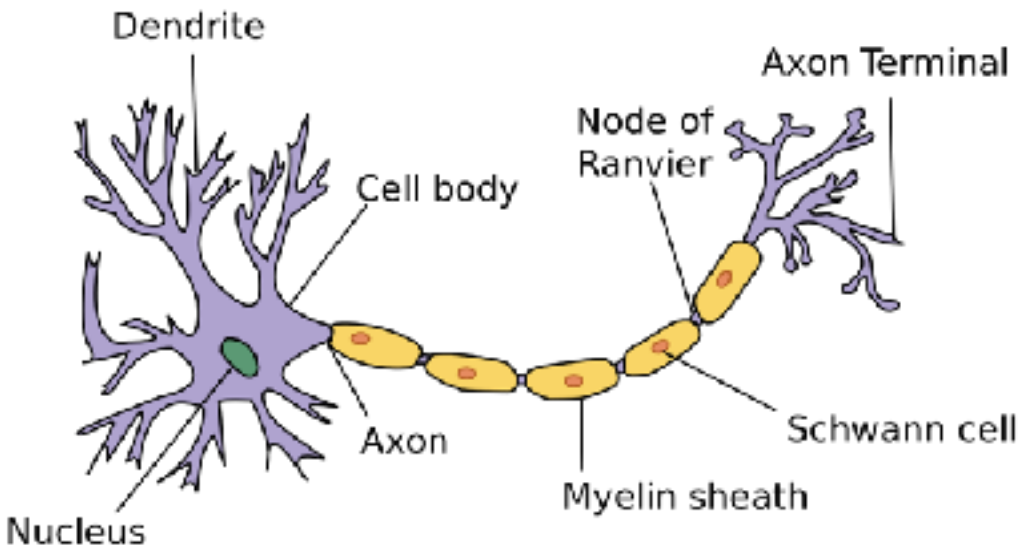
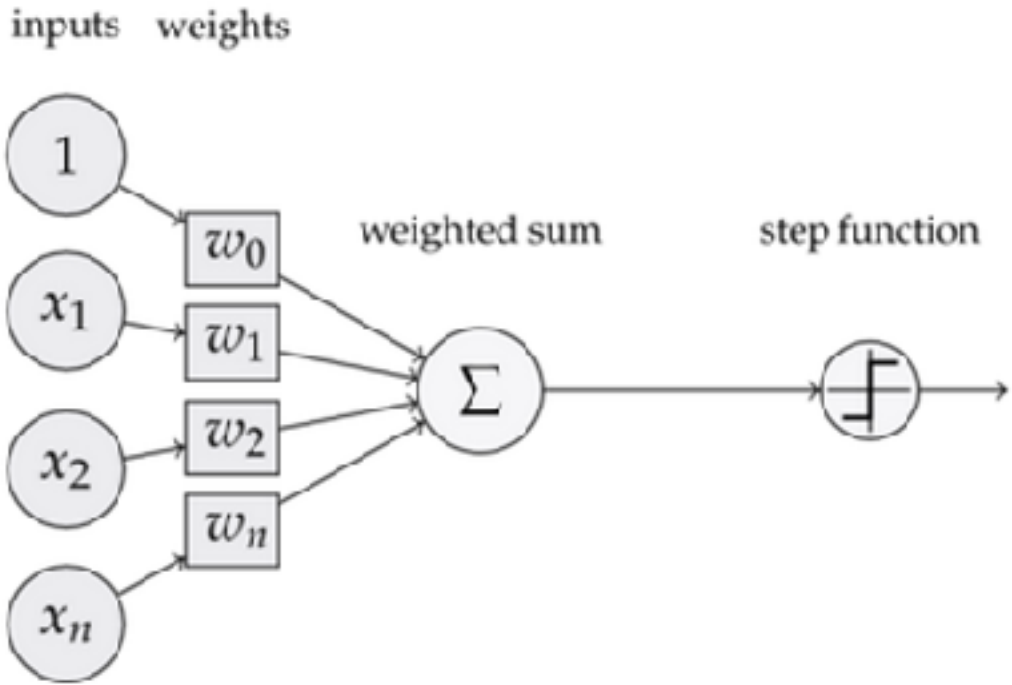
GENERAL ASSEMBLY

DATA SCIENCE
10 WEEK PART TIME COURSE

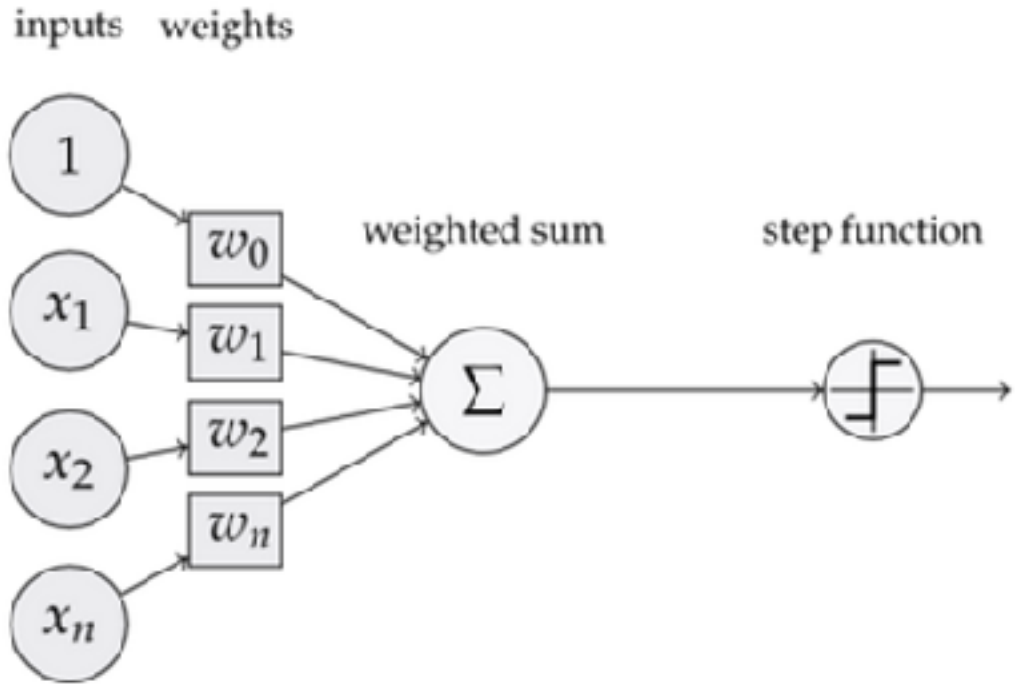
Week 9 – Artificial Neural Networks
Thursday 20th July 2017

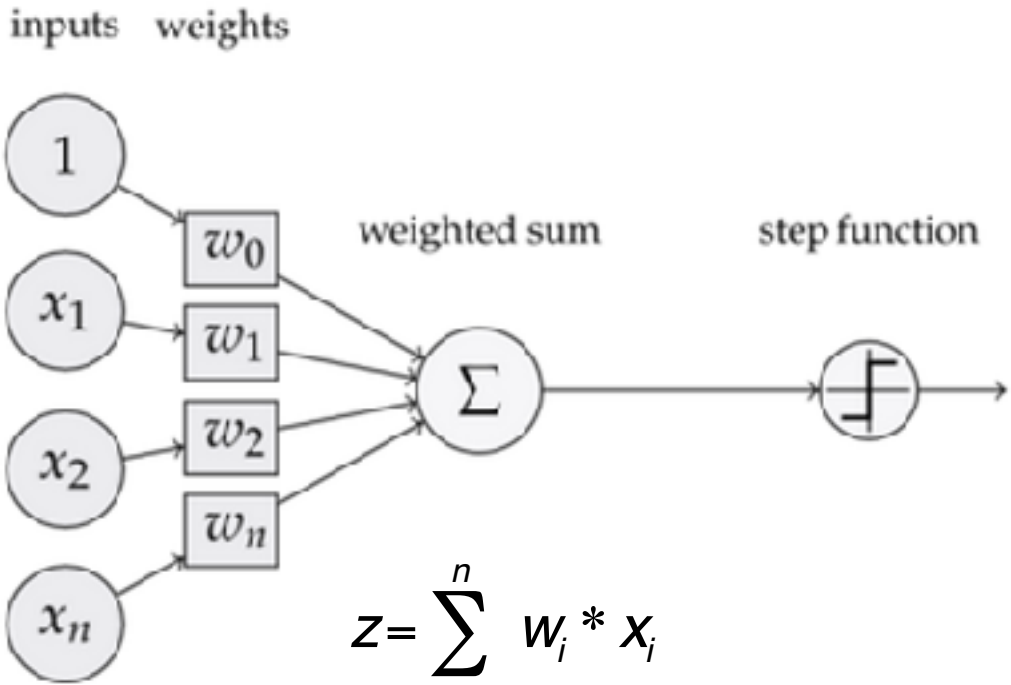
WHAT IS A NEURAL NETWORK?


Dendrite
Axon Terminal
Node of
Ranvier
Cell body
Schwann cell
Axon
Myelin sheath
Nucleus


inputs
weights
1
x_1
x_2
x_n
w_0
w_1
w_2
w_n
weighted sum
Σ
step function

A computational system comprised of layers and each layer is built of interconnected perceptrons

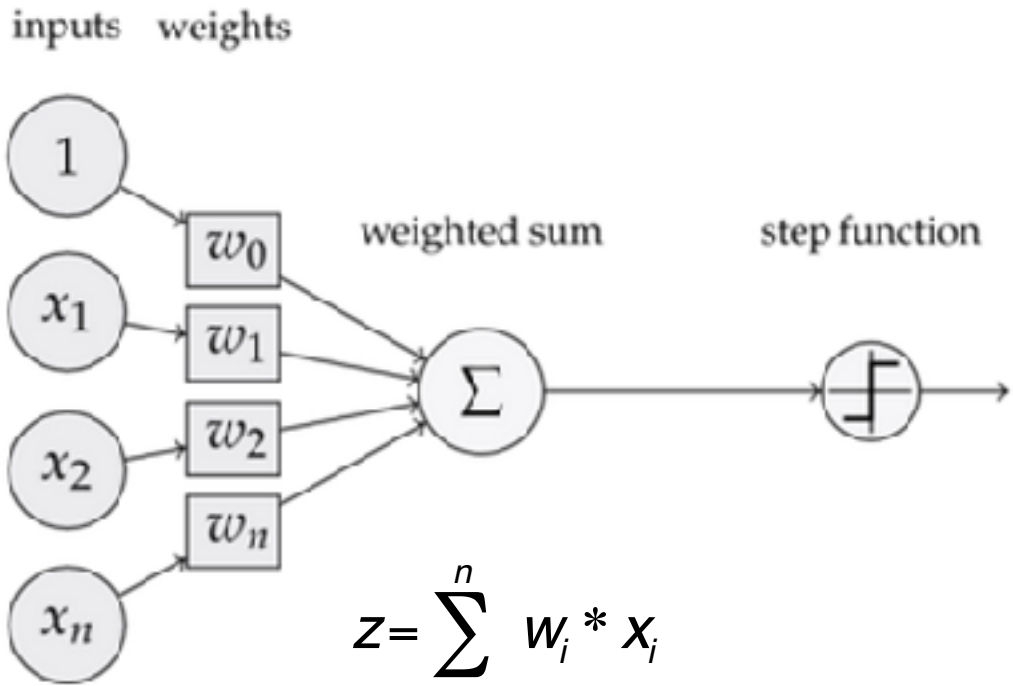




$$z = \sum_{i=0}^{n} w_i * x_i$$

$$f_{log}(z) = \frac{1}{1 + e^{-z}}$$

f_{log} is called logistic function



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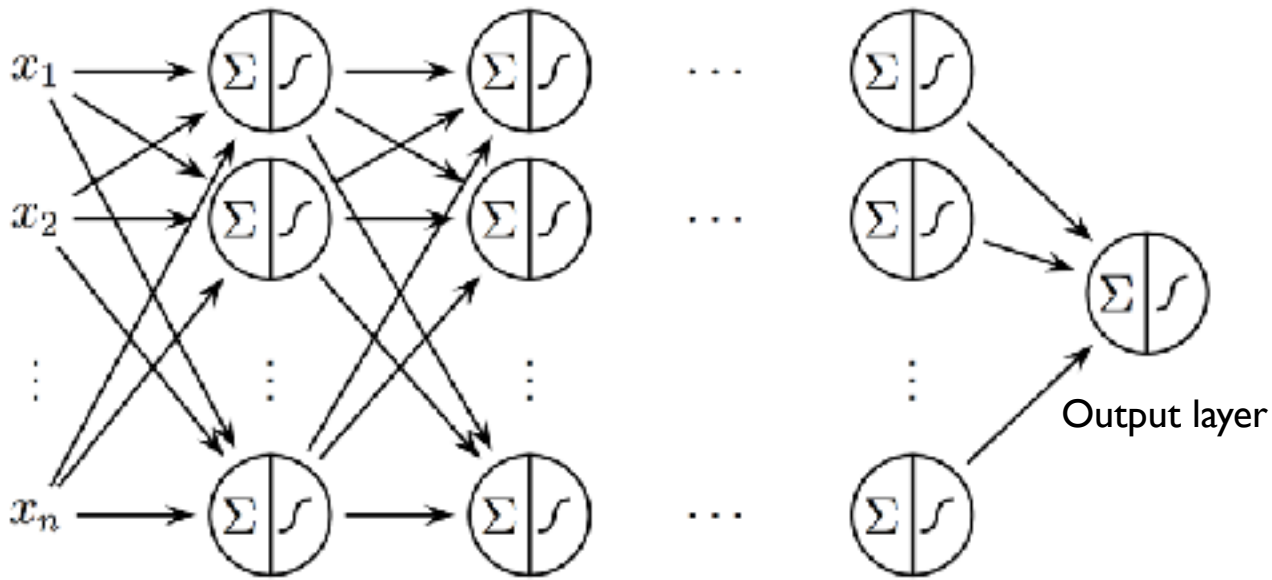
If f(z) if above a threshold, generally called theta, then the neuron “fires”

A multi layer perceptrons (MLP) is a finite acyclic graph. The nodes are neurons with logistic activation.



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NETWORK STRUCTURE

Input Layer - the original features of our dataset (our X)

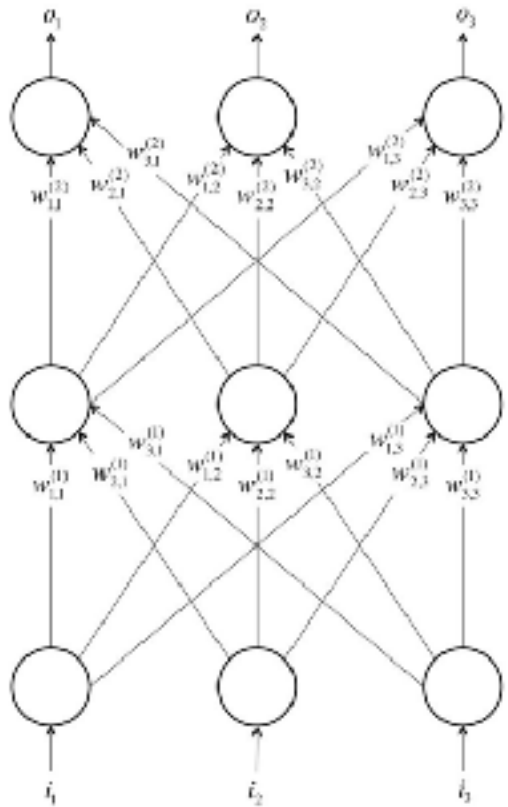
Hidden Layer - these are the derived features of the network. They are called hidden because they are not directly observed.

Output Layer - the final transformation of the inputs into a result

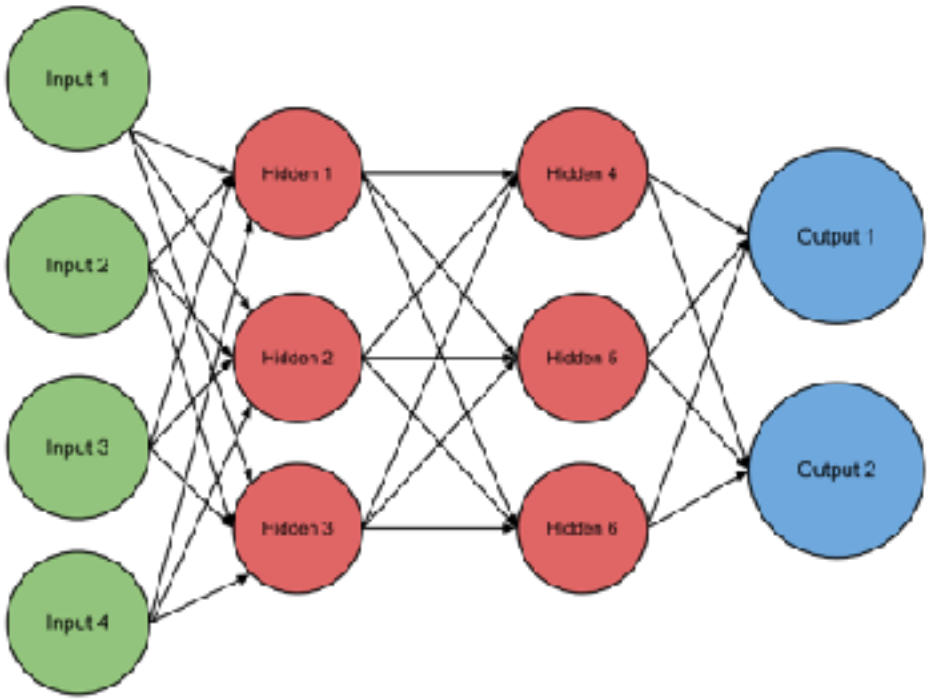
Output Layer ->

Hidden Layers ->

Input Layer ->



Hidden layers often have fewer neurons than the input layer to force the network to learn compressed representations of the original input.



The structure of the network can be thought of as just more hyper-parameters of the model. We search for the optimal structure just as we search for other hyper-parameters such as the learning rate.

It is not required that every neuron has its output connected to the inputs of all neurons in the next layer.

HOW DO WE FIND THE WEIGHTS?

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BACK-PROPAGATION

As we train the model we update the sigmoid function weights in order to get the best predictions possible

If an observation goes through the model and is outputted as False when it should have been True the logistic functions in the single perceptrons are changed slightly.

Back-Propogation is a two-pass algorithm.

The Forward pass fixes the current weights and the predicted values are calculated.

The Backward pass calculates the errors on the output layer and are then back-propagated to give the errors at the hidden layer units.

The good ol' chain rule!

Given the errors calculated between the test observations and the output, calculate the derivative of the error function using the chain rule. From this derivative we can compute the gradient and use it in an optimisation function like gradient descent to improve the weights at that neuron. Repeat down each layer of the network after each error calculation.

Pros

- Online model (updates as you go)
- Very fast predictions
- Can approximate almost any type of function
- Can be used in a supervised and unsupervised manner
- Very topical area of machine learning (lots of investment)
- Getting easier to run

Cons

- Requires many training samples to be considered good
- Hard to describe what is happening
- Requires a lot of hardware / computation power
- (Can be) Slow to train

WHY ARE NEURAL NETWORKS IN THE NEWS?

- http://www.wired.com/2016/01/googles-go-victory-is-just-a-glimpse-of-how-powerful-ai-will-be/

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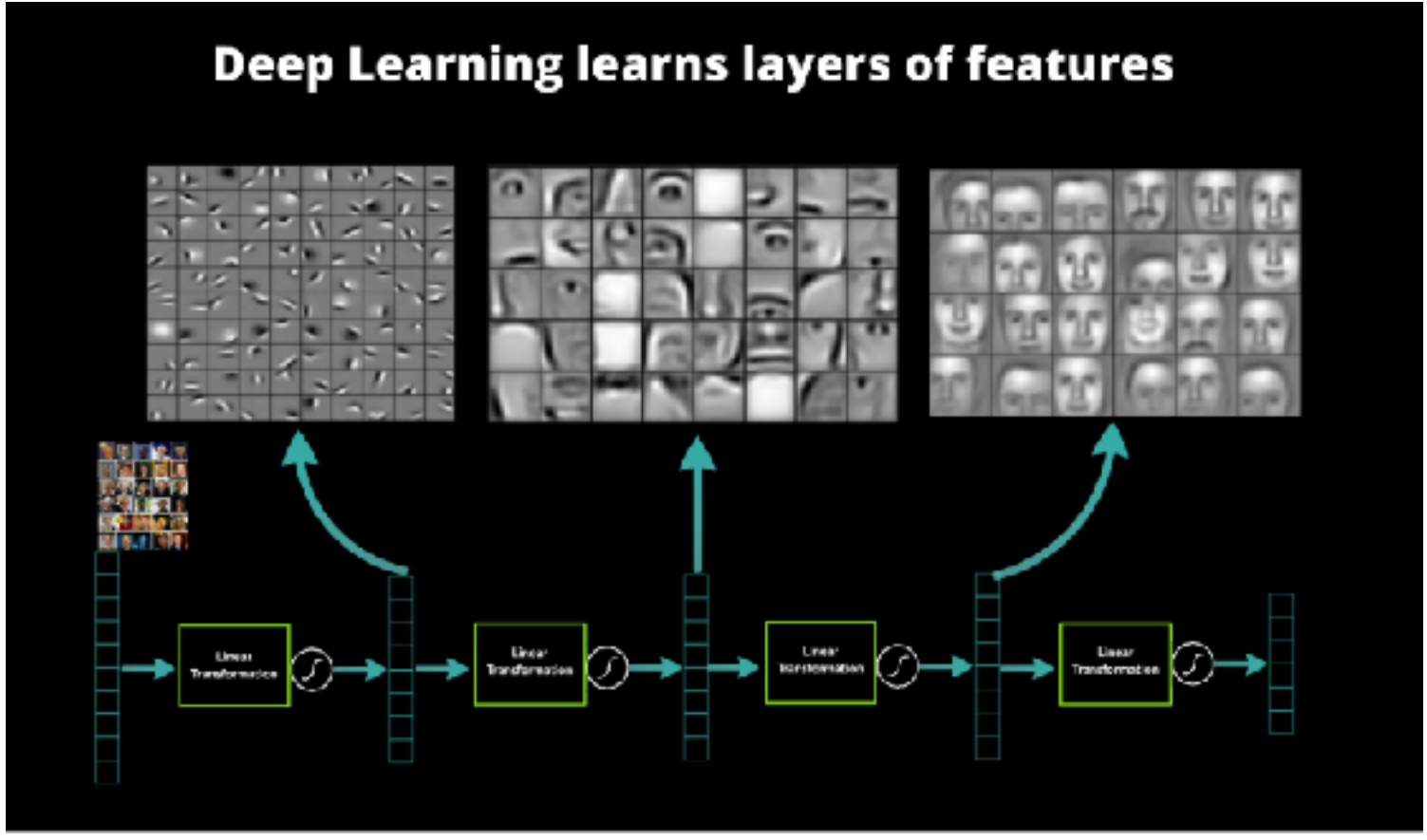
DEEP LEARNING


Deep Learning learns layers of features

When is deep learning the right choice of algorithm?

When the input features are dense:

- Images
- Videos
- Audio
- Text

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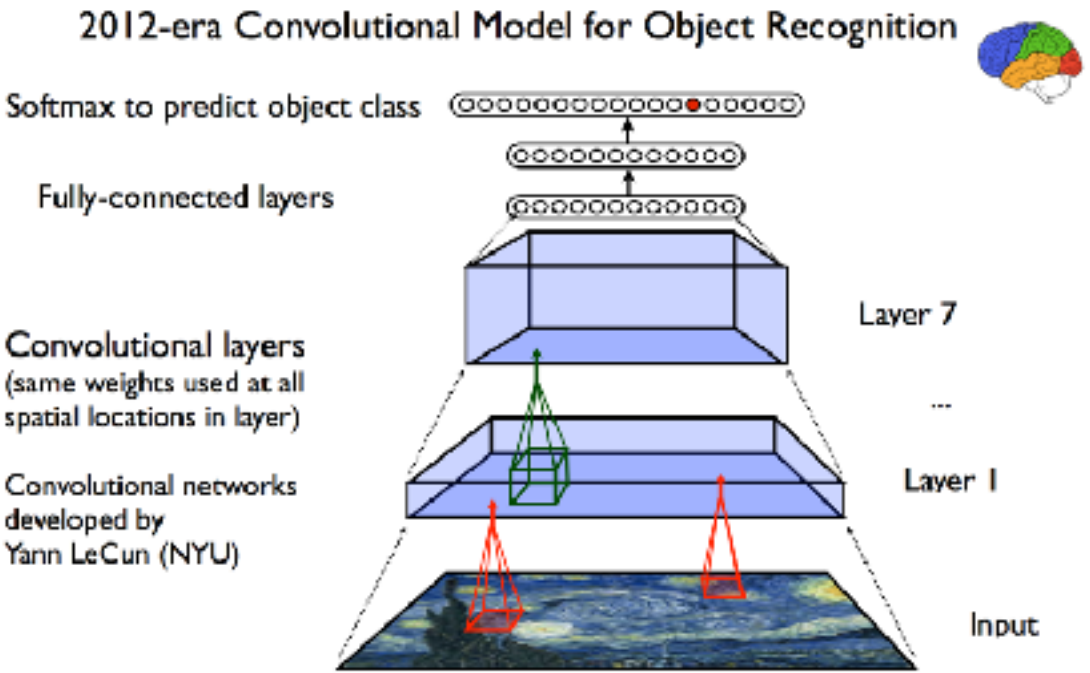
Some recent interesting applications:

- Colorisation of Black and White Images.
- Adding Sounds To Silent Movies.
- Automatic Machine Translation.
- Object Classification in Photographs.
- Automatic Handwriting Generation.
- Character Text Generation.
- Image Caption Generation.
- Automatic Game Playing.

Video on what neural networks see. Helpful for realising how the networks learns to distinguish through transformations.

https://aiexperiments.withgoogle.com/what-neural-nets-see



Basic architecture developed by Krizhevsky, Sutskever & Hinton (all now at Google).

Won 2012 ImageNet challenge with 16.4% top-5 error rate

http://deepdreamgenerator.com/

TensorFlow™ is an open source software library for numerical computation using data flow graphs. Nodes in the graph represent mathematical operations, while the graph edges represent the multidimensional data arrays (tensors) communicated between them.

GPUs for processing

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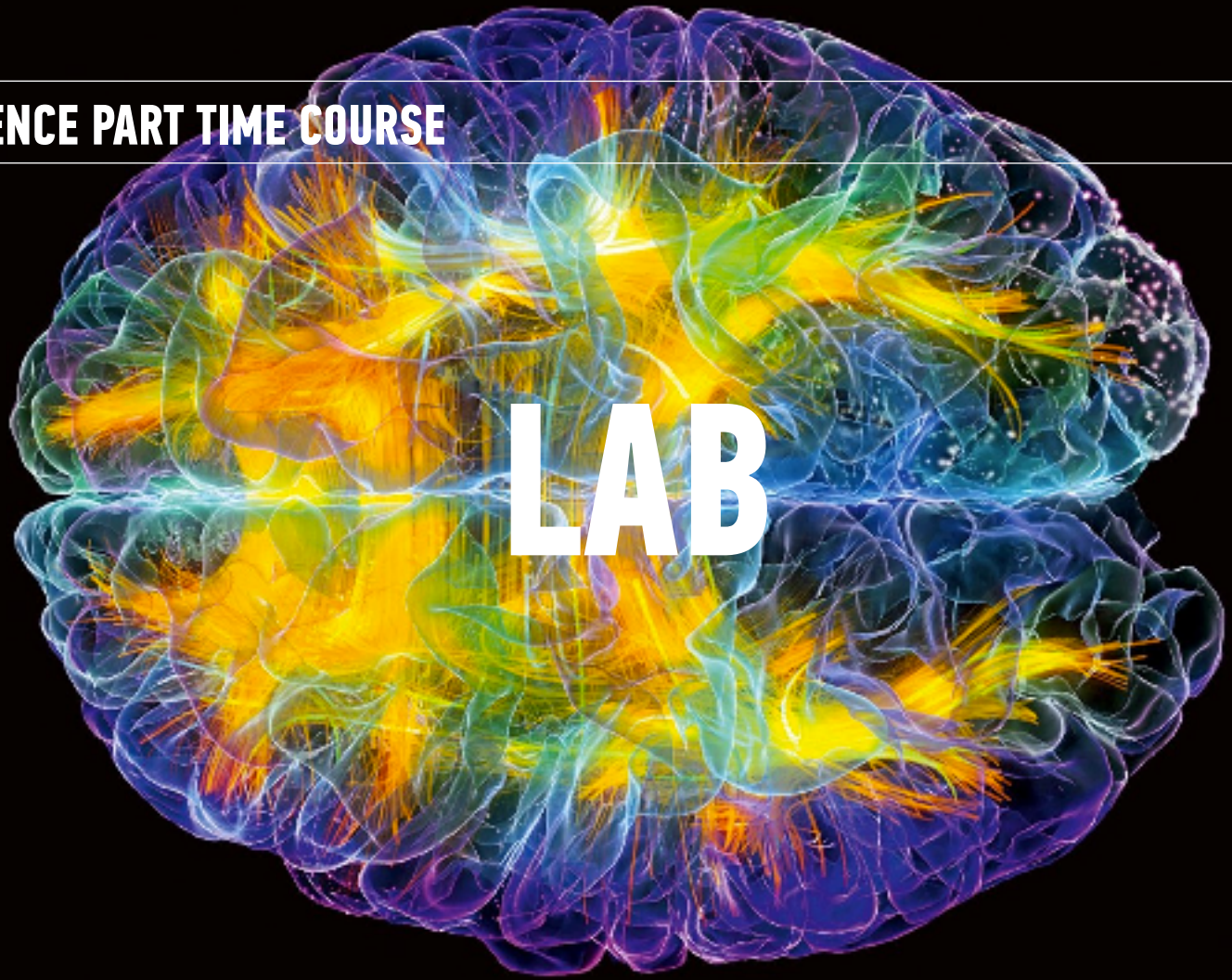

SYNCHING YOUR FORK WITH THE COURSE REPO

1. re-name your labs with lab_name.<yourname>.ipynb (to prevent a conflict)
2. cd <path to the root of your SYD_DAT_6 local repo>
3. commit your changes ahead of sync
   - git status
   - git add .
   - git commit -m "descriptive label for the commit"
   - git status
4. download new material from official course repo (upstream) and merge it
   - git checkout master (ensures you are in the master branch)
   - git fetch upstream
   - git merge upstream/master

A demo of deep learning being applied in the browser:

http://cs.stanford.edu/people/karpathy/convnetjs/demo/mnist.html

HOMEWORK

Homework

- Prepare you project presentations

Reading

- Evaluation of deep learning frameworks: https://github.com/zer0n/deepframeworks/blob/master/README.md
- Beginner: Fundamentals of Deep Learning – Nikhil Budhema
- Advanced: Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville

PRESENTATIONS

- 10 mins presentation with 5 mins for questions
  - What did you do?
  - What were the results?
  - What did you achieve?
  - What did you learn?
  - What else will you try in the future?
  - Appendix with any interesting findings
- On your own laptop or mine, your choice