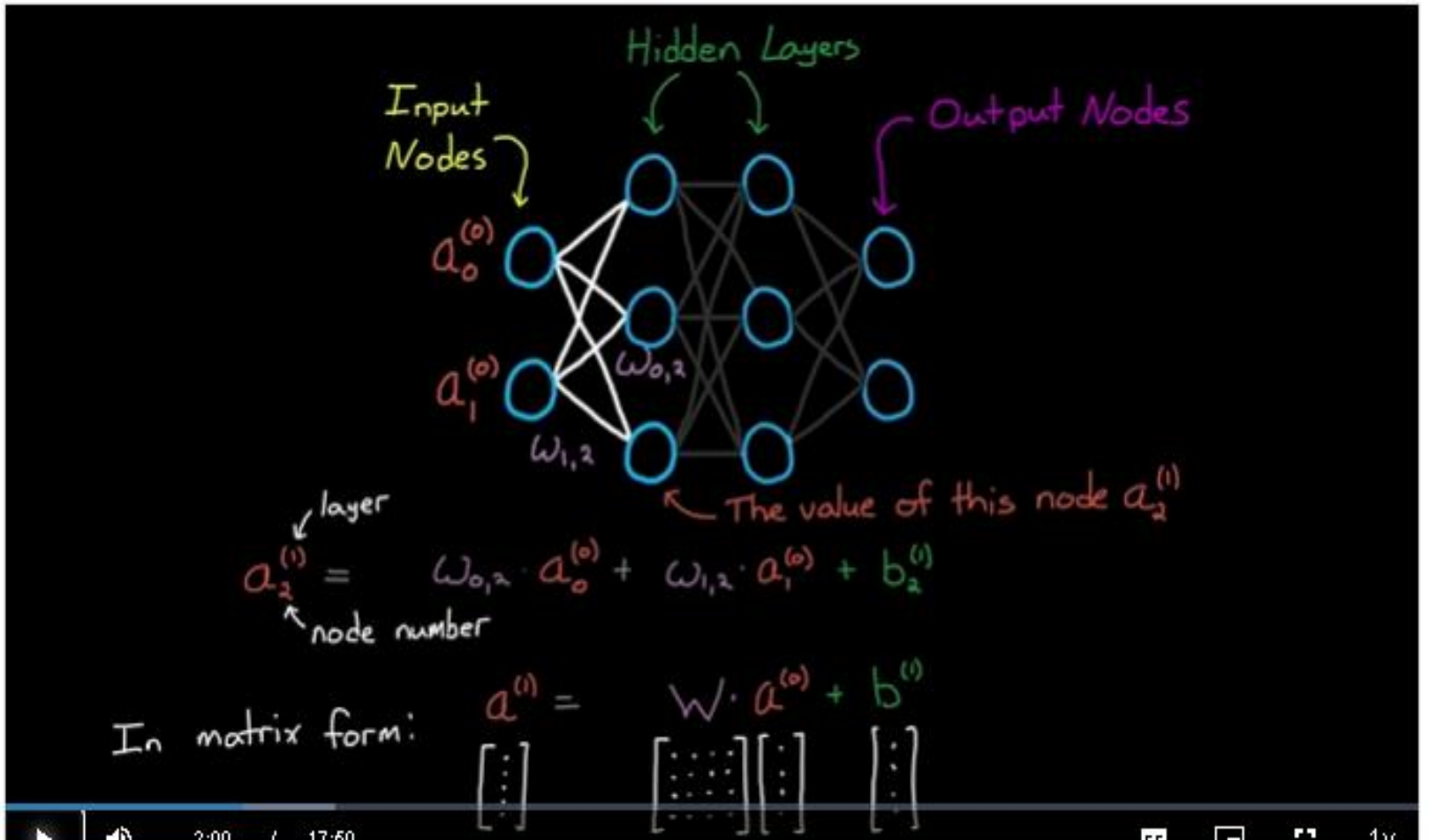
Appendix: Neural Network

- We can do a better job to have W(s) as a matrix representation for weight
- This is how

all the nodes in layer 1

get computed from

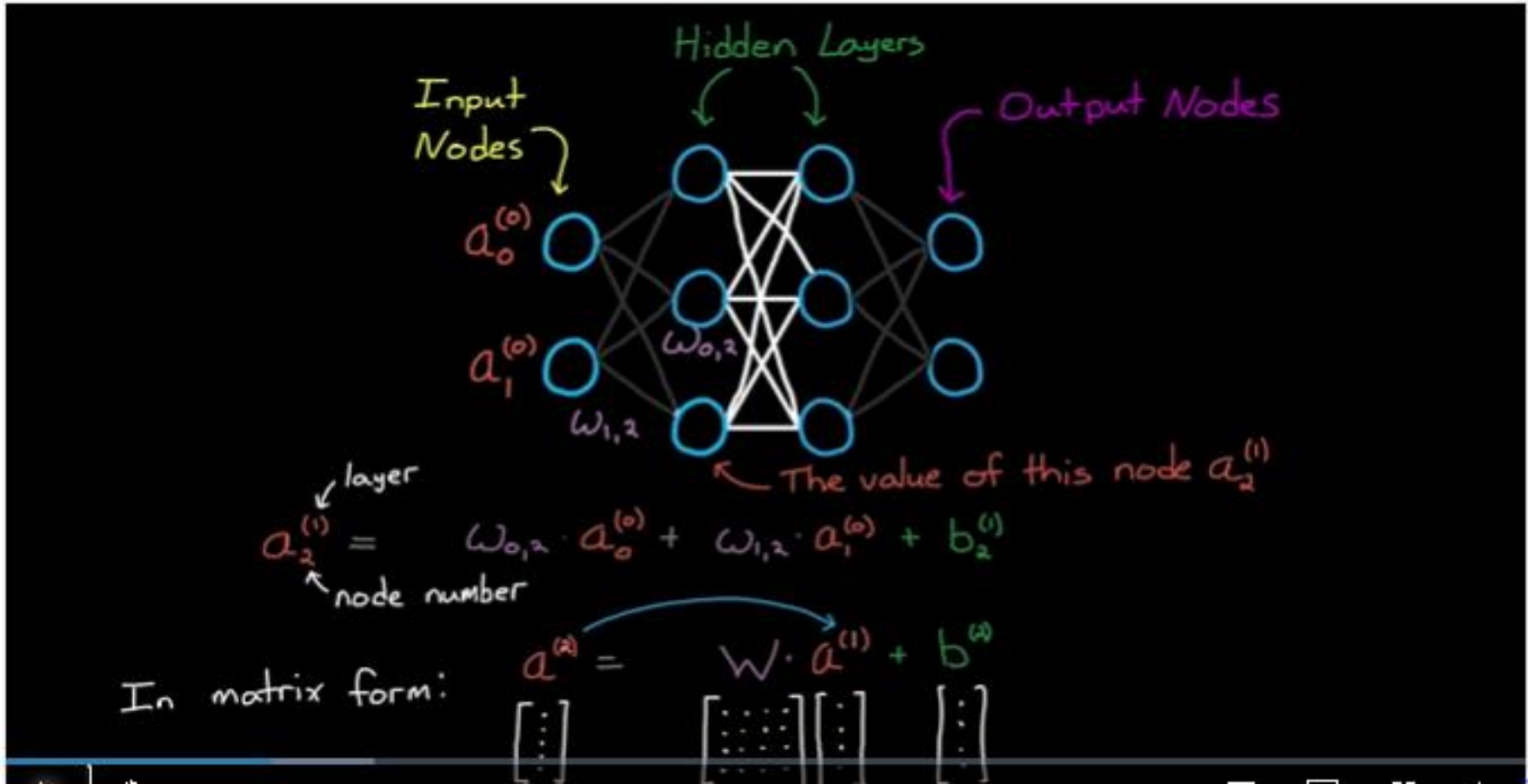
nodes in layer 0!



Appendix: Neural Network

- Similarly, by using this way, we can have all the nodes from layer 2 get computed from layer 1
- The Bias?

The way of this representation means all the bias in #2 layer (the numbering starts from #0) in the matrix format

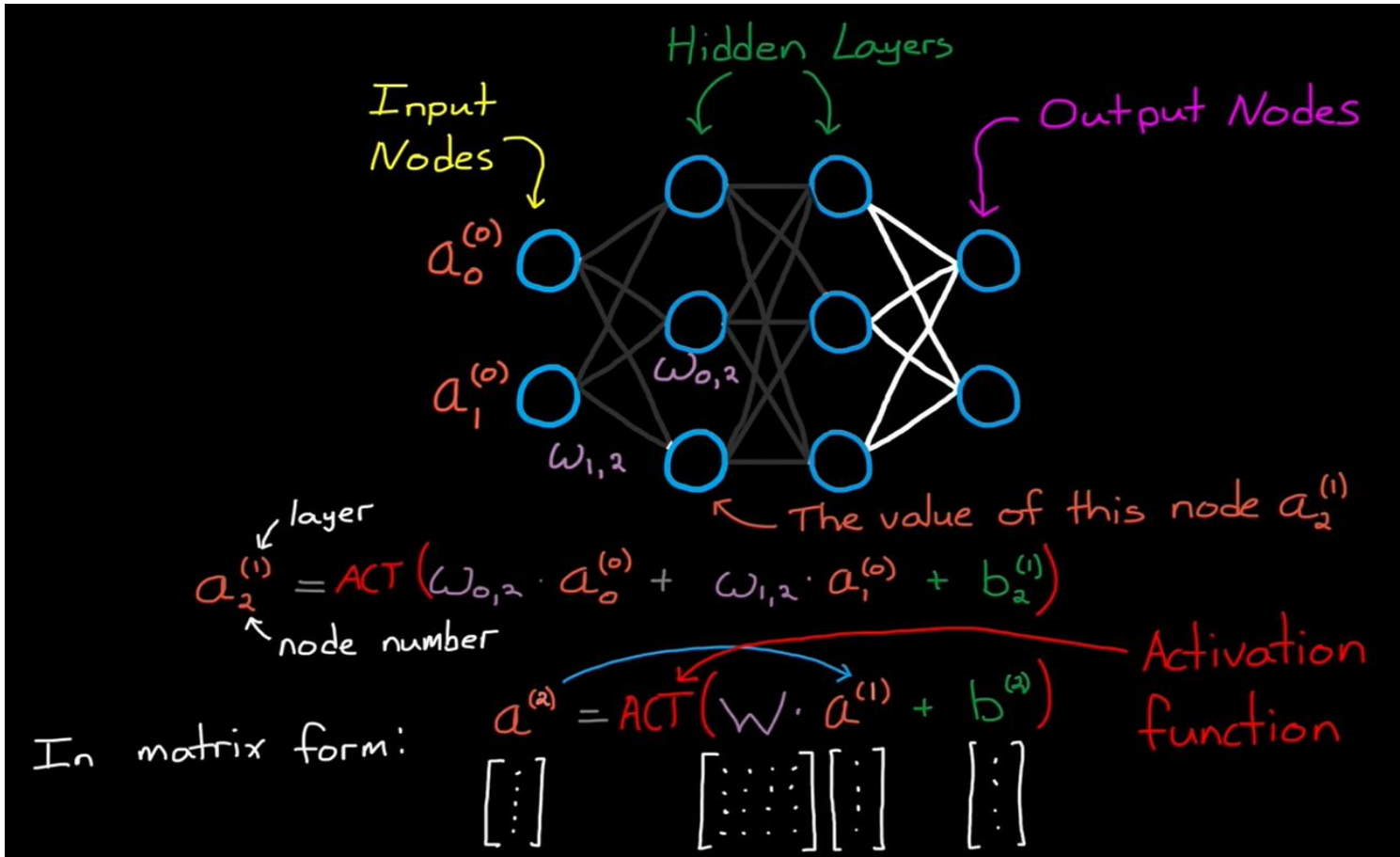


Appendix: Neural Network

- As you can see, the node values is propagated layer by layer and is accumulated
  - i.e. The values of nodes from layer 3 is from layer 2
    - Node values in layer 2 is from layer 1
    - Node values in layer 1 is from layer 0

Appendix: Neural Network

- There is one more thing we forget --- Activations Function

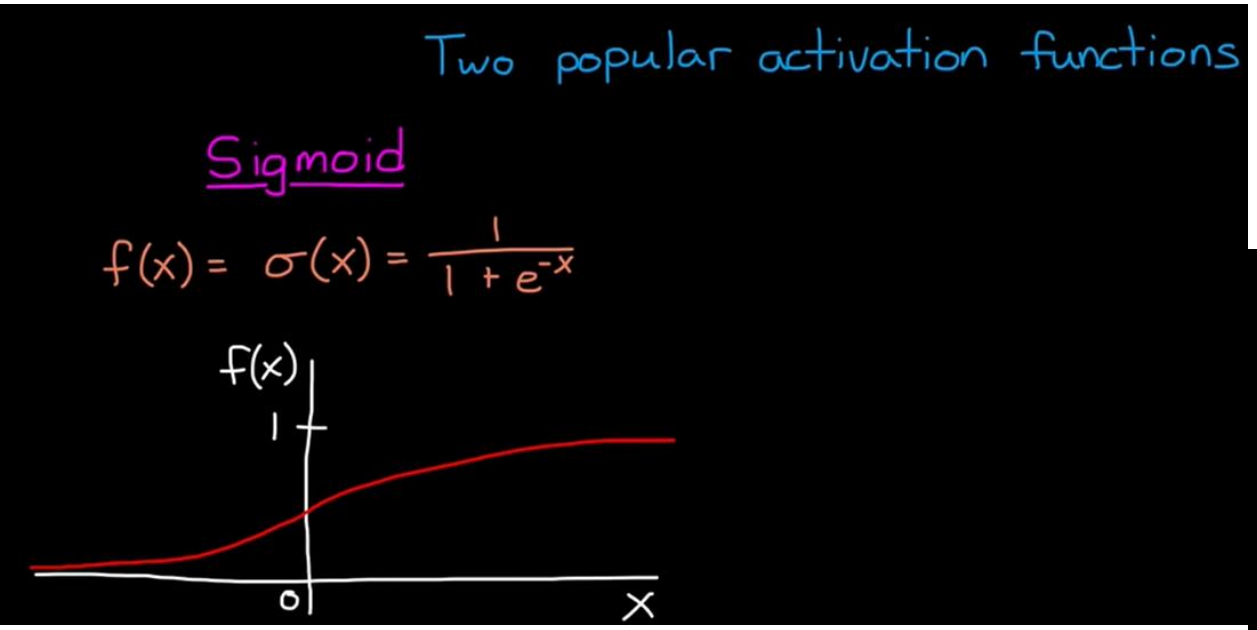


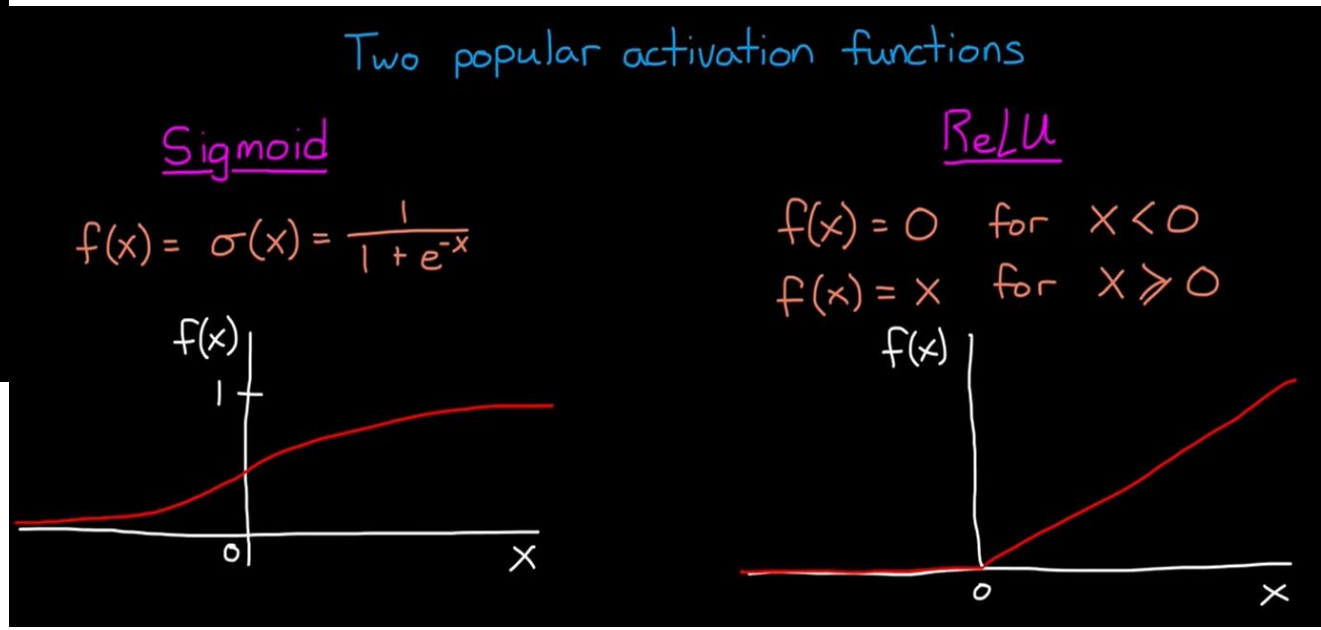
Appendix: Neural Network

- The **activation function** decides **whether a neuron should be activated** (or not) by calculating the weighted sum and further adding bias to it.
  - If we are going to compute values on layer 2, layer 1 has to be activated
- The purpose of the activation function is to introduce non-linearity into the output of a neuron --- Try to get our model can learn complicated values
- When comparing with a neuron-based model that is in our brains, the activation function is at the end deciding **what is to be fired to the next neuron**.

Appendix: Neural Network

- There are 2 popular activation functions, Sigmoid and ReLu





Appendix: Neural Network

- How the forecasted output data related to our realistic categorical data?
  - One Hot Encoding!
  - For example, Driving: 1, Working: 2, Eating: 3, Sleeping: 4, Break: 5, Shower: 6, Cooking: 7, Recreation: 8, Reading: 9, Workout: 10
  - You can ask Dr. Alan about Neural Net. predictions on categorical data
    - Not just on the continuous numerical values
    - We sometimes need to deal with discrete numbers!