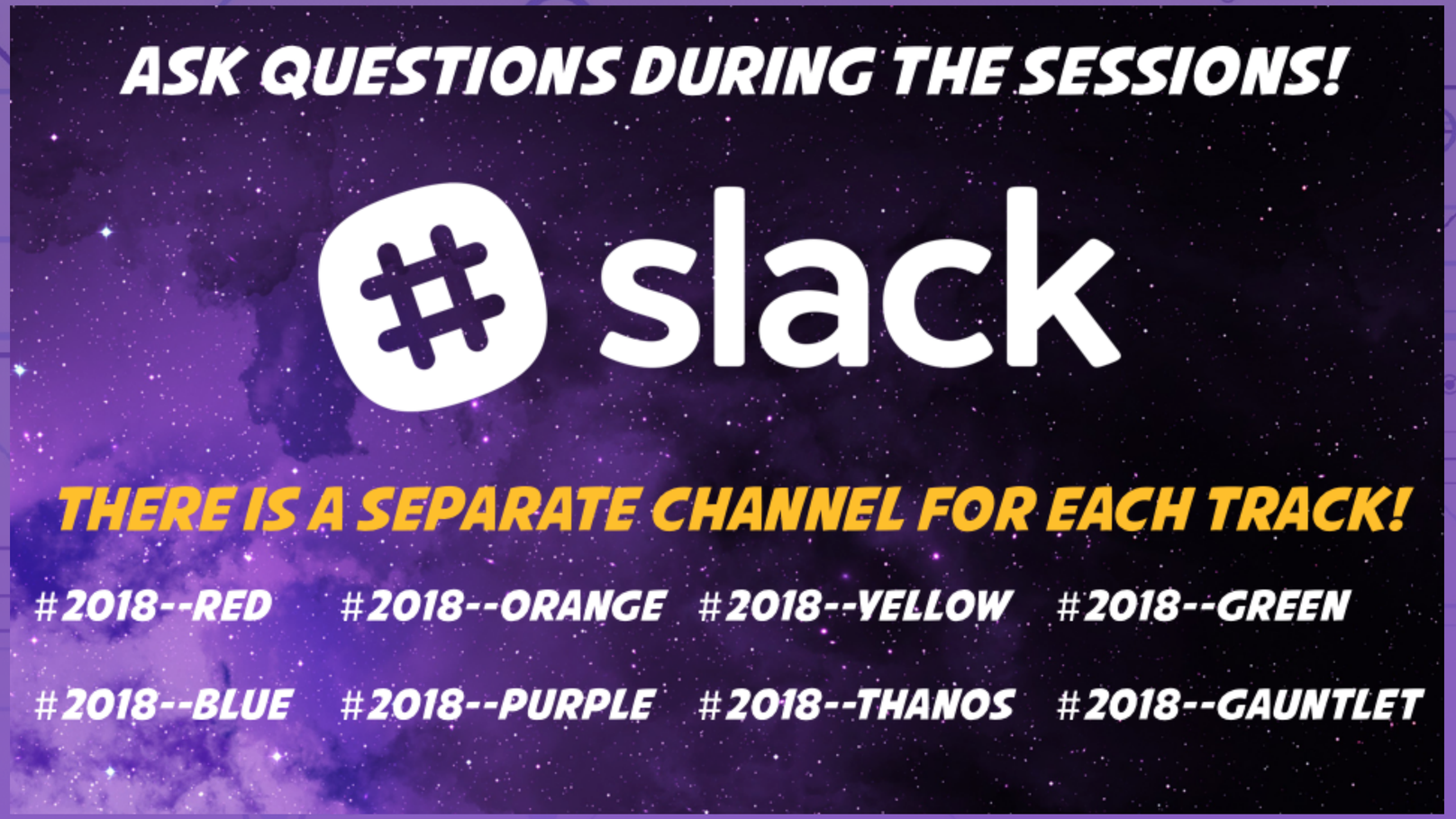
Image Recognition

With Convolutional Neural Networks
using Keras and CoreML



Hi There!

I am Tim LeMaster

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tim@thelemasters.net

WHAT IS MACHINE LEARNING?

A very brief history

“Field of study that gives computers the ability to learn without being explicitly programmed”

- Arthur Samuel, 1959

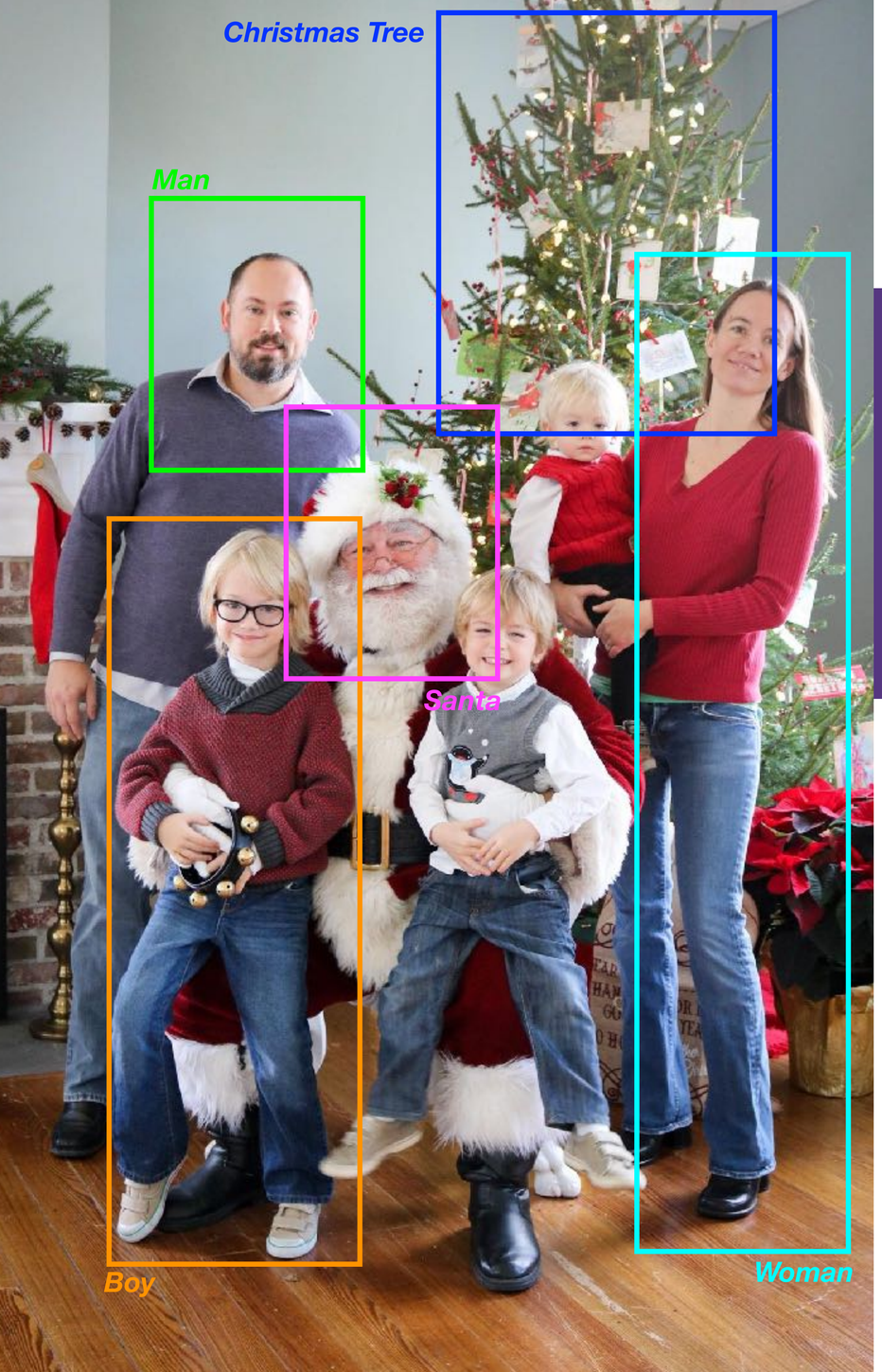
Modern Definition

“A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E.”

- Tom Mitchell

WHY MACHINE LEARNING?

Solving a new class of problems



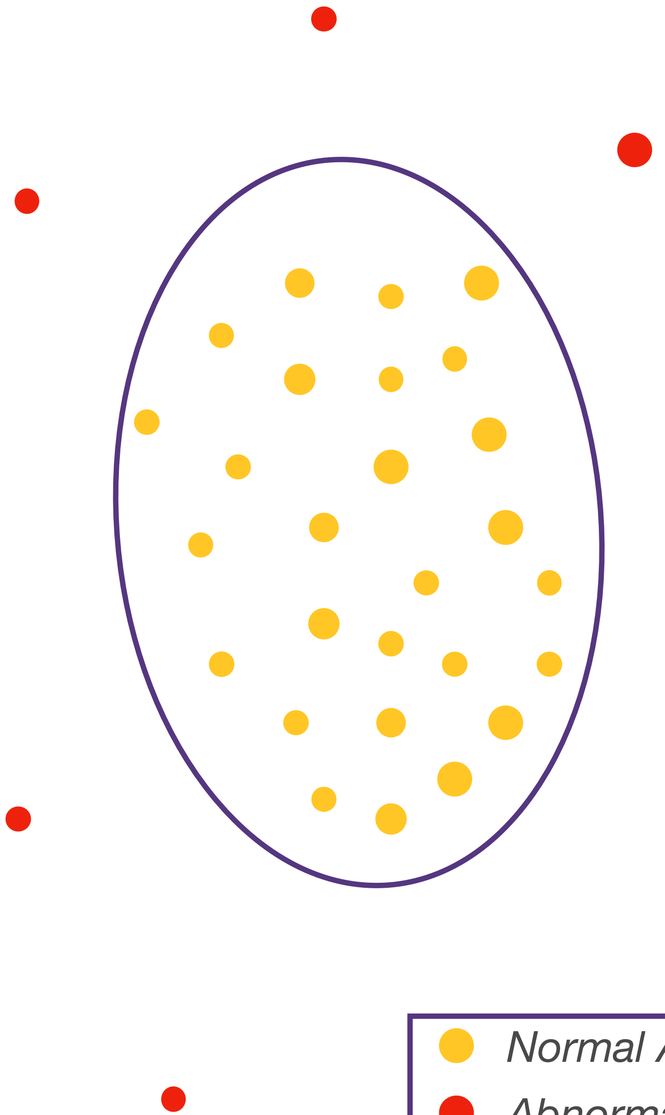
A New Class of Problems
Image Recognition

Who/What is in the photograph?
Easy for a human but how would I write an algorithm for it?

Actor: Bruce Willis
Genre: Action
Year: 1988

A New Class of Problems Recommendation System

What movies/restaurants/etc might I like?



A New Class of Problems
Anomaly Detection

Does this image show signs of cancer?
How is my data center health?

Modified National Institute of Standards and Technology (MNIST)

Large set of handwritten digits

- 60,000 training images
- 10,000 testing images
- Written by
  - American Census Workers
  - High School Students

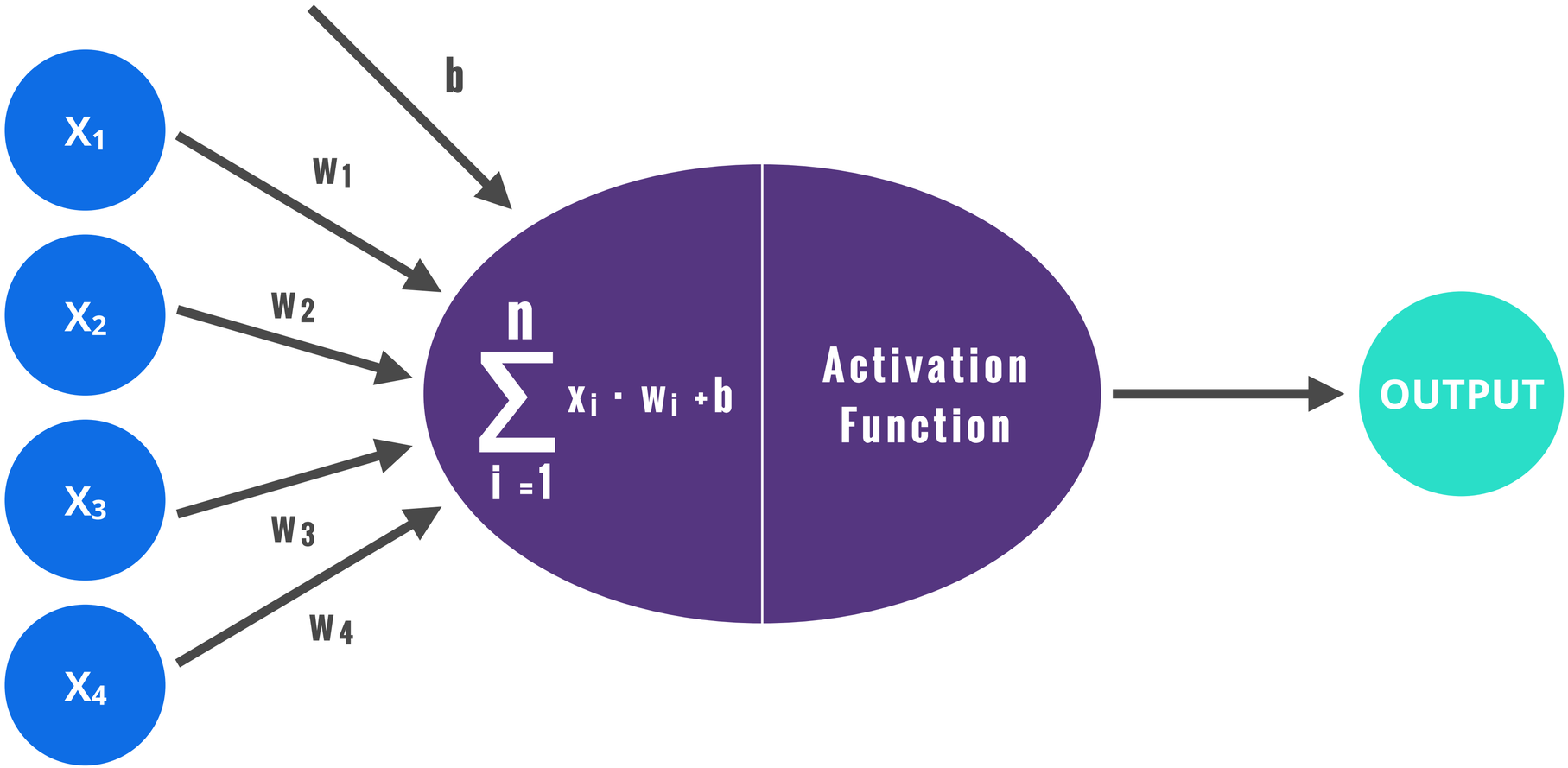
Remix of Original NIST dataset

- Original data all training data was Census Workers, all testing High School Students
- Black and White images
- Images were anti-aliased
- Normalized to fit 20x20
- Centered in 28x28 bounding box (784 pixels)

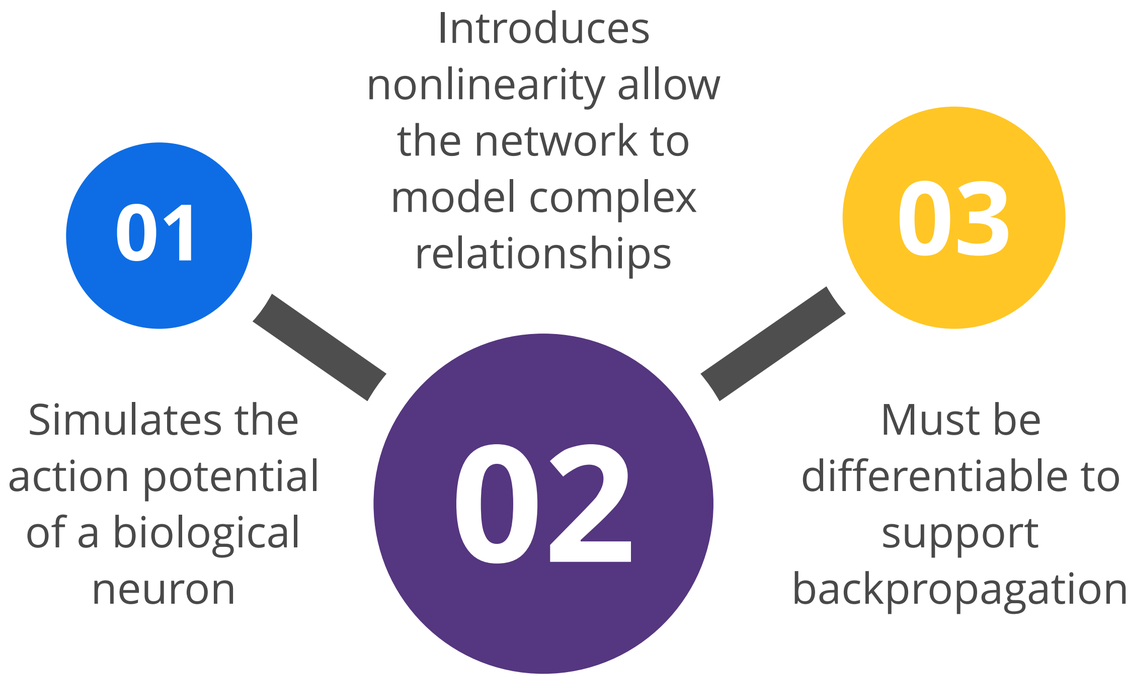
ARTIFICIAL NEURAL NETWORK

Biologically inspired machine learning system

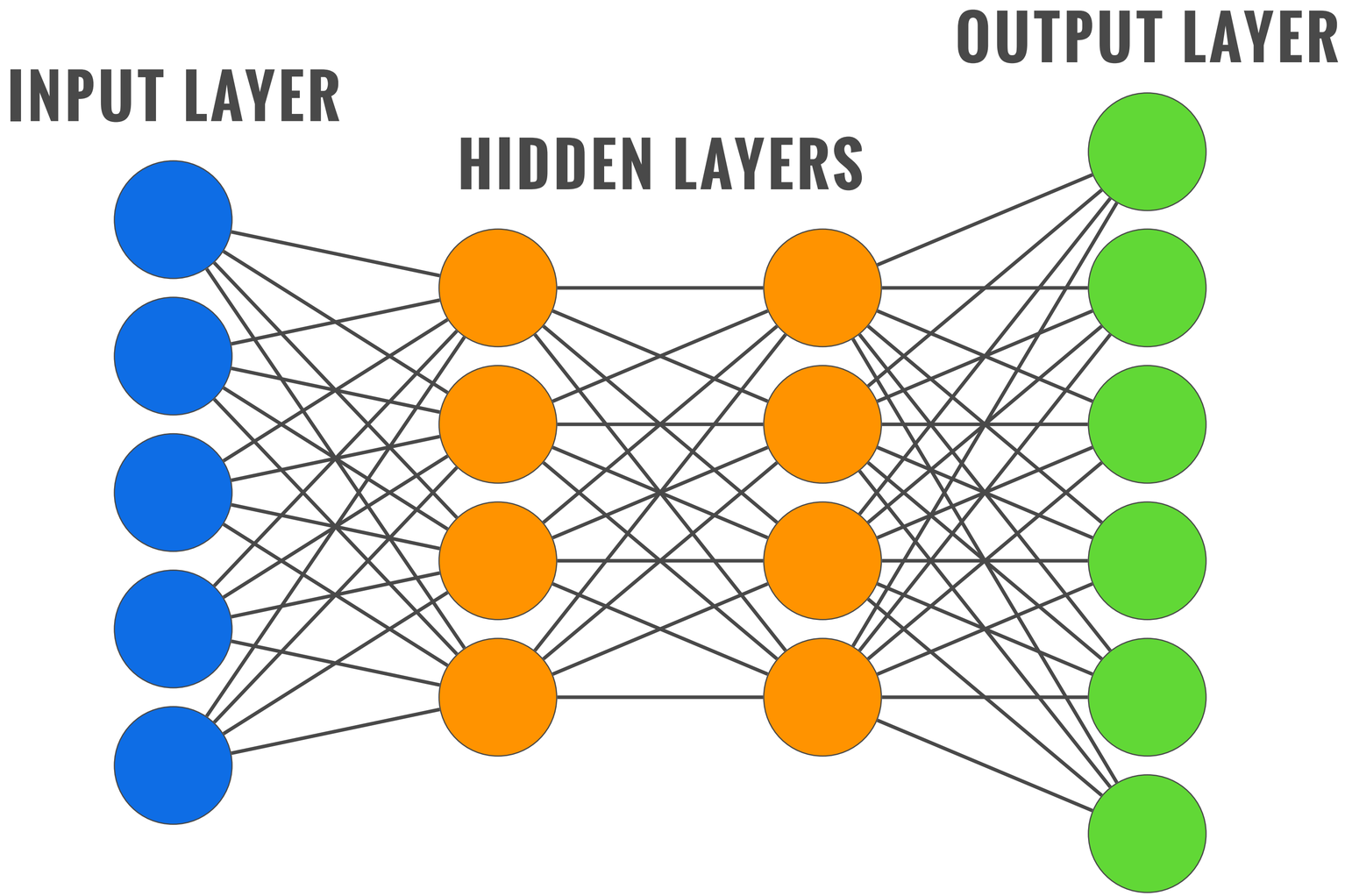
ARTIFICIAL NEURON



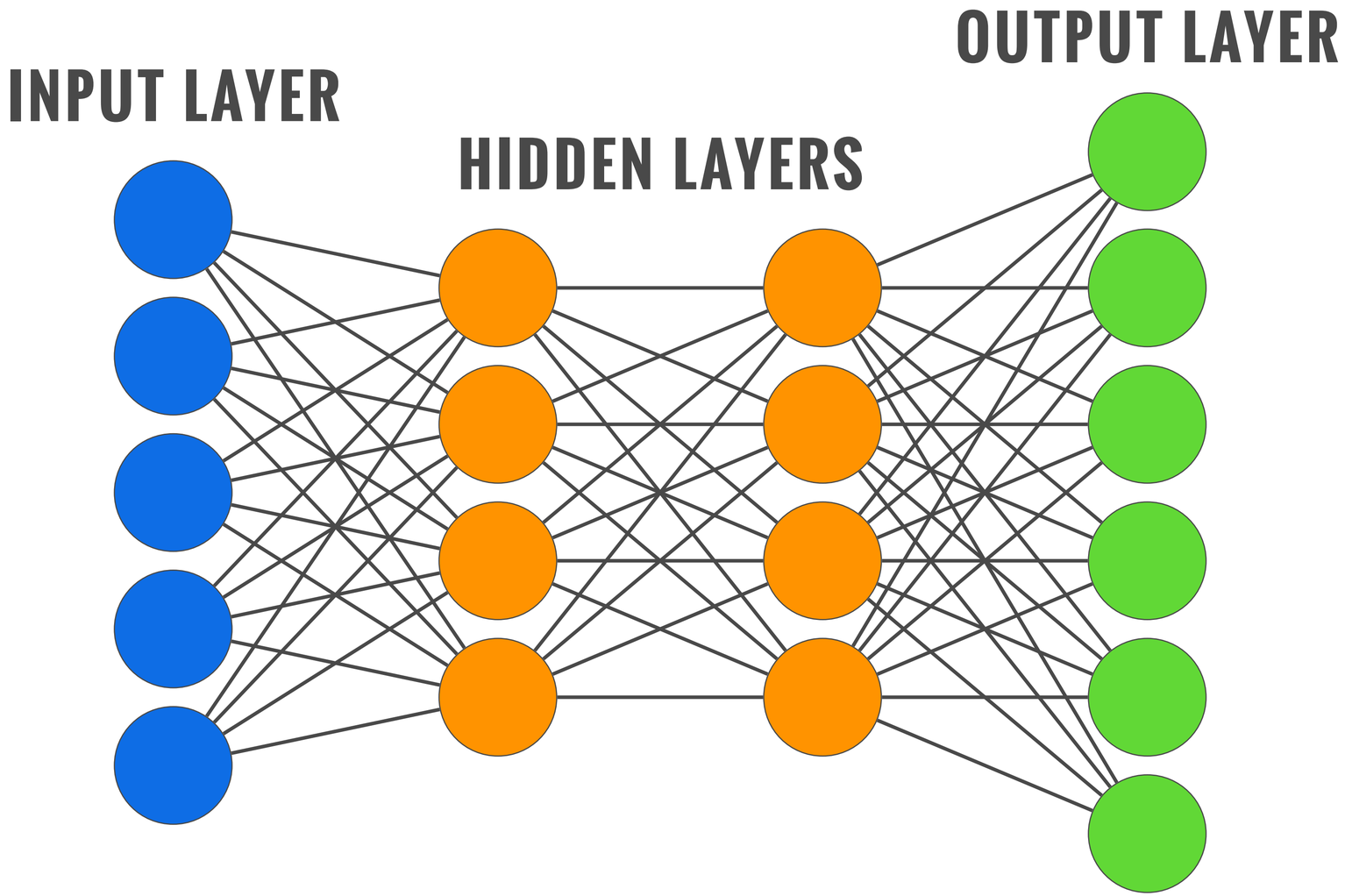
ACTIVATION FUNCTION



NEURAL NETWORK



NEURAL NETWORK



CONVOLUTIONAL NEURAL NETWORK

Specialized machine learning system

CONVOLUTION

35	40	21	46	15
6	11	43	25	27
31	42	7	5	17
26	37	44	39	23
4	9	24	38	49

*

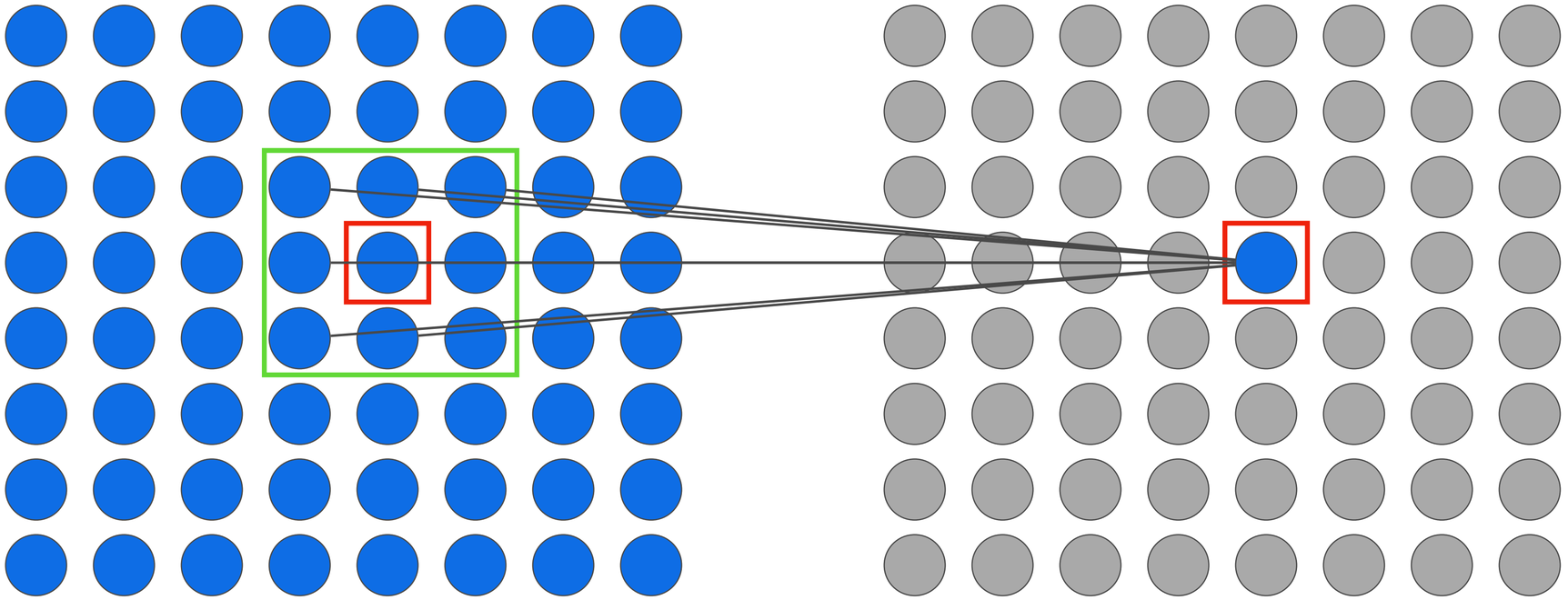
1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

=

35	40	21	46	15
6	11	43	25	27
31	42	28	5	17
26	37	44	39	23
4	9	24	38	49

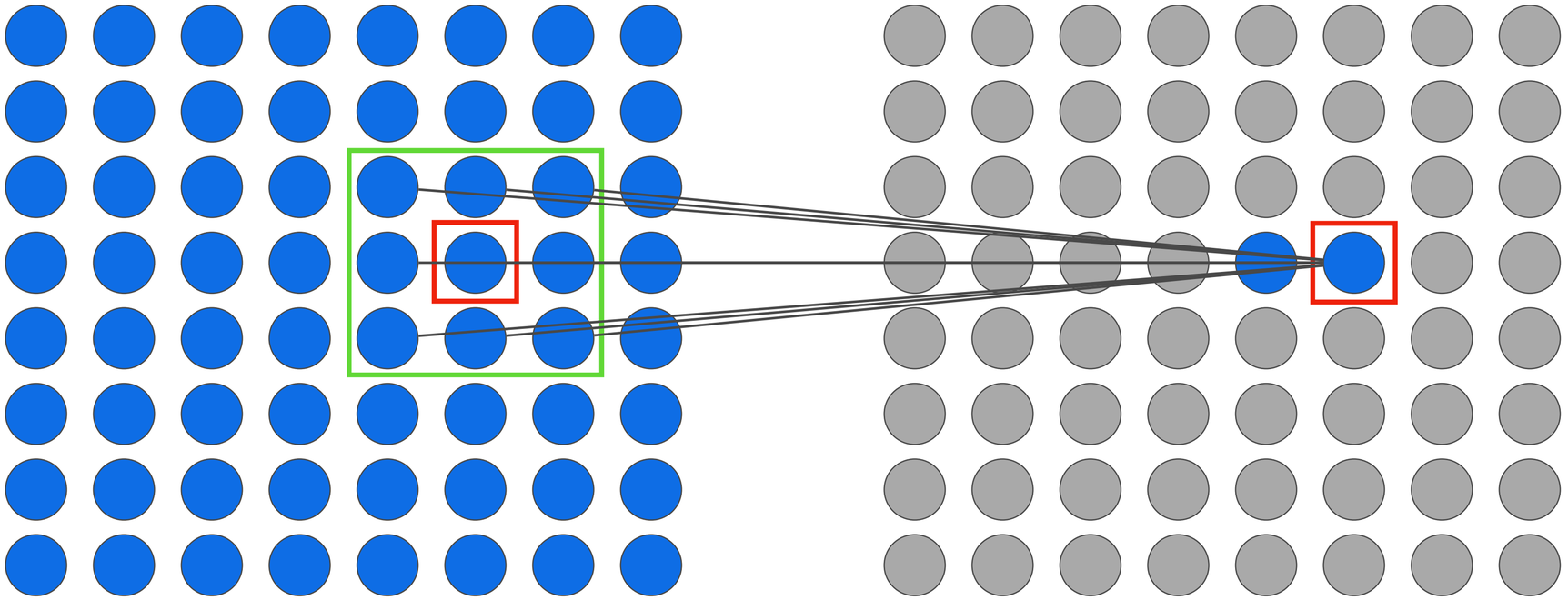
(11+43+25+42+7+5+37+44+39) / 9 ~= 28

RECEPTIVE FIELD



3 x 3 filter size

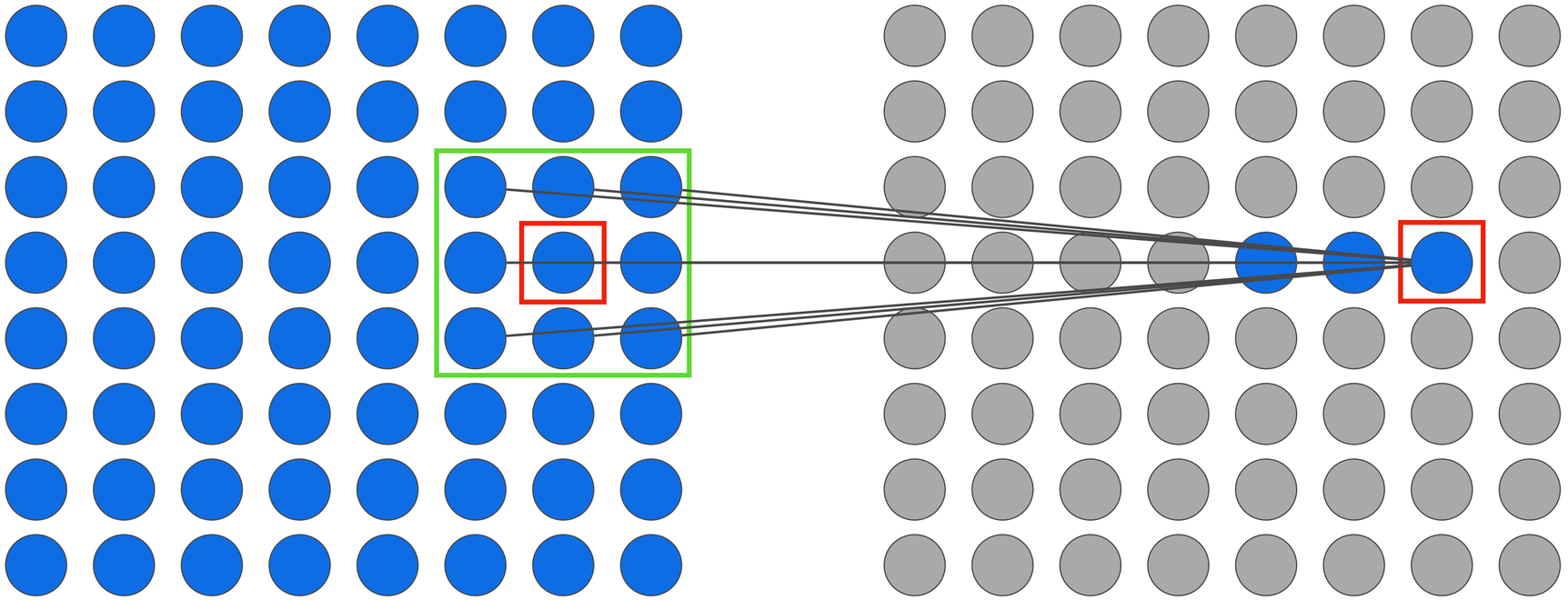
RECEPTIVE FIELD



3 x 3 filter size

stride 1

RECEPTIVE FIELD



3 x 3 filter size

stride 1

FEATURE MAP

Output of Convolution

The output of the convolution is know as the feature map. Its known as the feature map as it represents the features extracted by the filter. Alternatively its called an activation map as it represents the activation of the neurons in the network.

One Per Filter

Each filter in our layer produces a feature map. That is we get a feature map for each filter in our layer. So a 32 filter layer will produce 32 feature maps.

Stacked to Create Output

The individual feature maps are stacked to form the output volume which becomes the input for the next layer in the network.

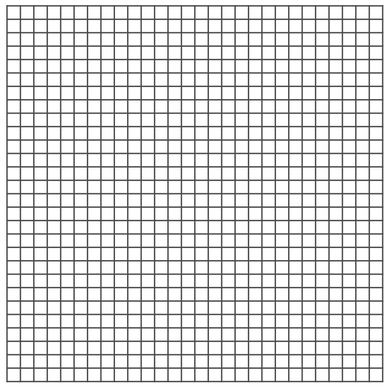
POOLING LAYER

1	4	12	6	3	13
7	10	20	2	17	33
9	10	19	1	13	31
8	15	12	26	27	15
4	11	12	20	24	20
3	9	10	15	20	19

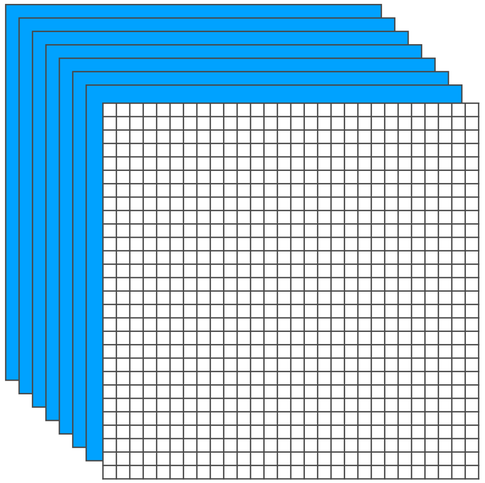
10	20	33
15	26	31
11	20	24

CONVOLUTIONAL NEURAL NETWORK

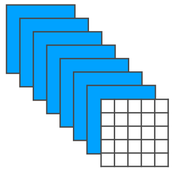
INPUT LAYER → CONVOLUTION LAYER → POOLING LAYER → FULLY CONNECTED LAYER → OUTPUT LAYER



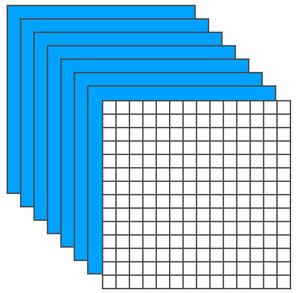
28 x 28 x 1 Image



28 x 28 x 8 Feature Map

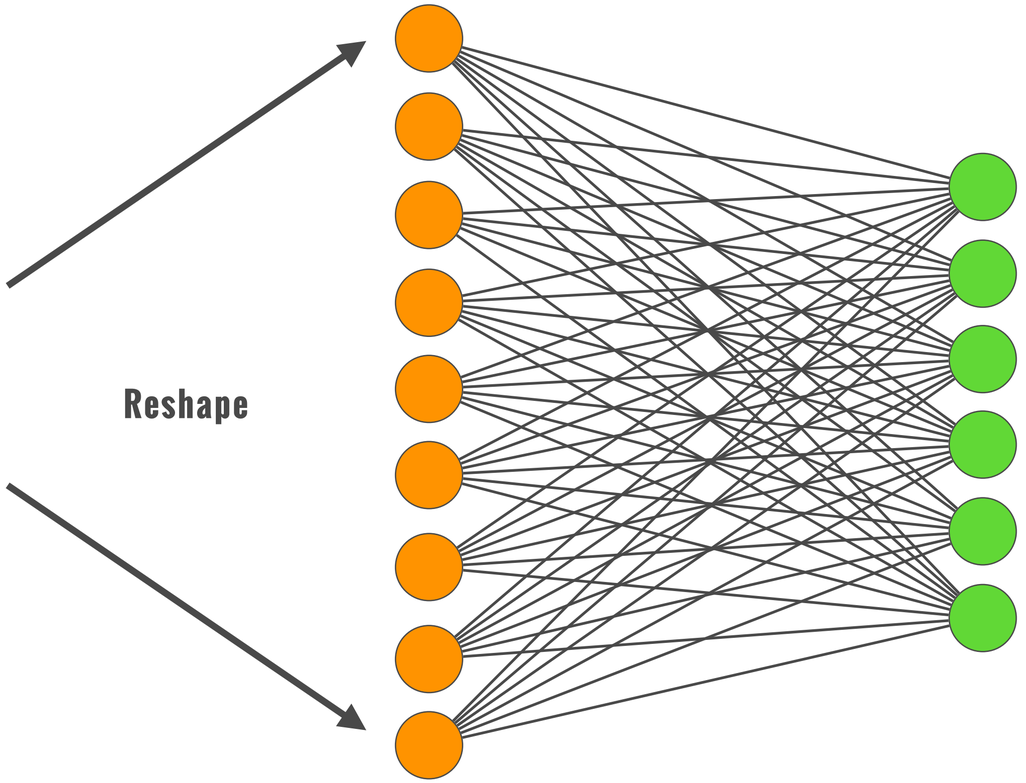


8 5x5 Filters

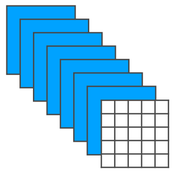


2 x 2 Max Pool

Reshape

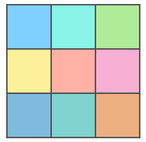


MNIST CONVOLUTIONAL NEURAL NETWORK



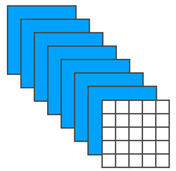
CONVOLUTION

32 filters
6x6 receptive field



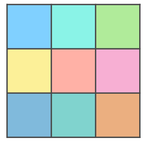
POOLING

Max pool
2x2 patches



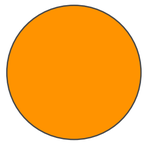
CONVOLUTION

16 filters
3x3 receptive field



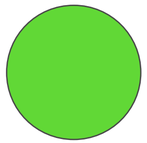
POOLING

Max pool
2x2 patches



FULLY CONNECTED

128 Neurons



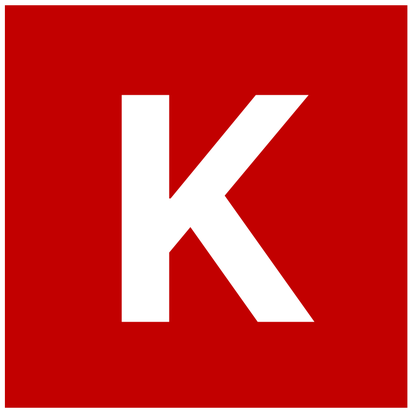
OUTPUT

10 Output Neurons

Keras

What

- High Level Neural Network API
- Written in Python
- Runs on top of TensorFlow, CNTK, Theano



Why

- Easy and Fast prototyping
- Supports CNN
- Runs on CPU and GPU
- CoreMLTools support

CoreML

- iOS Machine Learning SDK
- Supports Neural Networks (including CNN)
- Optimized for on-device performance
  - Memory
  - Power
- No training

Thanks!

Any questions?
slack #2018—blue

You can find me at: @timle8n1 tim@thelemasters.net

Slides/Code: https://github.com/timle8n1/stirtrek2018

REFERENCES

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