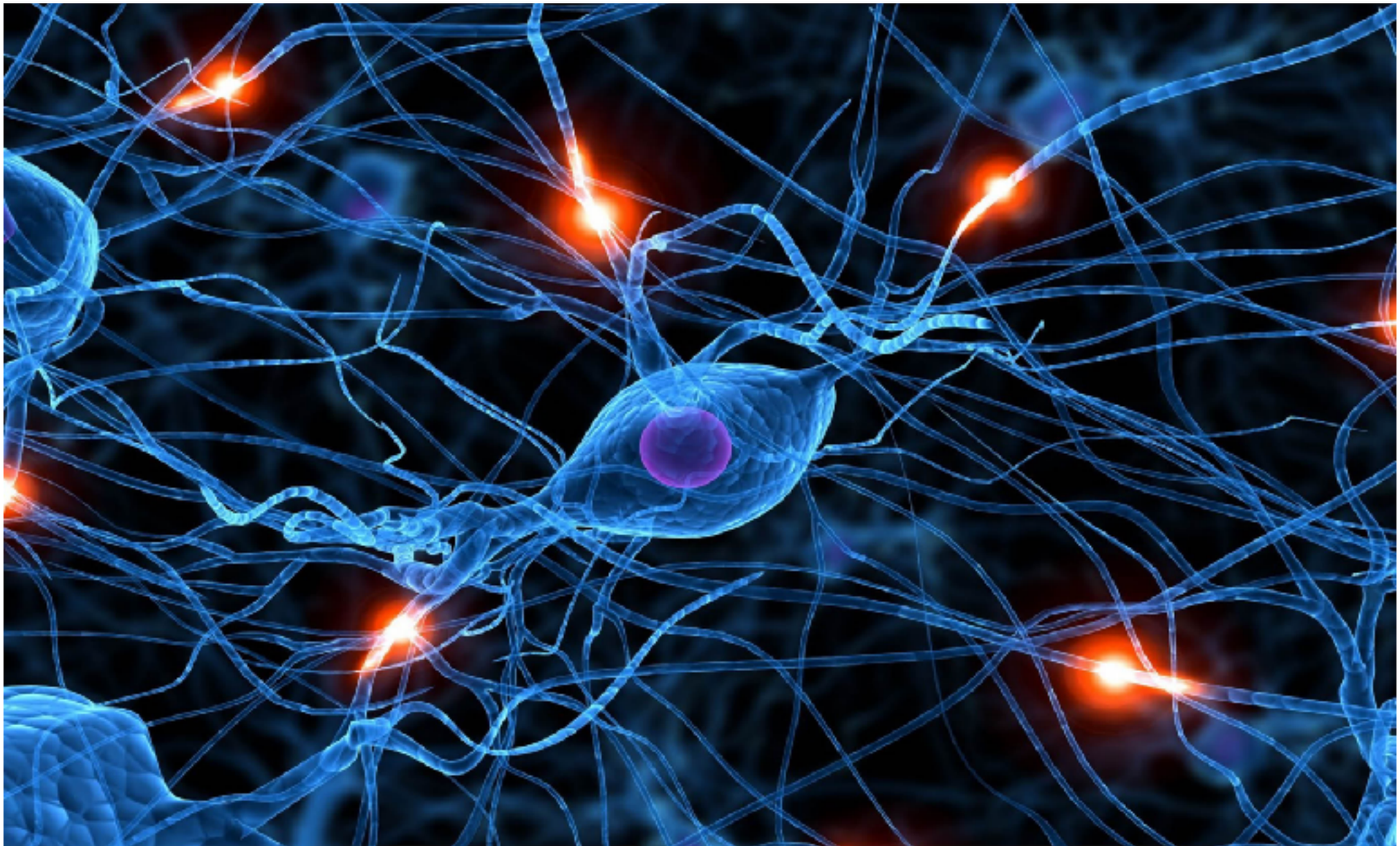


Neural Networks

16-385 Computer Vision (Kris Kitani)

Carnegie Mellon University

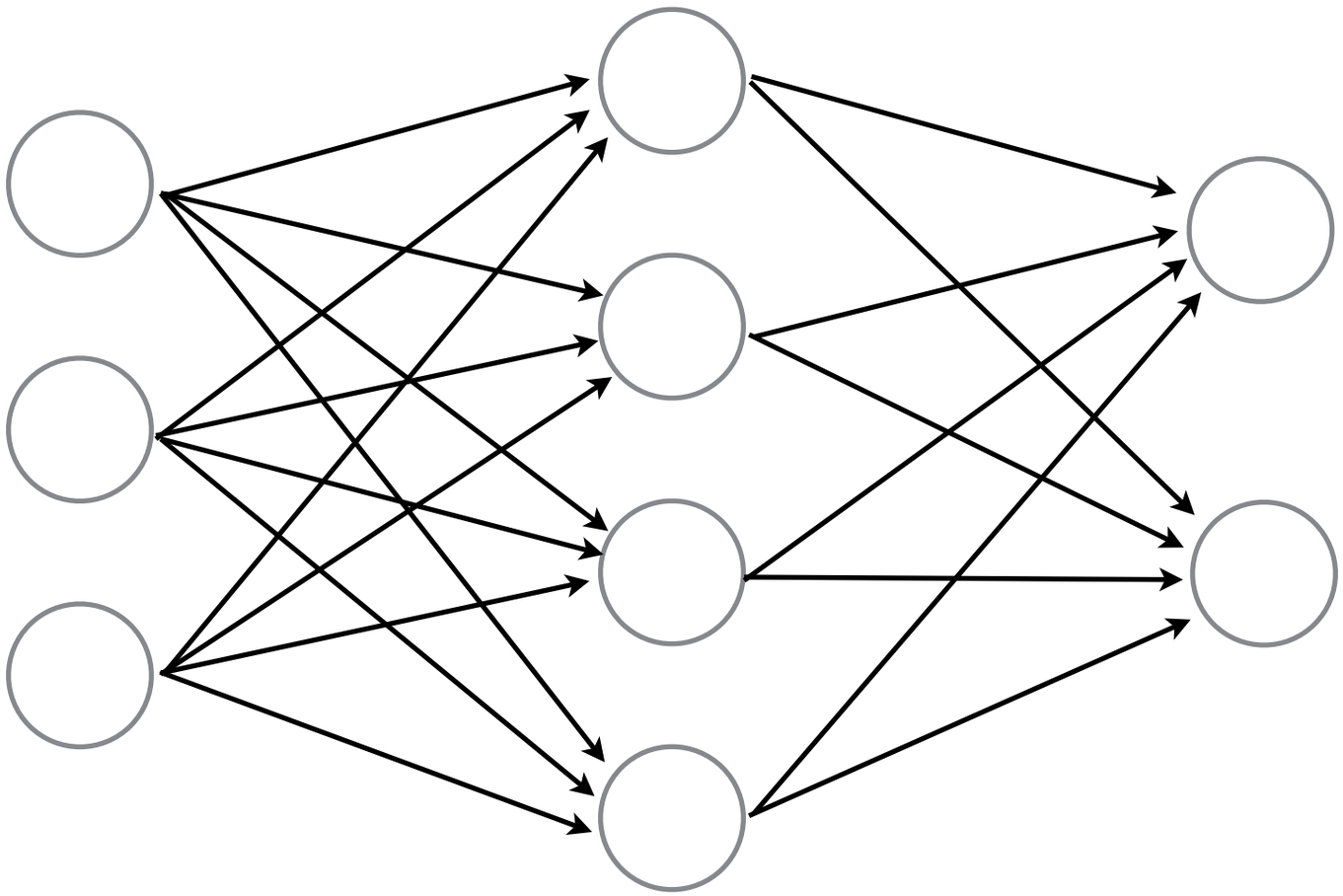
adapted from http://cs231n.github.io/neural-networks-1/

Connect a bunch of perceptrons together …

Connect a bunch of perceptrons together …

Neural Network

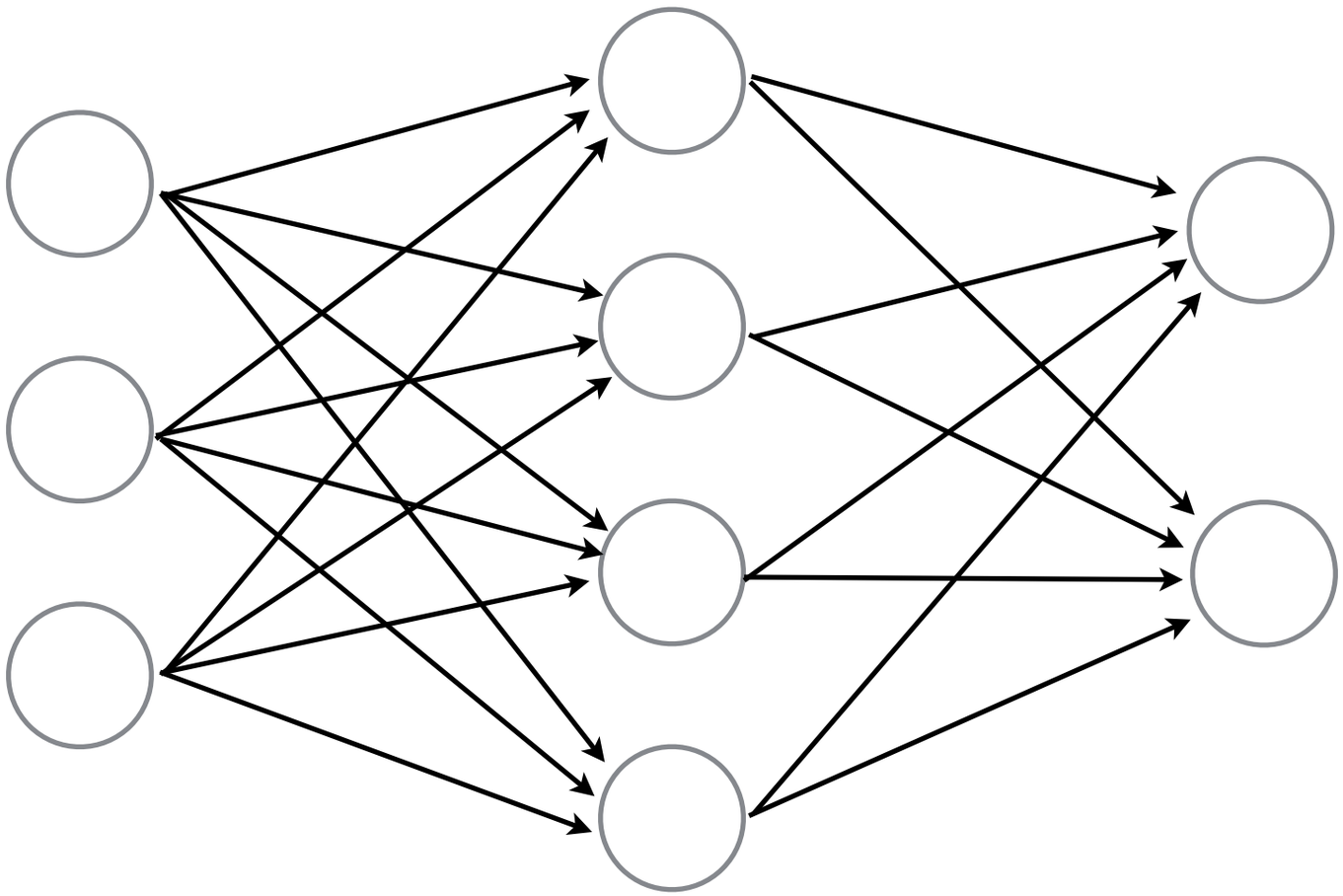
a collection of connected perceptrons



Connect a bunch of perceptrons together …

Neural Network

a collection of connected perceptrons

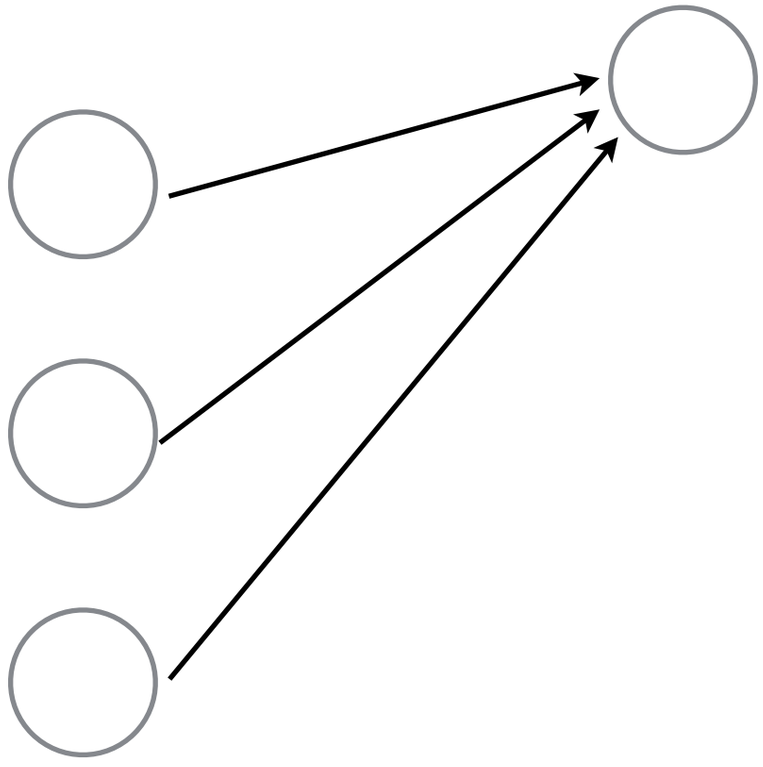


How many perceptrons in this neural network?

Connect a bunch of perceptrons together …

Neural Network

a collection of connected perceptrons

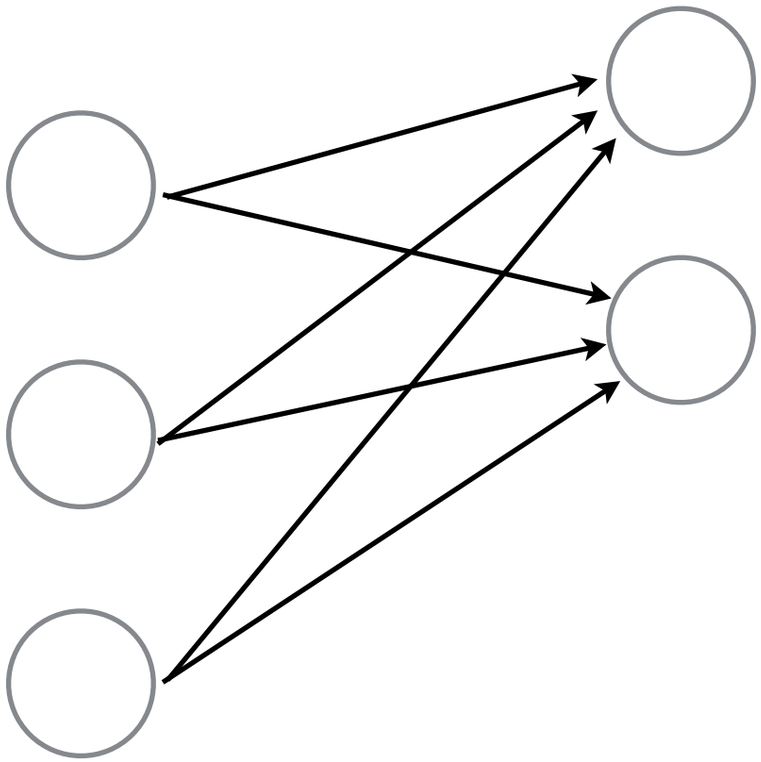


‘one perceptron’

Connect a bunch of perceptrons together …

Neural Network

a collection of connected perceptrons

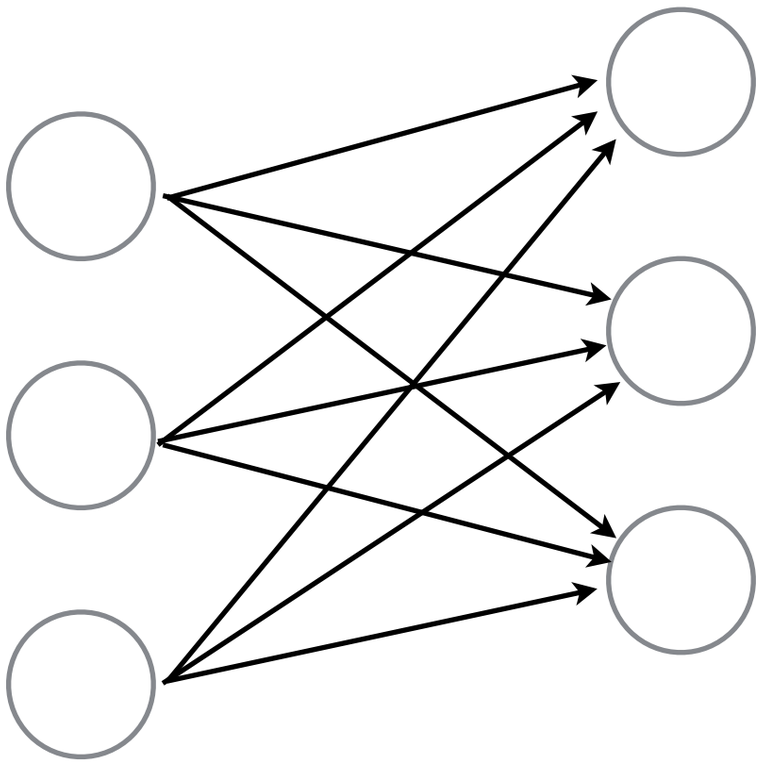


‘two perceptrons’

Connect a bunch of perceptrons together …

Neural Network

a collection of connected perceptrons

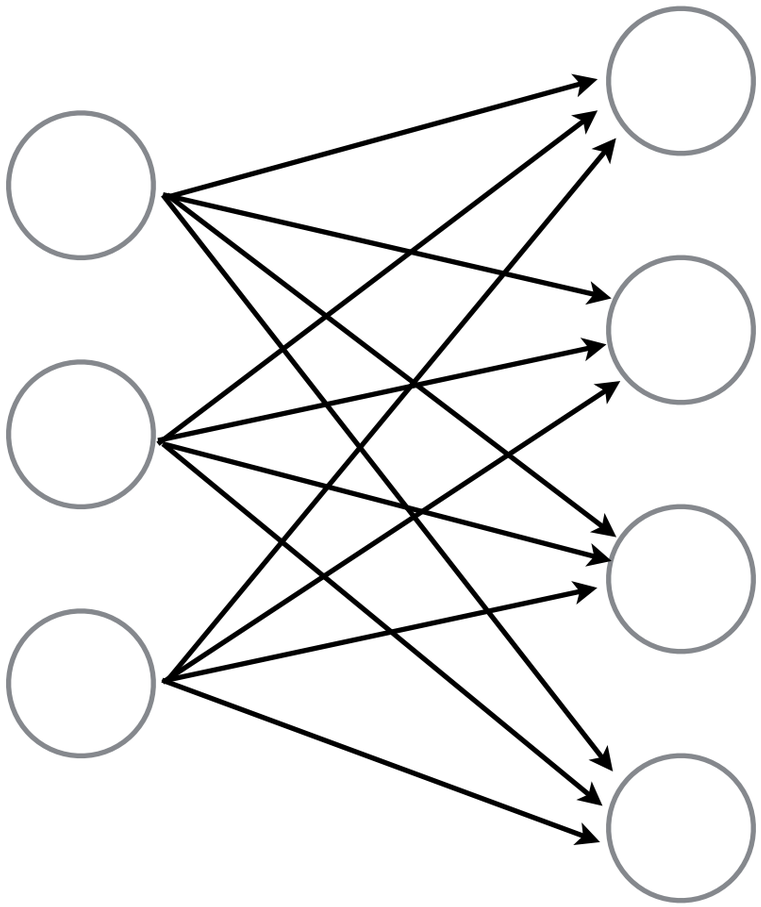


‘three perceptrons’

Connect a bunch of perceptrons together …

Neural Network

a collection of connected perceptrons

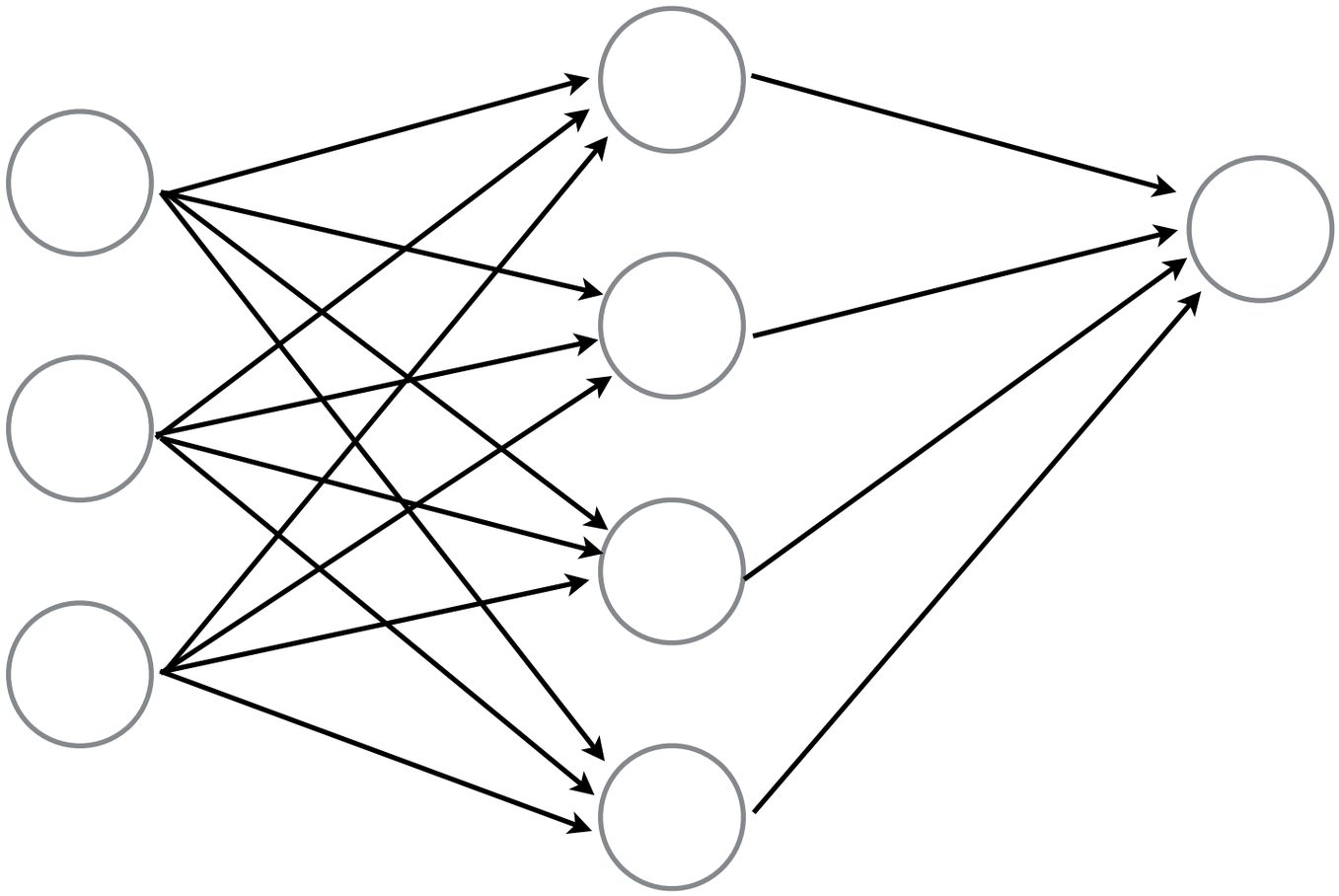


‘four perceptrons’

Connect a bunch of perceptrons together …

Neural Network

a collection of connected perceptrons

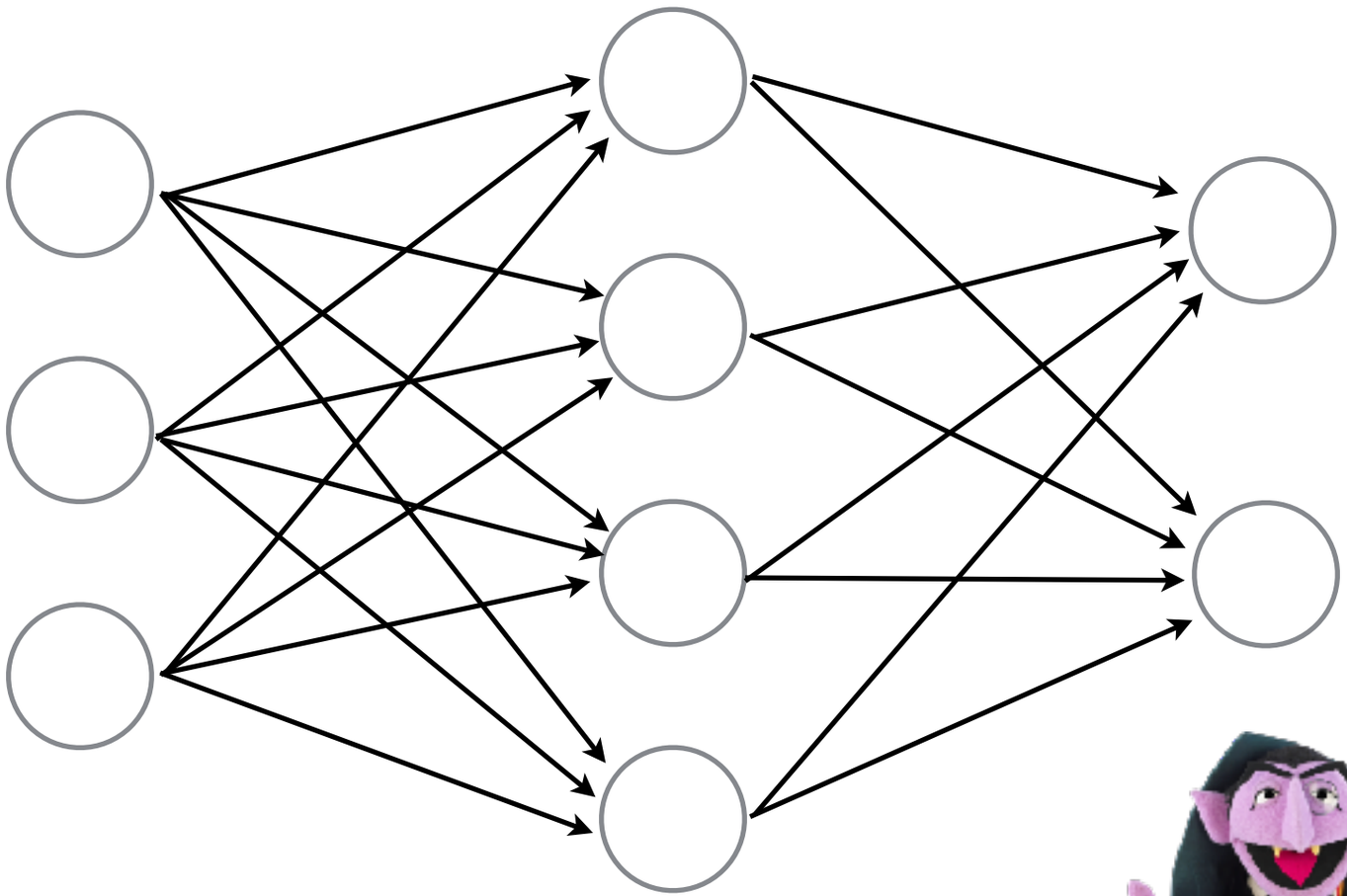


‘five perceptrons’

Connect a bunch of perceptrons together …

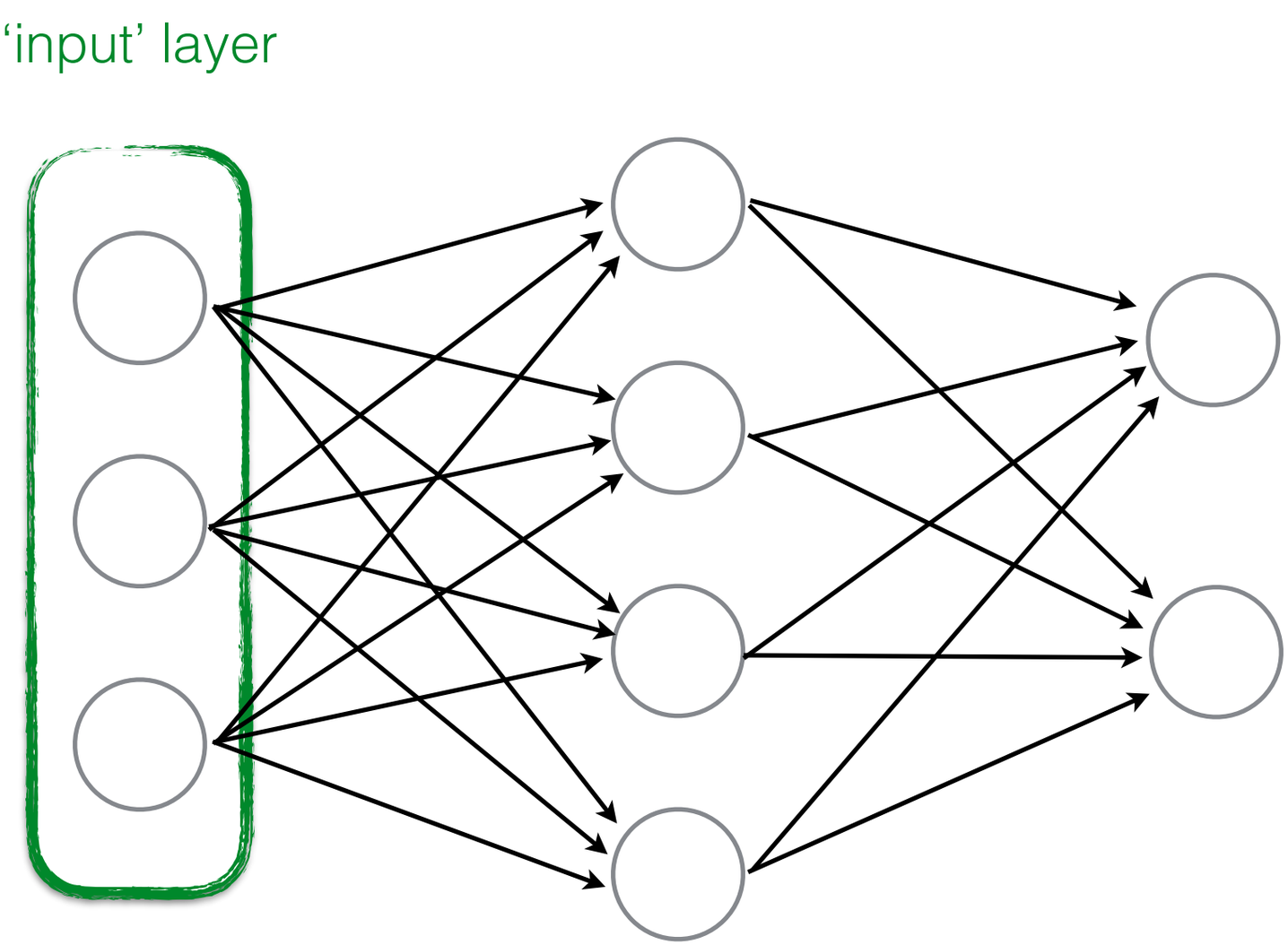
Neural Network

a collection of connected perceptrons



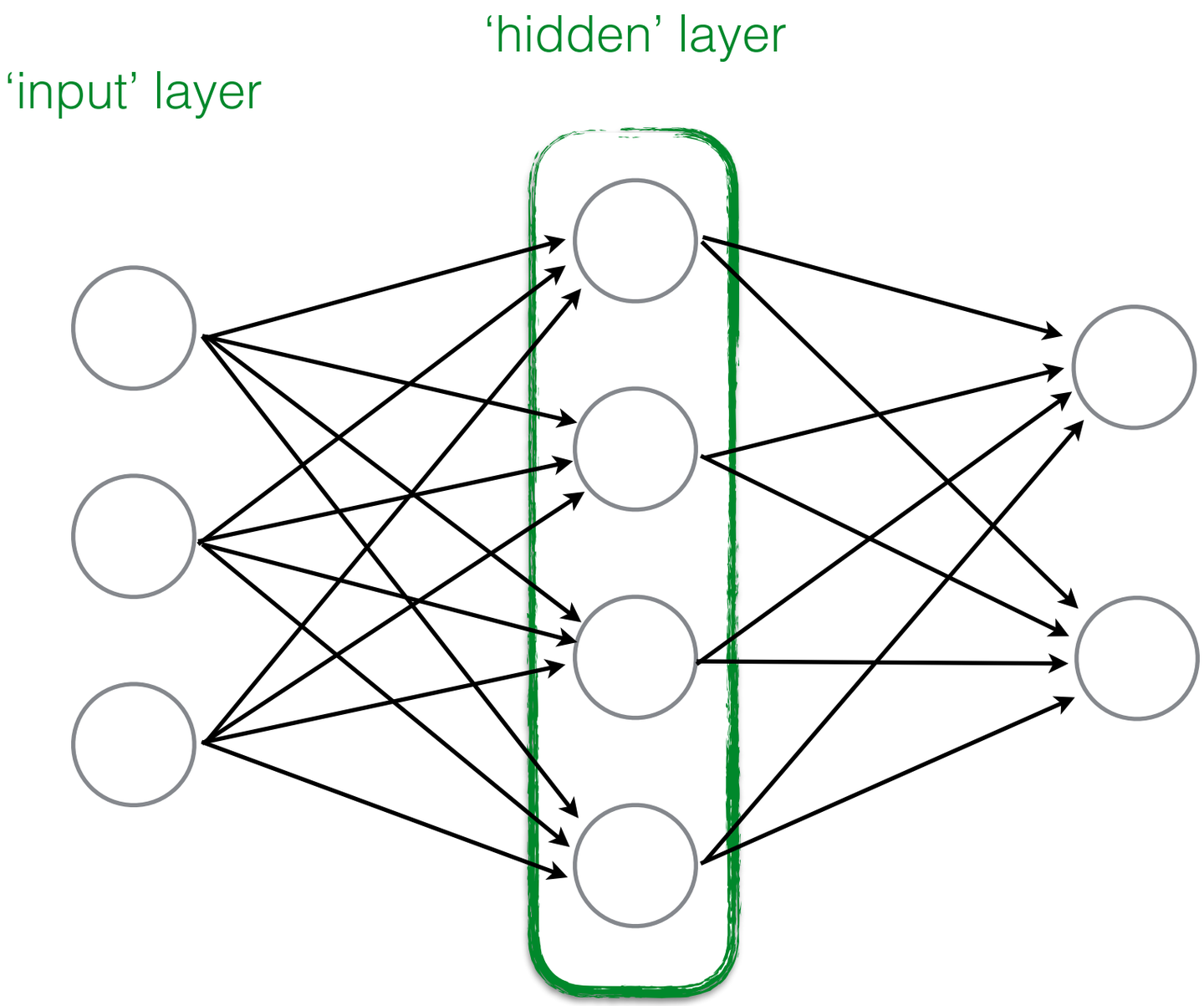
‘six perceptrons’

Some terminology…



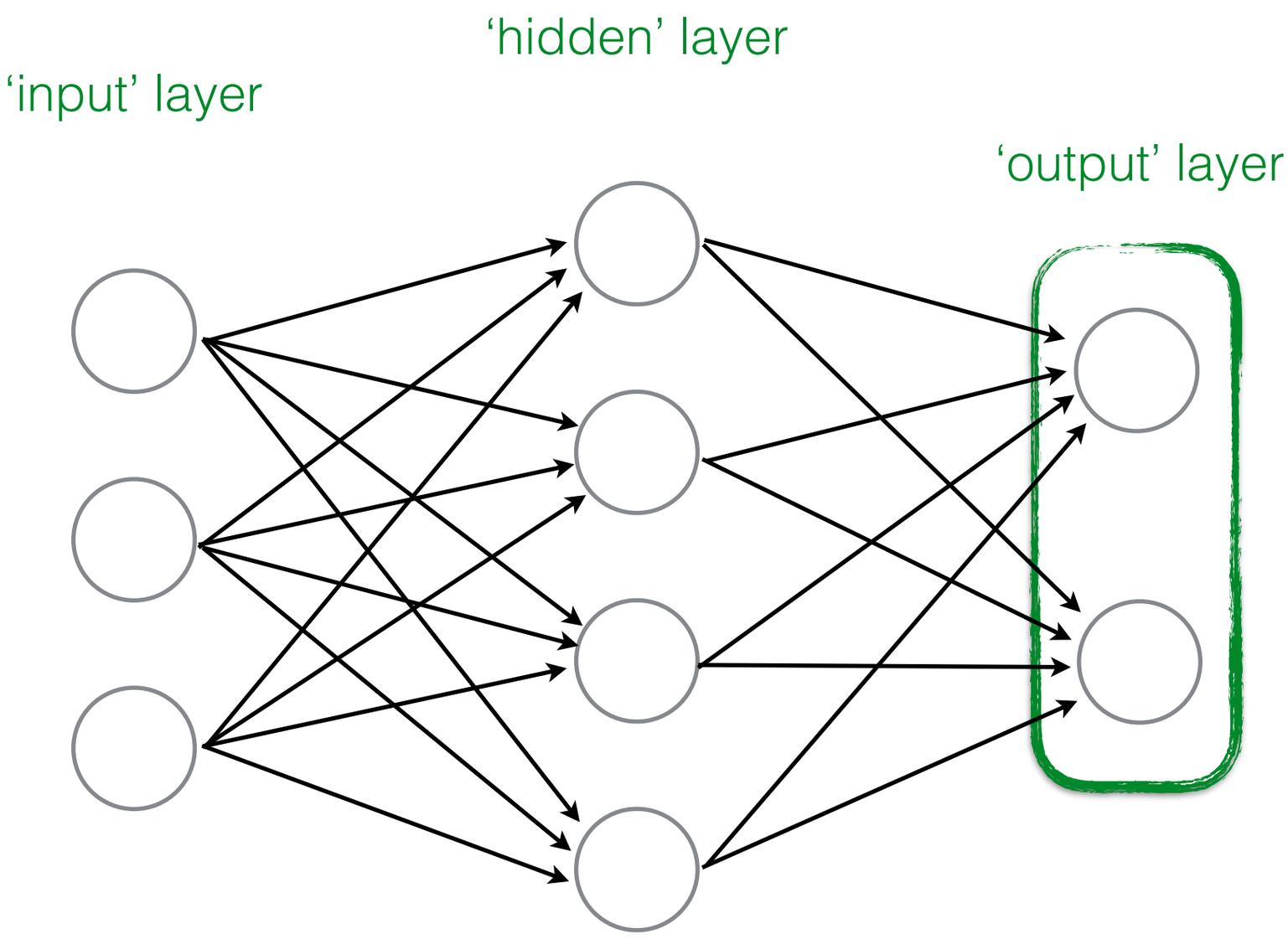
…also called a **Multi-layer Perceptron** (MLP)

Some terminology…



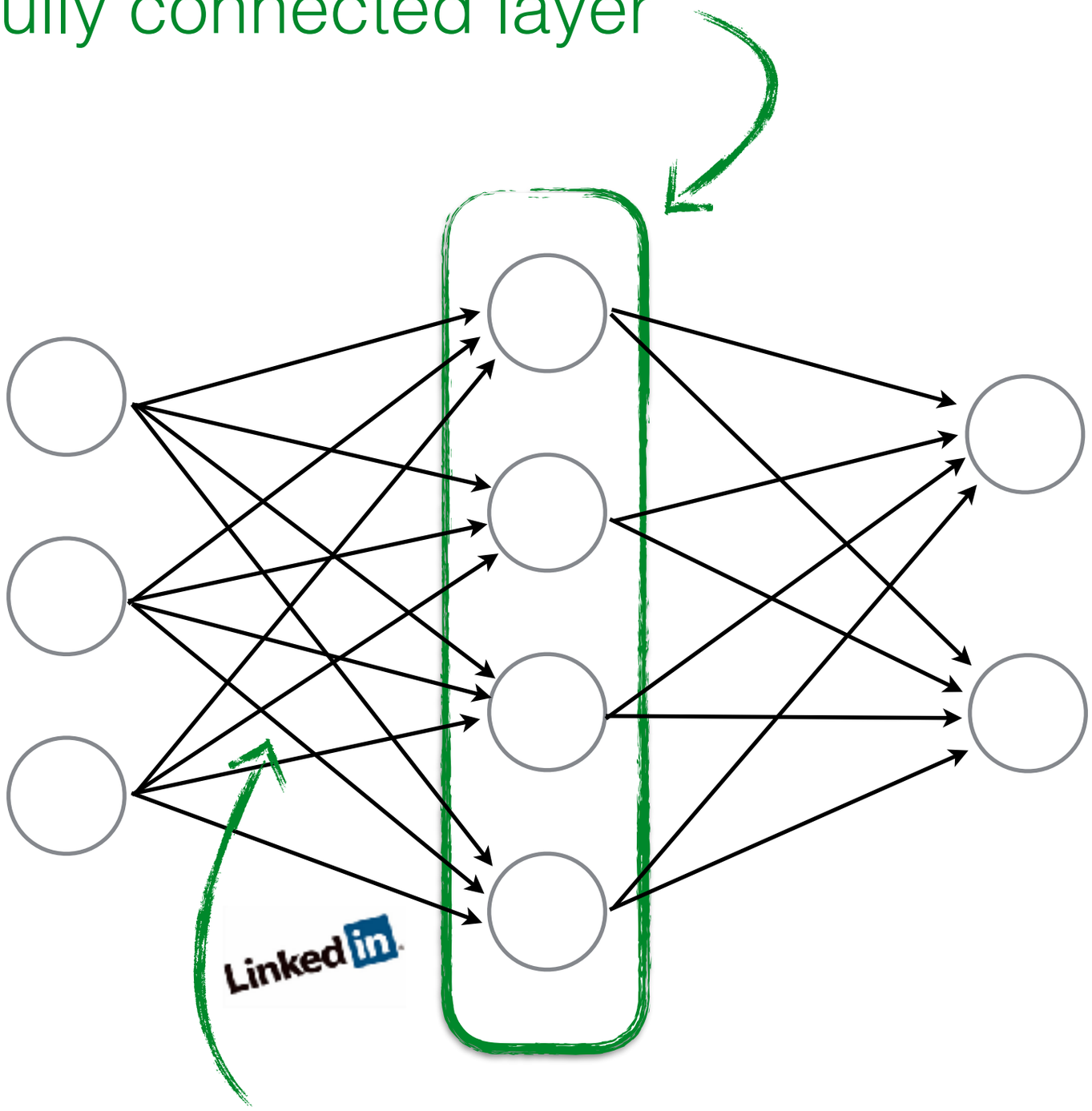
…also called a **Multi-layer Perceptron** (MLP)

Some terminology…



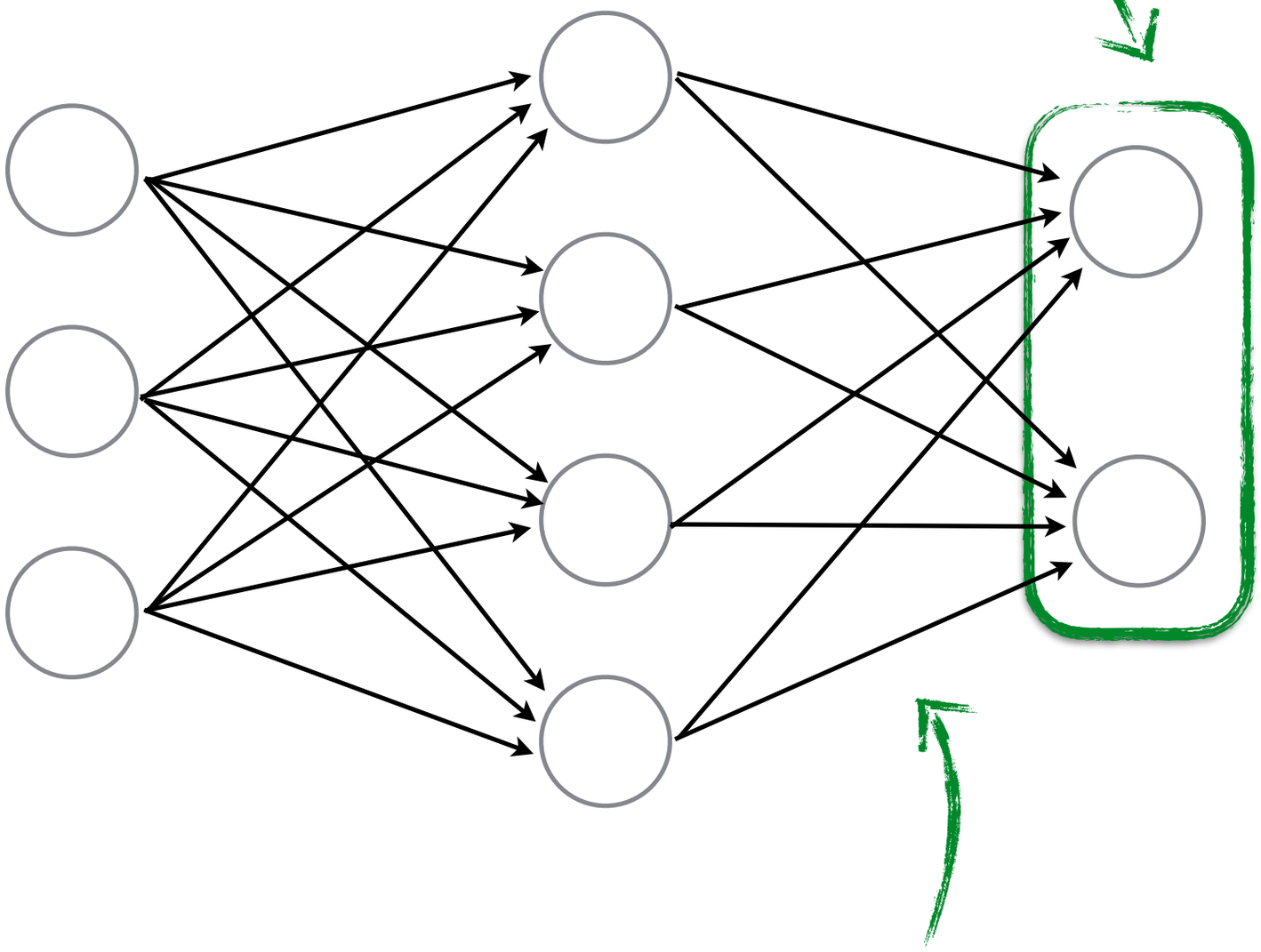
…also called a **Multi-layer Perceptron** (MLP)

this layer is a
‘fully connected layer’



all pairwise neurons between layers are connected

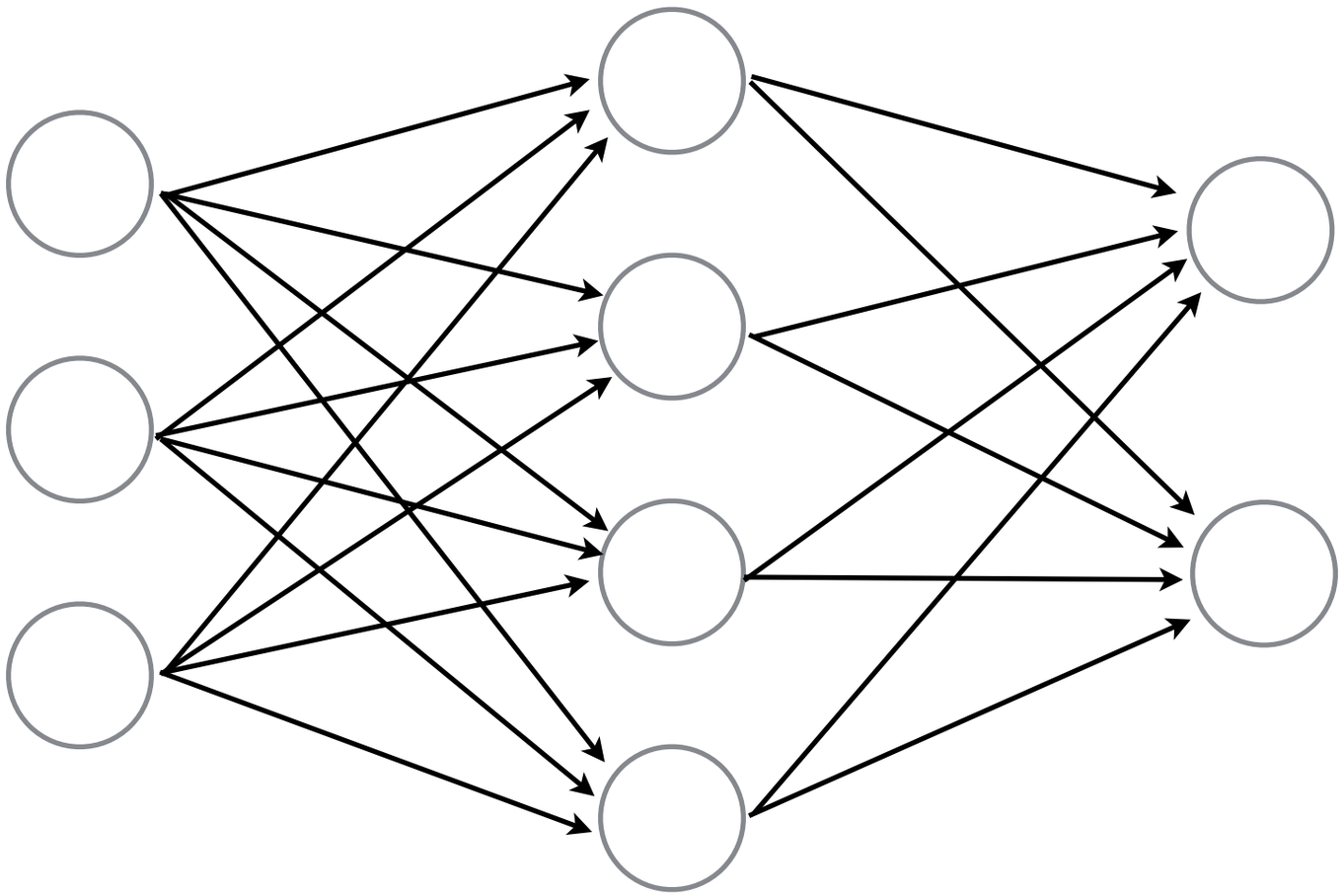
so is this



all pairwise neurons <u>between</u> layers are connected

How many neurons (perceptrons)?

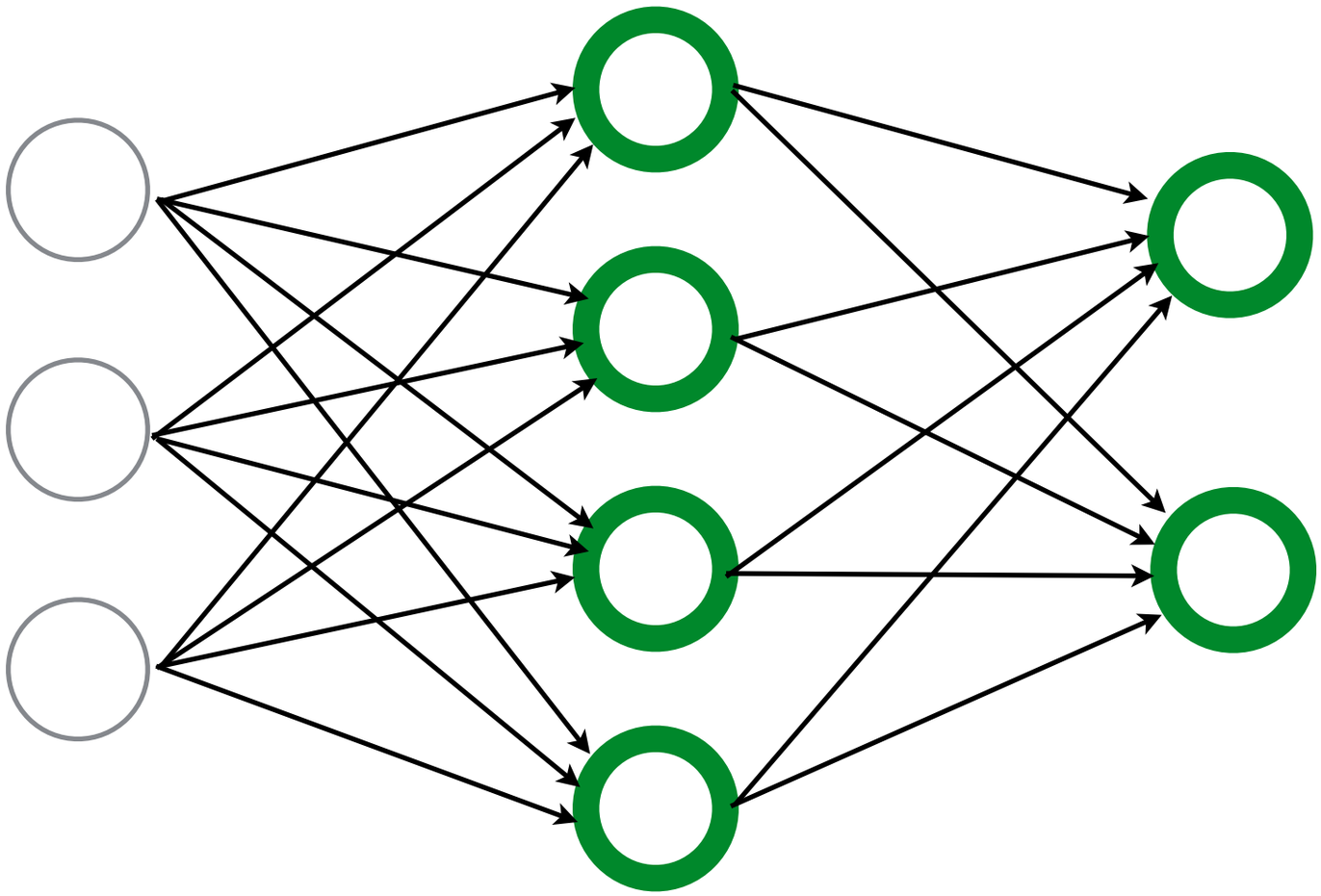
How many weights (edges)?



How many learnable parameters total?

How many neurons (perceptrons)? 4 + 2 = 6

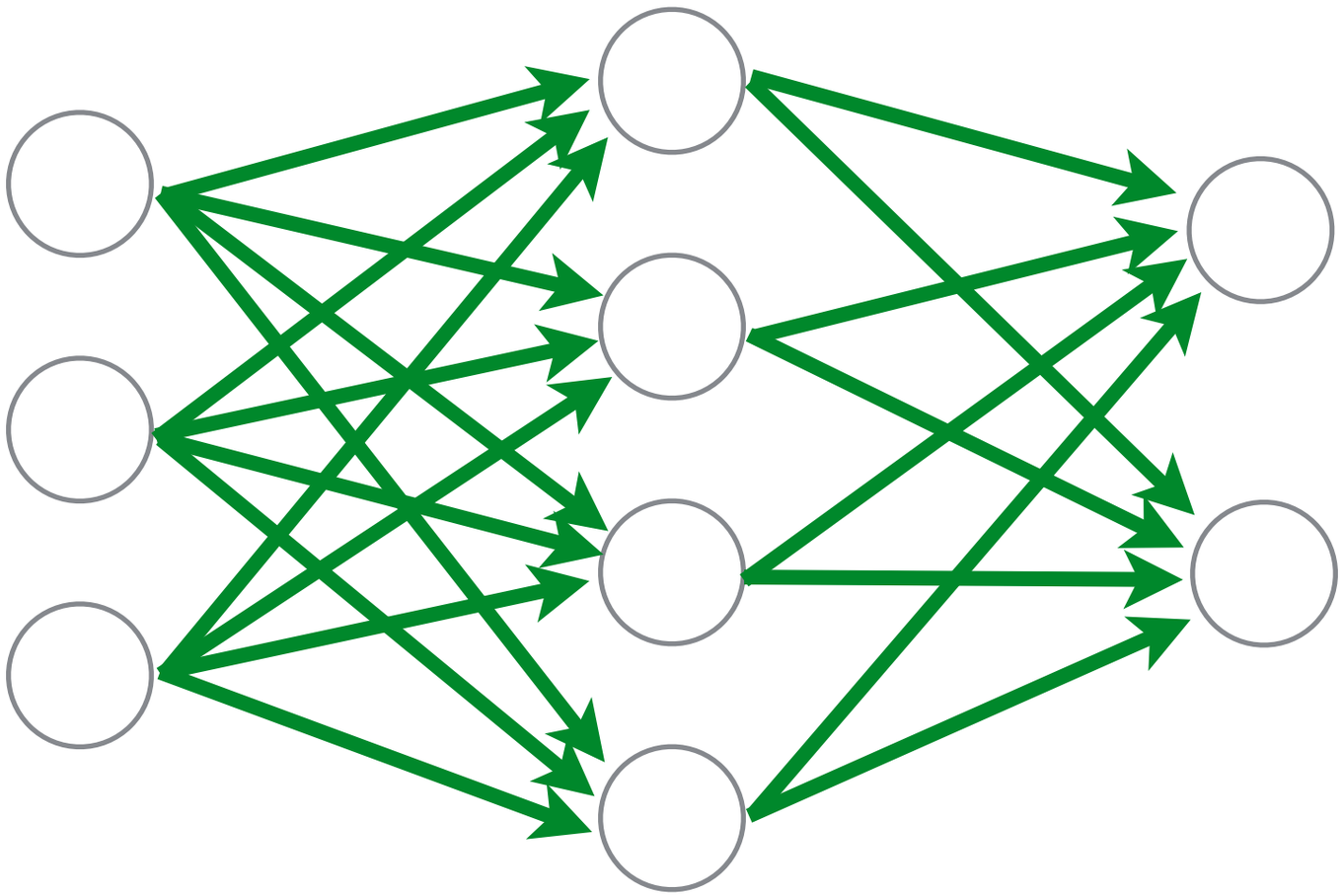
How many weights (edges)?



How many learnable parameters total?

How many neurons (perceptrons)? 4 + 2 = 6

How many weights (edges)? (3 x 4) + (4 x 2) = 20



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How many neurons (perceptrons)? 4 + 2 = 6

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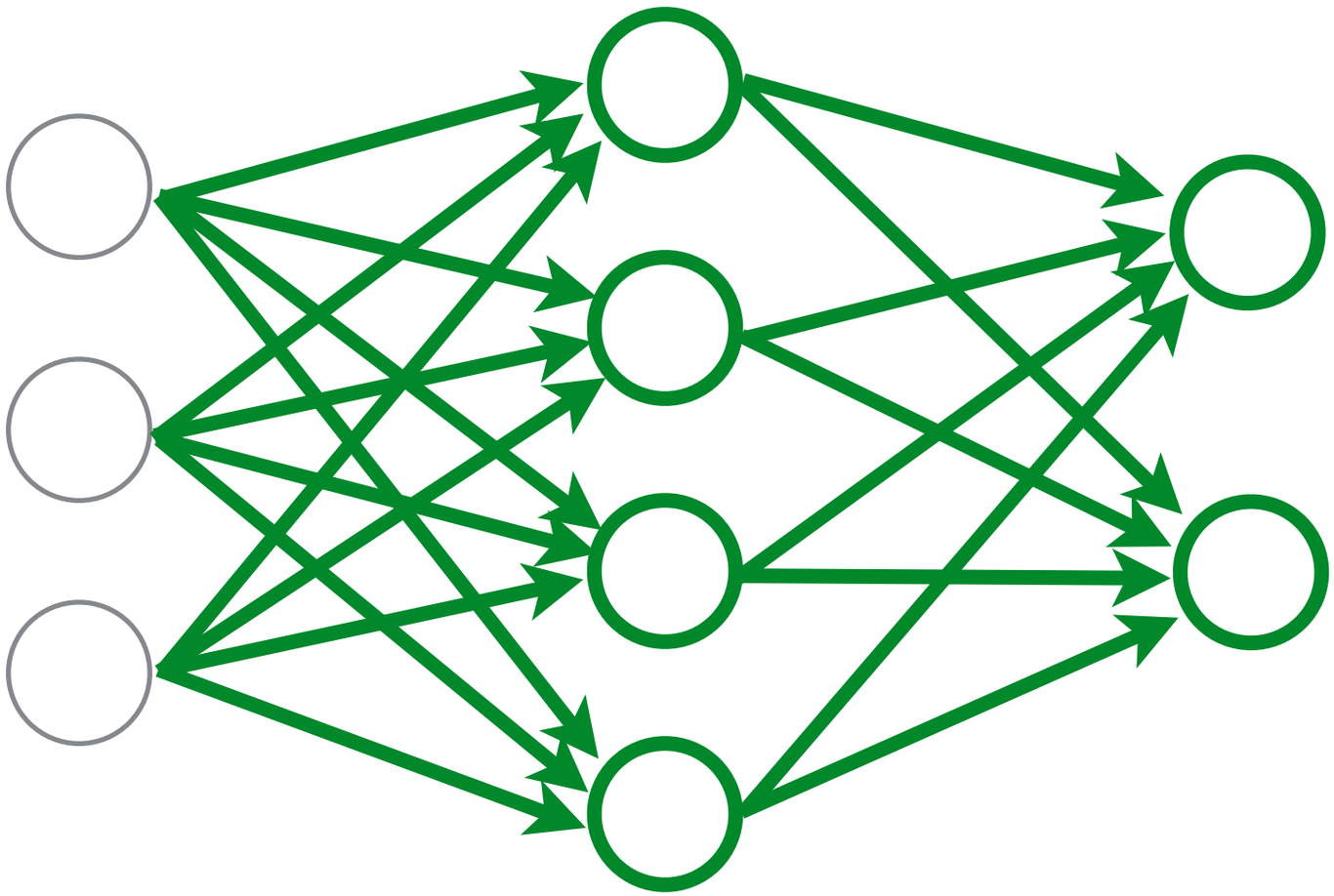
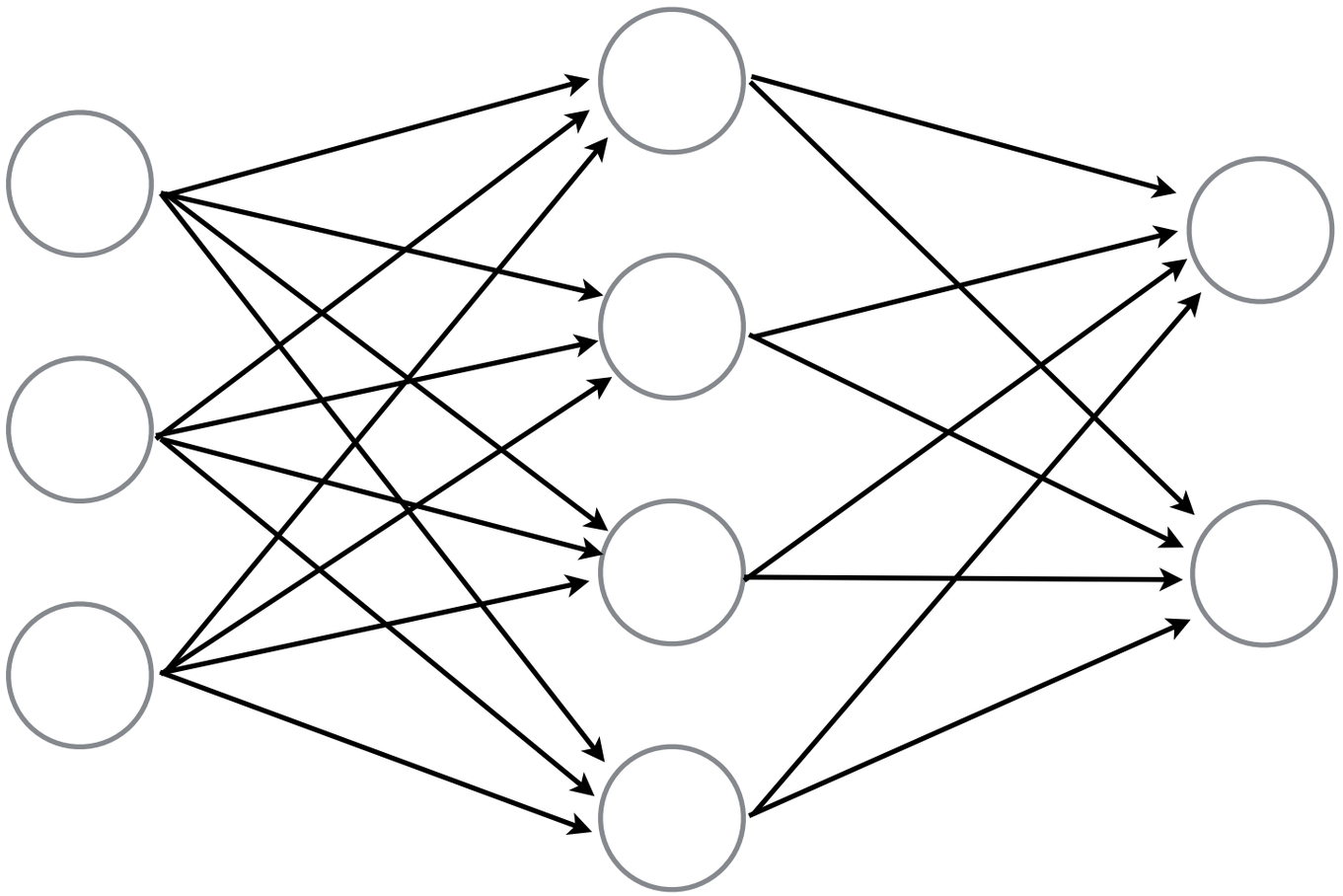


How many learnable parameters total? 20 + 4 + 2 = 26

bias terms

performance usually tops out at 2-3 layers,
deeper networks don't really improve performance...



...with the exception of **convolutional** networks for images