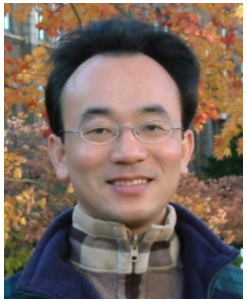
Social Computing and Big Data Analytics
社群運算與大數據分析

Deep Learning with Theano and Keras in Python (Python Theano 和 Keras 深度學習)

1052SCBDA09
MIS MBA (M2226) (8606)
Wed, 8,9, (15:10-17:00) (L206)



Min-Yuh Day
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專任助理教授
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淡江大學 資訊管理學系

http://mail. tku.edu.tw/myday/

2017-04-26

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	2017/02/15	Course Orientation for Social Computing and Big Data Analytics (社群運算與大數據分析課程介紹)
2	2017/02/22	Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data (資料科學與大數據分析： 探索、分析、視覺化與呈現資料)
3	2017/03/01	Fundamental Big Data: MapReduce Paradigm, Hadoop and Spark Ecosystem (大數據基礎：MapReduce典範、 Hadoop與Spark生態系統)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
4	2017/03/08	Big Data Processing Platforms with SMACK: Spark, Mesos, Akka, Cassandra and Kafka (大數據處理平台SMACK： Spark, Mesos, Akka, Cassandra, Kafka)
5	2017/03/15	Big Data Analytics with Numpy in Python (Python Numpy 大數據分析)
6	2017/03/22	Finance Big Data Analytics with Pandas in Python (Python Pandas 財務大數據分析)
7	2017/03/29	Text Mining Techniques and Natural Language Processing (文字探勘分析技術與自然語言處理)
8	2017/04/05	Off-campus study (教學行政觀摩日)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
9	2017/04/12	Social Media Marketing Analytics (社群媒體行銷分析)
10	2017/04/19	期中報告 (Midterm Project Report)
11	2017/04/26	Deep Learning with Theano and Keras in Python (Python Theano 和 Keras 深度學習)
12	2017/05/03	Deep Learning with Google TensorFlow (Google TensorFlow 深度學習)
13	2017/05/10	Sentiment Analysis on Social Media with Deep Learning (深度學習社群媒體情感分析)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
14	2017/05/17	Social Network Analysis (社會網絡分析)
15	2017/05/24	Measurements of Social Network (社會網絡量測)
16	2017/05/31	Tools of Social Network Analysis (社會網絡分析工具)
17	2017/06/07	Final Project Presentation I (期末報告 I)
18	2017/06/14	Final Project Presentation II (期末報告 II)

Deep Learning

with

Theano

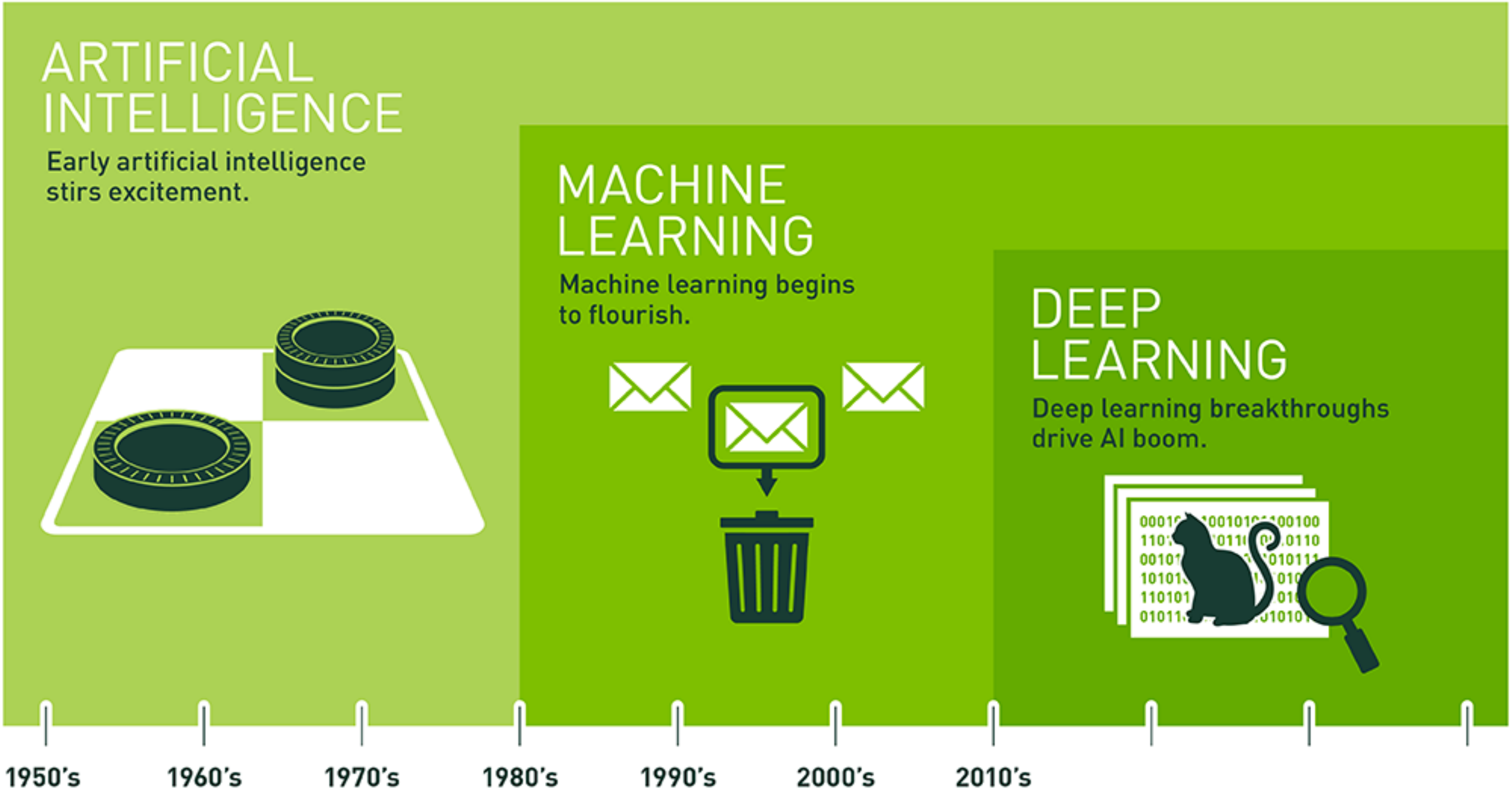
and

Keras

in

Python

Artificial Intelligence
Machine Learning & Deep Learning


ARTIFICIAL INTELLIGENCE
Early artificial intelligence stirs excitement.
MACHINE LEARNING
Machine learning begins to flourish.
DEEP LEARNING
Deep learning breakthroughs drive AI boom.
1950's
1960's
1970's
1980's
1990's
2000's
2010's

Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

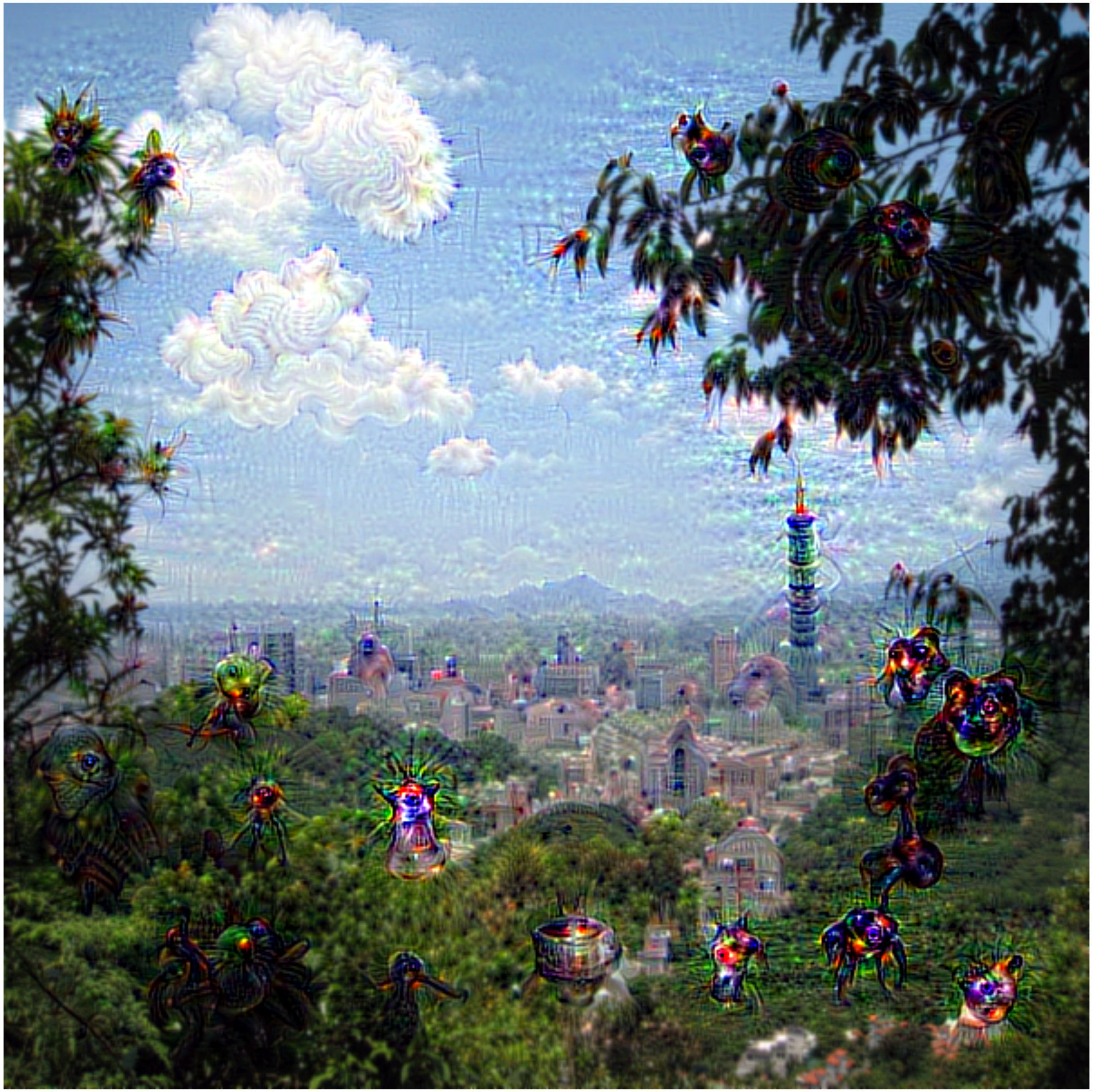
Source: https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/

Deep Learning Evolution

Deep Learning

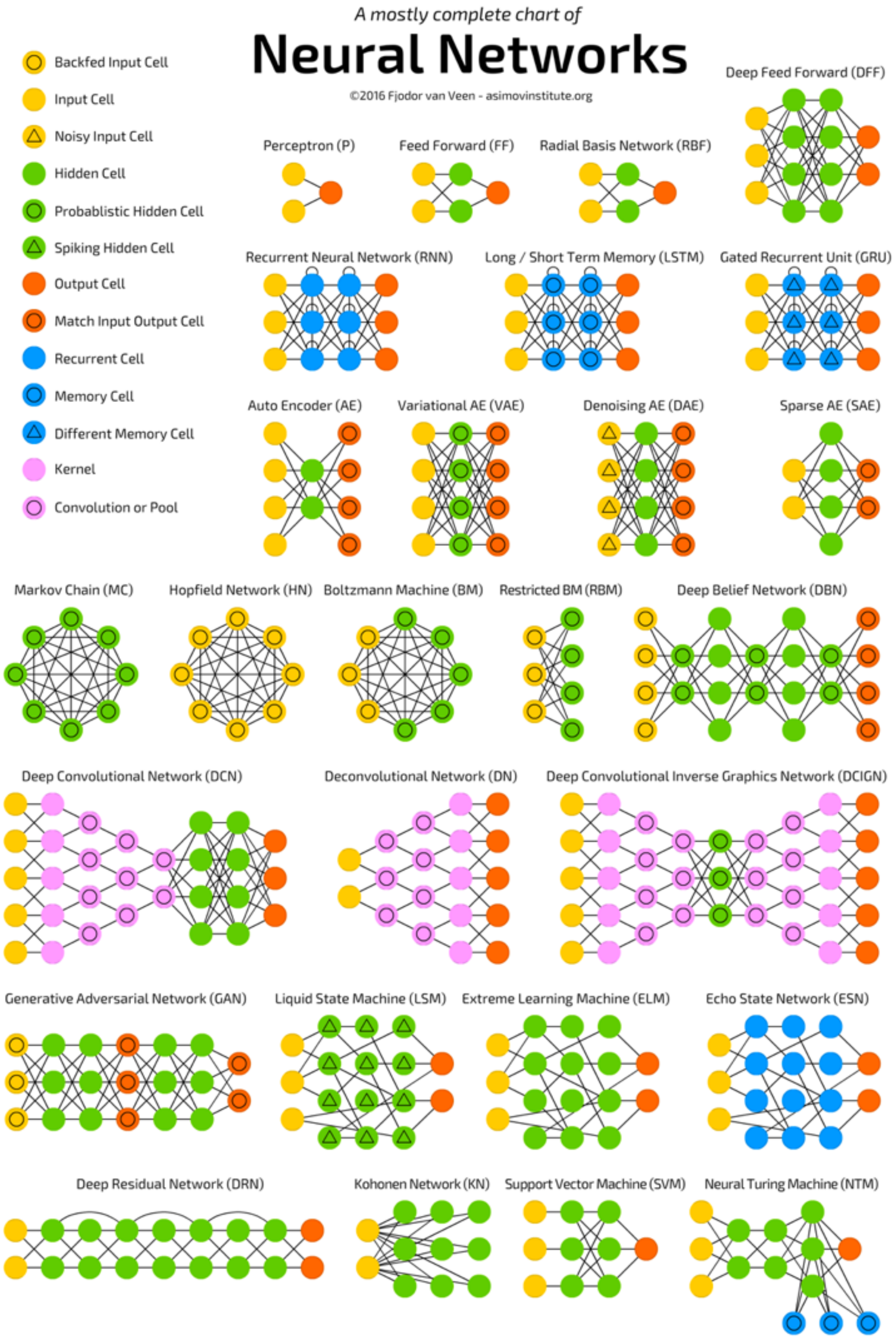
Source: http://www.erogol.com/brief-history-machine-learning/

Deep Dream

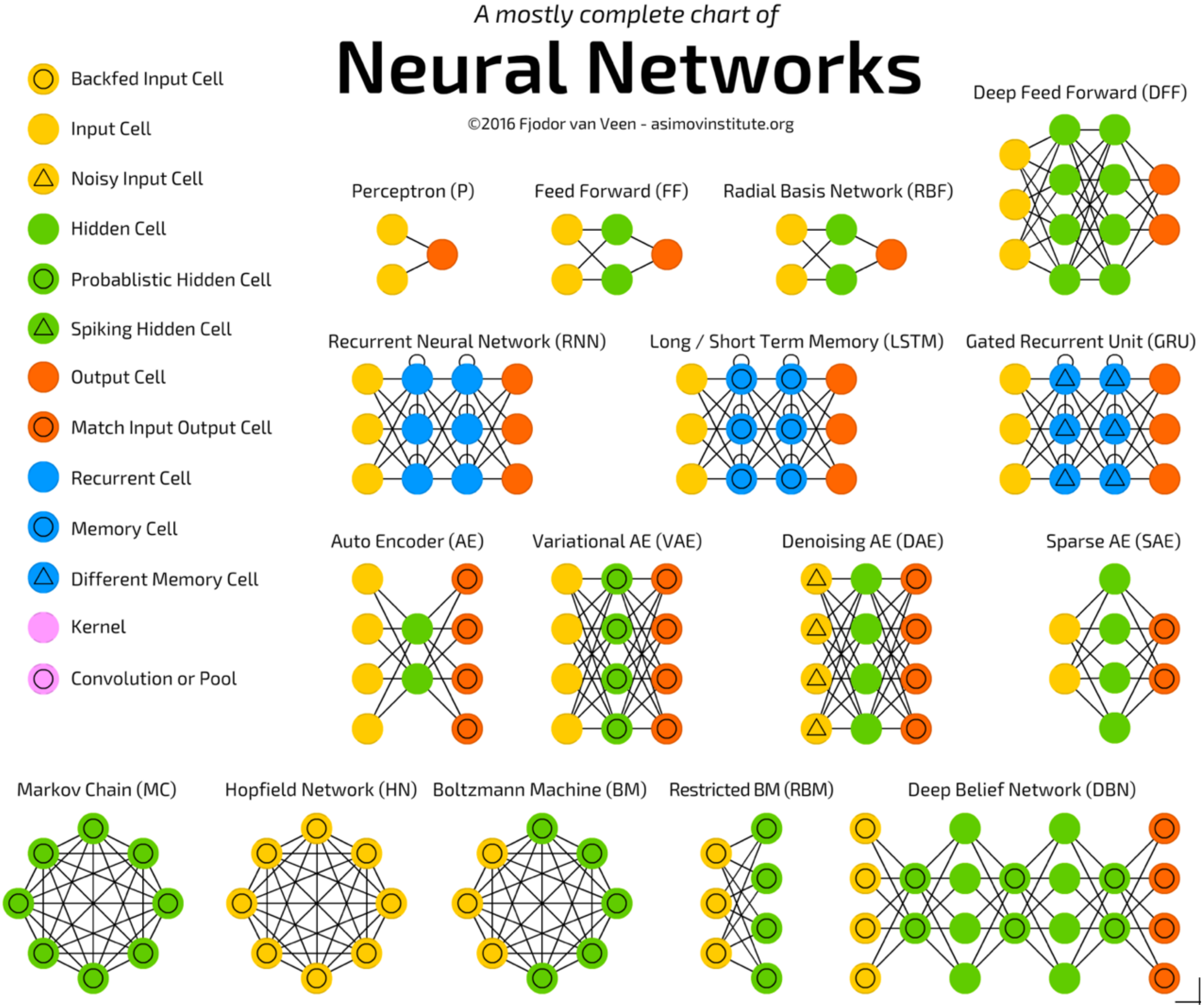


https://github.com/fchollet/keras/blob/master/examples/deep_dream.py

Neural Networks (NN)

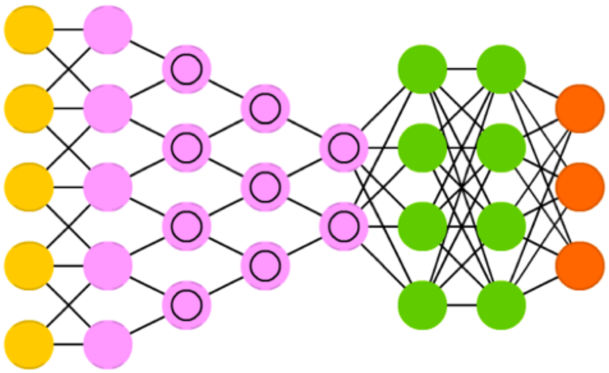

A mostly complete chart of
Neural Networks
©2016 Fjodor van Veen - asimovinstitute.org
Backfed Input Cell
Input Cell
Noisy Input Cell
Hidden Cell
Probablistic Hidden Cell
Spiking Hidden Cell
Output Cell
Match Input Output Cell
Recurrent Cell
Memory Cell
Different Memory Cell
Kernel
Convolution or Pool
Perceptron (P)
Feed Forward (FF)
Radial Basis Network (RBF)
Deep Feed Forward (DFF)
Recurrent Neural Network (RNN)
Long / Short Term Memory (LSTM)
Gated Recurrent Unit (GRU)
Auto Encoder (AE)
Variational AE (VAE)
Denoising AE (DAE)
Sparse AE (SAE)
Markov Chain (MC)
Hopfield Network (HN)
Boltzmann Machine (BM)
Restricted BM (RBM)
Deep Belief Network (DBN)
Deep Convolutional Network (DCN)
Deconvolutional Network (DN)
Deep Convolutional Inverse Graphics Network (DCIGN)
Generative Adversarial Network (GAN)
Liquid State Machine (LSM)
Extreme Learning Machine (ELM)
Echo State Network (ESN)
Deep Residual Network (DRN)
Kohonen Network (KN)
Support Vector Machine (SVM)
Neural Turing Machine (NTM)

Source: http://www.asimovinstitute.org/neural-network-zoo/

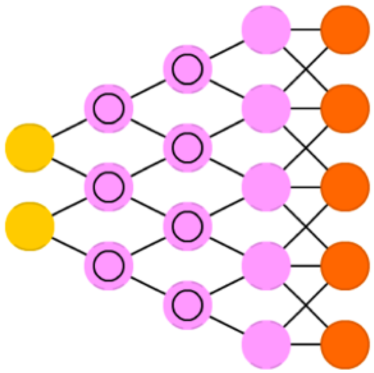


Source: http://www.asimovinstitute.org/neural-network-zoo/

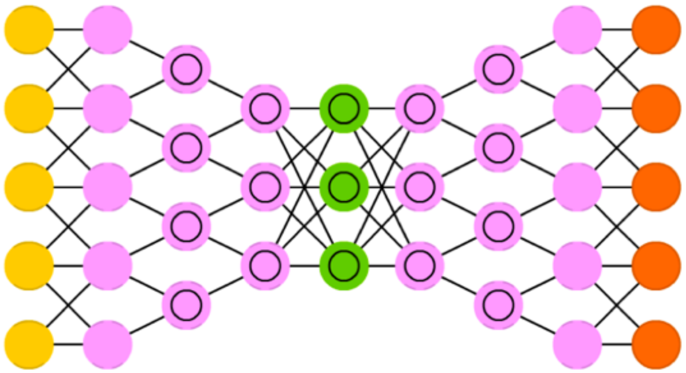
Deep Convolutional Network (DCN)



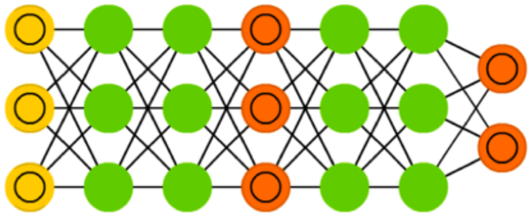
Deconvolutional Network (DN)



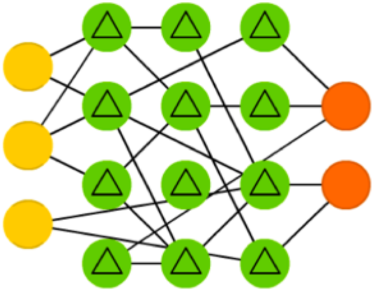
Deep Convolutional Inverse Graphics Network (DCIGN)



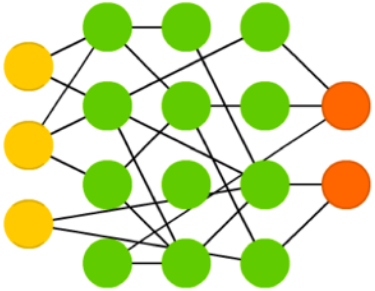
Generative Adversarial Network (GAN)



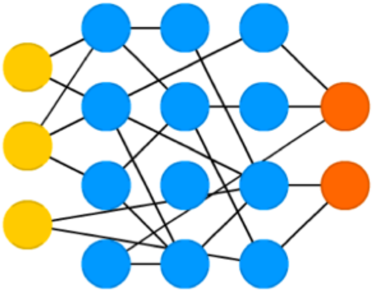
Liquid State Machine (LSM)



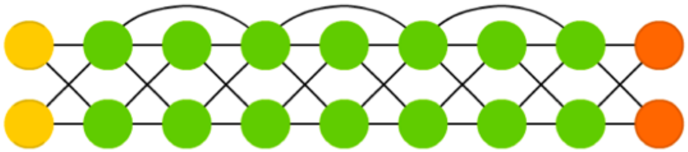
Extreme Learning Machine (ELM)



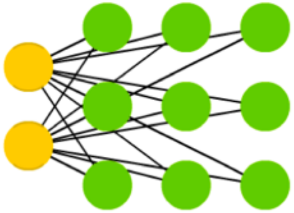
Echo State Network (ESN)



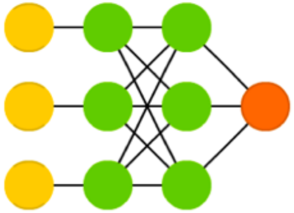
Deep Residual Network (DRN)



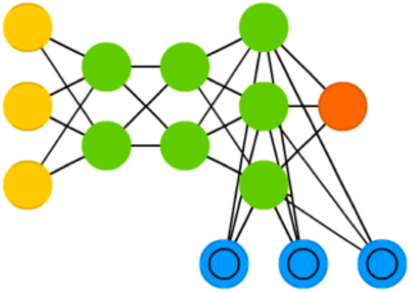
Kohonen Network (KN)



Support Vector Machine (SVM)



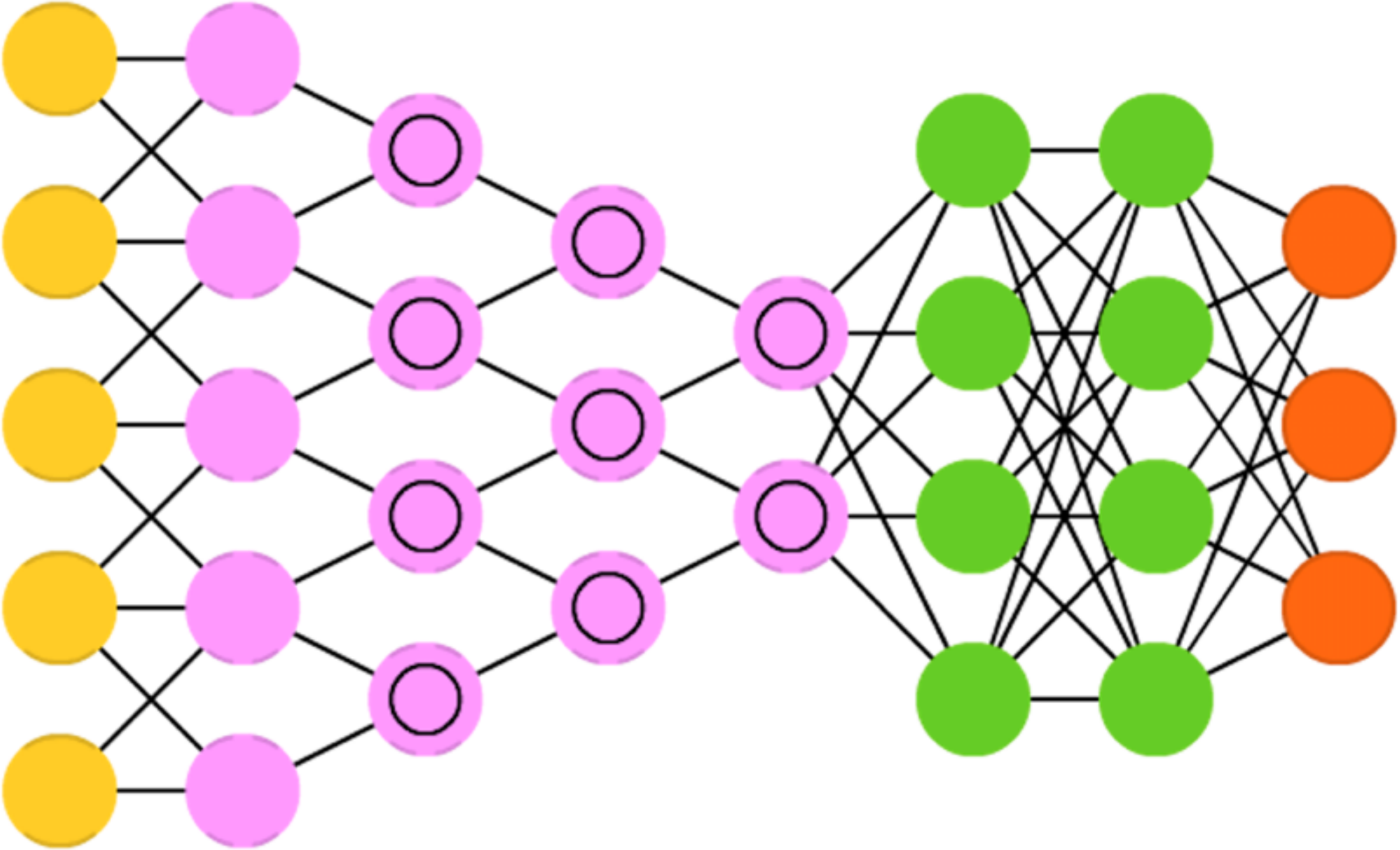
Neural Turing Machine (NTM)



Source: http://www.asimovinstitute.org/neural-network-zoo/

Convolutional Neural Networks

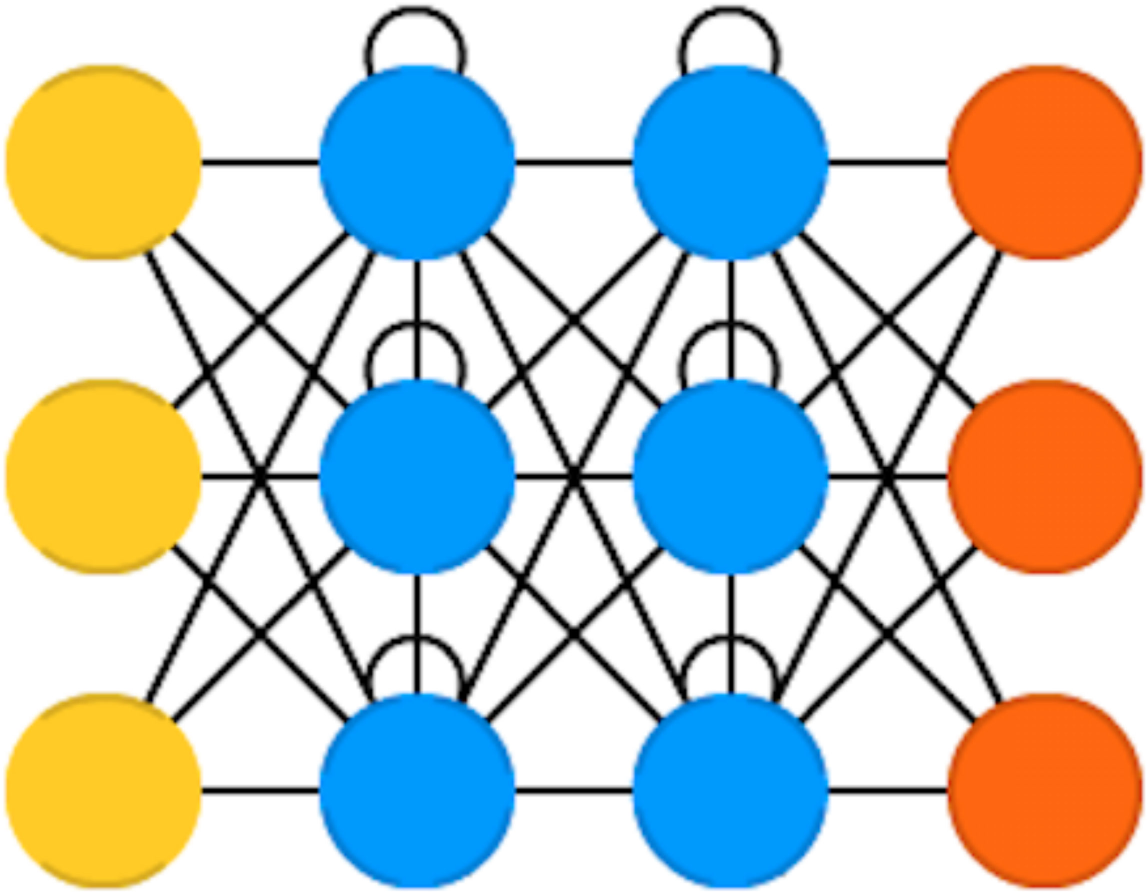
(CNN or Deep Convolutional Neural Networks, DCNN)



LeCun, Yann, et al. “Gradient-based learning applied to document recognition.” Proceedings of the IEEE 86.11 (1998): 2278-2324.

Source: http://www.asimovinstitute.org/neural-network-zoo/

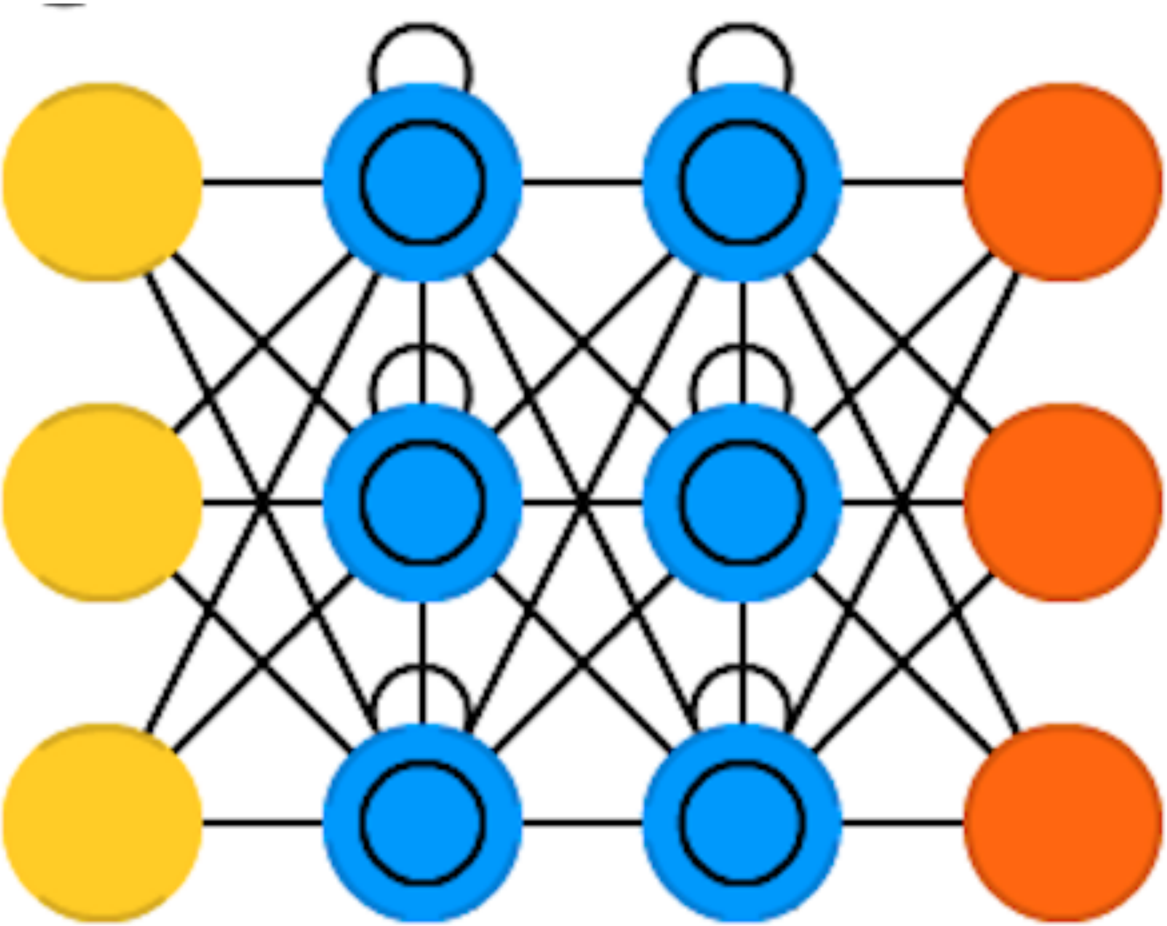
Recurrent Neural Networks (RNN)



Elman, Jeffrey L. "Finding structure in time." Cognitive science 14.2 (1990): 179-211

Source: http://www.asimovinstitute.org/neural-network-zoo/

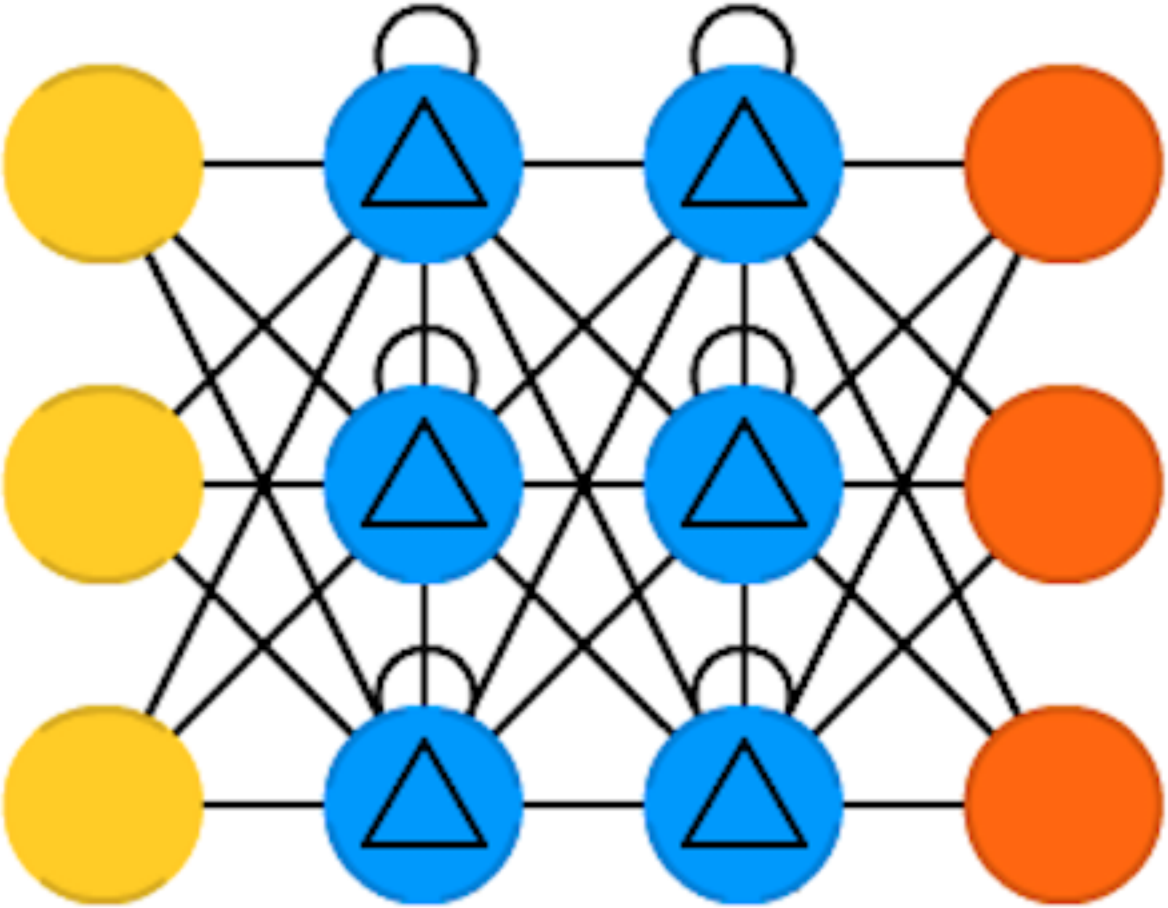
Long / Short Term Memory (LSTM)



Hochreiter, Sepp, and Jürgen Schmidhuber. "Long short-term memory." Neural computation 9.8 (1997): 1735-1780.

Source: http://www.asimovinstitute.org/neural-network-zoo/

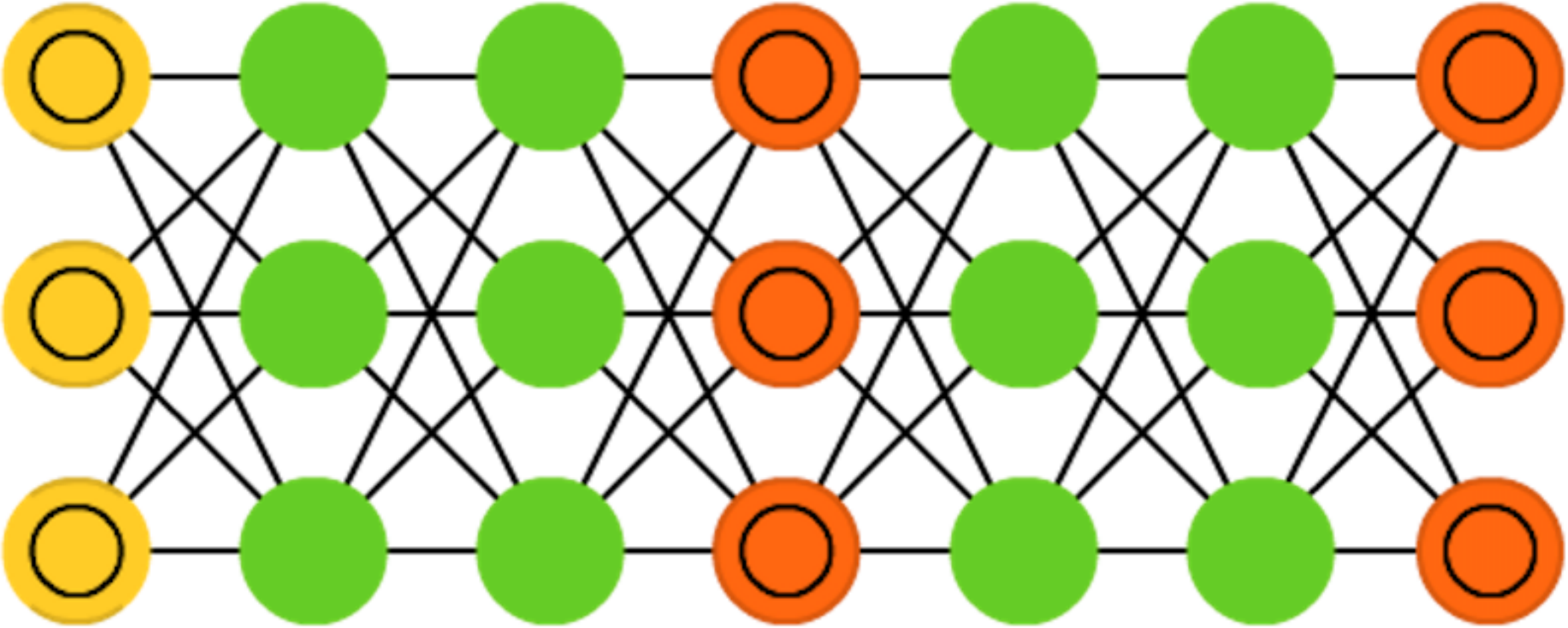
Gated Recurrent Units (GRU)



Chung, Junyoung, et al. "Empirical evaluation of gated recurrent neural networks on sequence modeling." arXiv preprint arXiv:1412.3555 (2014).

Source: http://www.asimovinstitute.org/neural-network-zoo/

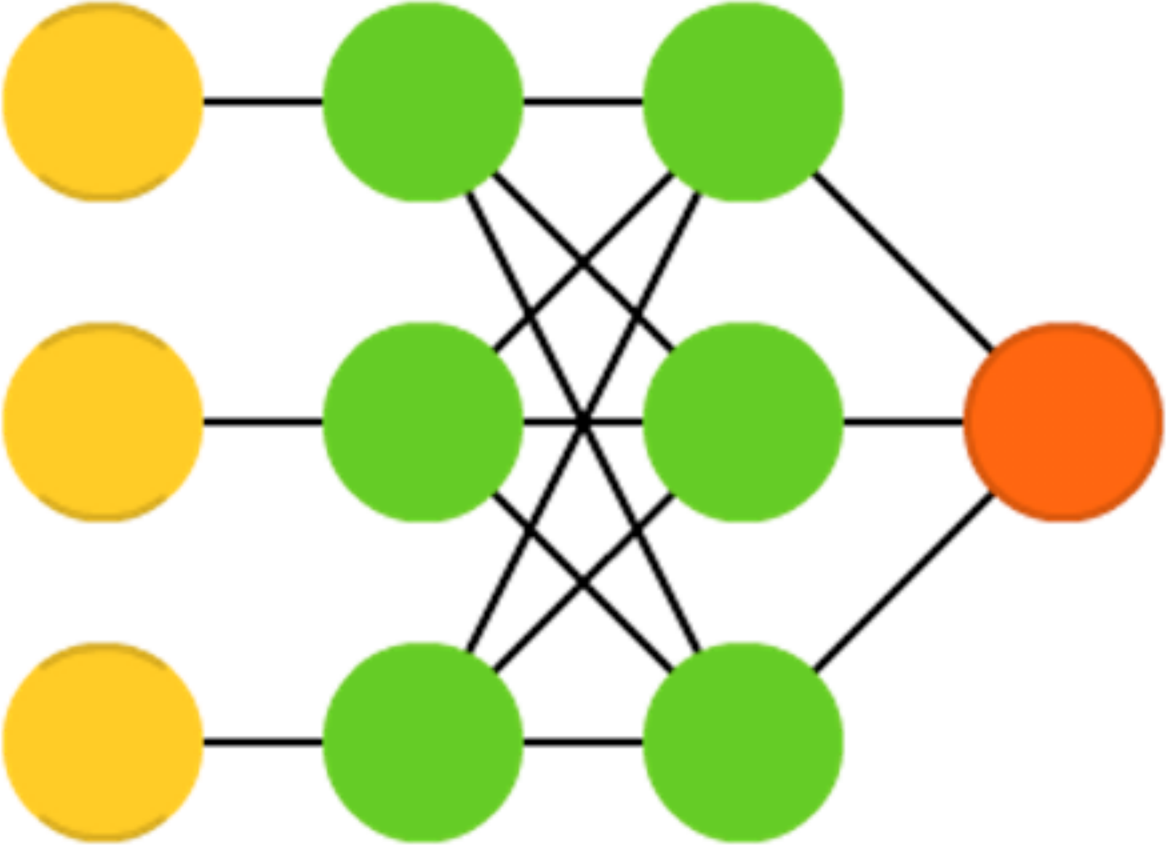
Generative Adversarial Networks (GAN)



Goodfellow, Ian, et al. “Generative adversarial nets.” Advances in Neural Information Processing Systems. 2014.

Source: http://www.asimovinstitute.org/neural-network-zoo/

Support Vector Machines (SVM)



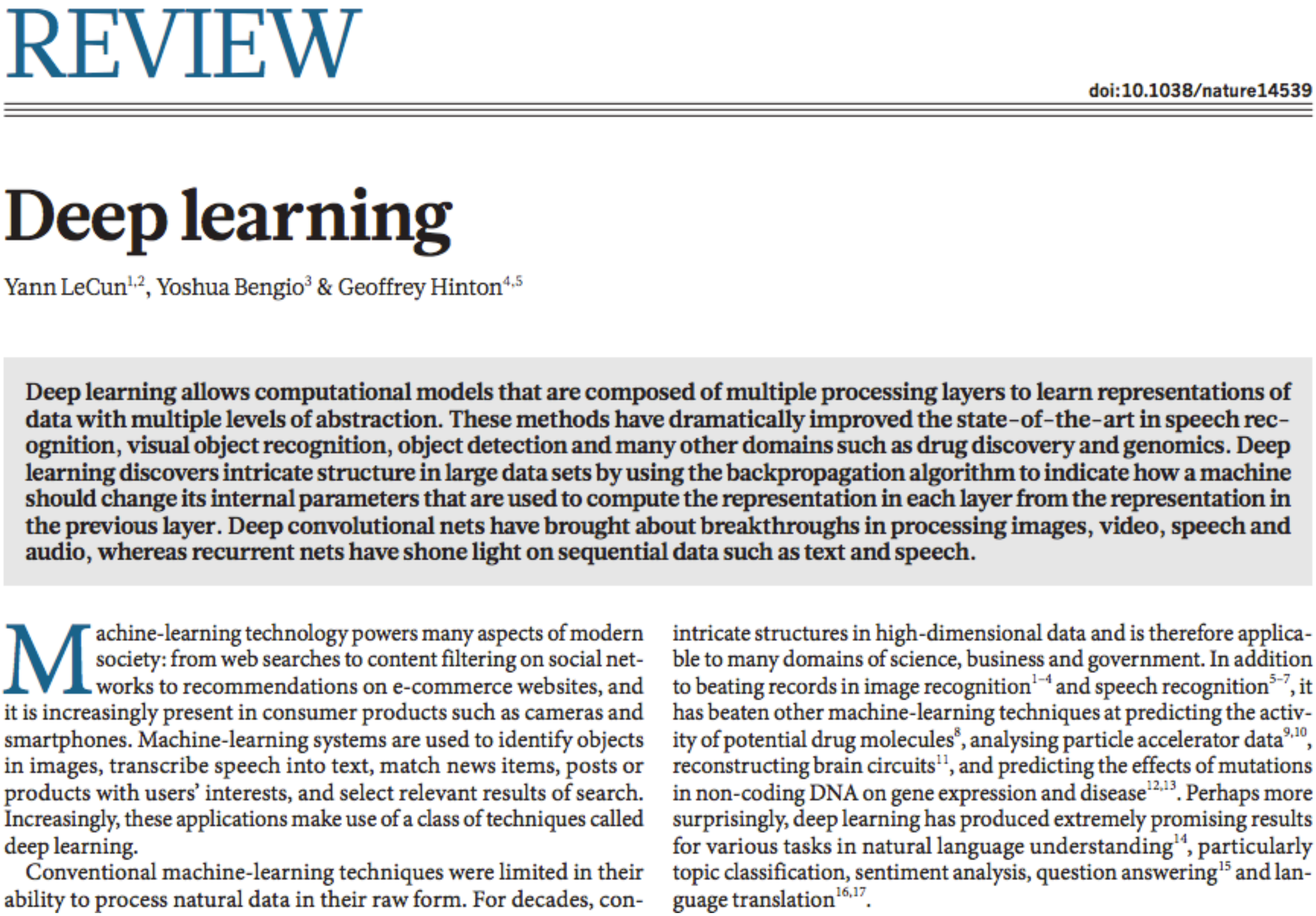
Cortes, Corinna, and Vladimir Vapnik. “Support-vector networks.” Machine learning 20.3 (1995): 273-297.

Source: http://www.asimovinstitute.org/neural-network-zoo/

LeCun, Yann,
Yoshua Bengio,
and Geoffrey Hinton.

"**Deep learning**."

Nature 521, no. 7553 (2015): 436-444.



REVIEW

doi:10.1038/nature14539

Deep learning

Yann LeCun[1,2], Yoshua Bengio[3] & Geoffrey Hinton[4,5]

Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction. These methods have dramatically improved the state-of-the-art in speech recognition, visual object recognition, object detection and many other domains such as drug discovery and genomics. Deep learning discovers intricate structure in large data sets by using the backpropagation algorithm to indicate how a machine should change its internal parameters that are used to compute the representation in each layer from the representation in the previous layer. Deep convolutional nets have brought about breakthroughs in processing images, video, speech and audio, whereas recurrent nets have shone light on sequential data such as text and speech.

Machine-learning technology powers many aspects of modern society: from web searches to content filtering on social networks to recommendations on e-commerce websites, and it is increasingly present in consumer products such as cameras and smartphones. Machine-learning systems are used to identify objects in images, transcribe speech into text, match news items, posts or products with users' interests, and select relevant results of search. Increasingly, these applications make use of a class of techniques called deep learning.

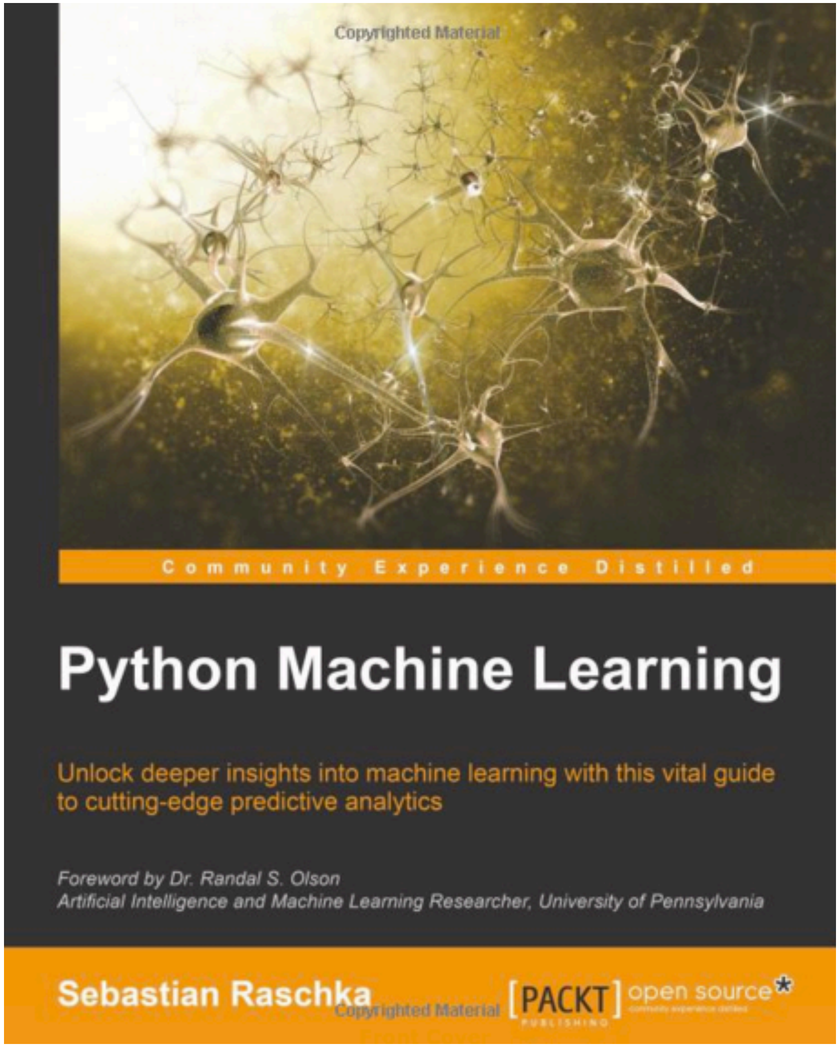
Conventional machine-learning techniques were limited in their ability to process natural data in their raw form. For decades, con- intricate structures in high-dimensional data and is therefore applicable to many domains of science, business and government. In addition to beating records in image recognition[1–4] and speech recognition[5–7], it has beaten other machine-learning techniques at predicting the activity of potential drug molecules[8], analysing particle accelerator data[9,10], reconstructing brain circuits[11], and predicting the effects of mutations in non-coding DNA on gene expression and disease[12,13]. Perhaps more surprisingly, deep learning has produced extremely promising results for various tasks in natural language understanding[14], particularly topic classification, sentiment analysis, question answering[15] and language translation[16,17].

Source: LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." Nature 521, no. 7553 (2015): 436-444.

Sebastian Raschka (2015),

Python Machine Learning,

Packt Publishing



Community Experience Distilled

Python Machine Learning

Unlock deeper insights into machine learning with this vital guide to cutting-edge predictive analytics

Foreword by Dr. Randal S. Olson
Artificial Intelligence and Machine Learning Researcher, University of Pennsylvania

Sebastian Raschka

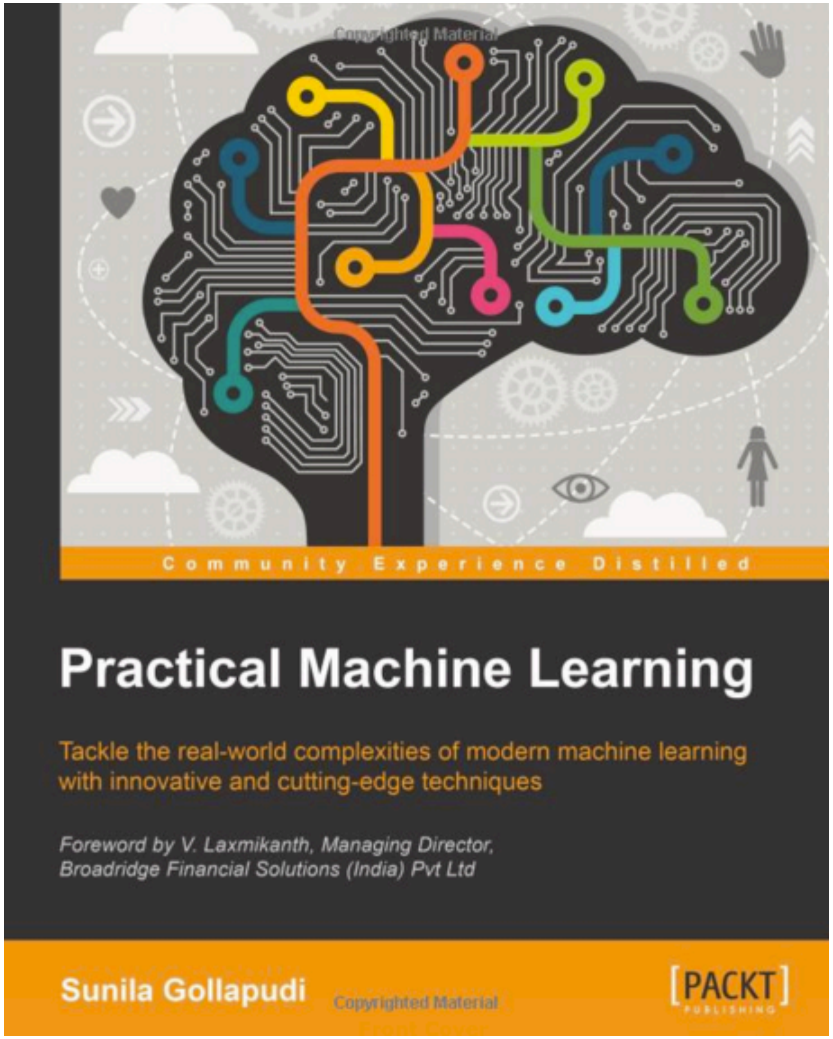
[PACKT] PUBLISHING open source*

Source: http://www.amazon.com/Python-Machine-Learning-Sebastian-Raschka/dp/1783555130

Sunila Gollapudi (2016),

Practical Machine Learning,

Packt Publishing



Community Experience Distilled

Practical Machine Learning

Tackle the real-world complexities of modern machine learning with innovative and cutting-edge techniques

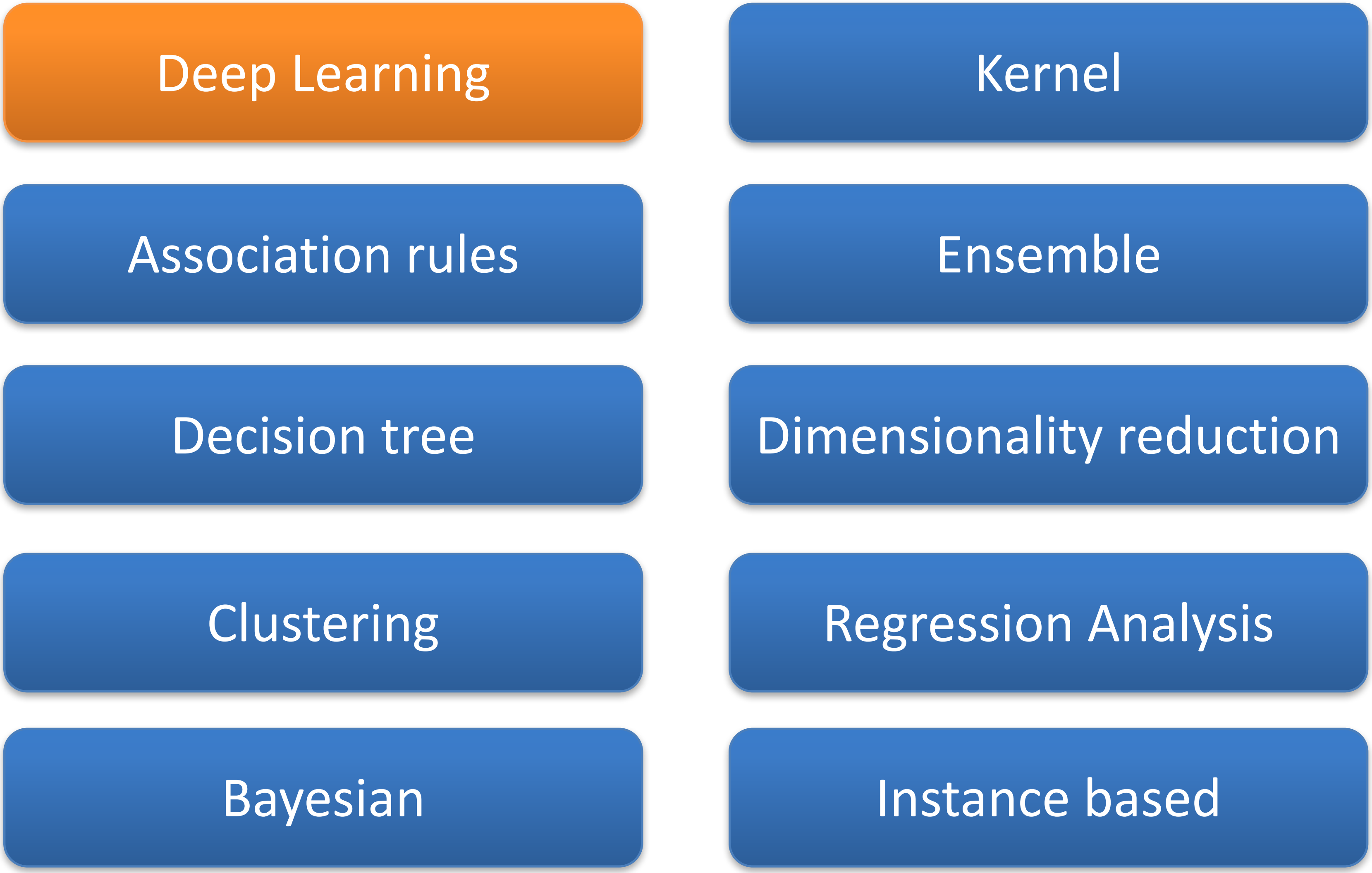
Foreword by V. Laxmikanth, Managing Director,
Broadridge Financial Solutions (India) Pvt Ltd

Sunila Gollapudi

[PACKT] PUBLISHING

Source: http://www.amazon.com/Practical-Machine-Learning-Sunila-Gollapudi/dp/178439968X

Machine Learning Models



- Deep Learning
- Kernel
- Association rules
- Ensemble
- Decision tree
- Dimensionality reduction
- Clustering
- Regression Analysis
- Bayesian
- Instance based

Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Neural networks (NN) 1960

Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Multilayer Perceptrons (MLP) 1985

Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Restricted Boltzmann Machine (RBM) 1986

Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Support Vector Machine (SVM) 1995

Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Hinton presents the

Deep Belief Network (DBN)

New interests in deep learning and RBM

State of the art MNIST

2005

Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Deep
Recurrent Neural Network
(RNN)
2009

Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Convolutional DBN 2010

Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Max-Pooling CDBN
2011

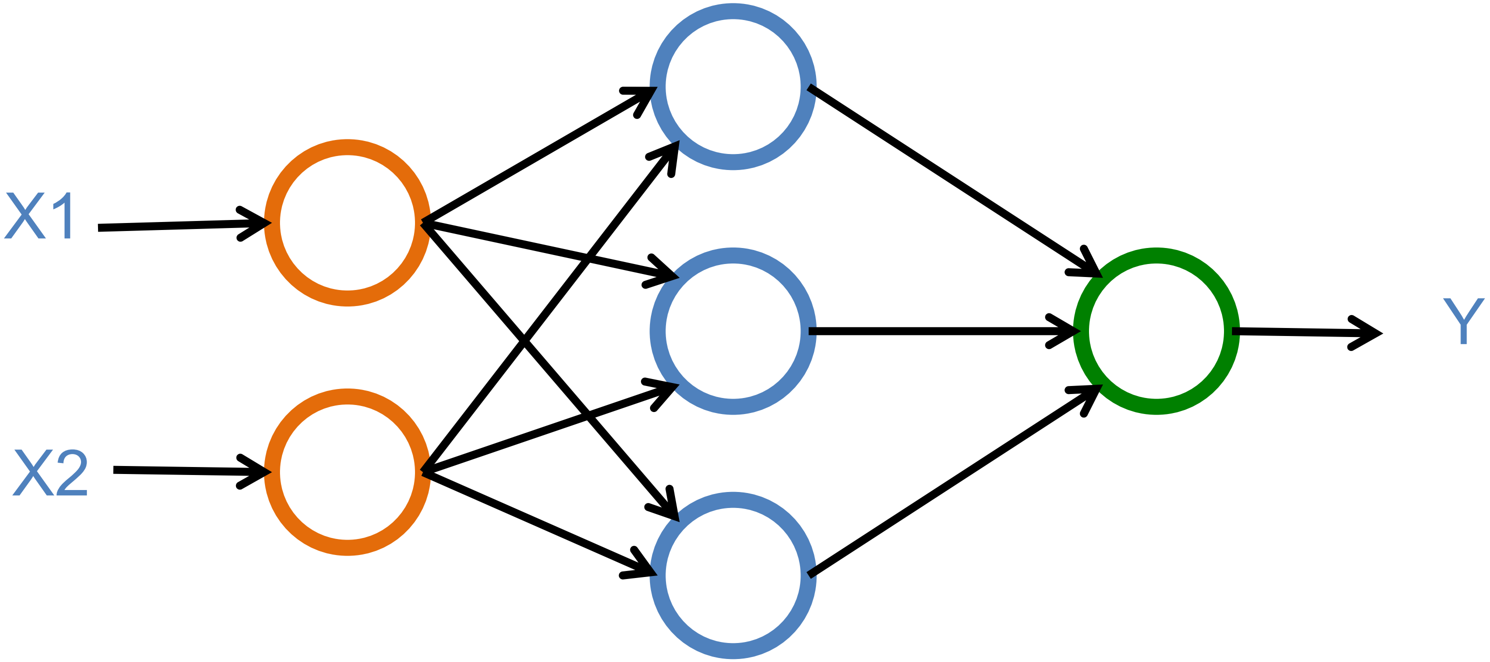
Source: Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing

Neural Networks

Input Layer
(X)

Hidden Layer
(H)

Output Layer
(Y)



Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Deep Learning

Geoffrey Hinton
Yann LeCun
Yoshua Bengio
Andrew Y. Ng

Geoffrey Hinton

Google

University of Toronto

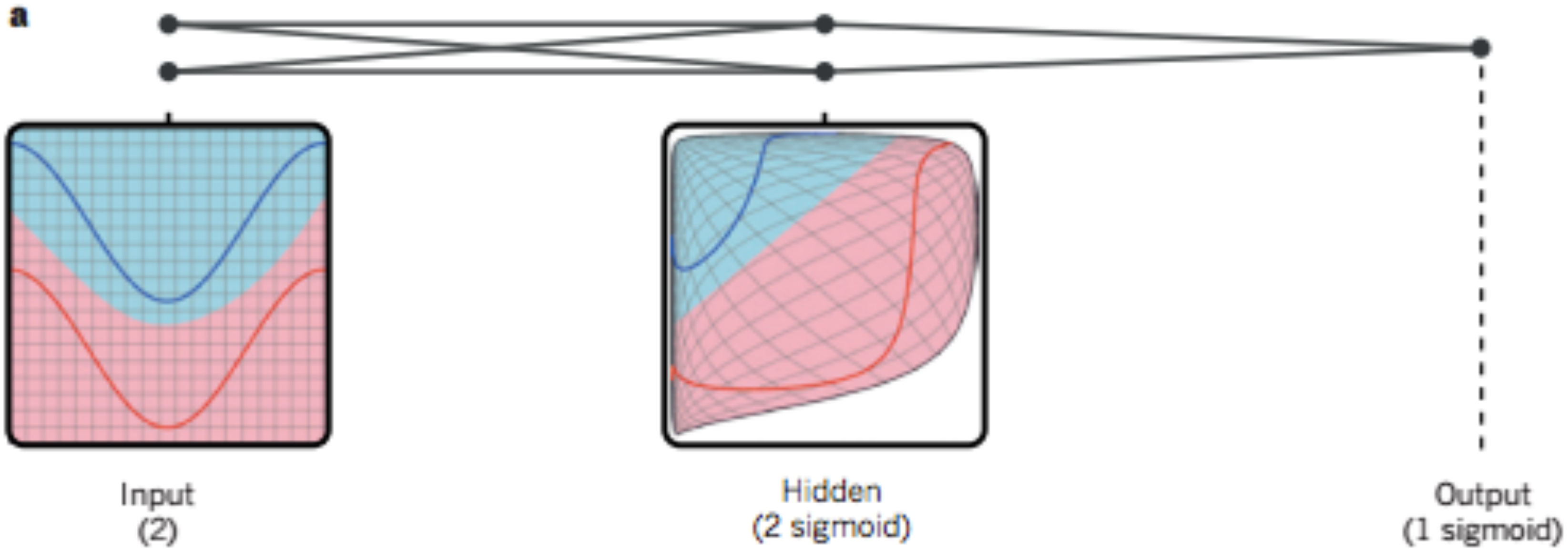
Source: https://en.wikipedia.org/wiki/Geoffrey_Hinton

LeCun, Yann,
Yoshua Bengio,
and Geoffrey Hinton.

"**Deep learning**."

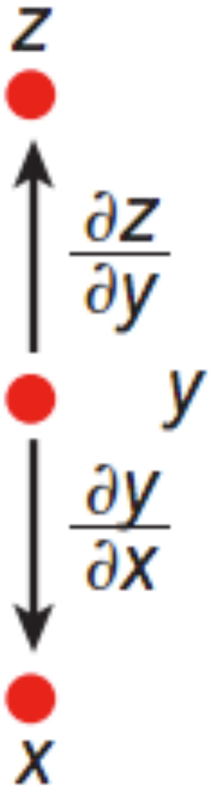
Nature 521, no. 7553 (2015): 436-444.

Deep Learning



Source: LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." Nature 521, no. 7553 (2015): 436-444.

Deep Learning


z
$\frac{\partial z}{\partial y}$
y
$\frac{\partial y}{\partial x}$
x

$$\Delta z = \frac{\partial z}{\partial y} \Delta y$$

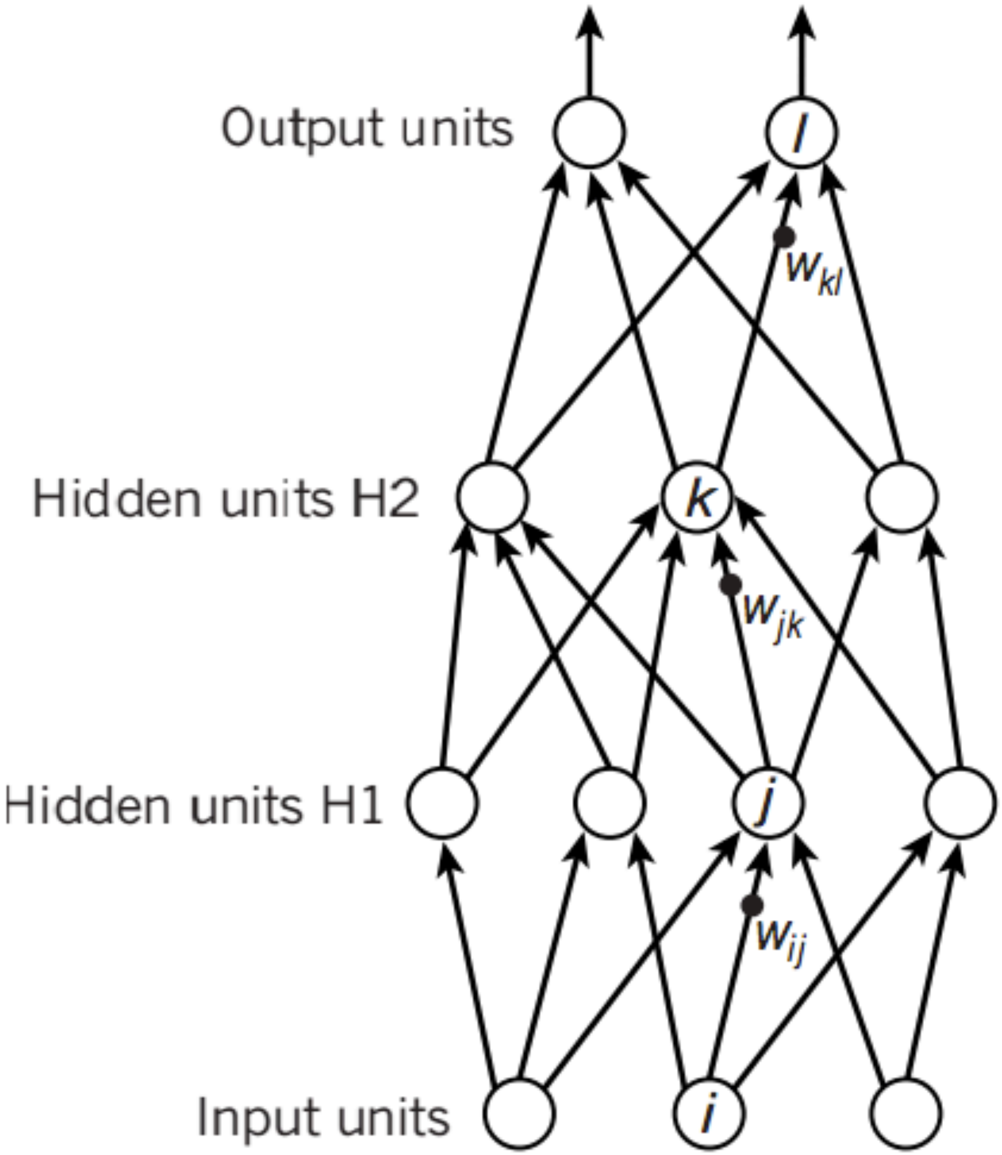
$$\Delta y = \frac{\partial y}{\partial x} \Delta x$$

$$\Delta z = \frac{\partial z}{\partial y} \frac{\partial y}{\partial x} \Delta x$$

$$\frac{\partial z}{\partial x} = \frac{\partial z}{\partial y} \frac{\partial y}{\partial x}$$

Source: LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." Nature 521, no. 7553 (2015): 436-444.

Deep Learning



$$y_l = f(z_l)$$

$$z_l = \sum_{k \, \varepsilon \, \mathrm{H2}} w_{kl} \, y_k$$

$$y_k = f(z_k)$$

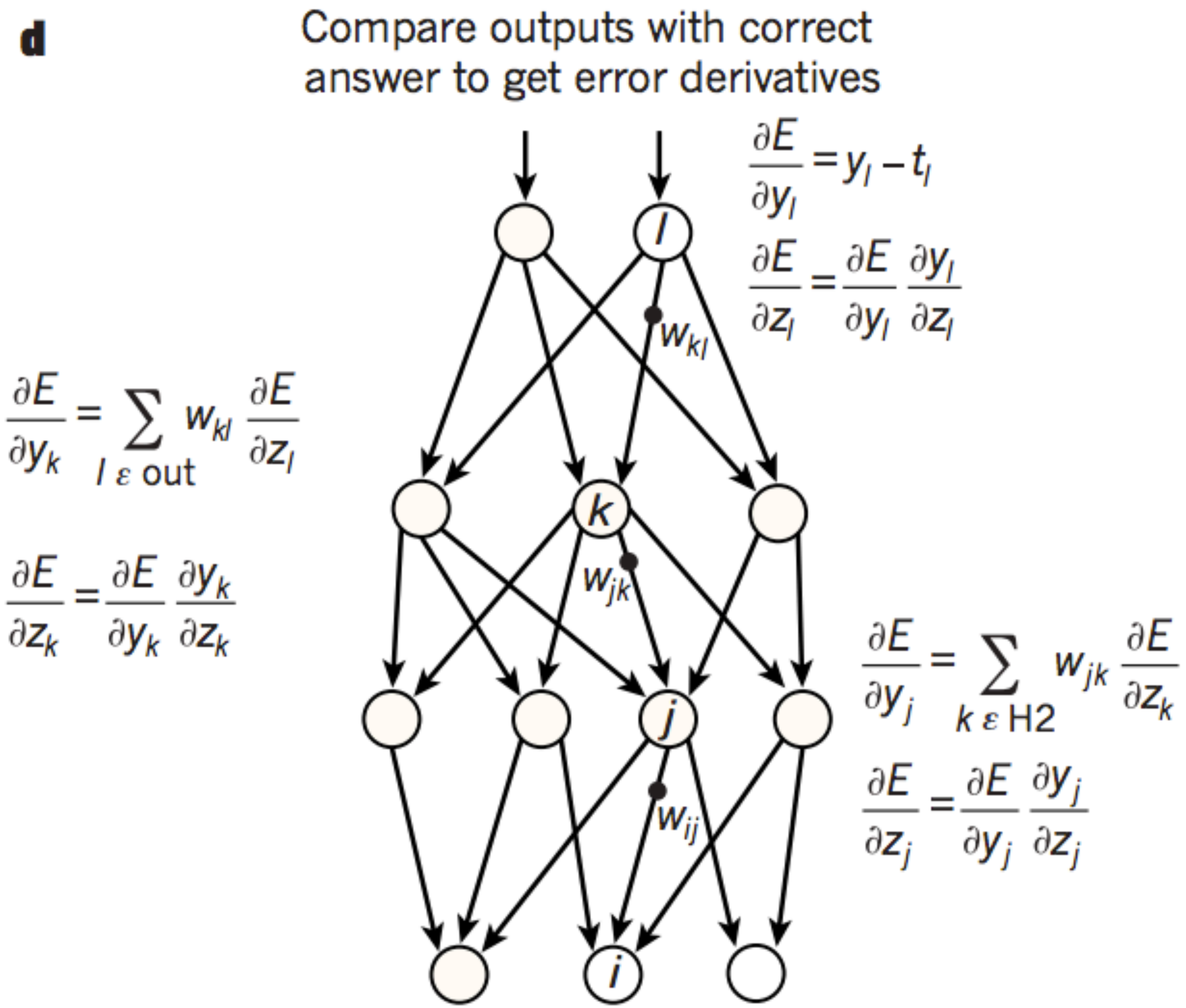
$$z_k = \sum_{j \, \varepsilon \, \mathrm{H1}} w_{jk} \, y_j$$

$$y_j = f(z_j)$$

$$z_j = \sum_{i \, \varepsilon \, \mathrm{Input}} w_{ij} \, x_i$$

Source: LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." Nature 521, no. 7553 (2015): 436-444.

Deep Learning



Compare outputs with correct answer to get error derivatives

$$\frac{\partial E}{\partial y_l} = y_l - t_l$$

$$\frac{\partial E}{\partial z_l} = \frac{\partial E}{\partial y_l} \frac{\partial y_l}{\partial z_l}$$

$$\frac{\partial E}{\partial y_k} = \sum_{l \,\varepsilon\, \text{out}} w_{kl} \frac{\partial E}{\partial z_l}$$

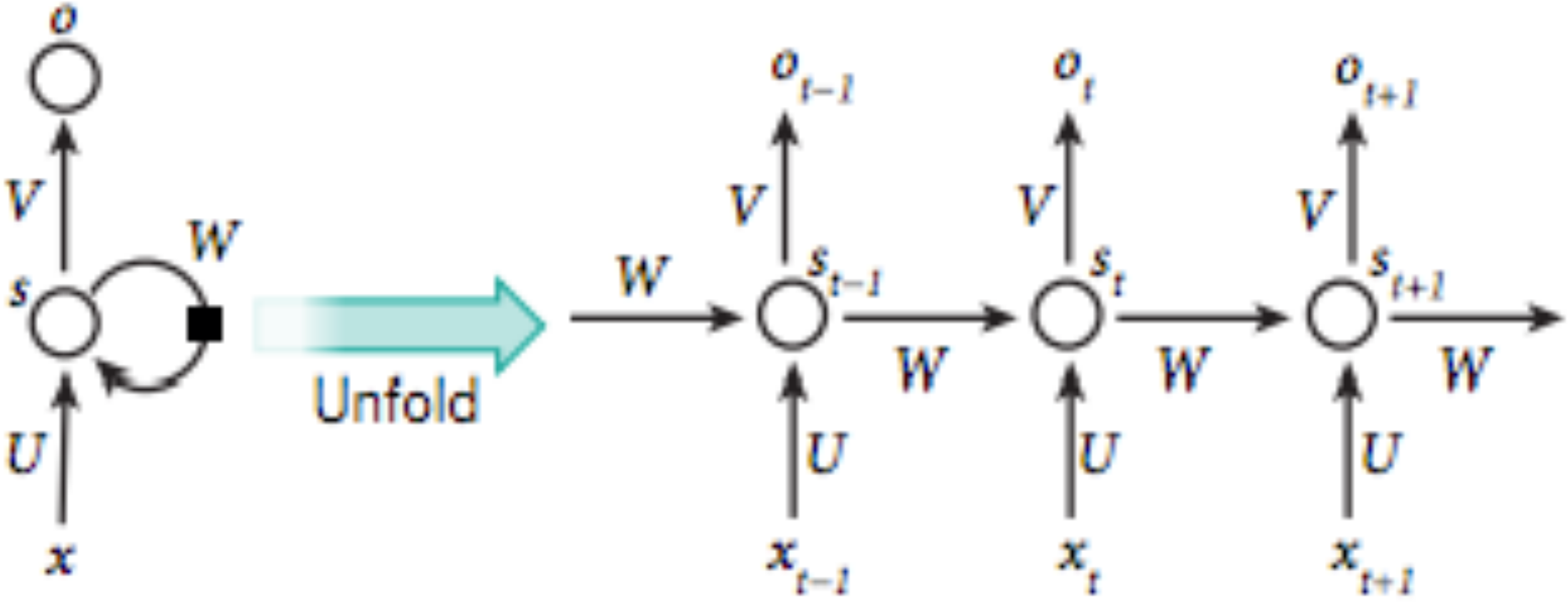
$$\frac{\partial E}{\partial z_k} = \frac{\partial E}{\partial y_k} \frac{\partial y_k}{\partial z_k}$$

$$\frac{\partial E}{\partial y_j} = \sum_{k \,\varepsilon\, \text{H2}} w_{jk} \frac{\partial E}{\partial z_k}$$

$$\frac{\partial E}{\partial z_j} = \frac{\partial E}{\partial y_j} \frac{\partial y_j}{\partial z_j}$$

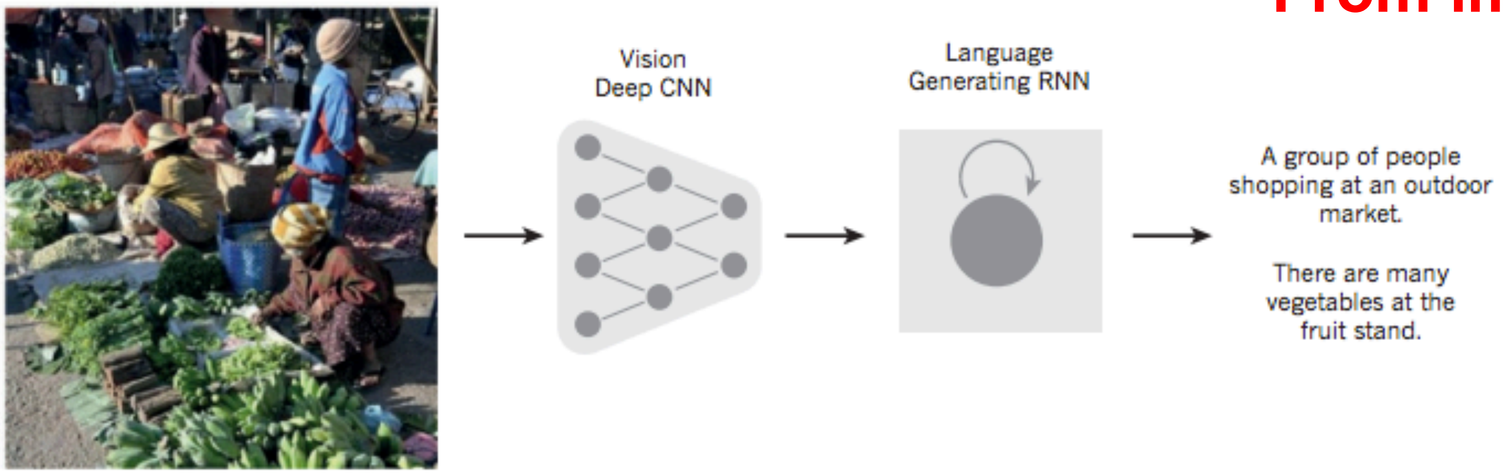
Source: LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." Nature 521, no. 7553 (2015): 436-444.

Recurrent Neural Network (RNN)



Source: LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." Nature 521, no. 7553 (2015): 436-444.

From image to text



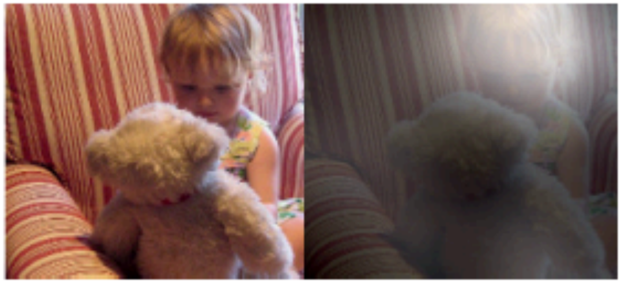
A group of people shopping at an outdoor market.

There are many vegetables at the fruit stand.

A woman is throwing a **frisbee** in a park.

A **dog** is standing on a hardwood floor.

A **stop** sign is on a road with a mountain in the background



A little **girl** sitting on a bed with a teddy bear.

A group of **people** sitting on a boat in the water.

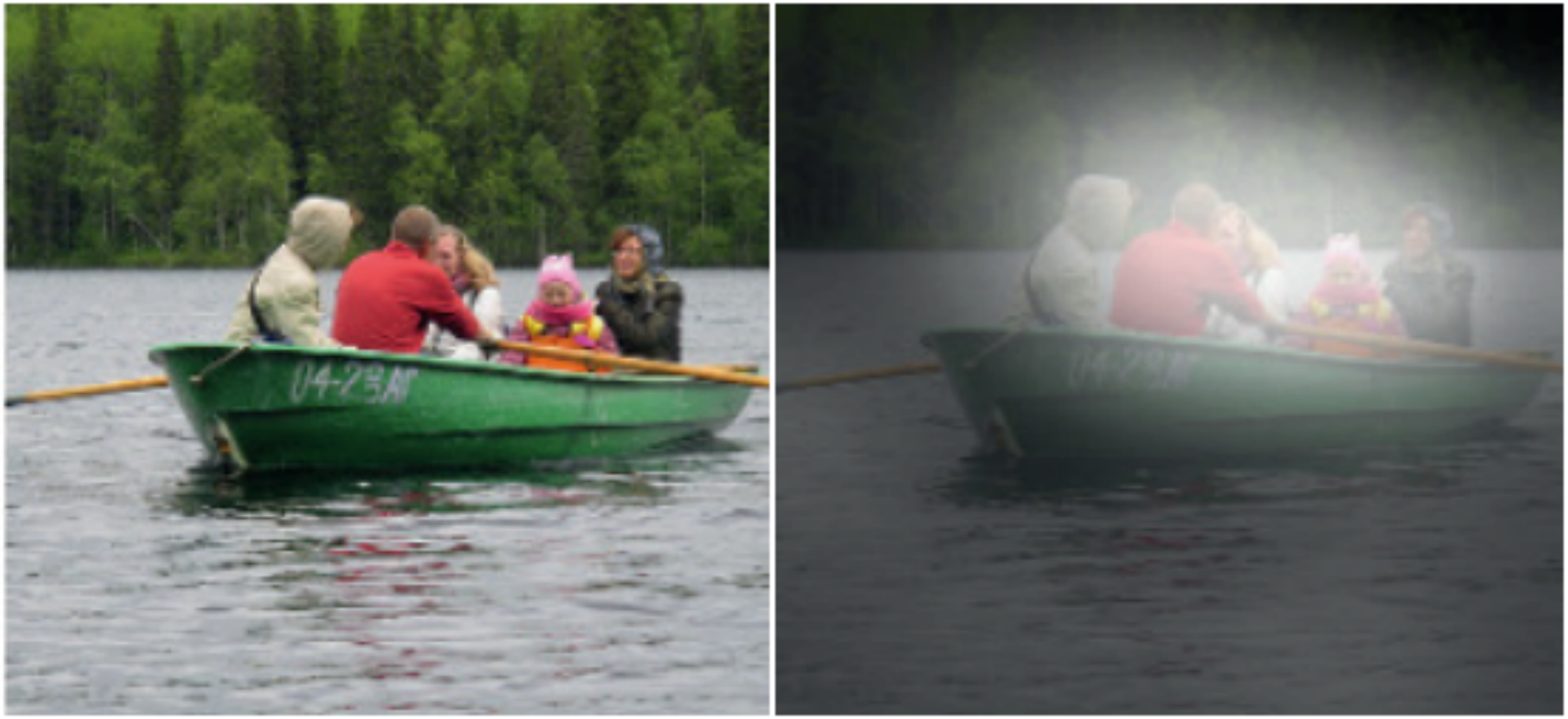
A giraffe standing in a forest with **trees** in the background.

Source: LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." Nature 521, no. 7553 (2015): 436-444.

From image to text

Image: deep convolution neural network (CNN)

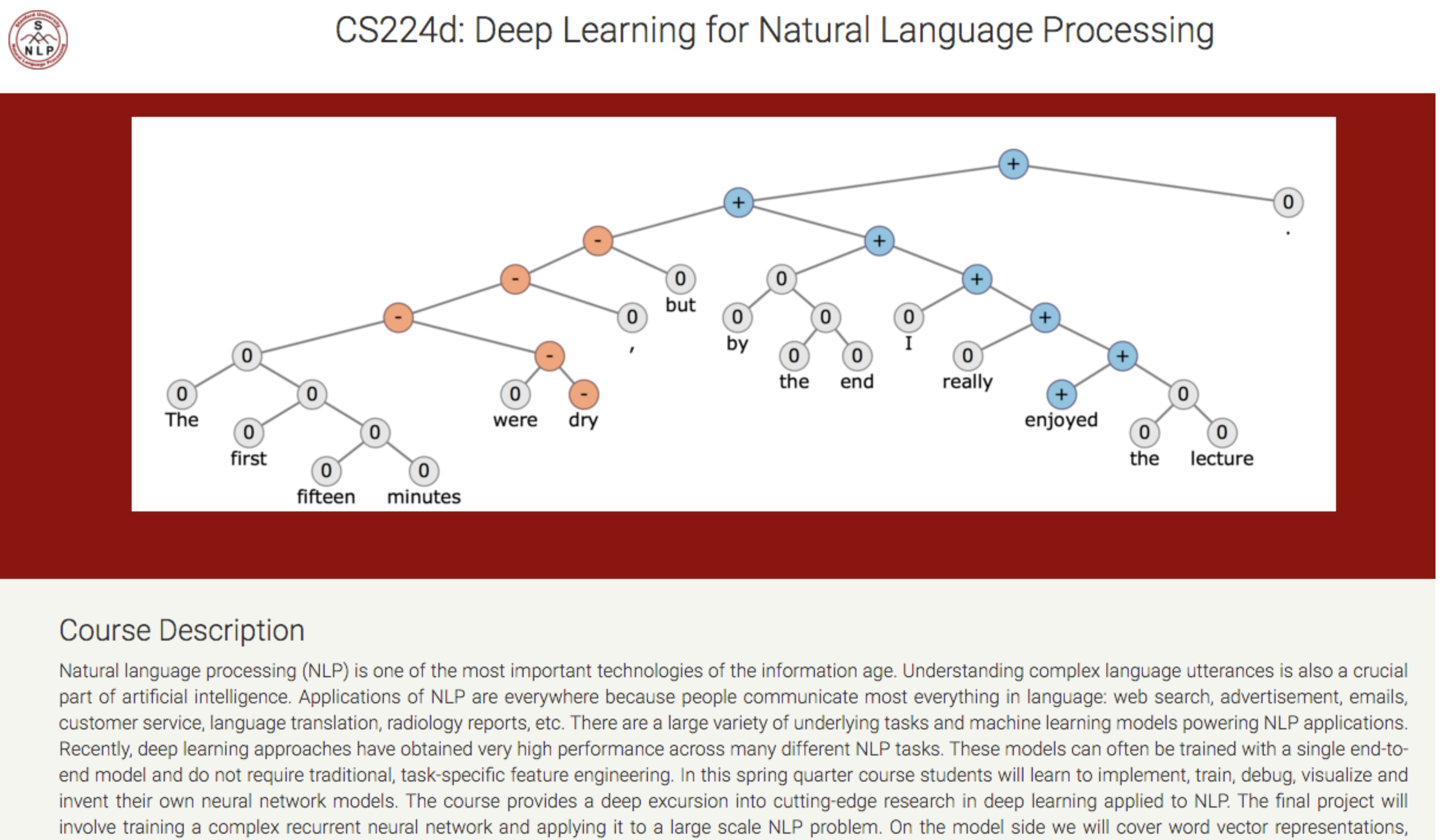
Text: recurrent neural network (RNN)



A group of **people** sitting on a boat in the water.

Source: LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." Nature 521, no. 7553 (2015): 436-444.

CS224d: Deep Learning for Natural Language Processing



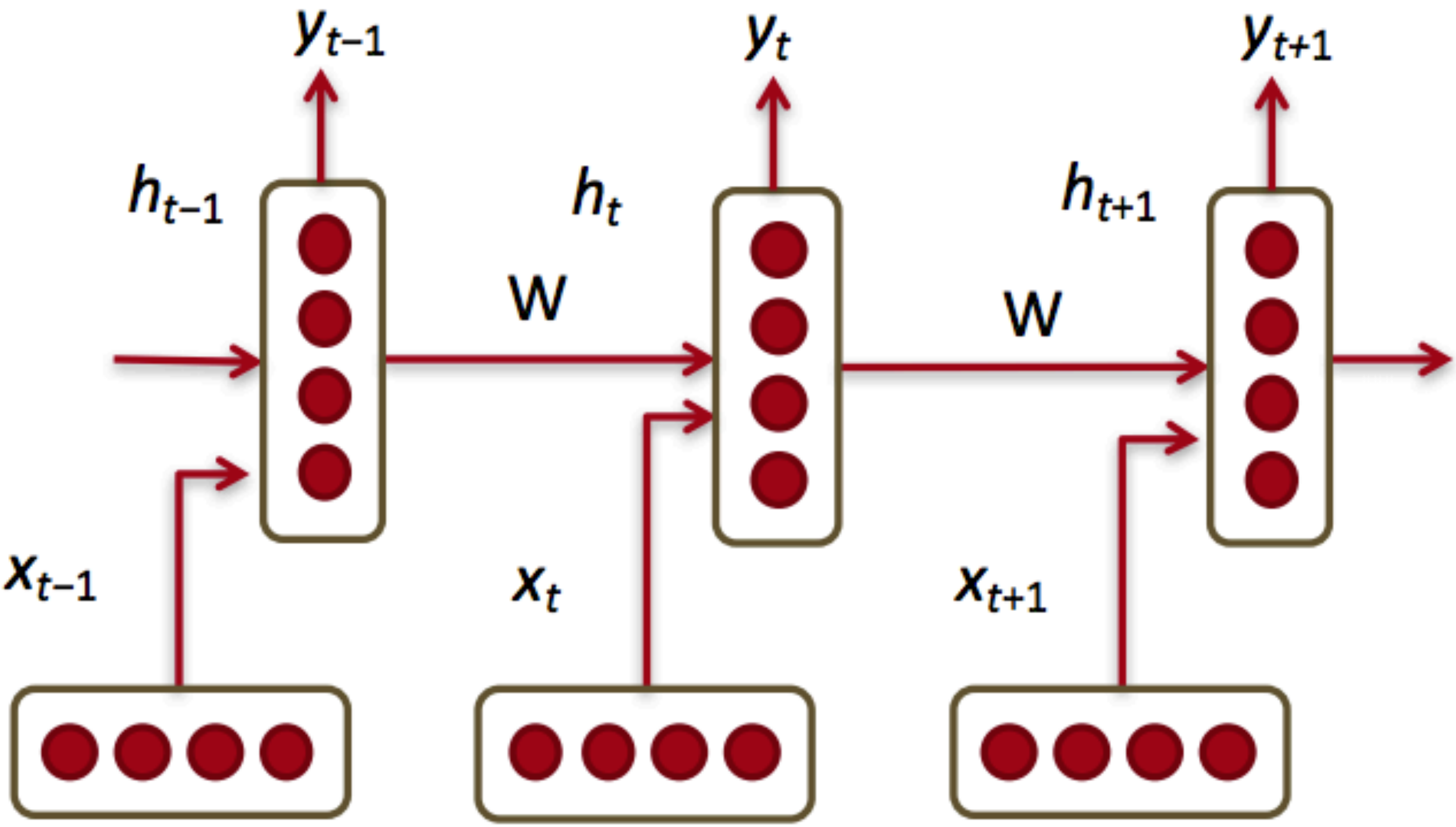
CS224d: Deep Learning for Natural Language Processing

Course Description

Natural language processing (NLP) is one of the most important technologies of the information age. Understanding complex language utterances is also a crucial part of artificial intelligence. Applications of NLP are everywhere because people communicate most everything in language: web search, advertisement, emails, customer service, language translation, radiology reports, etc. There are a large variety of underlying tasks and machine learning models powering NLP applications. Recently, deep learning approaches have obtained very high performance across many different NLP tasks. These models can often be trained with a single end-to-end model and do not require traditional, task-specific feature engineering. In this spring quarter course students will learn to implement, train, debug, visualize and invent their own neural network models. The course provides a deep excursion into cutting-edge research in deep learning applied to NLP. The final project will involve training a complex recurrent neural network and applying it to a large scale NLP problem. On the model side we will cover word vector representations,

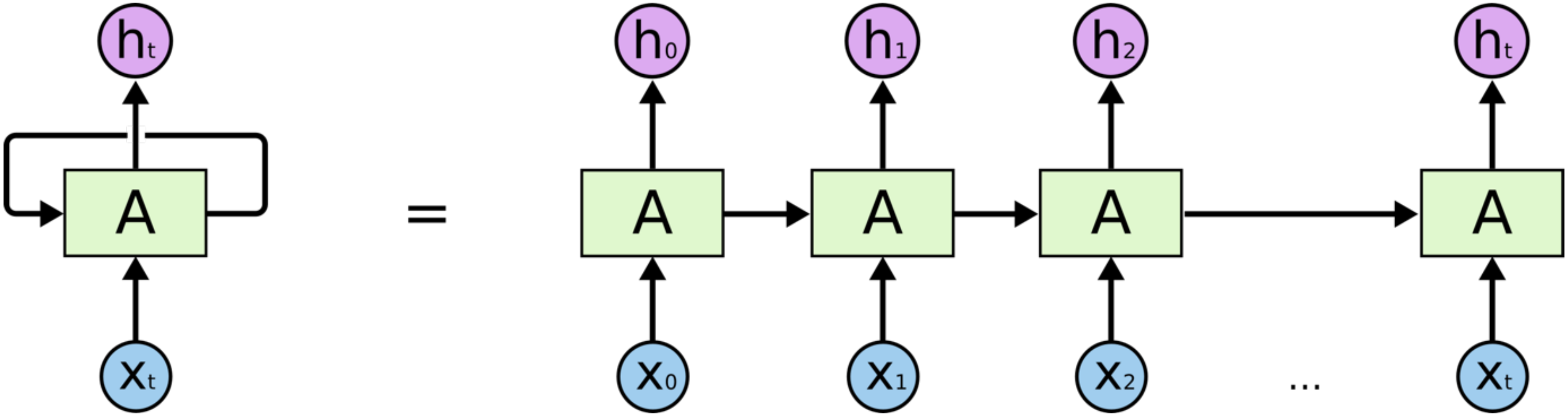
http://cs224d.stanford.edu/

Recurrent Neural Networks (RNNs)



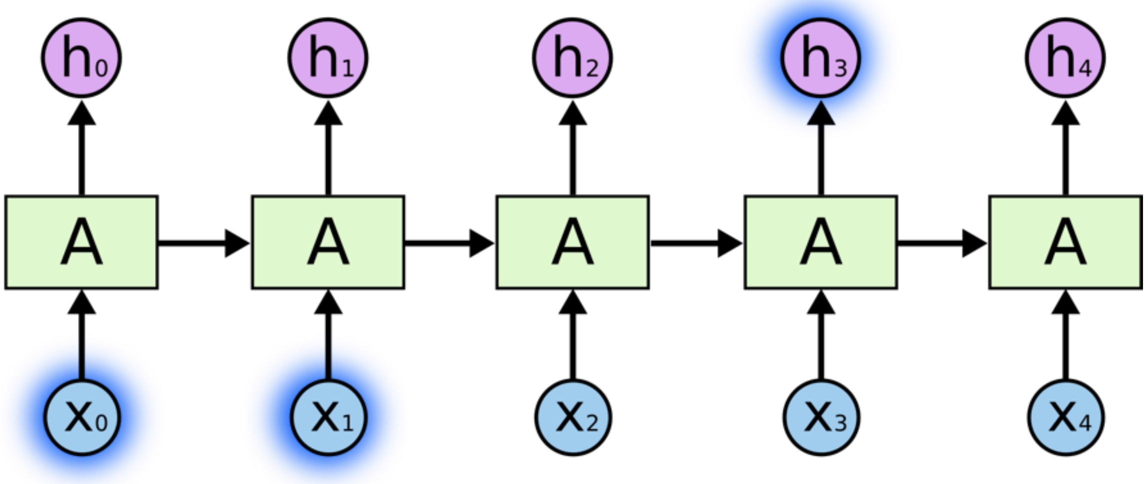
Source: http://cs224d.stanford.edu/lectures/CS224d-Lecture8.pdf

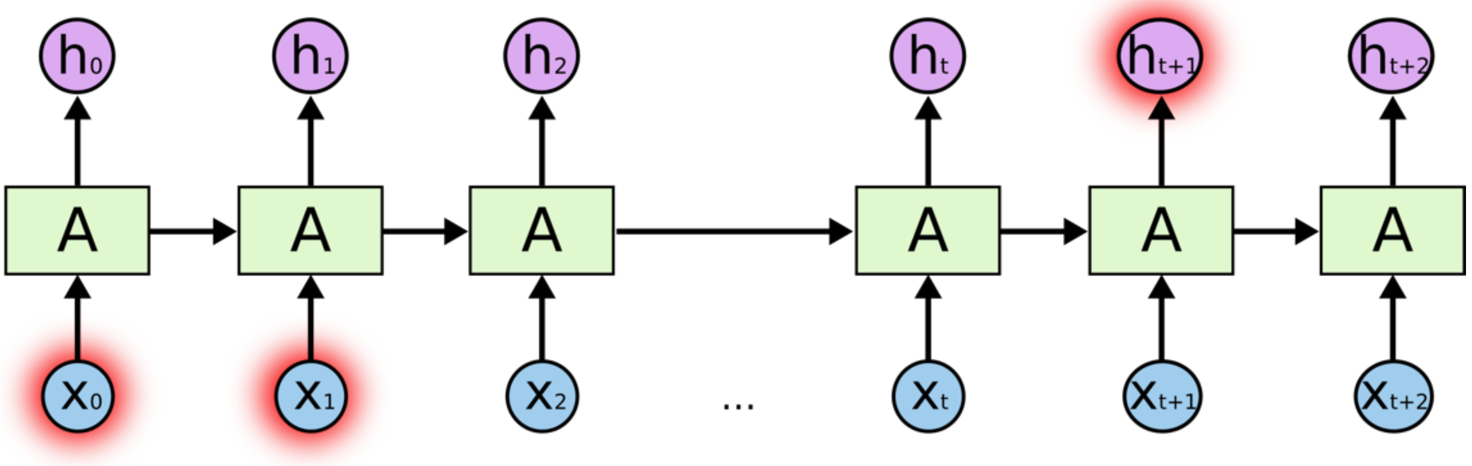
RNN



Source: http://colah.github.io/posts/2015-08-Understanding-LSTMs/

RNN long-term dependencies

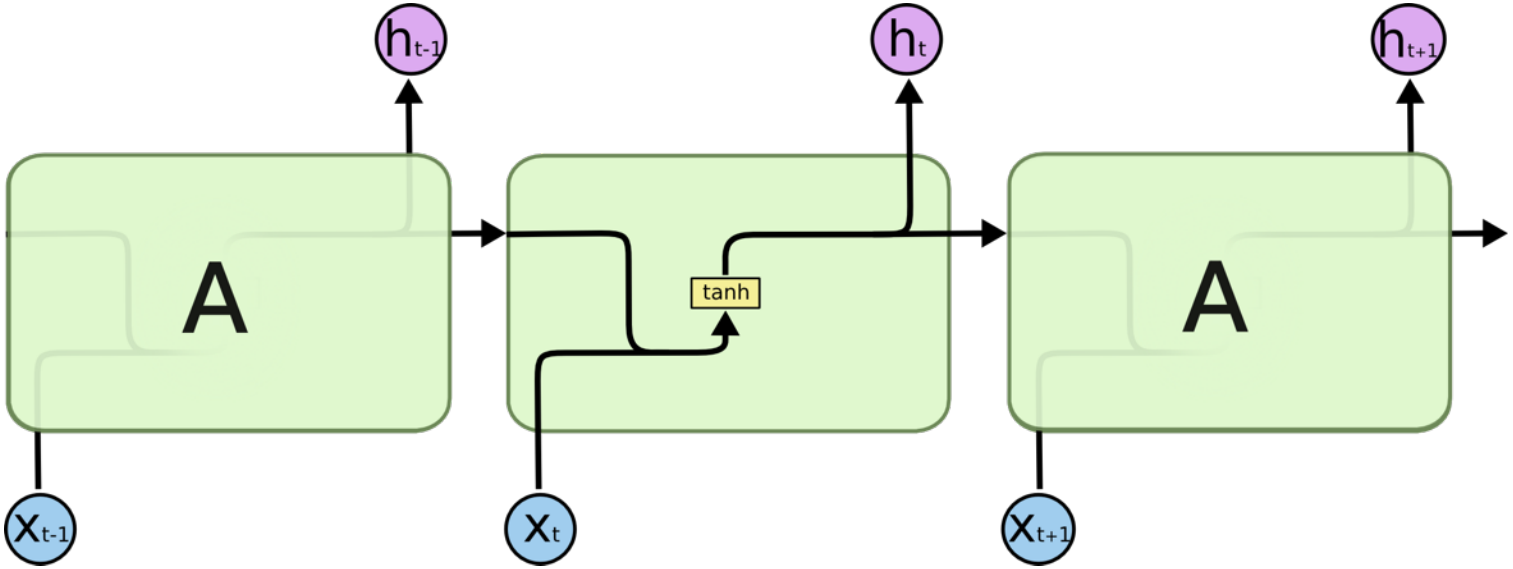


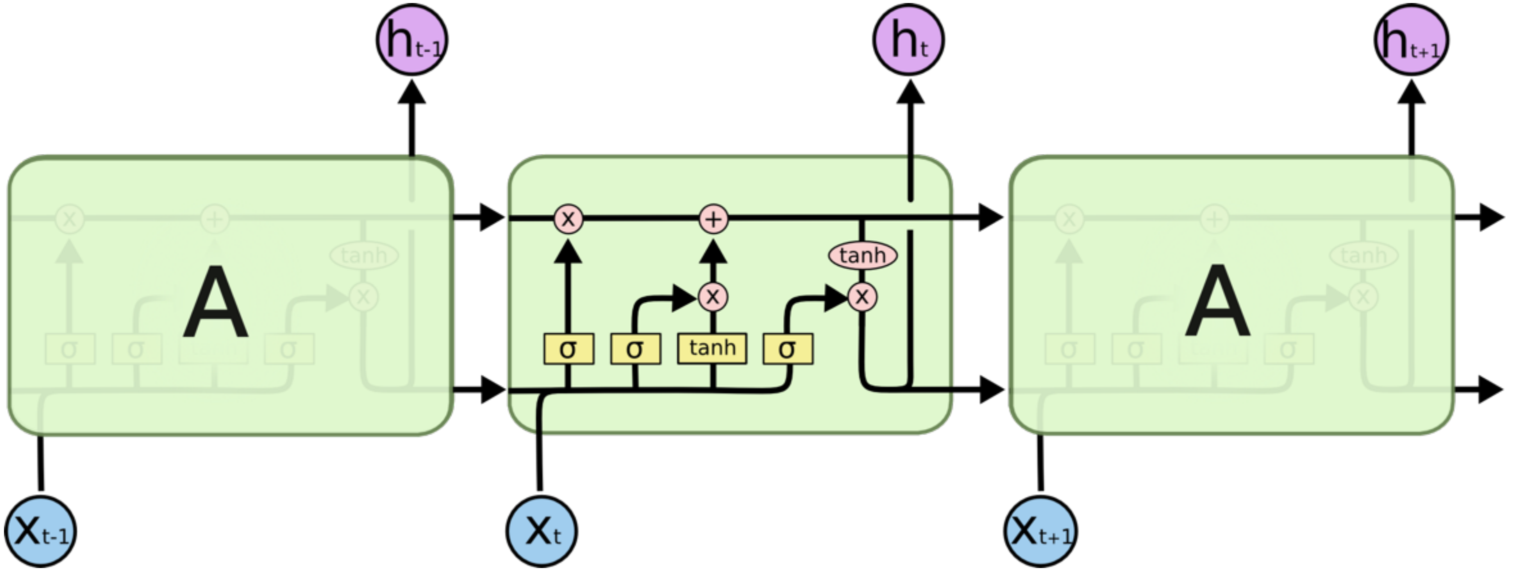


I grew up in France… I speak fluent French.

Source: http://colah.github.io/posts/2015-08-Understanding-LSTMs/

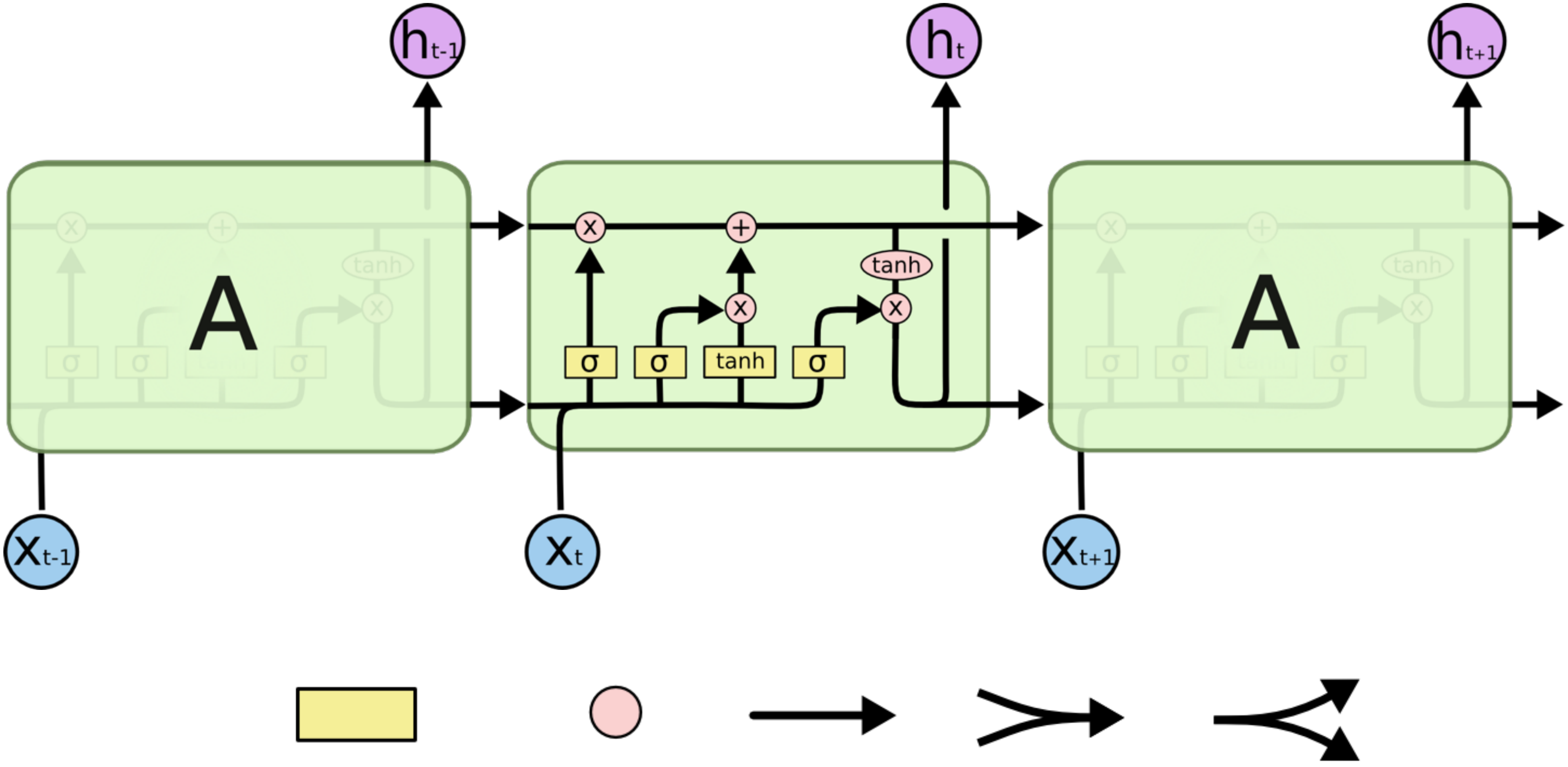
RNN LSTM





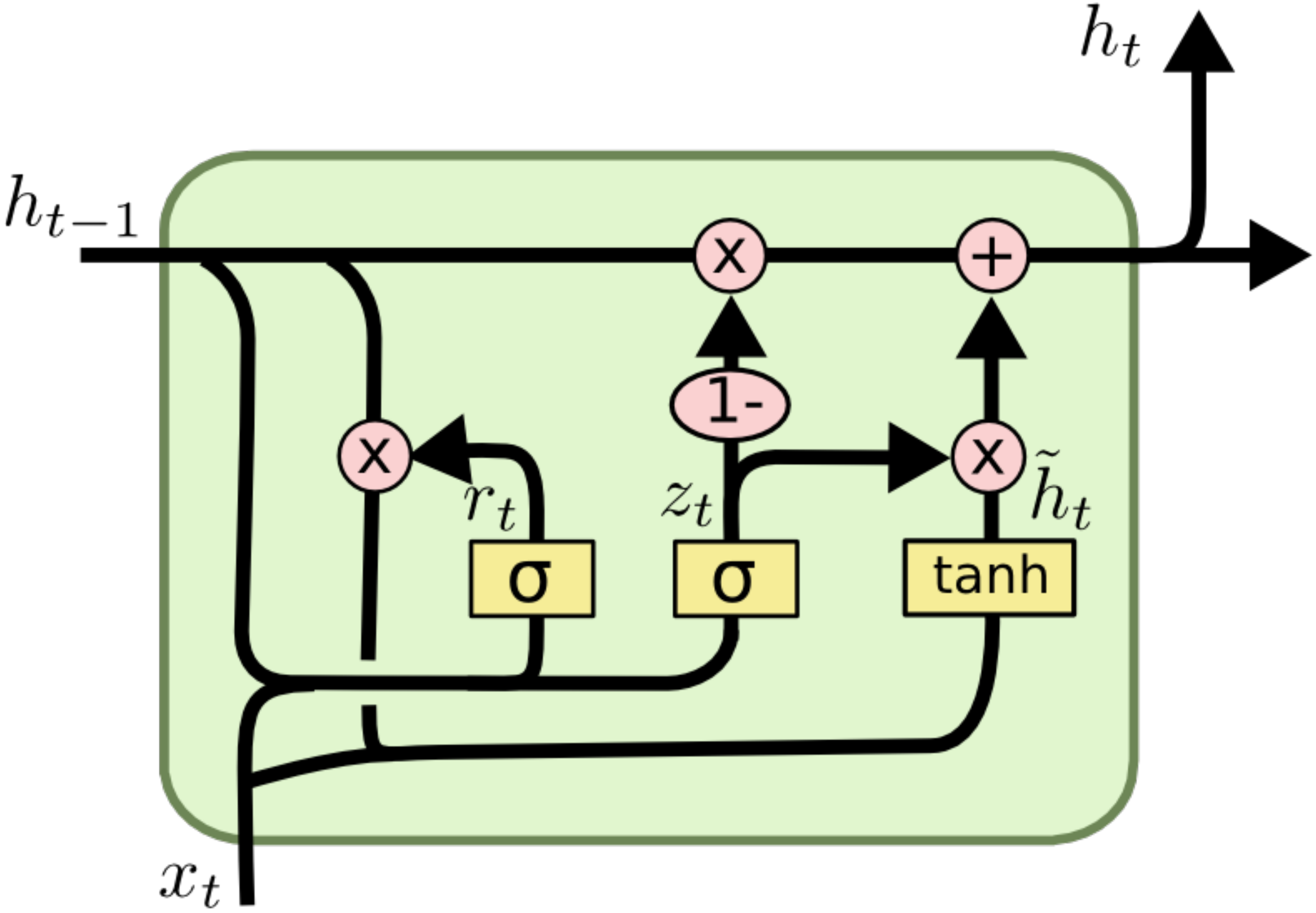
Source: http://colah.github.io/posts/2015-08-Understanding-LSTMs/

Long Short Term Memory (LSTM)



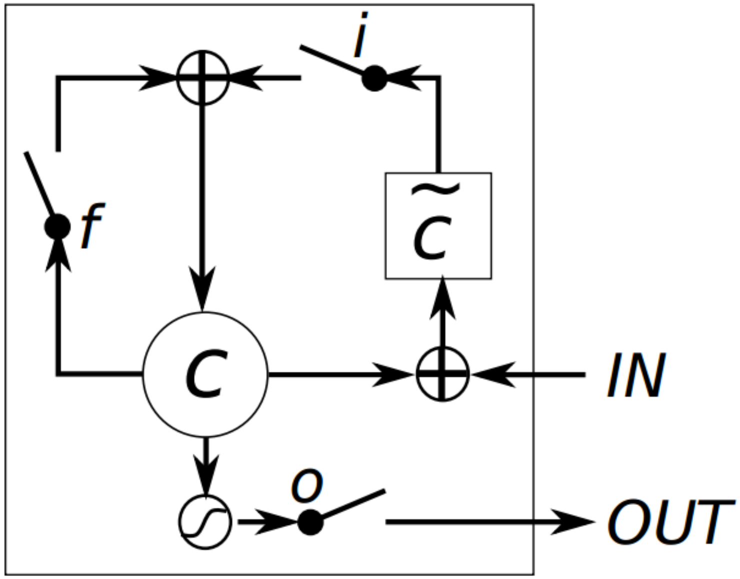
Source: http://colah.github.io/posts/2015-08-Understanding-LSTMs/

Gated Recurrent Unit (GRU)



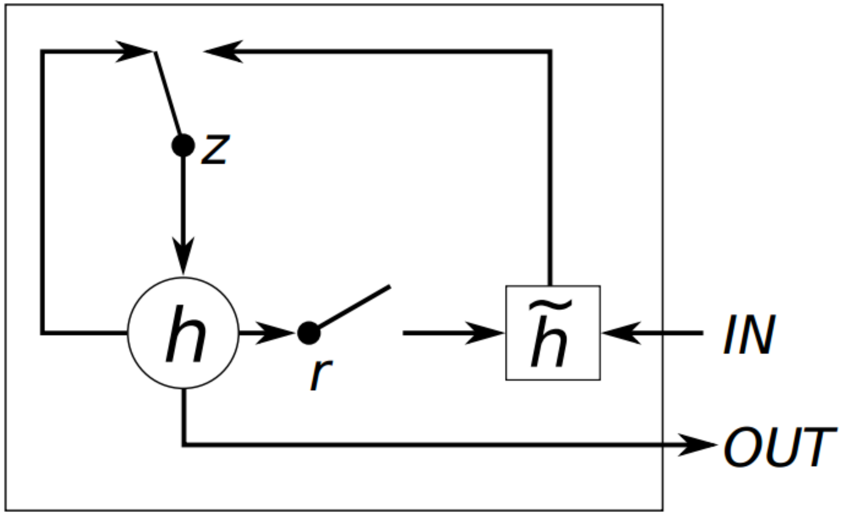
Source: http://colah.github.io/posts/2015-08-Understanding-LSTMs/

LSTM vs GRU



LSTM

i, f and o are the input, forget and output gates, respectively.
c and c˜ denote the memory cell and the new memory cell content.

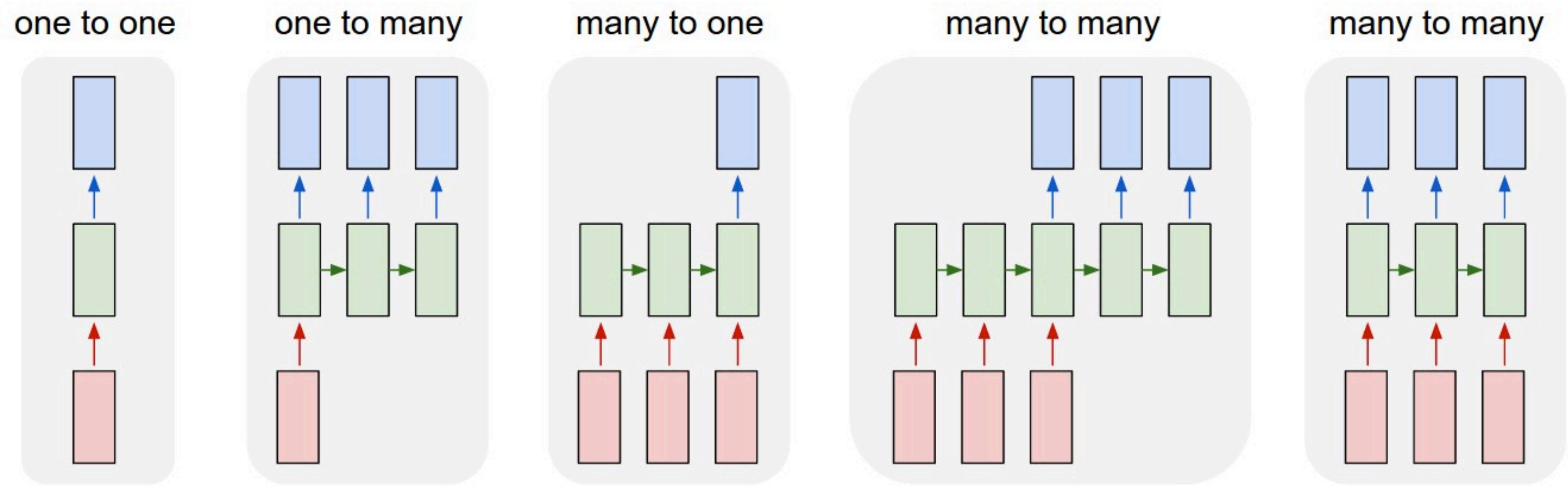


GRU

r and z are the reset and update gates, and h and h˜ are the activation and the candidate activation.

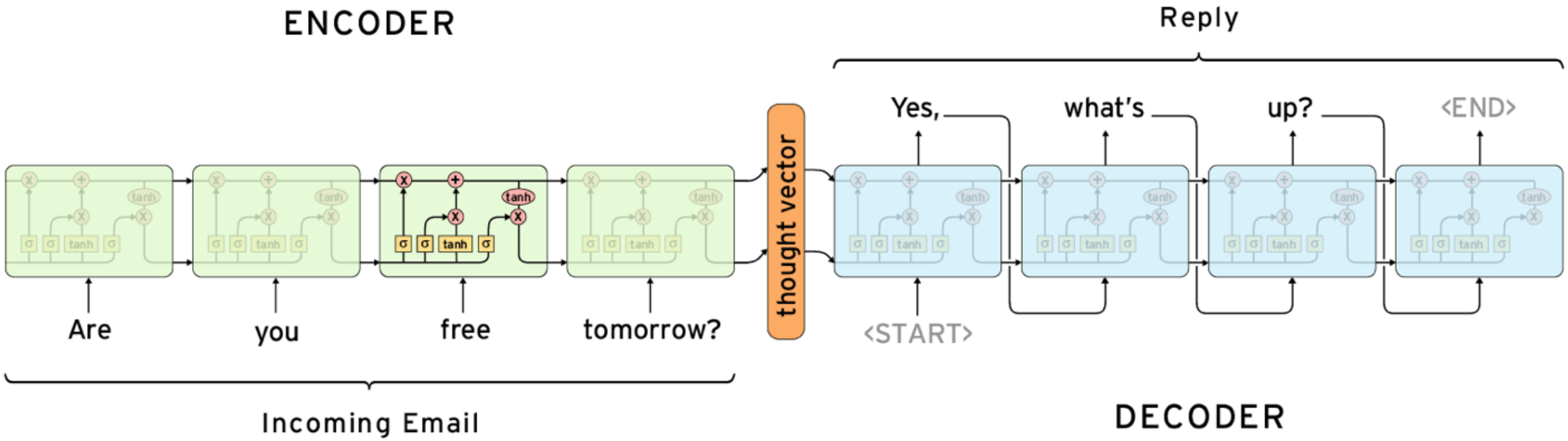
Source: Chung, Junyoung, Caglar Gulcehre, KyungHyun Cho, and Yoshua Bengio. "Empirical evaluation of gated recurrent neural networks on sequence modeling." *arXiv preprint arXiv:1412.3555* (2014).

LSTM Recurrent Neural Network



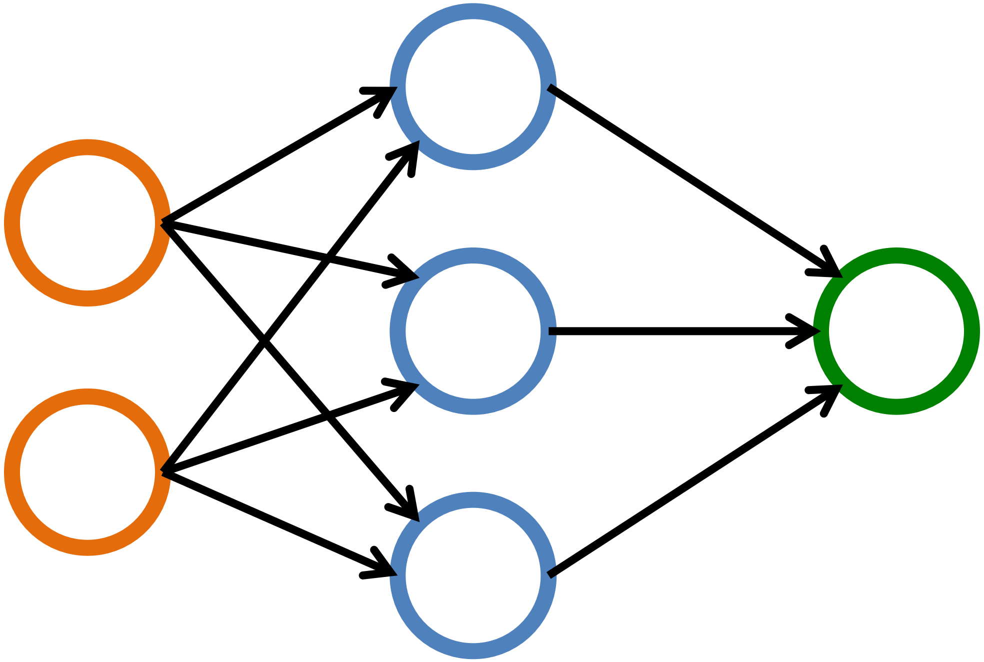
Source: https://github.com/Vict0rSch/deep_learning/tree/master/keras/recurrent

The Sequence to Sequence model (seq2seq)



Source: http://suriyadeepan.github.io/2016-12-31-practical-seq2seq/

Neural Networks



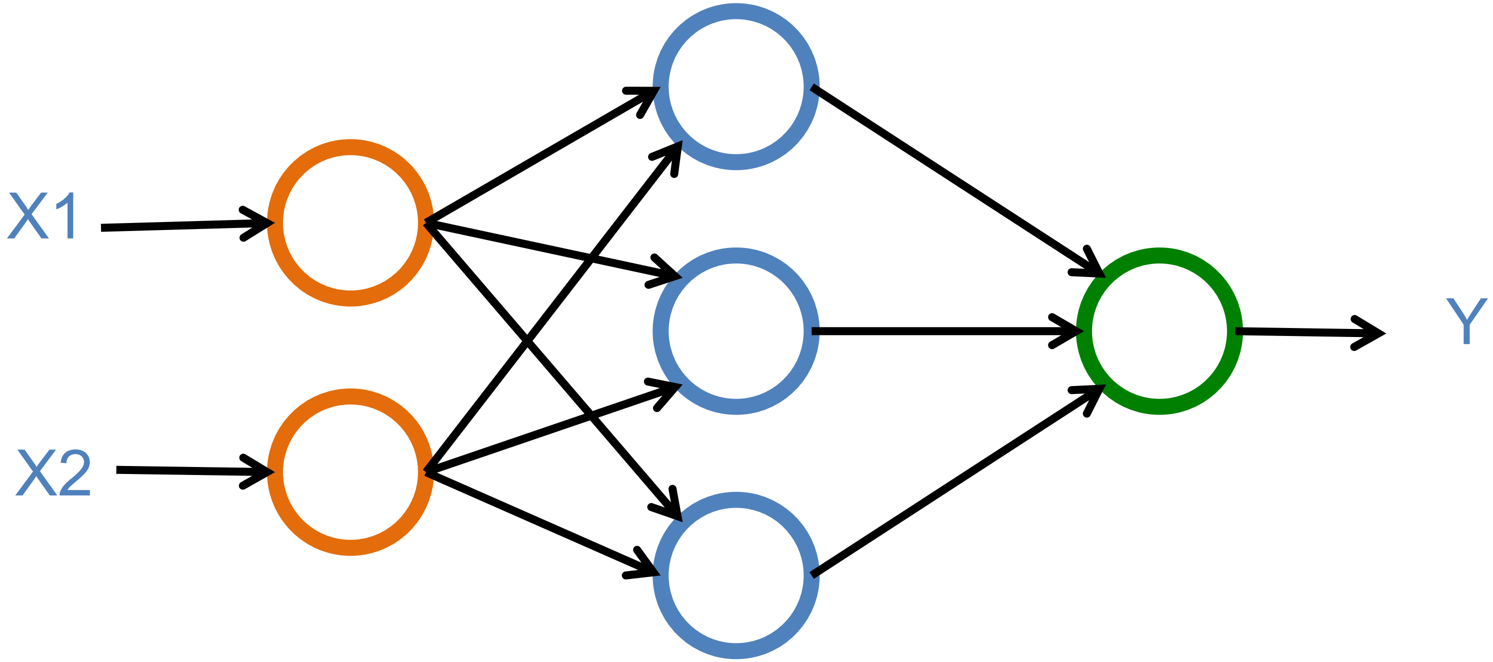
Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Neural Networks

Input Layer (X)

Hidden Layer (H)

Output Layer (Y)



Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

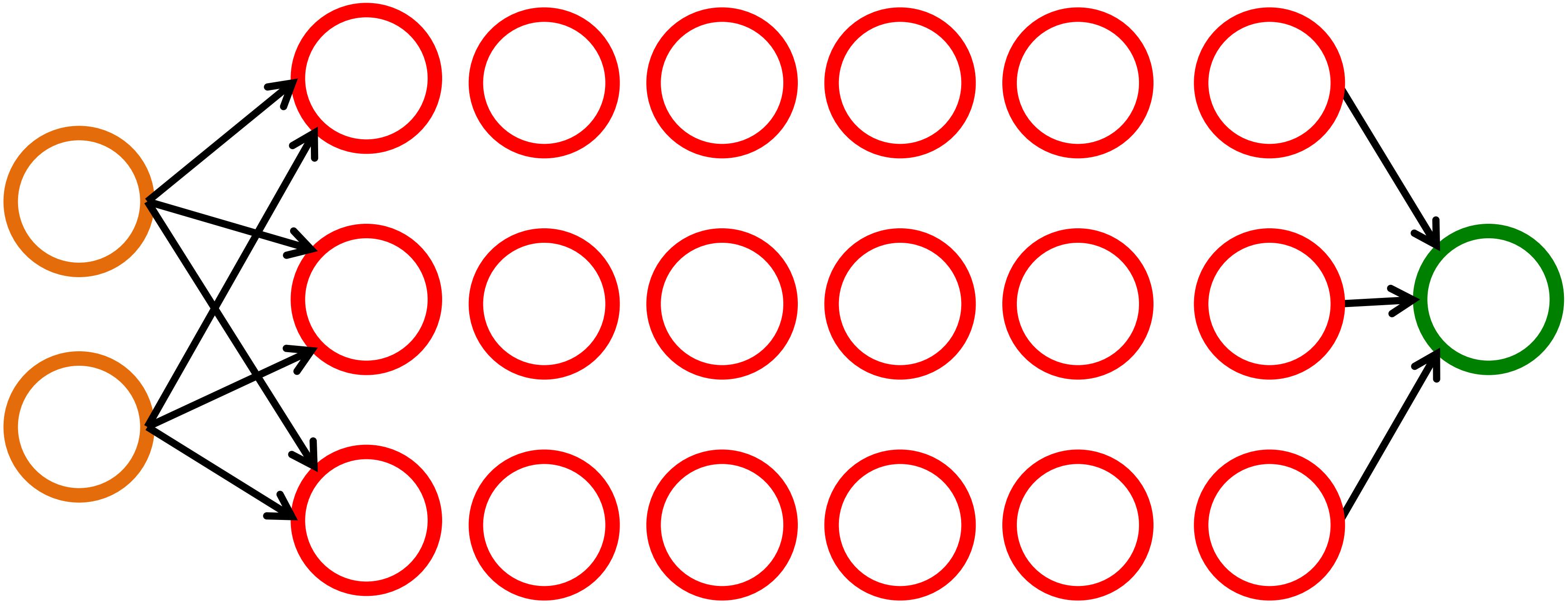
Neural Networks

Input Layer
(X)

Hidden Layers
(H)

Output Layer
(Y)

Deep Neural Networks
Deep Learning



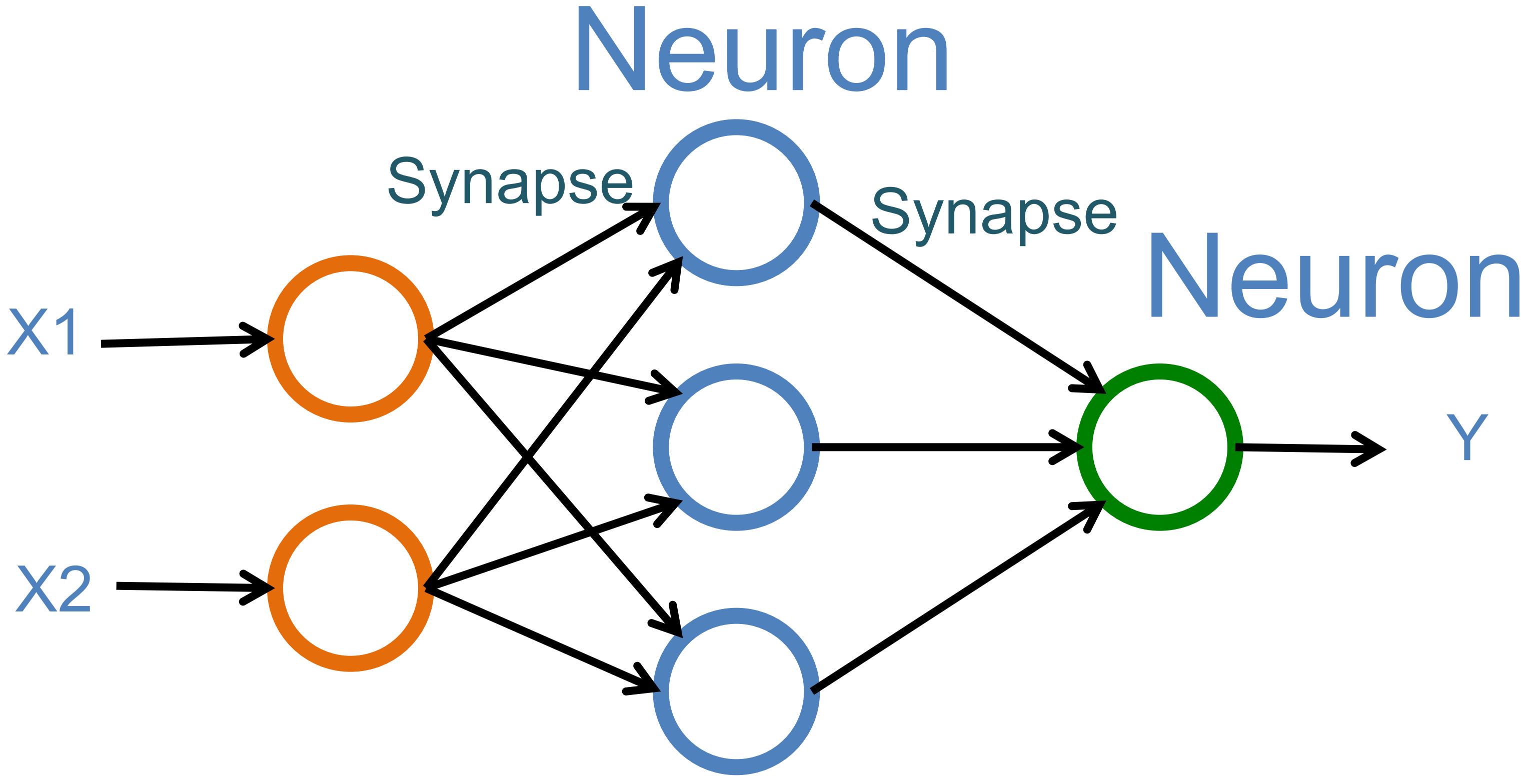
Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Neural Networks

Input Layer (X)

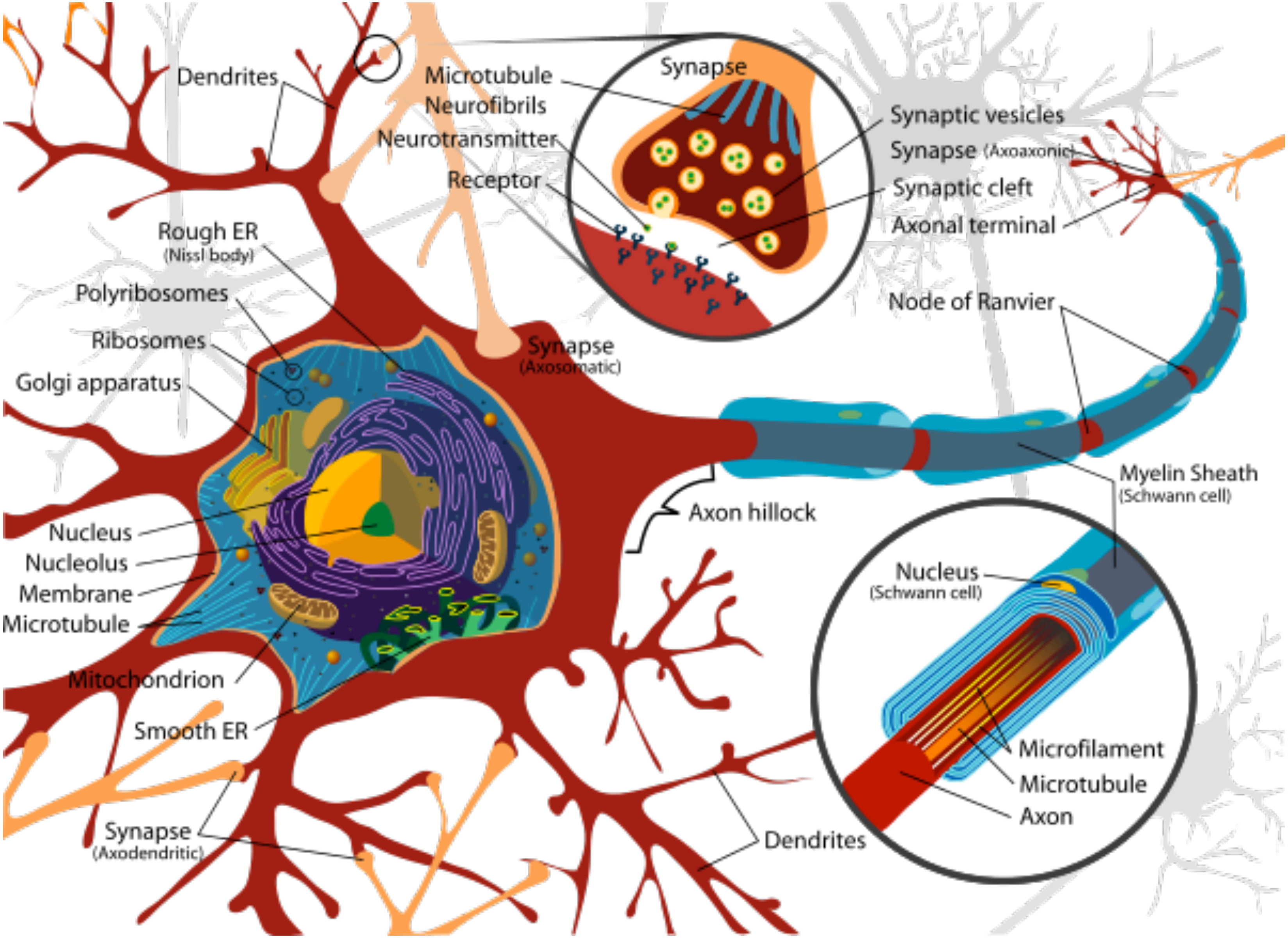
Hidden Layer (H)

Output Layer (Y)



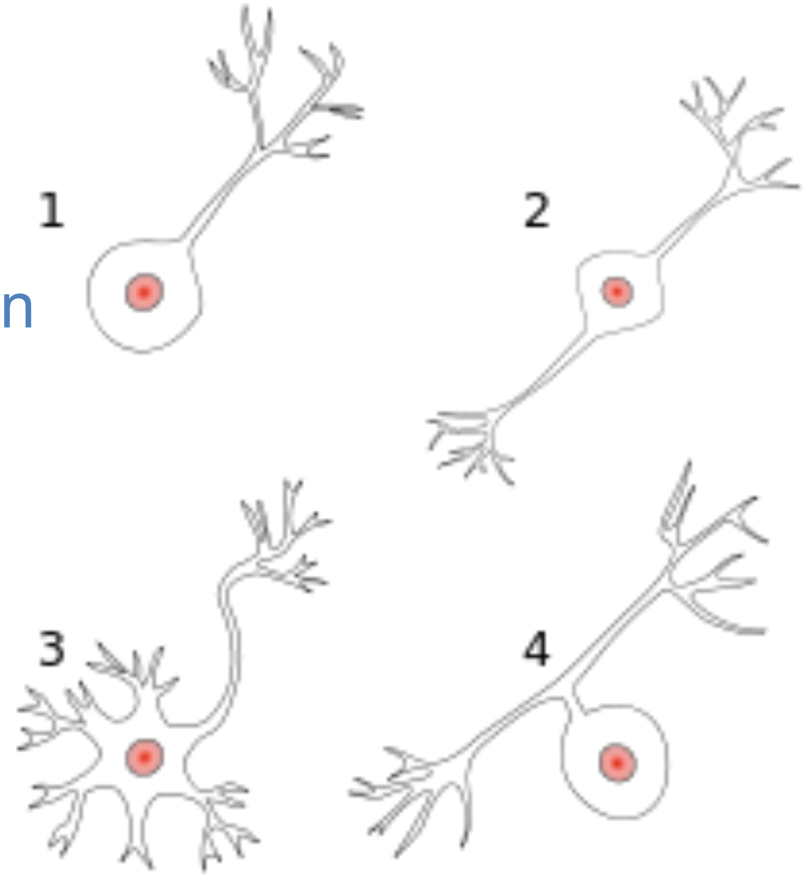
Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Neuron and Synapse



Source: https://en.wikipedia.org/wiki/Neuron

Neurons



1 Unipolar neuron

2 Bipolar neuron

3 Multipolar neuron

4 Pseudounipolar neuron

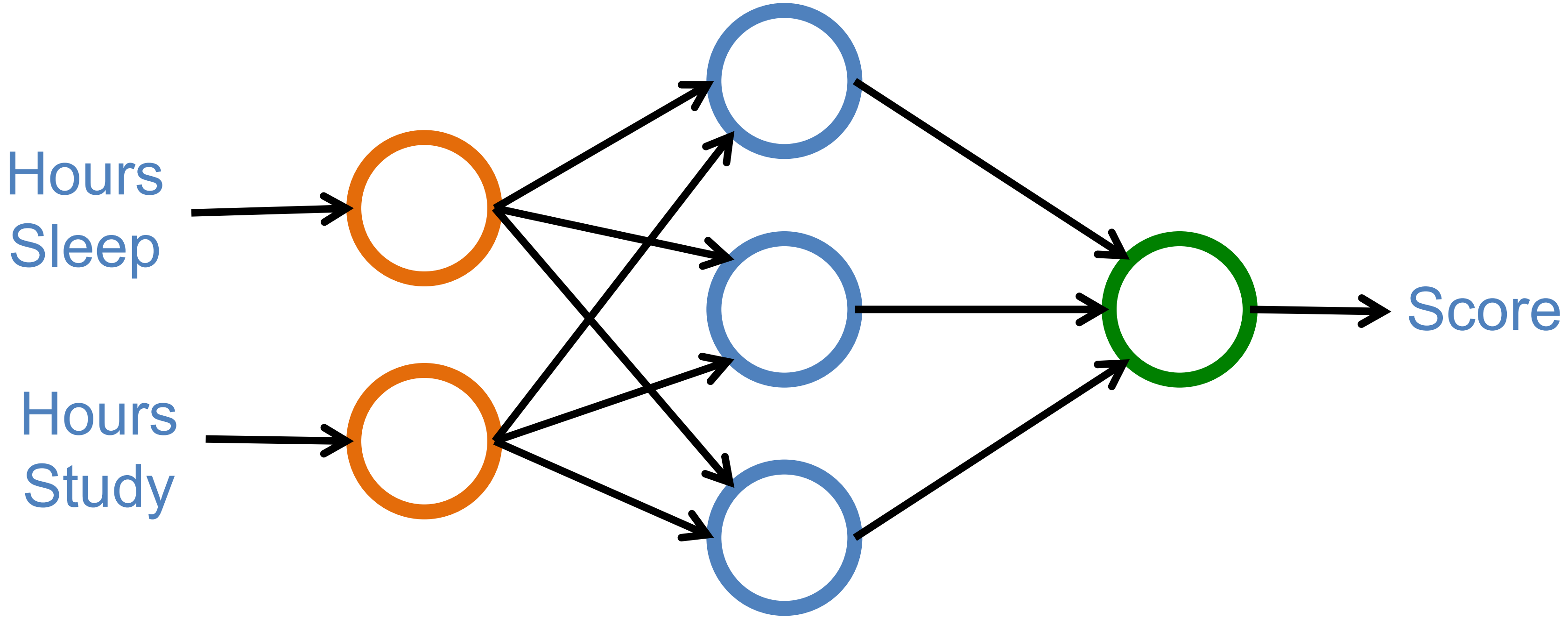
Source: https://en.wikipedia.org/wiki/Neuron

Neural Networks

Input Layer (X)

Hidden Layer (H)

Output Layer (Y)



Hours Sleep

Hours Study

Score

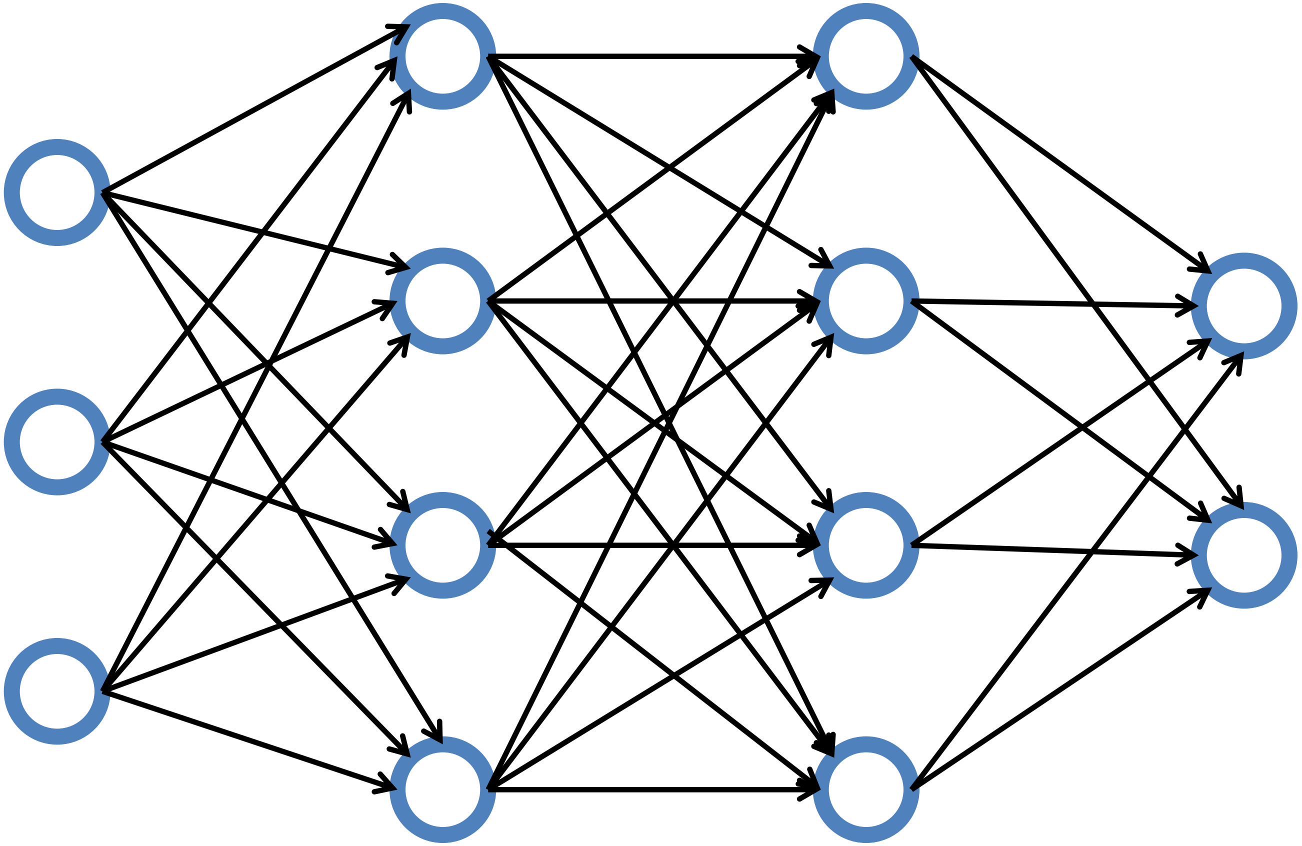
Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Neural Networks

Input Layer
(X)

Hidden Layer
(H)

Output Layer
(Y)

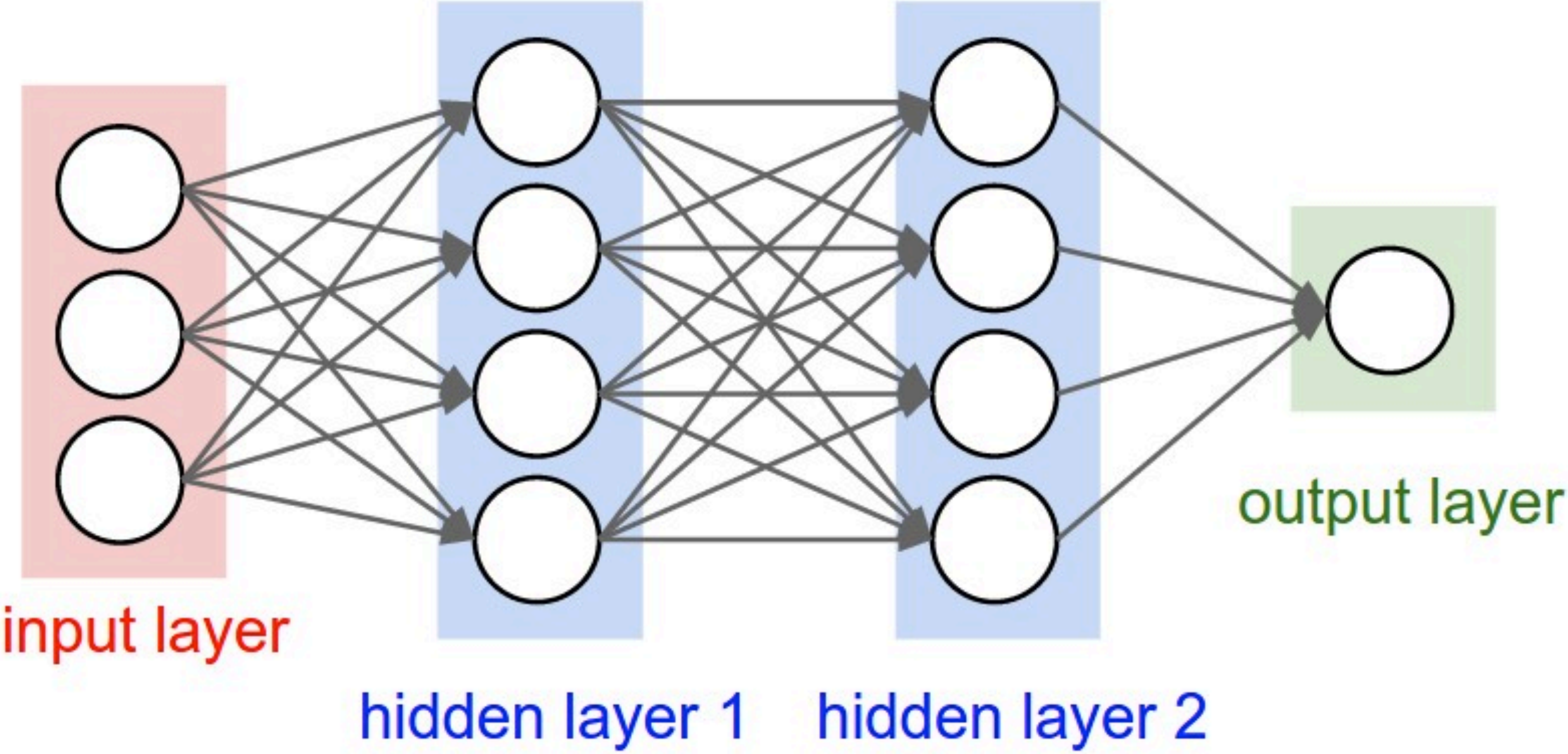


Source: https://www.youtube.com/watch?v=P2HPcj8lRJE&list=PLjJh1vlSEYgvGod9wWiydumYl8hOXixNu&index=2

Convolutional Neural Networks (CNNs / ConvNets)

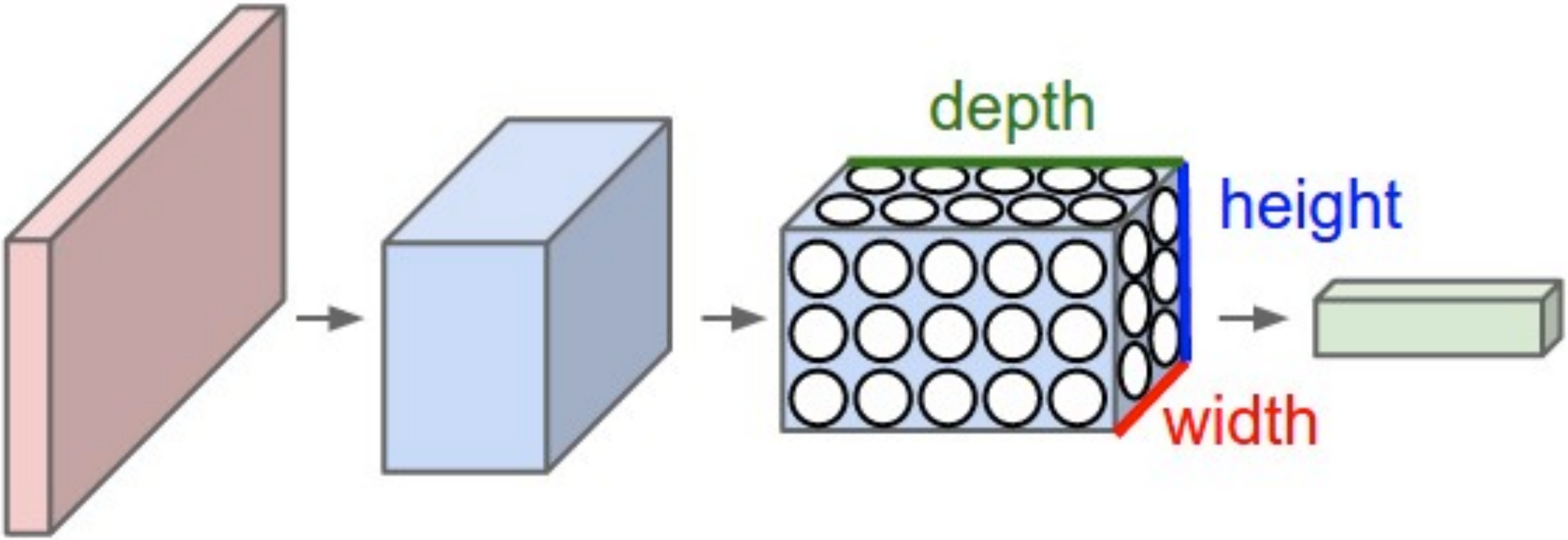
http://cs231n.github.io/convolutional-networks/

A regular 3-layer Neural Network



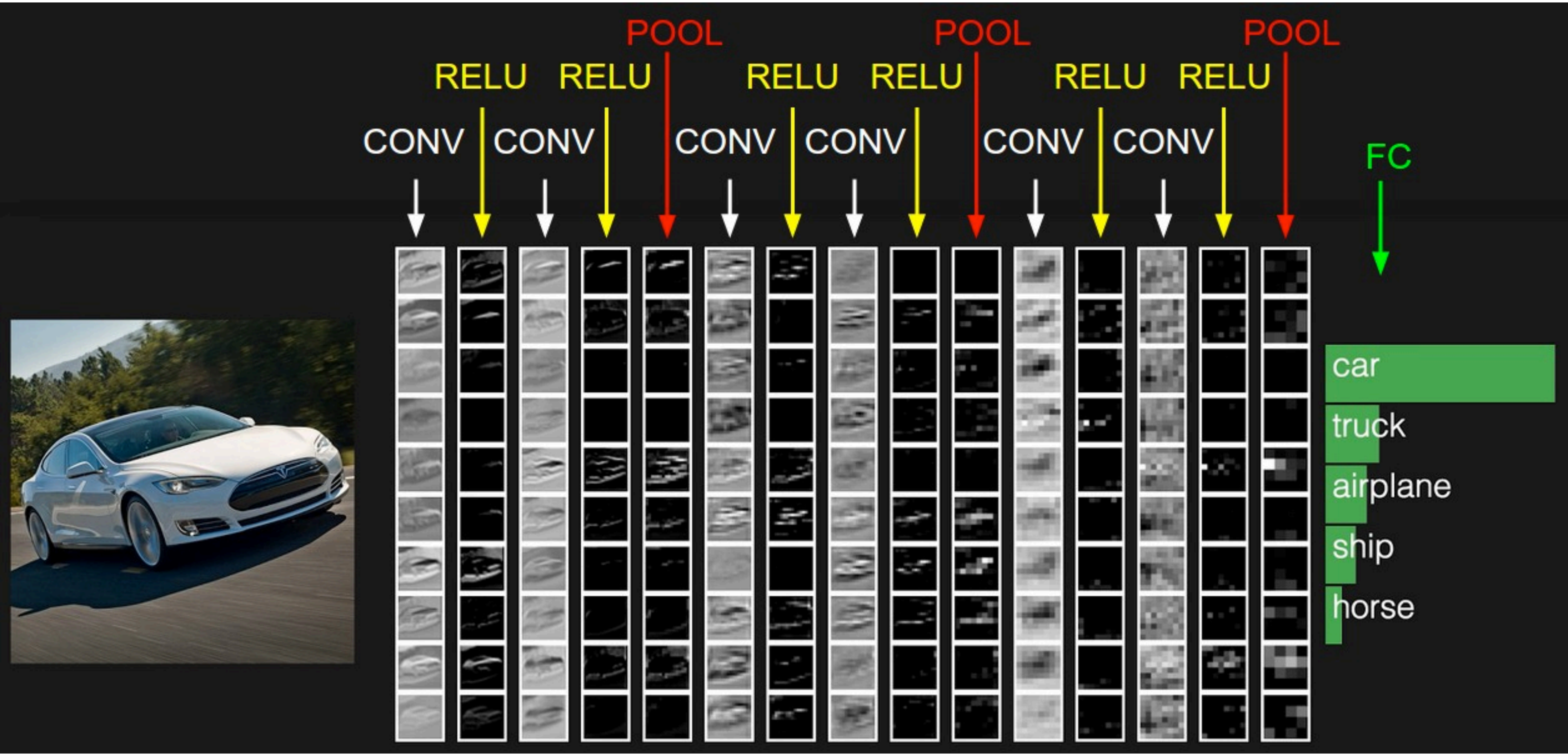
http://cs231n.github.io/convolutional-networks/

A ConvNet arranges its neurons in three dimensions (width, height, depth)



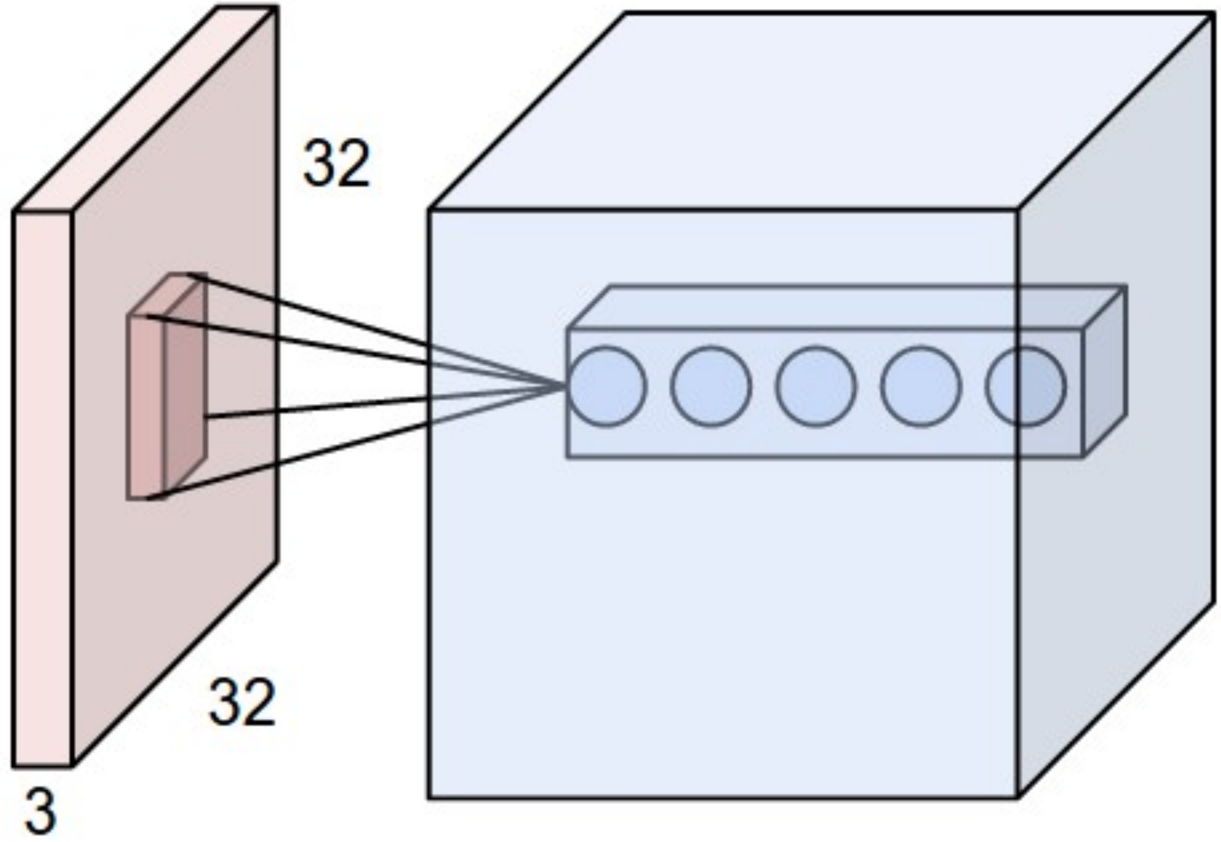
http://cs231n.github.io/convolutional-networks/

The activations of an example ConvNet architecture.



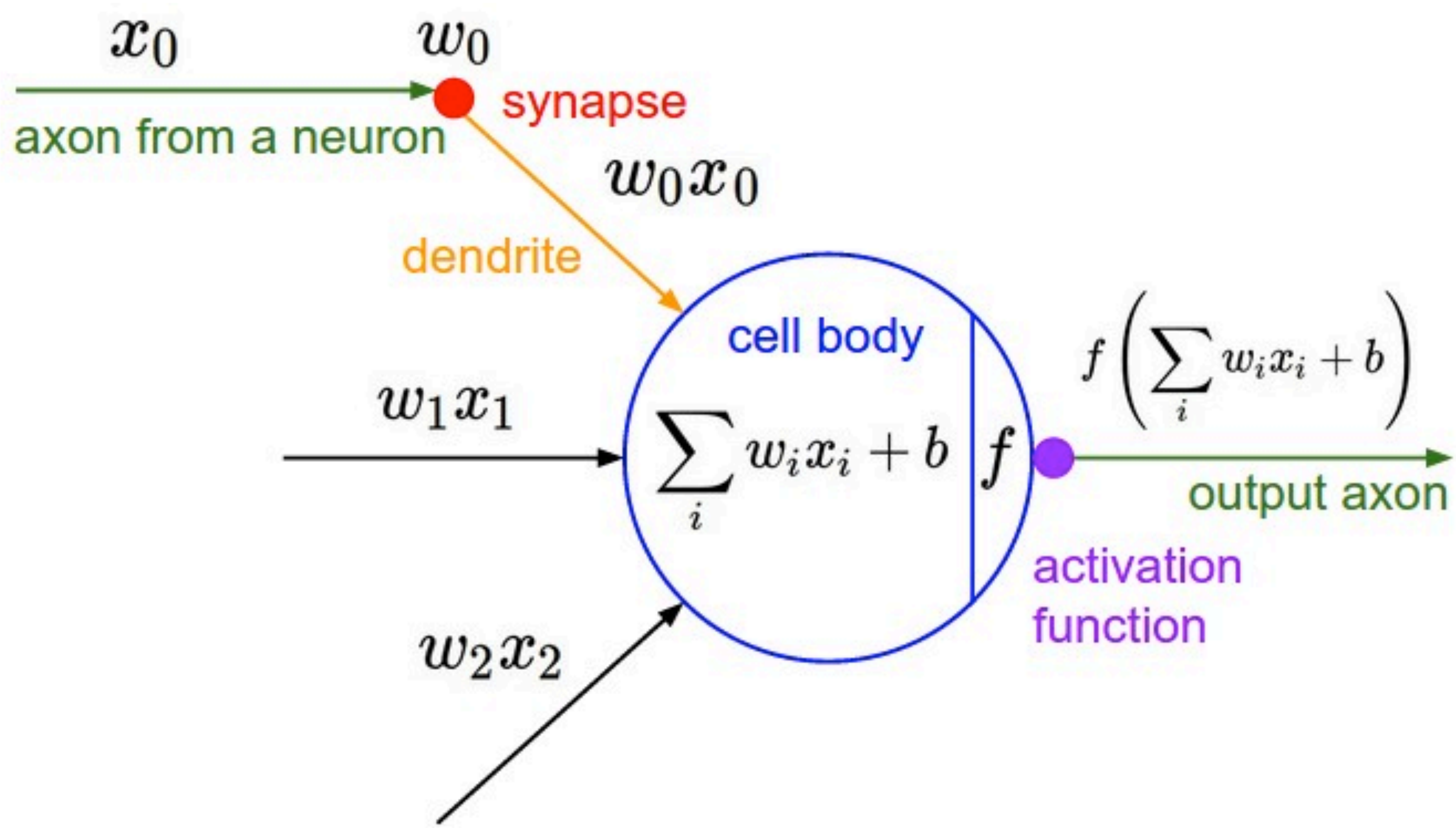
http://cs231n.github.io/convolutional-networks/

ConvNets



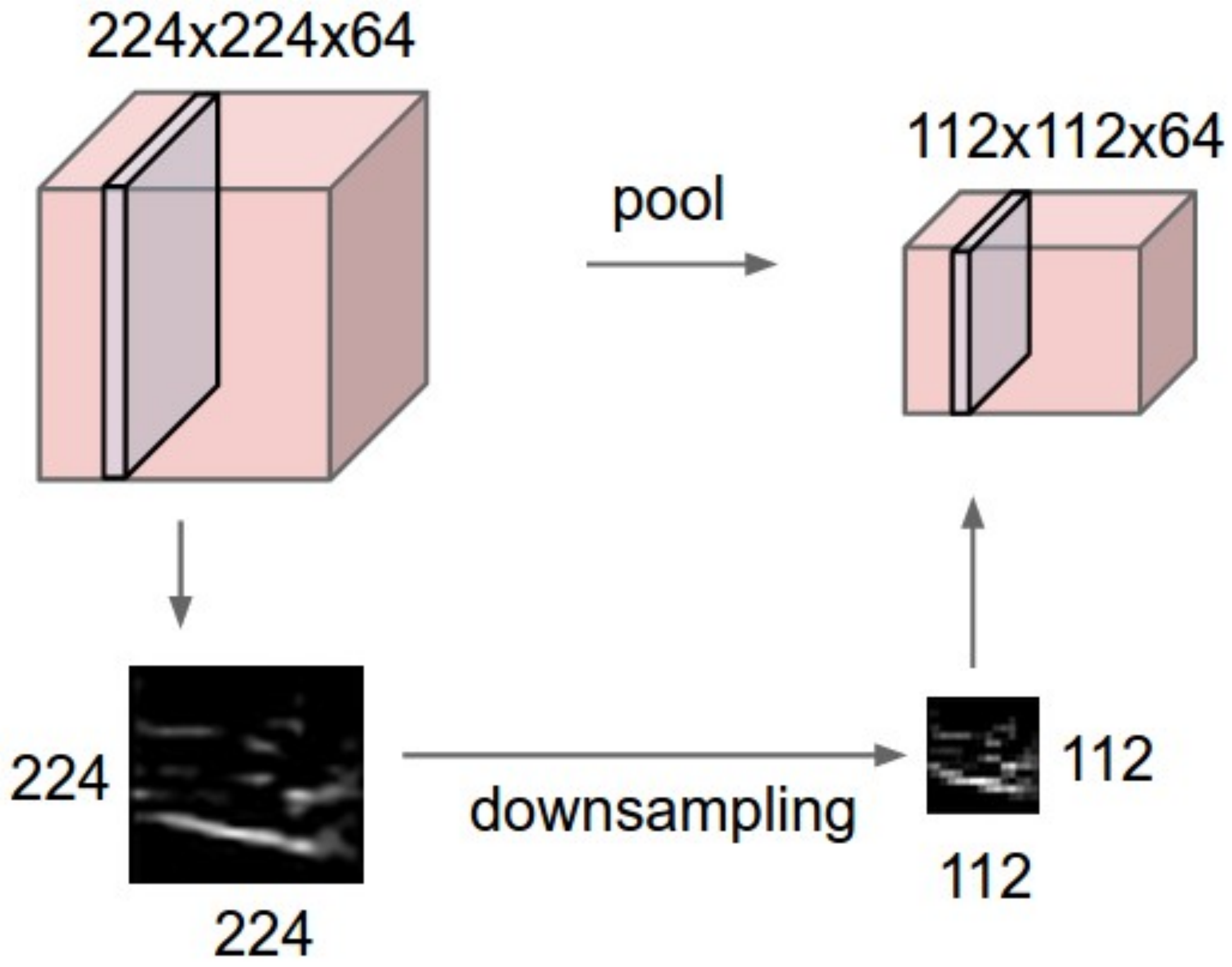
http://cs231n.github.io/convolutional-networks/

ConvNets



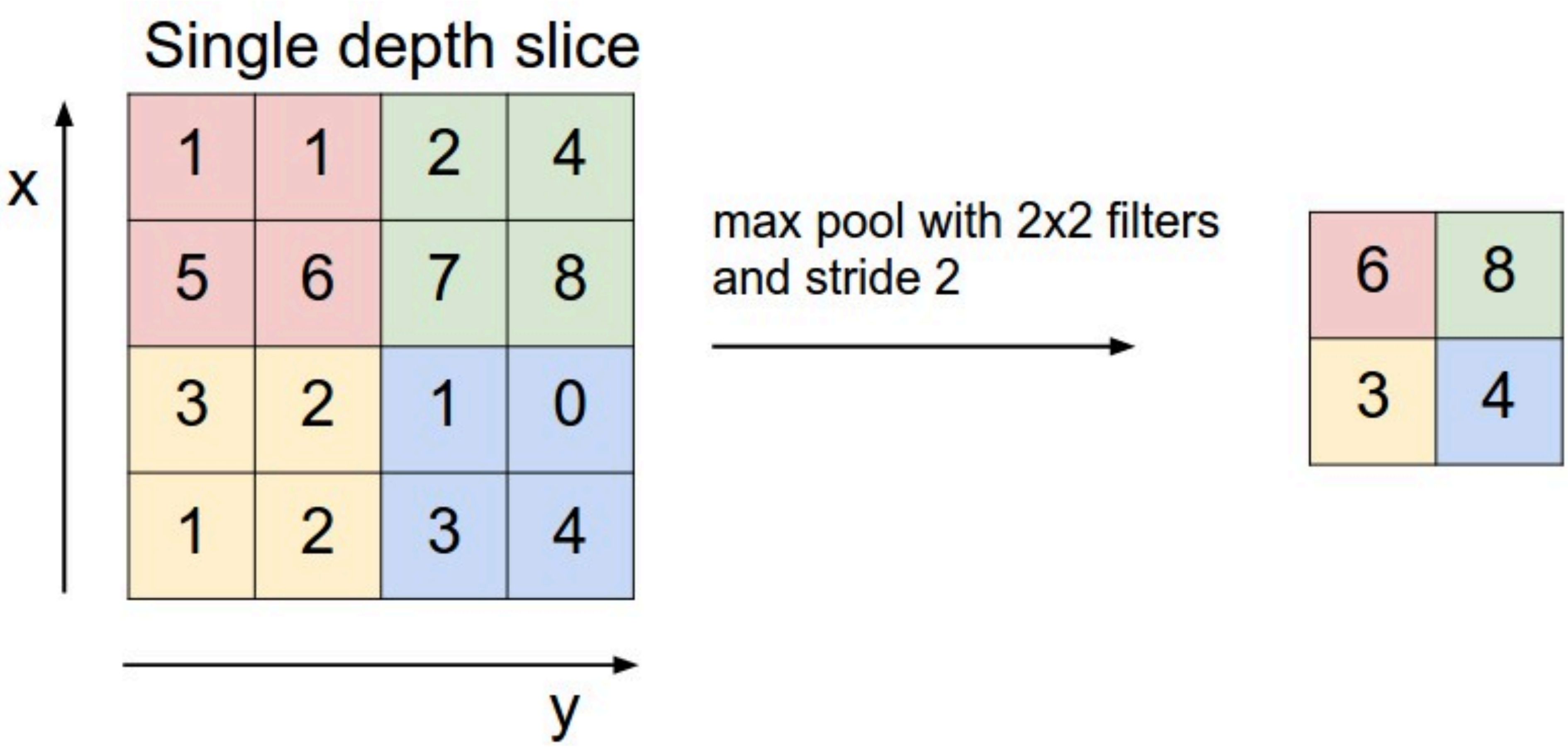
http://cs231n.github.io/convolutional-networks/

ConvNets



http://cs231n.github.io/convolutional-networks/

ConvNets
max pooling



Single depth slice

1	1	2	4
5	6	7	8
3	2	1	0
1	2	3	4

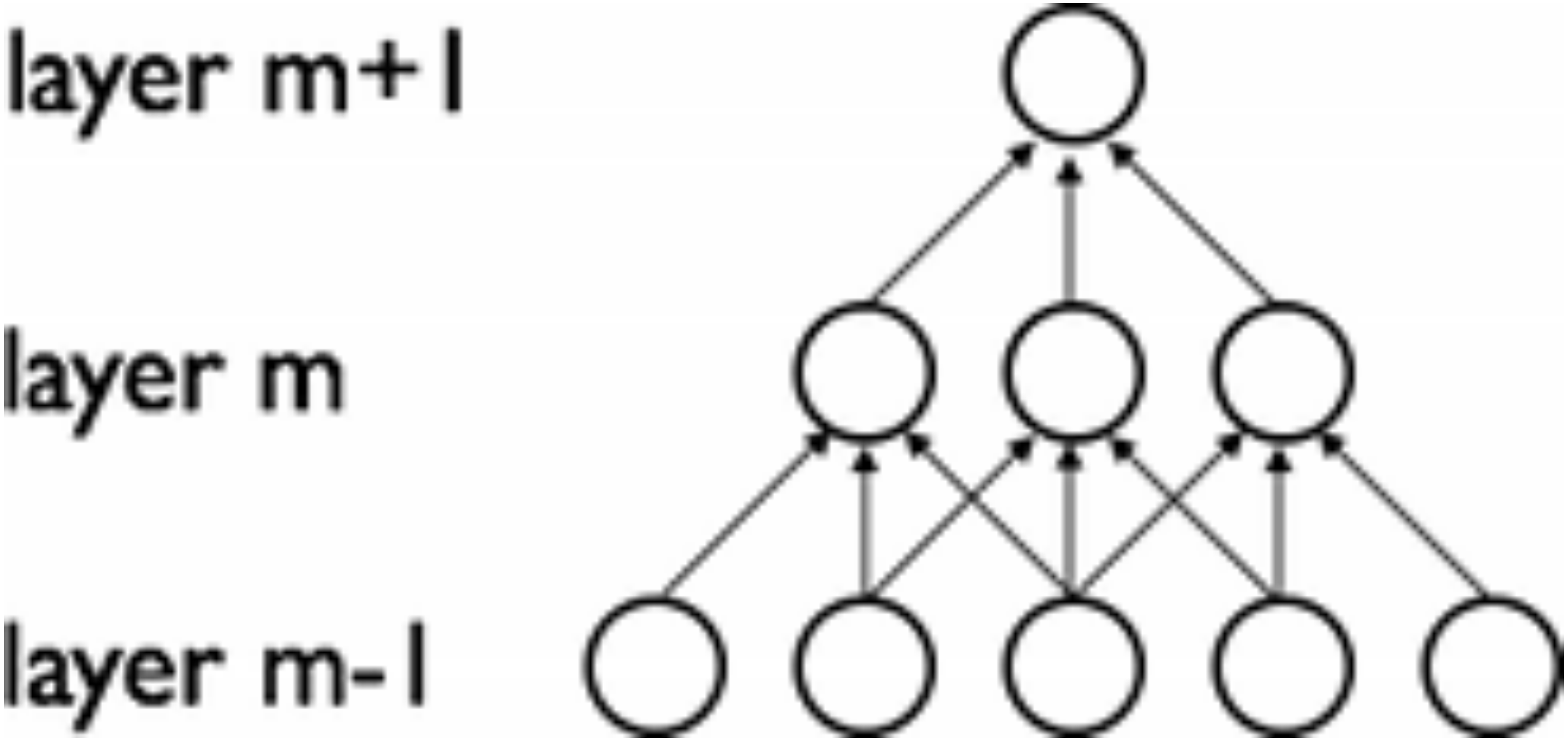
max pool with 2x2 filters and stride 2

6	8
3	4

http://cs231n.github.io/convolutional-networks/

Convolutional Neural Networks (CNN) (LeNet)

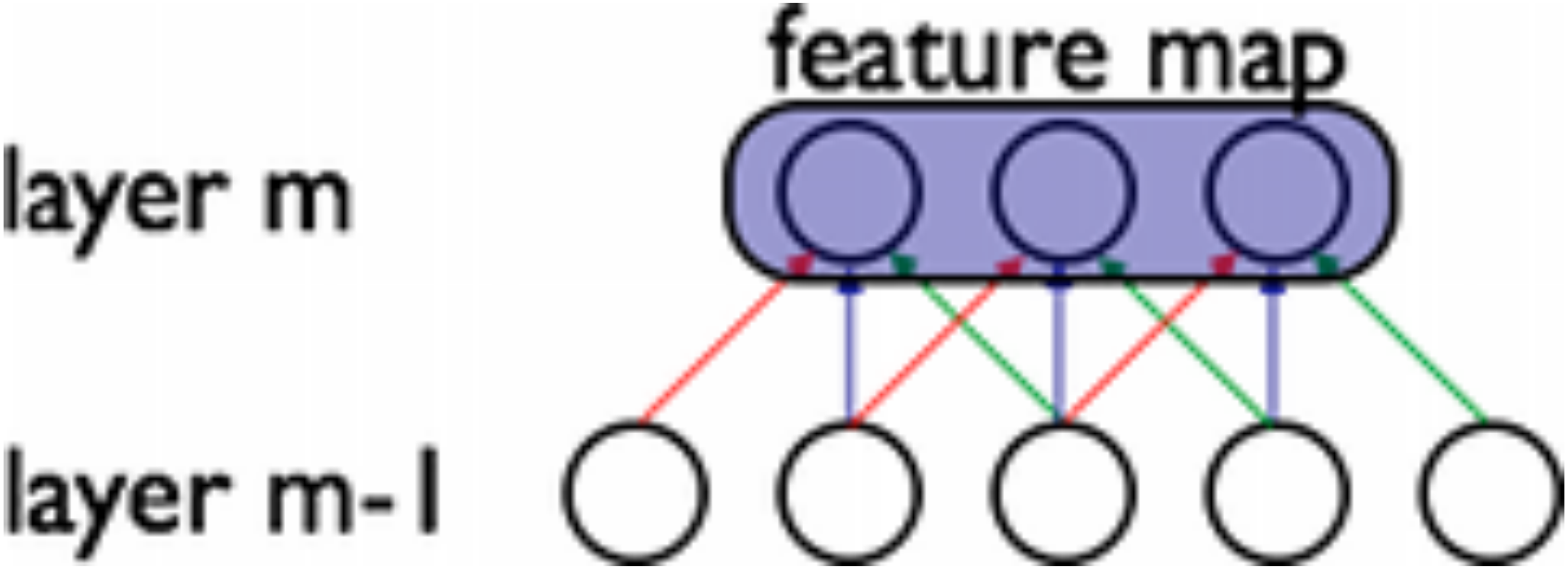
Sparse Connectivity



Source: http://deeplearning.net/tutorial/lenet.html

Convolutional Neural Networks (CNN) (LeNet)

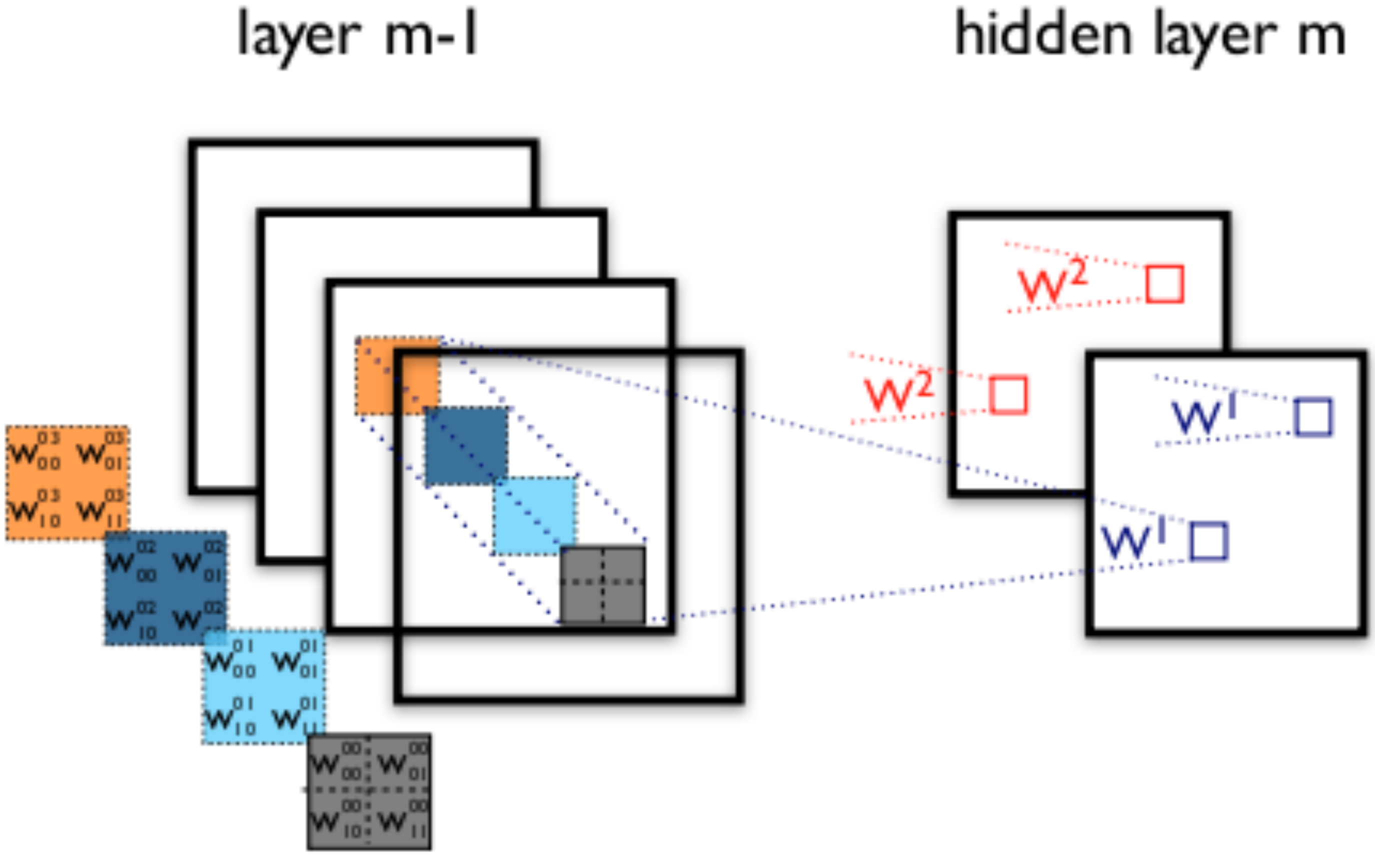
Shared Weights



Source: http://deeplearning.net/tutorial/lenet.html

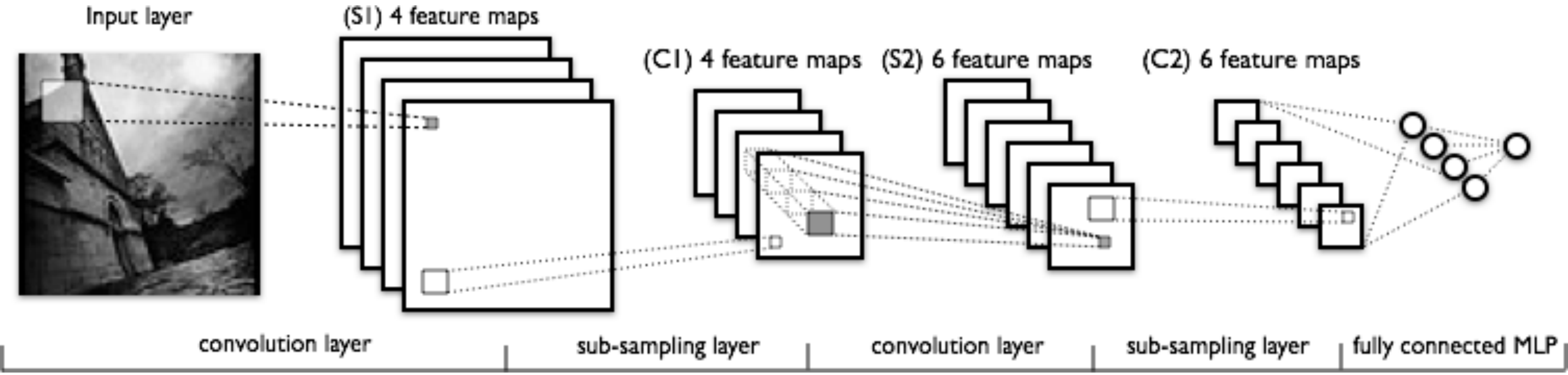
Convolutional Neural Networks (CNN) (LeNet)

example of a convolutional layer


layer m-1
hidden layer m
W^2
W^2
W^1
W^1
W^{03}_{00} W^{03}_{01}
W^{03}_{10} W^{03}_{11}
W^{02}_{00} W^{02}_{01}
W^{02}_{10} W^{02}_{11}
W^{01}_{00} W^{01}_{01}
W^{01}_{10} W^{01}_{11}
W^{00}_{00} W^{00}_{01}
W^{00}_{10} W^{00}_{11}

Source: http://deeplearning.net/tutorial/lenet.html

Convolutional Neural Networks (CNN) (LeNet)



Source: http://deeplearning.net/tutorial/lenet.html

show flights from Boston to New York today

Source: http://deeplearning.net/tutorial/rnnslu.html

Recurrent Neural Networks with Word Embeddings Semantic Parsing / Slot-Filling (Spoken Language Understanding)

Input (words)	show	flights	from	Boston	to	New	York	today
Output (labels)	O	O	O	B-dept	O	B-arr	I-arr	B-date

Source: http://deeplearning.net/tutorial/rnnslu.html

show flights from Boston to New York today

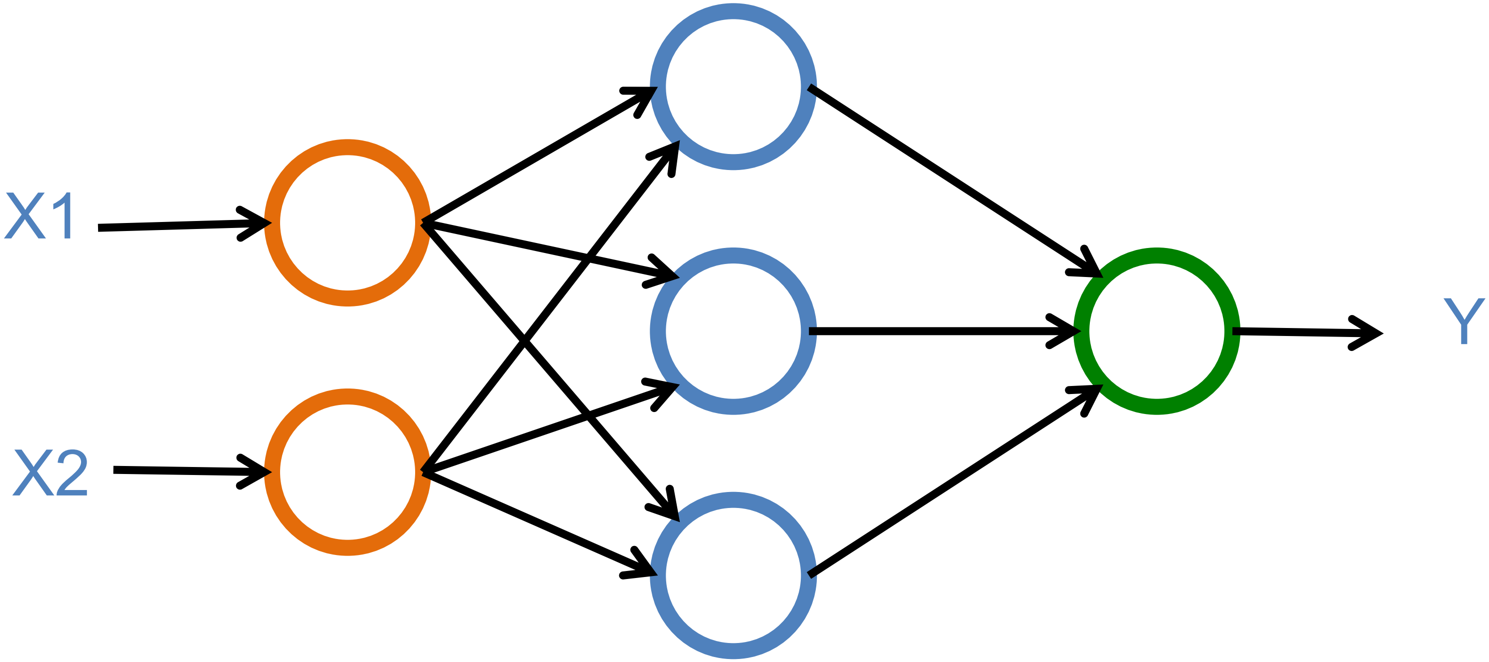
show flights from Boston to New York today

Input (words)	show	flights	from	Boston	to	New	York	today
Output (labels)	O	O	O	B-dept	O	B-arr	I-arr	B-date

Source: http://deeplearning.net/tutorial/rnnslu.html

Neural Networks

Input Layer (X) Hidden Layer (H) **Output Layer (Y)**



Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

X		Y
Hours Sleep	Hours Study	Score
3	5	75
5	1	82
10	2	93
8	3	?

Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

	X		Y
	Hours Sleep	Hours Study	Score
Training	3	5	75
	5	1	82
	10	2	93
Testing	8	3	?

Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Training a Network

=

Minimize the Cost Function

Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Training a Network

=

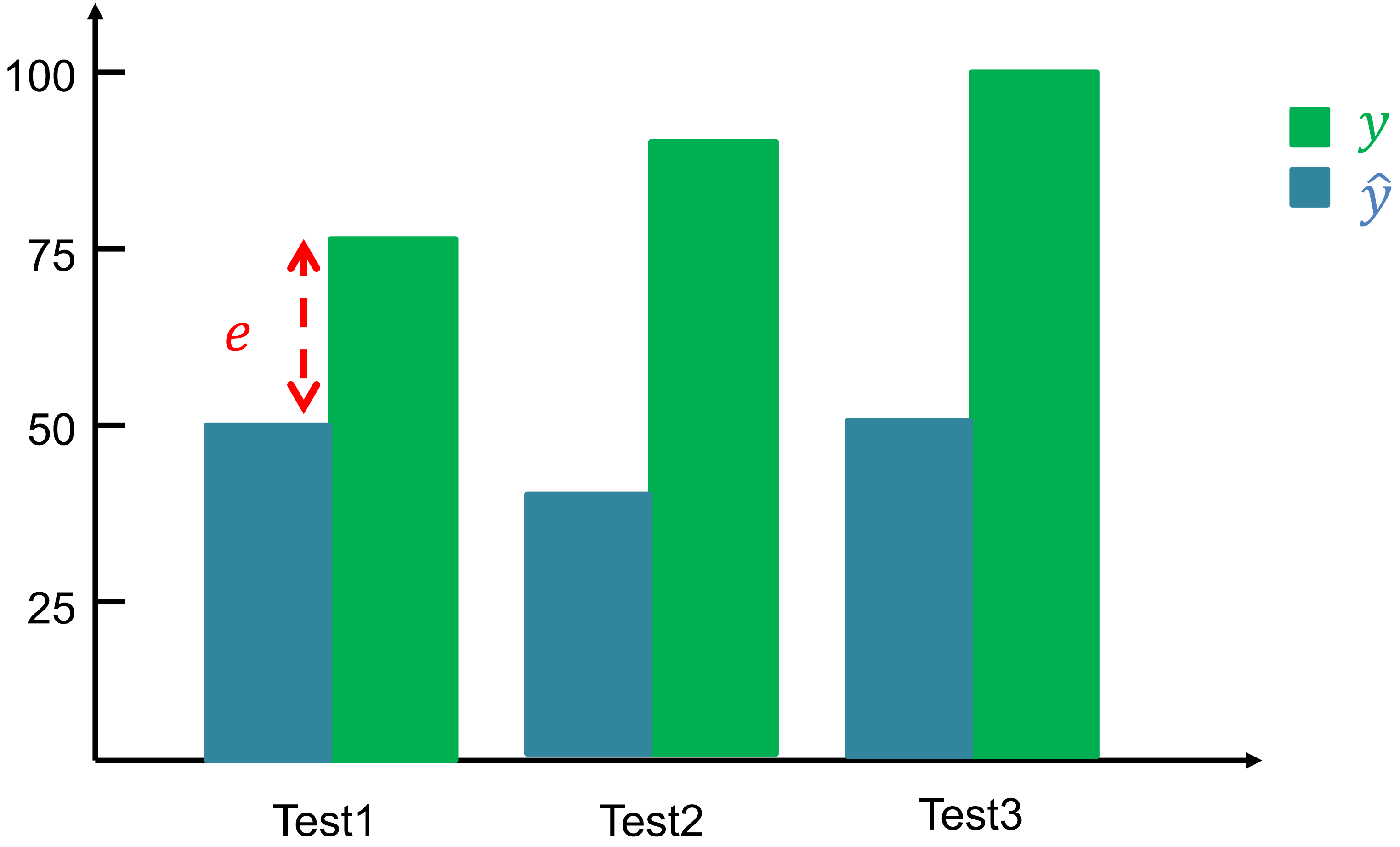
Minimize the Cost Function

Minimize the Loss Function

Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Error = Predict Y - Actual Y

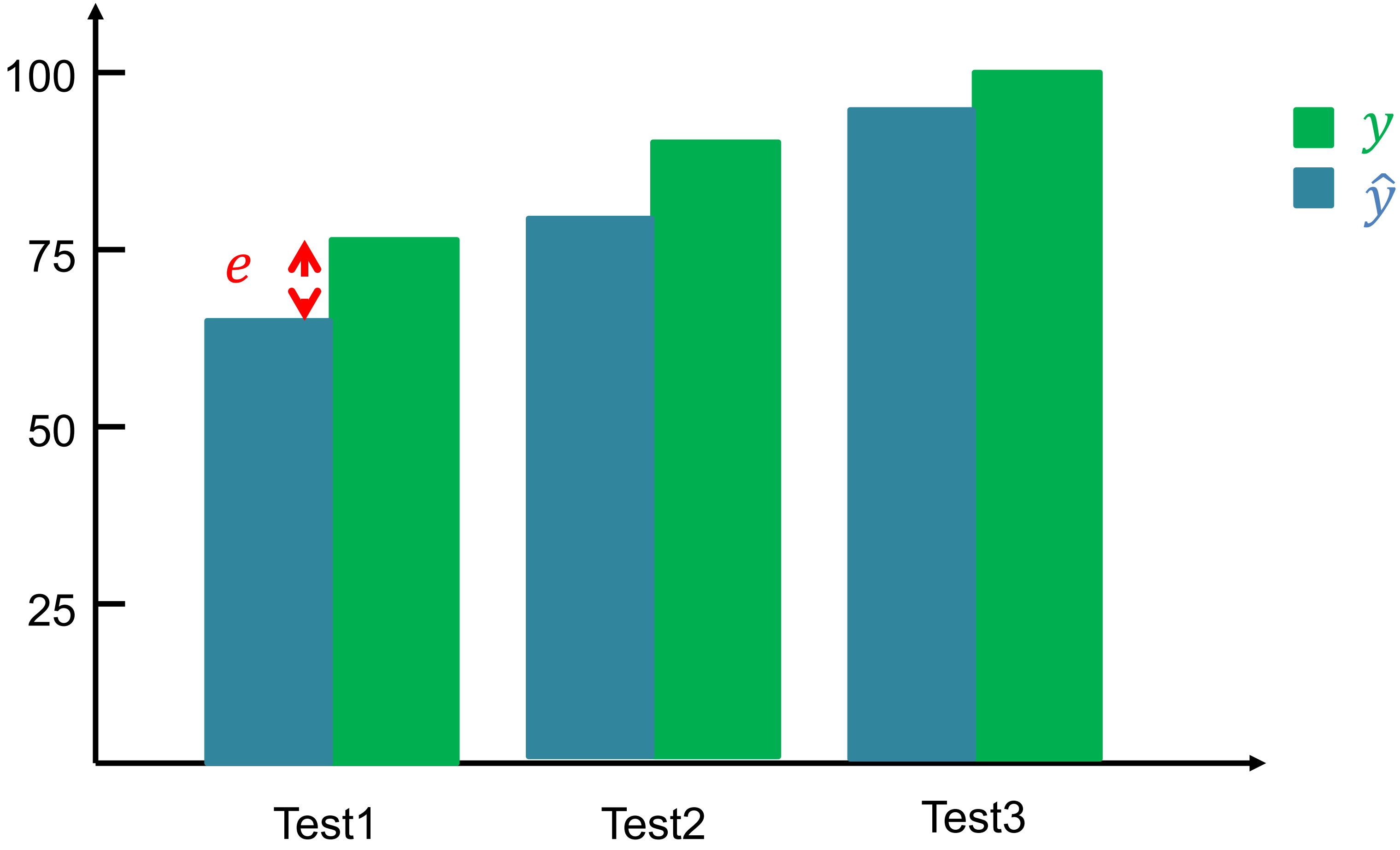
Error : Cost : Loss



Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Error = Predict Y - Actual Y

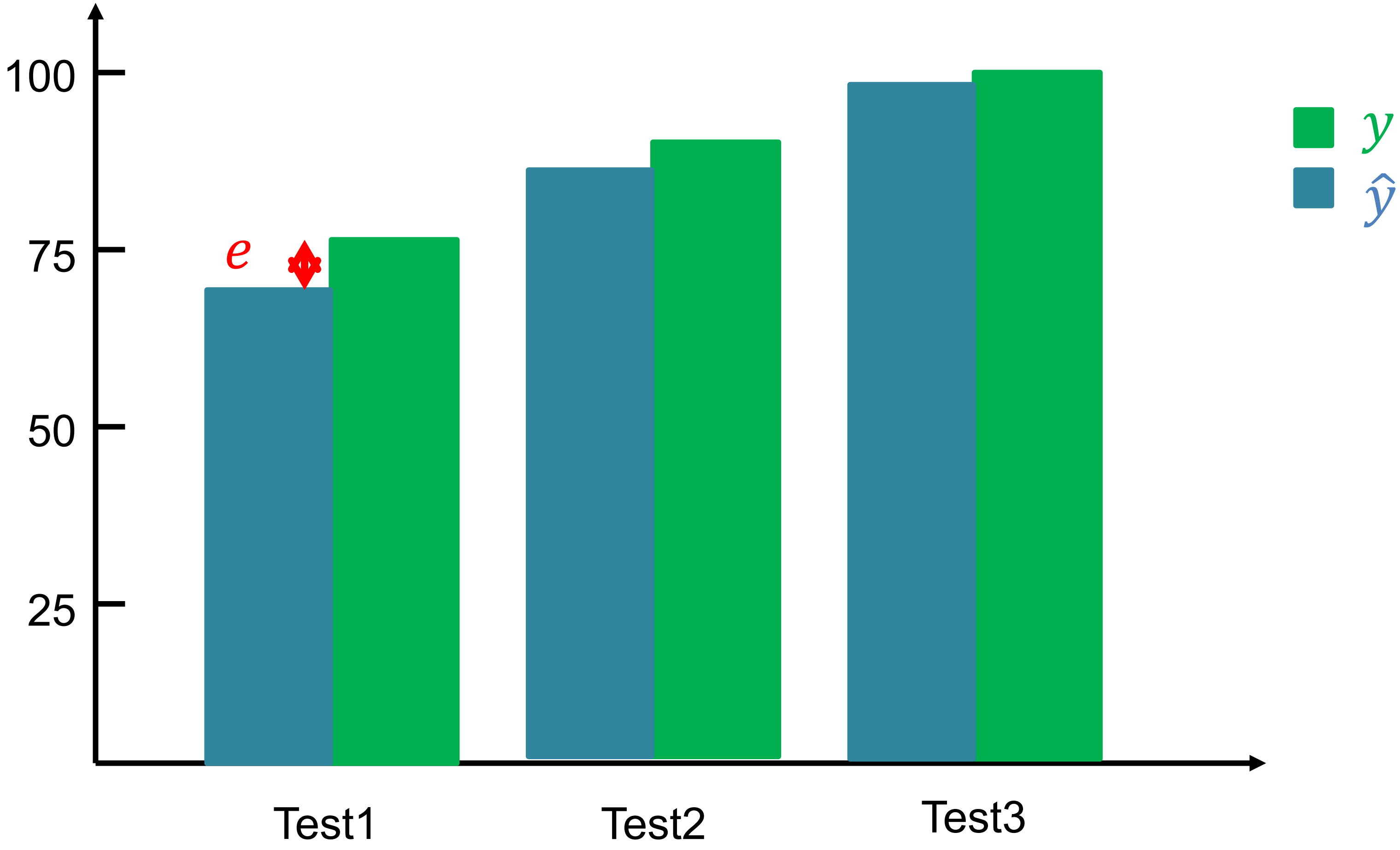
Error : Cost : Loss



Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Error = Predict Y - Actual Y

Error : Cost : Loss

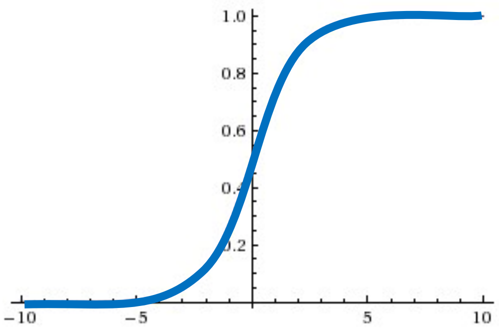


Source: https://www.youtube.com/watch?v=bxe2T-V8XRs&index=1&list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU

Activation Functions

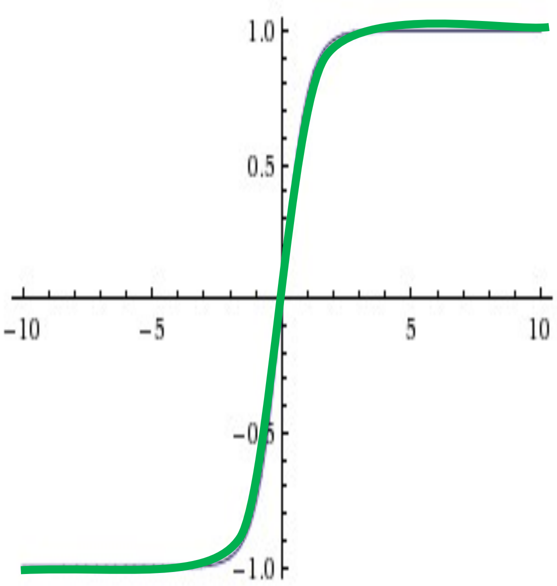
Activation Functions

Sigmoid



[0, 1]

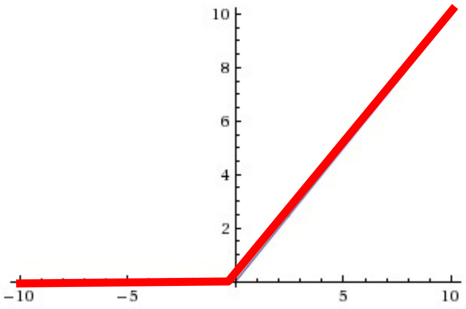
TanH



[-1, 1]

ReLU

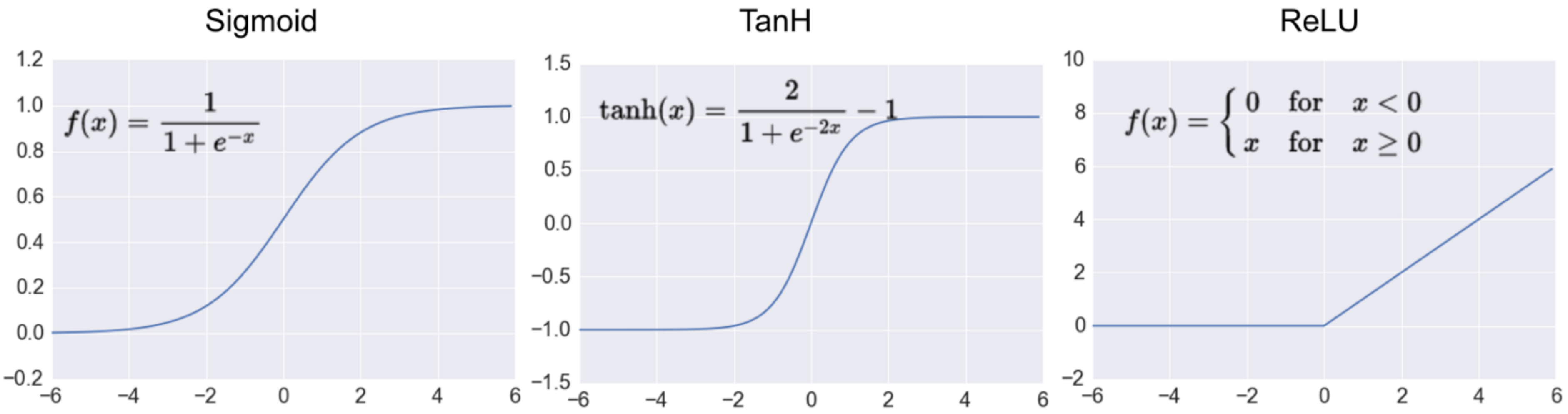
(Rectified Linear Unit)



$f(x) = max(0, x)$

Source: http://cs231n.github.io/neural-networks-1/

Activation Functions



Sigmoid

$$f(x) = \frac{1}{1+e^{-x}}$$

TanH

$$\tanh(x) = \frac{2}{1+e^{-2x}} - 1$$

ReLU

$$f(x) = \begin{cases} 0 & \text{for} \quad x < 0 \\ x & \text{for} \quad x \geq 0 \end{cases}$$

Source: http://adilmoujahid.com/posts/2016/06/introduction-deep-learning-python-caffe/

Loss Function

Binary Classification: 2 Class

Activation Function:
Sigmoid

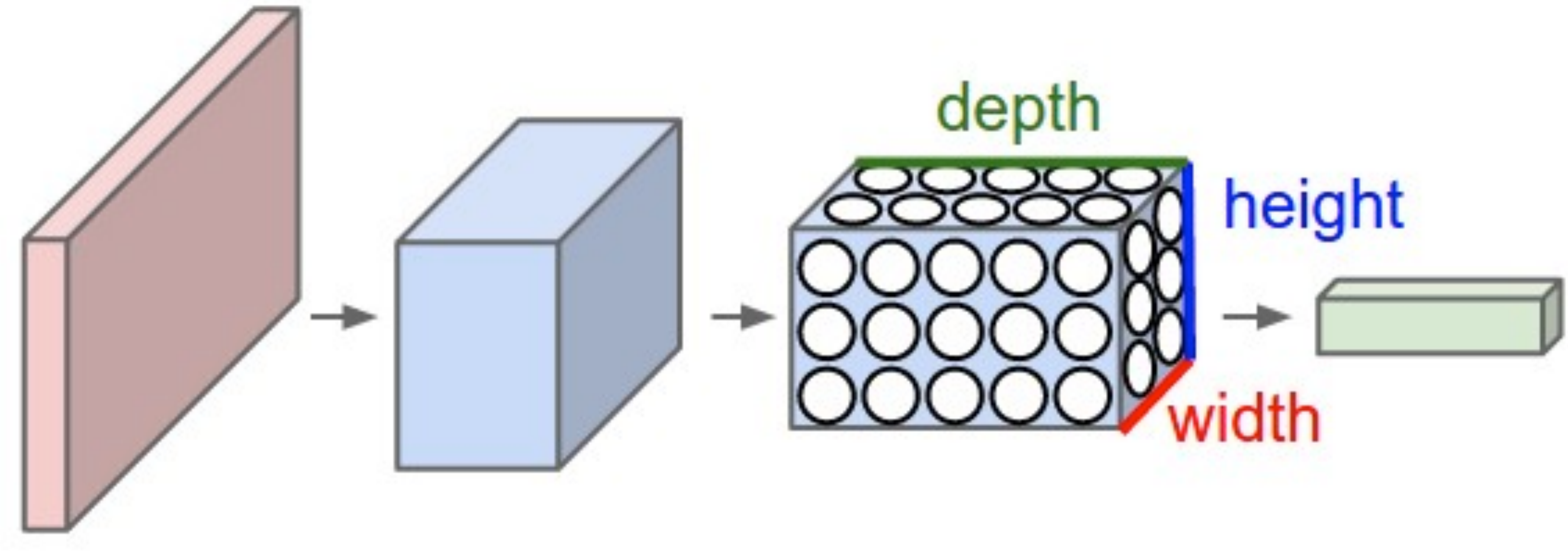
Loss Function:
Binary Cross-Entropy

Multiple Classification: 10 Class

Activation Function:
SoftMAX

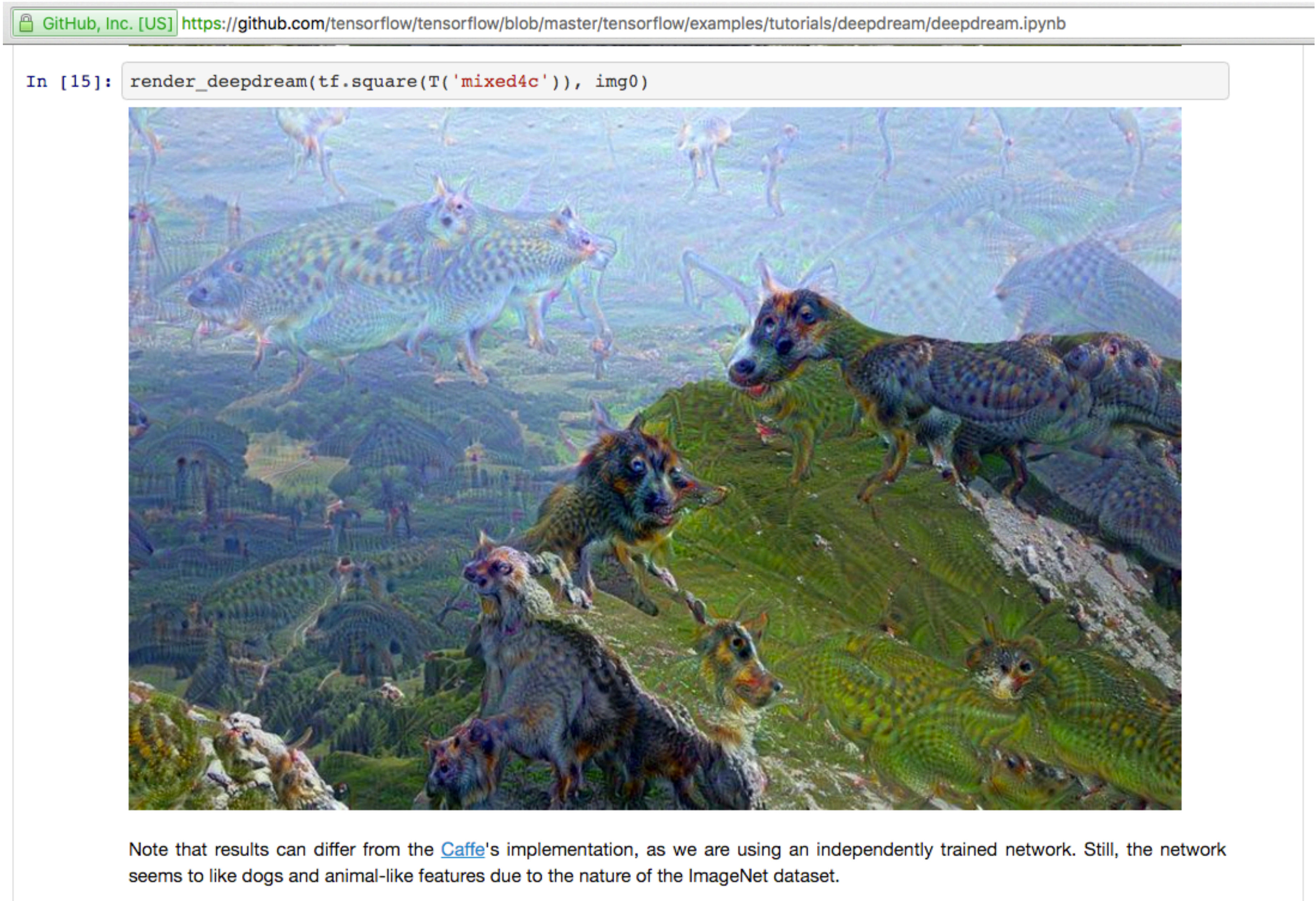
Loss Function:
Categorical Cross-Entropy

A ConvNet arranges its neurons in three dimensions (width, height, depth)



http://cs231n.github.io/convolutional-networks/

DeepDream



https://github.com/tensorflow/tensorflow/blob/master/tensorflow/examples/tutorials/deepdream/deepdream.ipynb

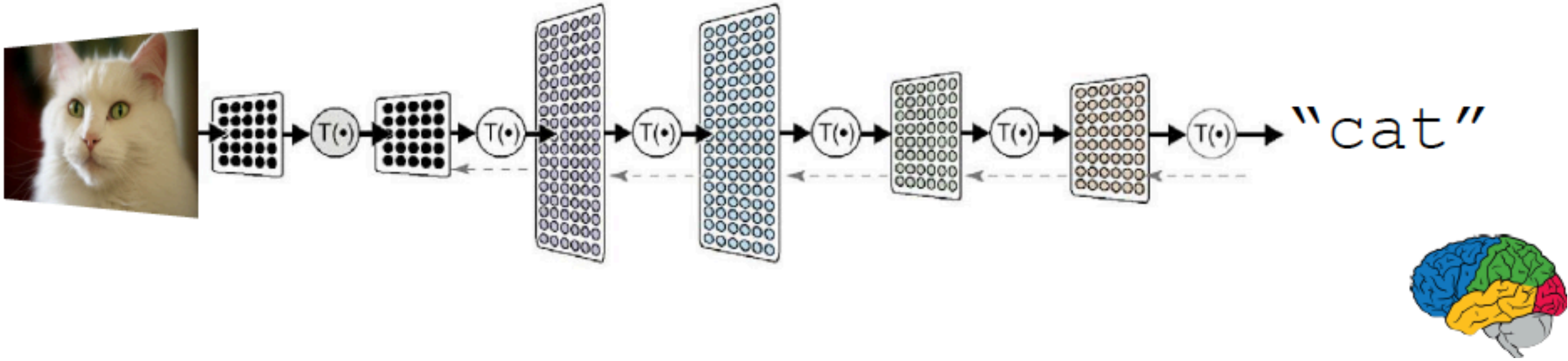
```
In [15]: render_deepdream(tf.square(T('mixed4c')), img0)
```

Note that results can differ from the Caffe's implementation, as we are using an independently trained network. Still, the network seems to like dogs and animal-like features due to the nature of the ImageNet dataset.

Source: https://github.com/tensorflow/tensorflow/blob/master/tensorflow/examples/tutorials/deepdream/deepdream.ipynb

Deep Learning

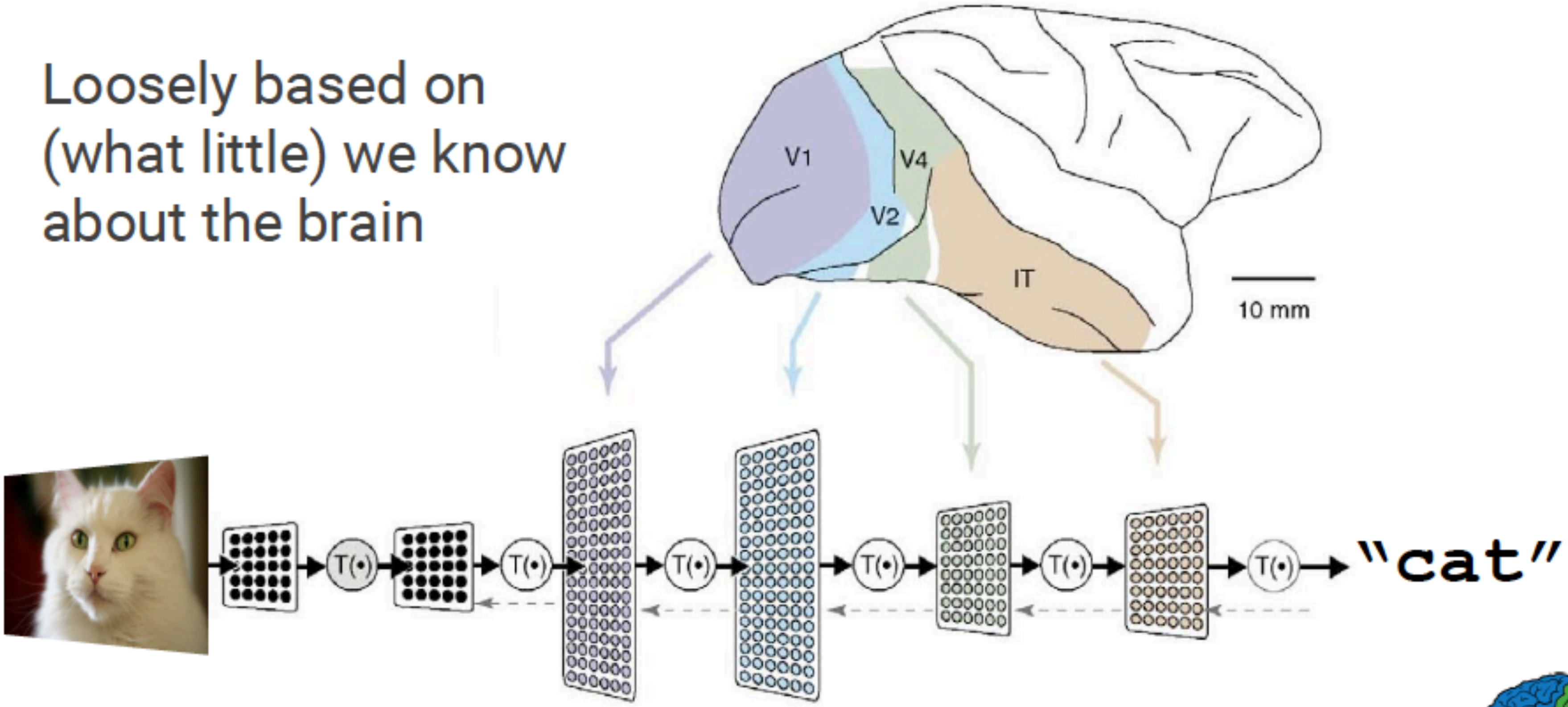
- A powerful class of machine learning model
- Modern reincarnation of artificial neural networks
- Collection of simple,
  trainable mathematical functions
- Compatible with many variants of machine learning



Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

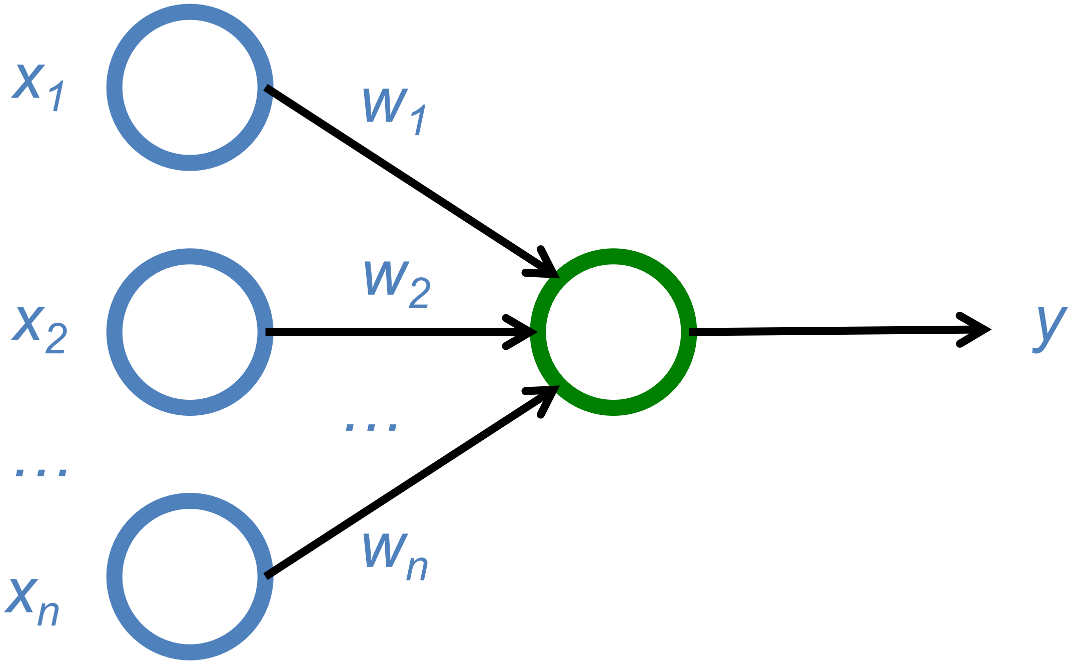
What is Deep Learning?

- Loosely based on (what little) we know about the brain



Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

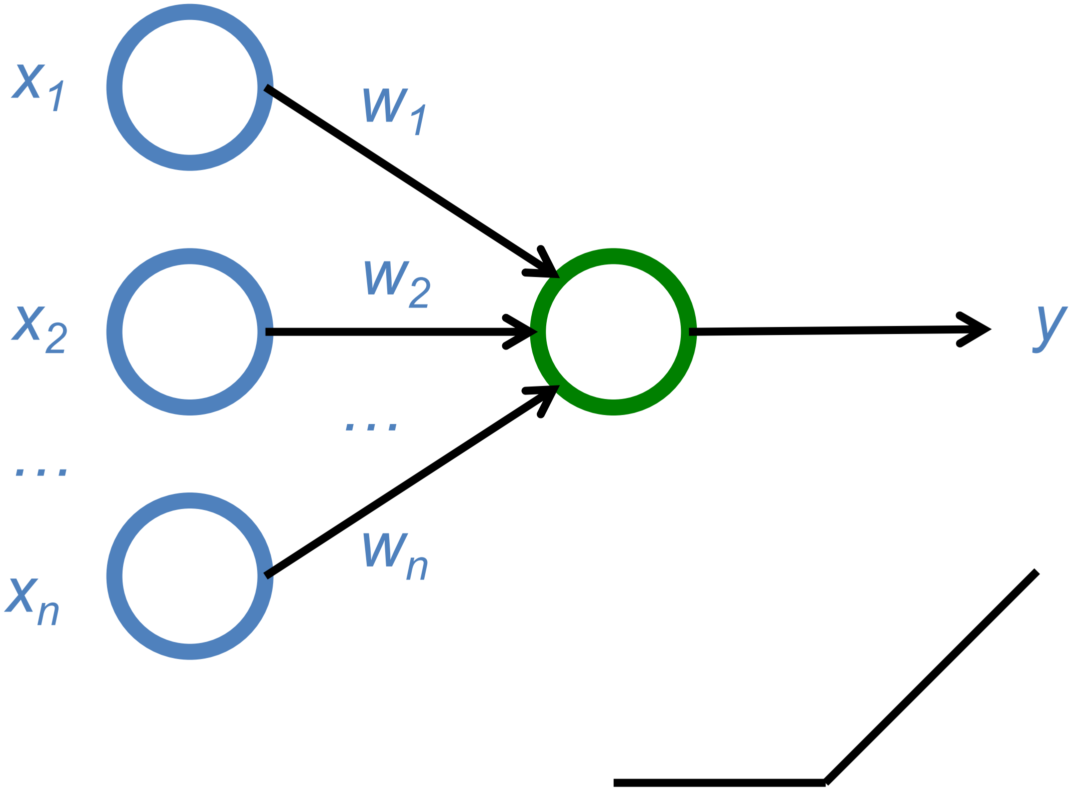
The Neuron



Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

The Neuron

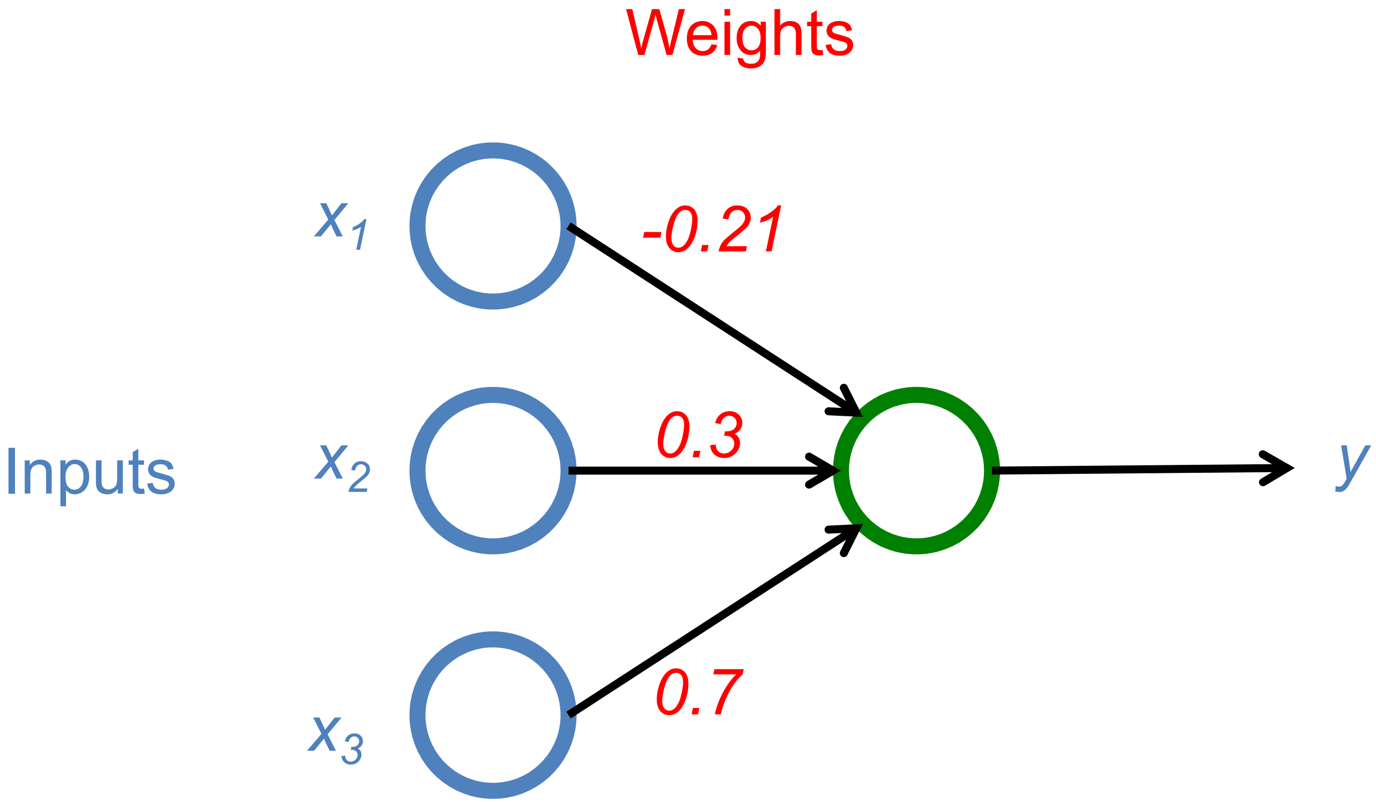
$$y = F\left(\sum_i w_i x_i\right)$$



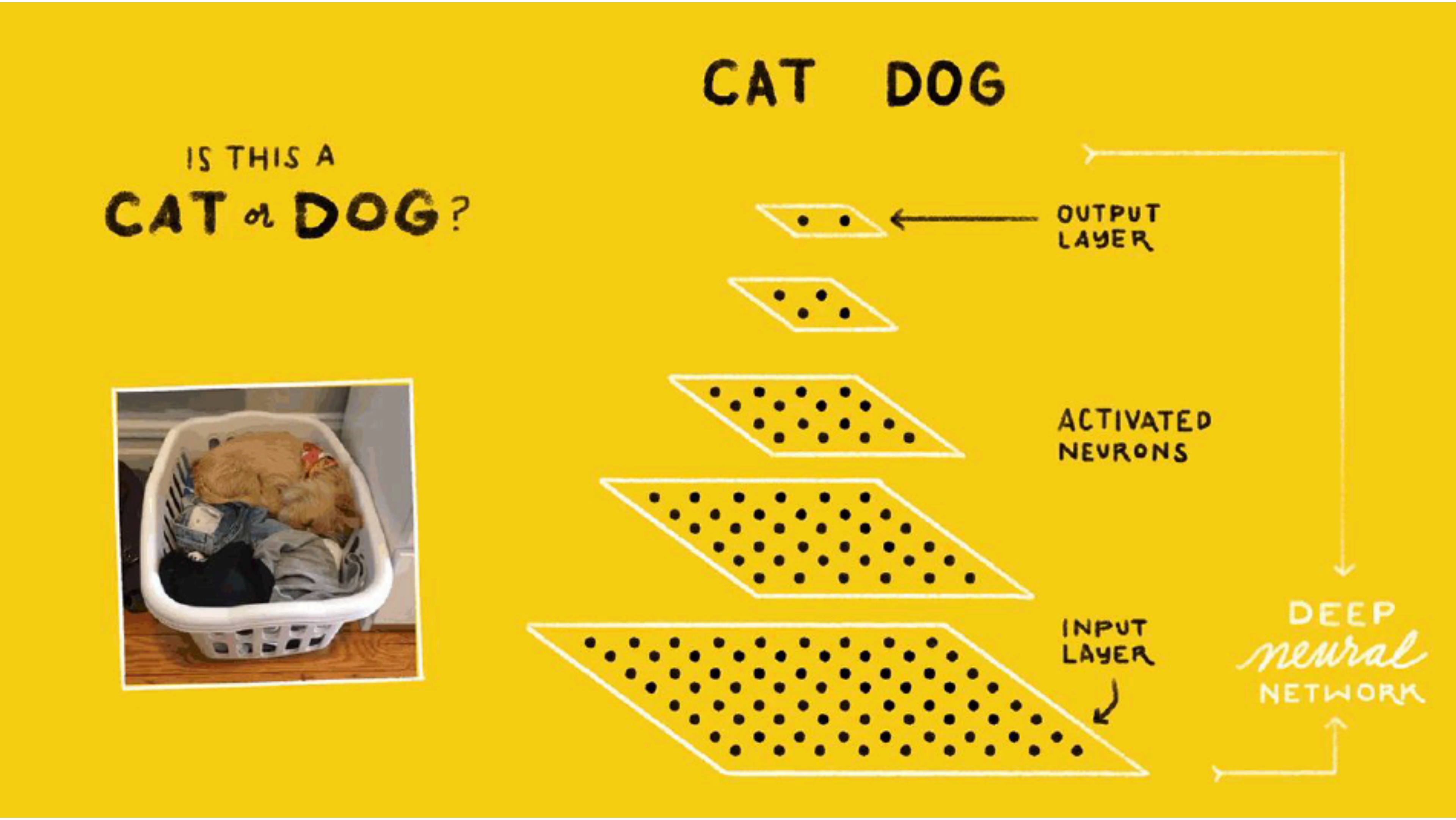
$$F(x) = \max(0, x)$$

Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

$$y = max\,(\,0,\ -0.21 * x_1 + 0.3 * x_2 + 0.7 * x_3\,)$$



Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016



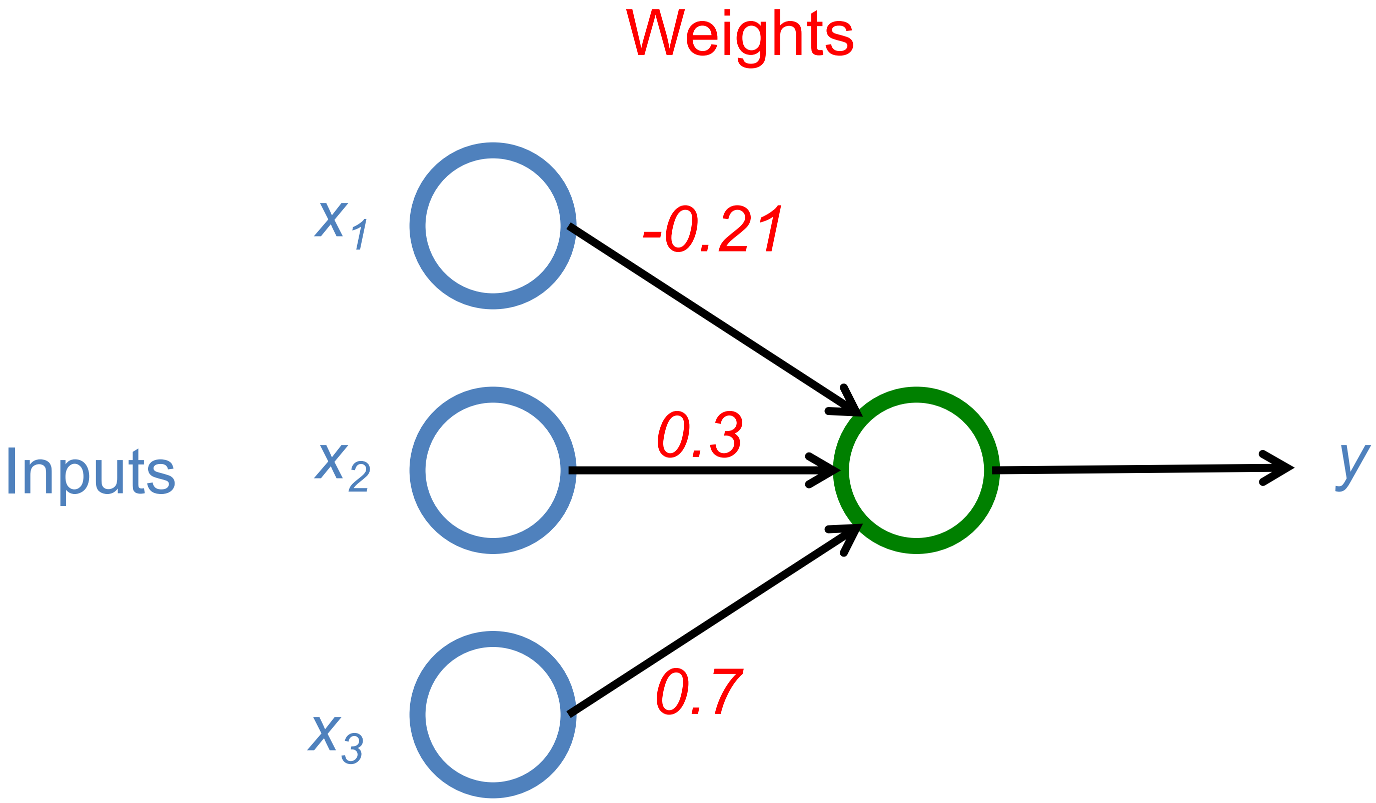
Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

Learning Algorithm

```
While not done:
    Pick a random training example “(input, label)”
    Run neural network on “input”
    Adjust weights on edges to make output closer to “label”
```

Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

$$y = max\ (\ 0,\ -0.21\ *\ x_1 + 0.3\ *\ x_2 + 0.7\ *\ x_3\ )$$



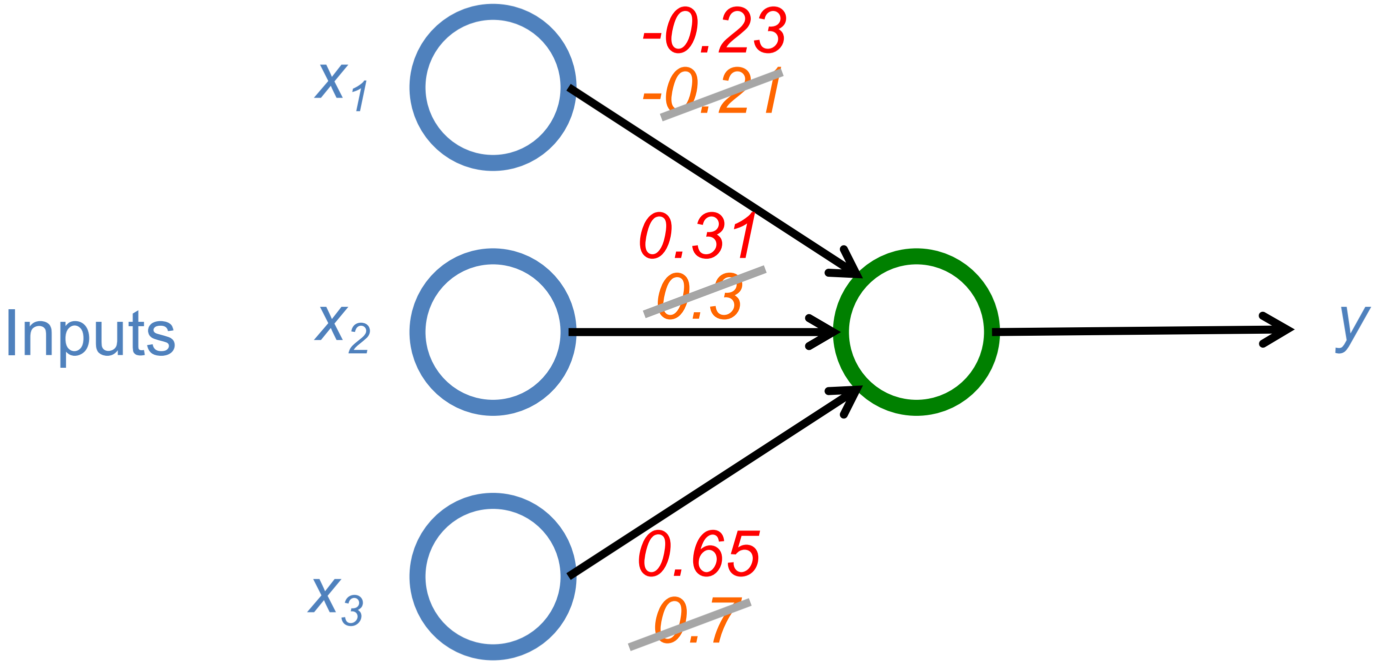
Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

Next time:

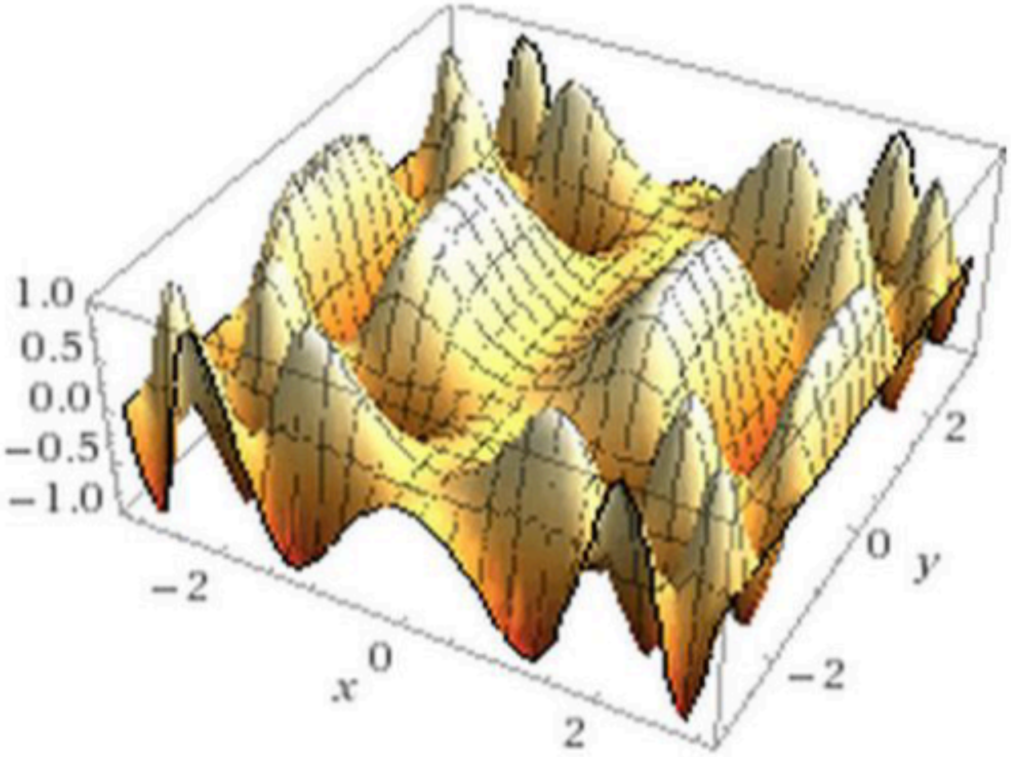
$$y = \max(0, -0.23 * x_1 + 0.31 * x_2 + 0.65 * x_3)$$

~~$y = \max(0, -0.21 * x_1 + 0.3 * x_2 + 0.7 * x_3)$~~

Weights



Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016



This shows a function of 2 variables: real neural nets are functions of hundreds of millions of variables!

Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

Important Property of Neural Networks

Results get better with

More data +

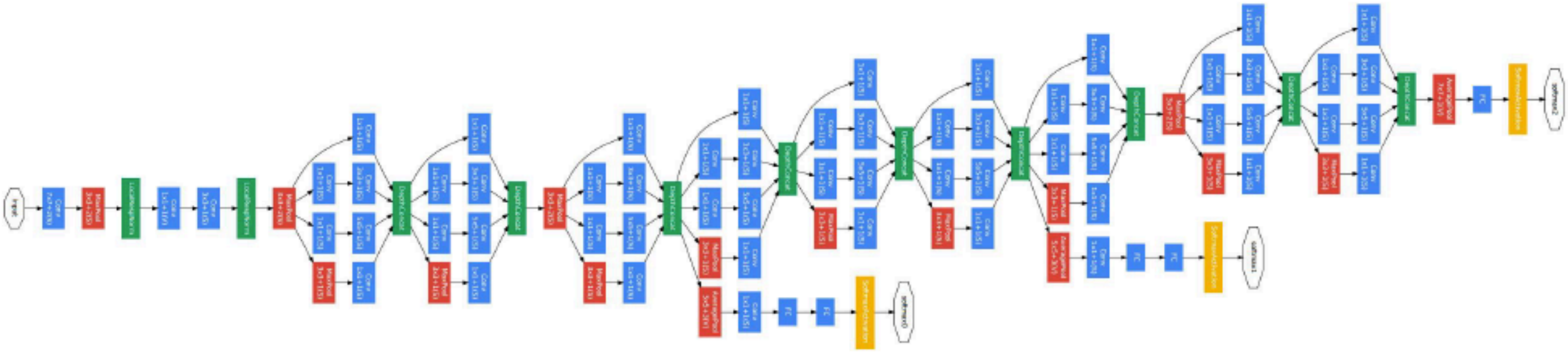
Bigger models +

More computation

(Better algorithms, new insights and improved techniques always help, too!)

Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

The Inception Architecture (GoogLeNet, 2014)



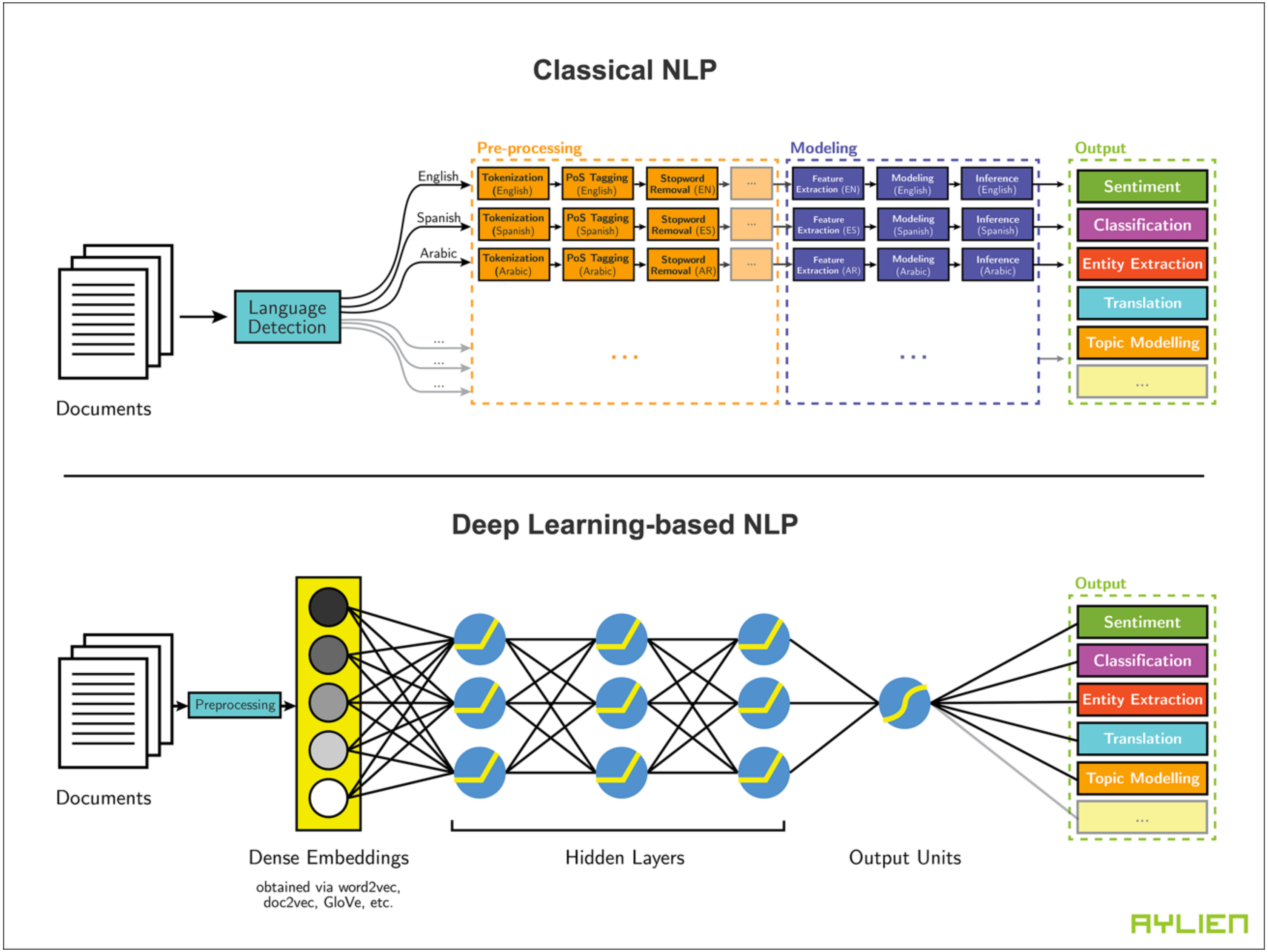
Going Deeper with Convolutions

Christian Szegedy, Wei Liu, Yangqing Jia, Pierre Sermanet, Scott Reed, Dragomir Anguelov, Dumitru Erhan, Vincent Vanhoucke, Andrew Rabinovich

ArXiv 2014, CVPR 2015

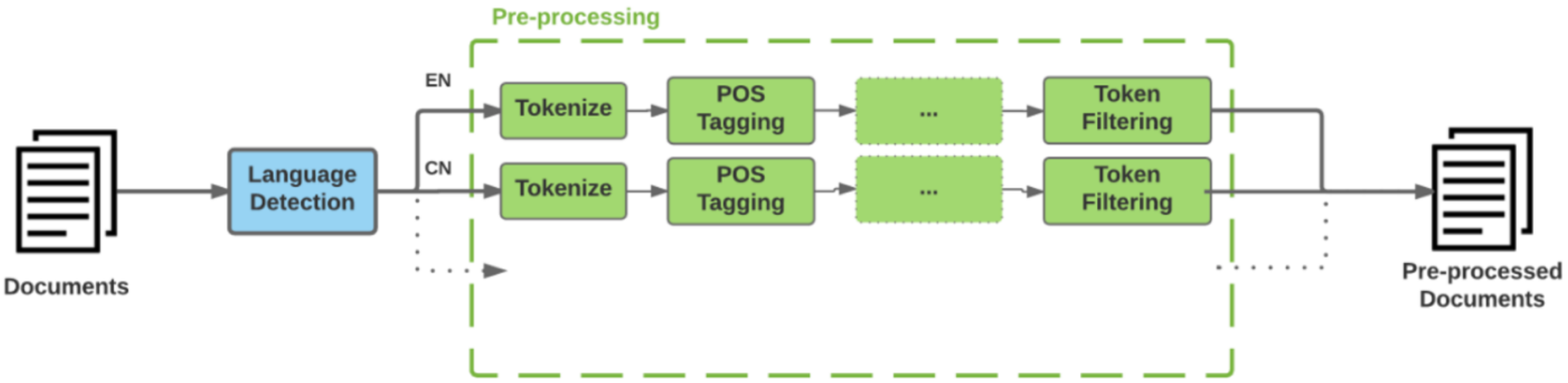
Source: Jeff Dean (2016), Large-Scale Deep Learning For Building Intelligent Computer Systems, WSDM 2016

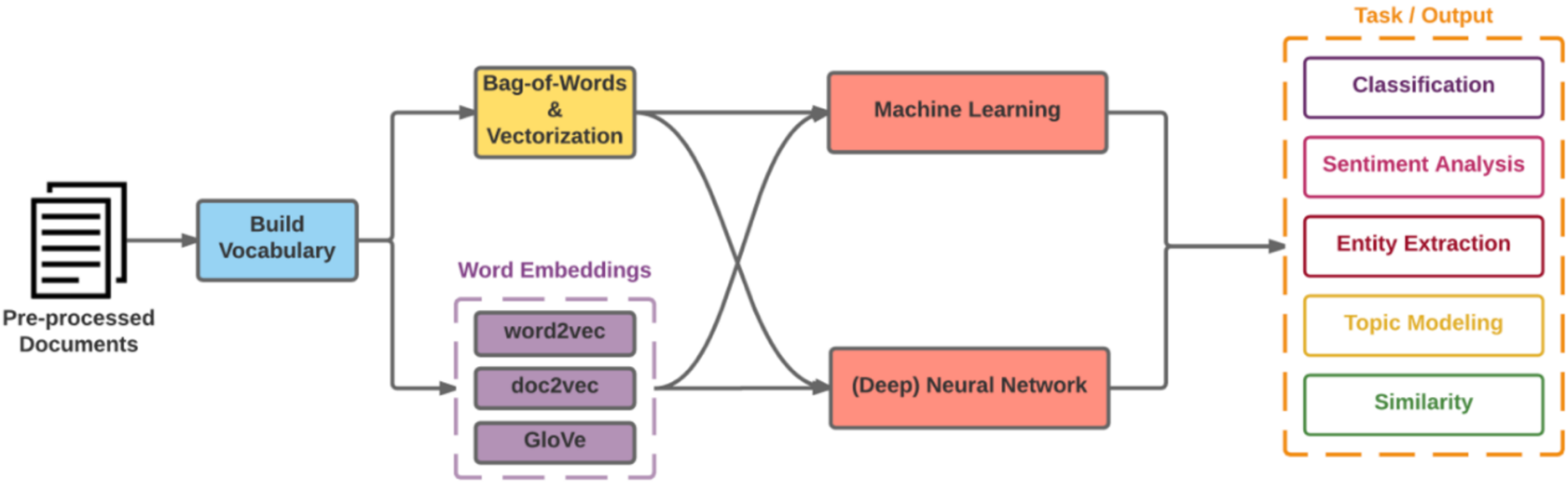
NLP



Source: http://blog.aylien.com/leveraging-deep-learning-for-multilingual/

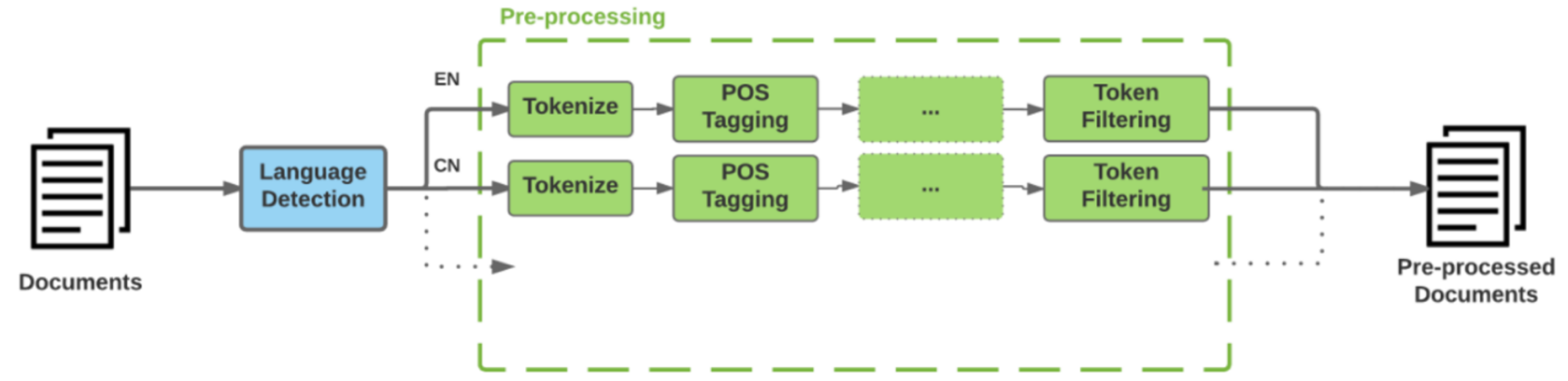
Modern NLP Pipeline

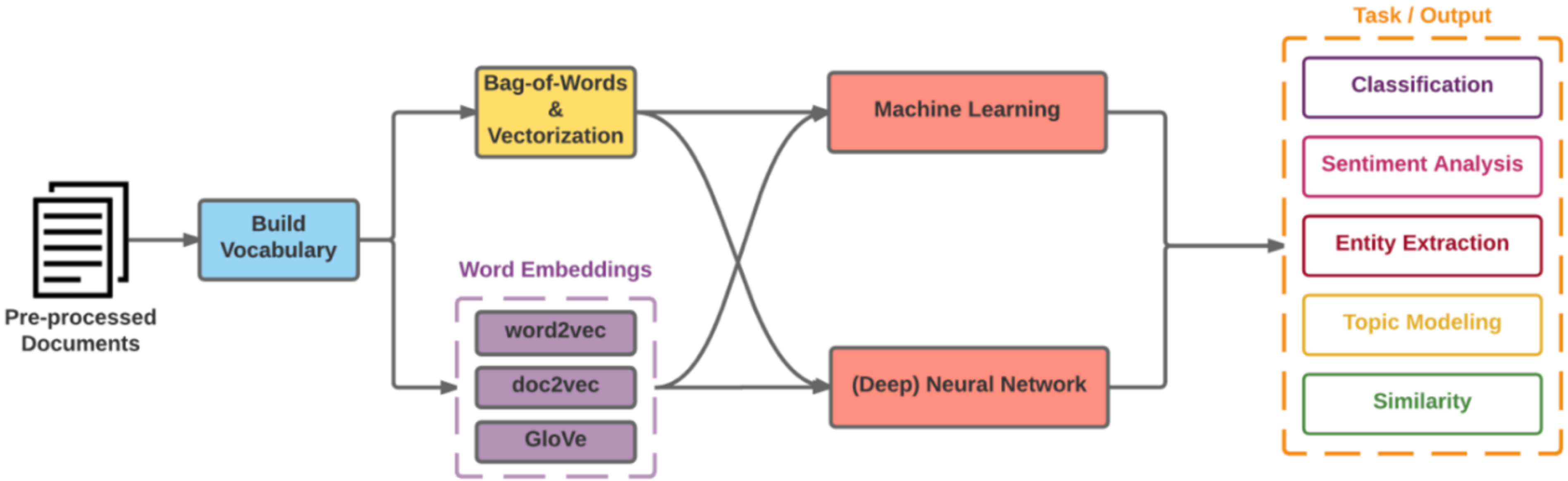




Source: https://github.com/fortiema/talks/blob/master/opendata2016sh/pragmatic-nlp-opendata2016sh.pdf

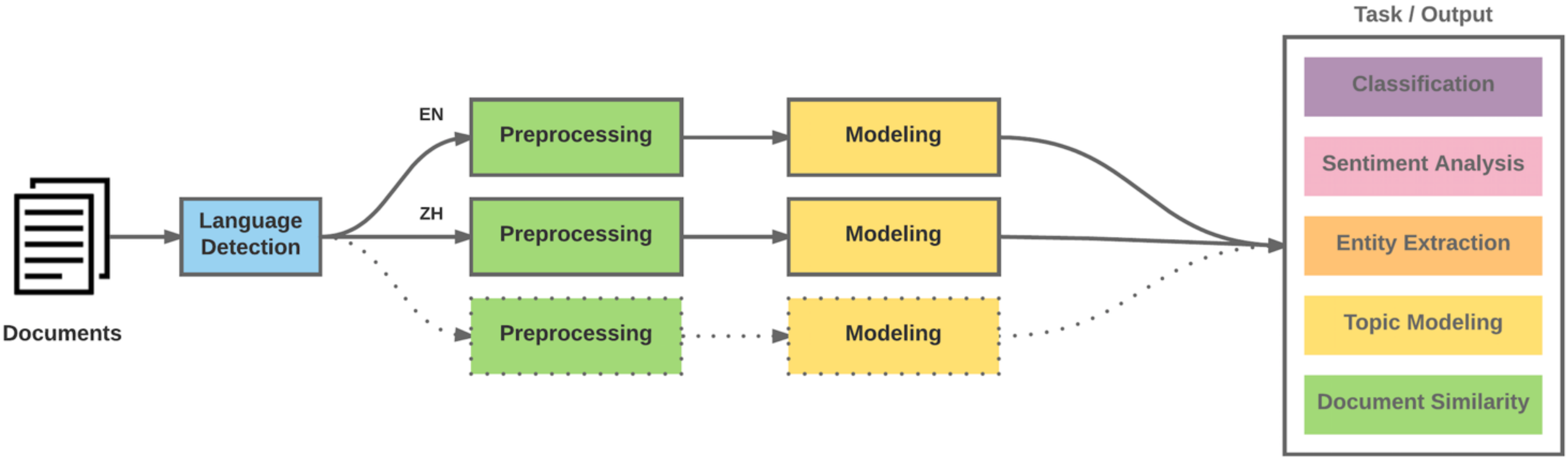
Modern NLP Pipeline





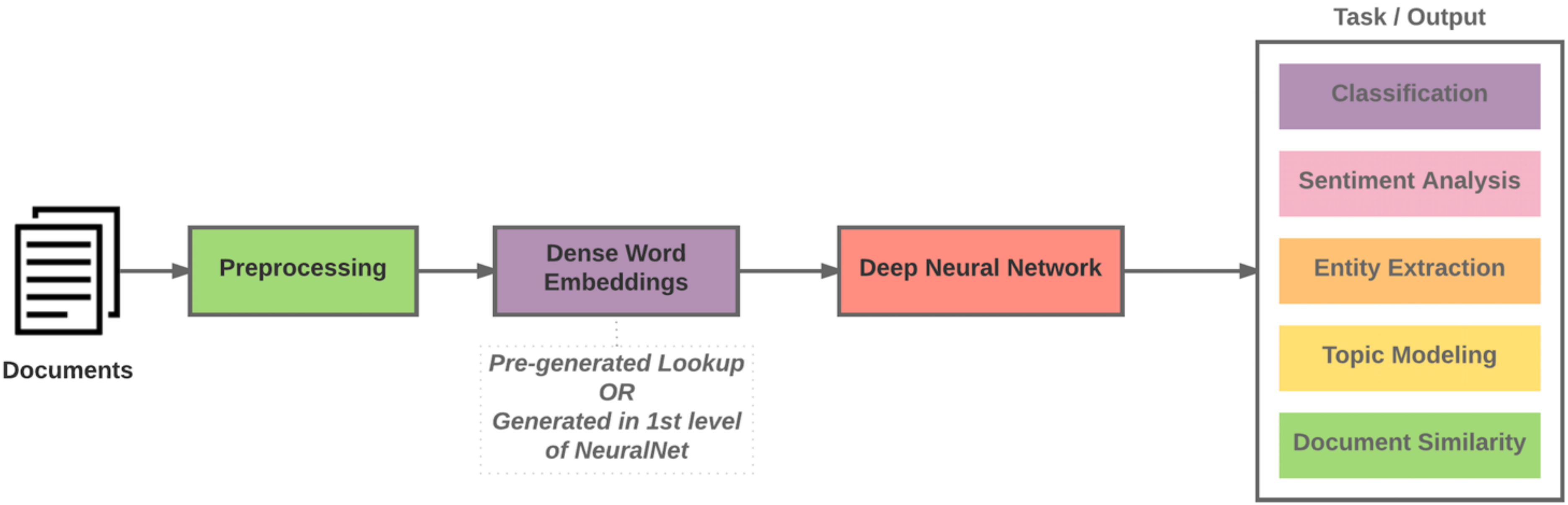
Source: https://github.com/fortiema/talks/blob/master/opendata2016sh/pragmatic-nlp-opendata2016sh.pdf

Modern NLP Pipeline



Source: http://mattfortier.me/2017/01/31/nlp-intro-pt-1-overview/

Deep Learning NLP



Source: http://mattfortier.me/2017/01/31/nlp-intro-pt-1-overview/

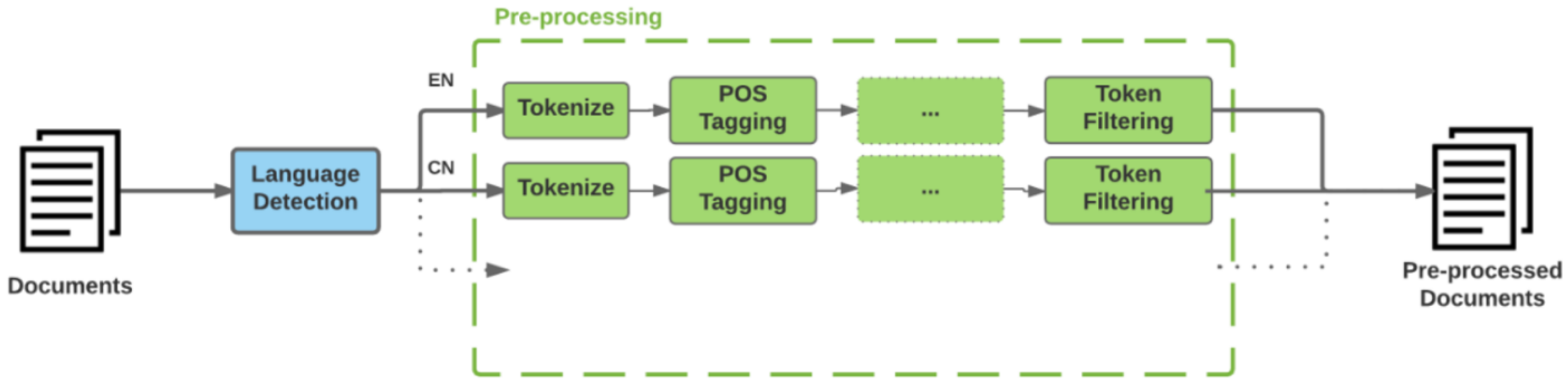
Vector Representations of Words

Word Embeddings

Word2Vec

GloVe

Modern NLP Pipeline



Pre-processing

Documents

Language Detection

EN

CN

Tokenize

POS Tagging

...

Token Filtering

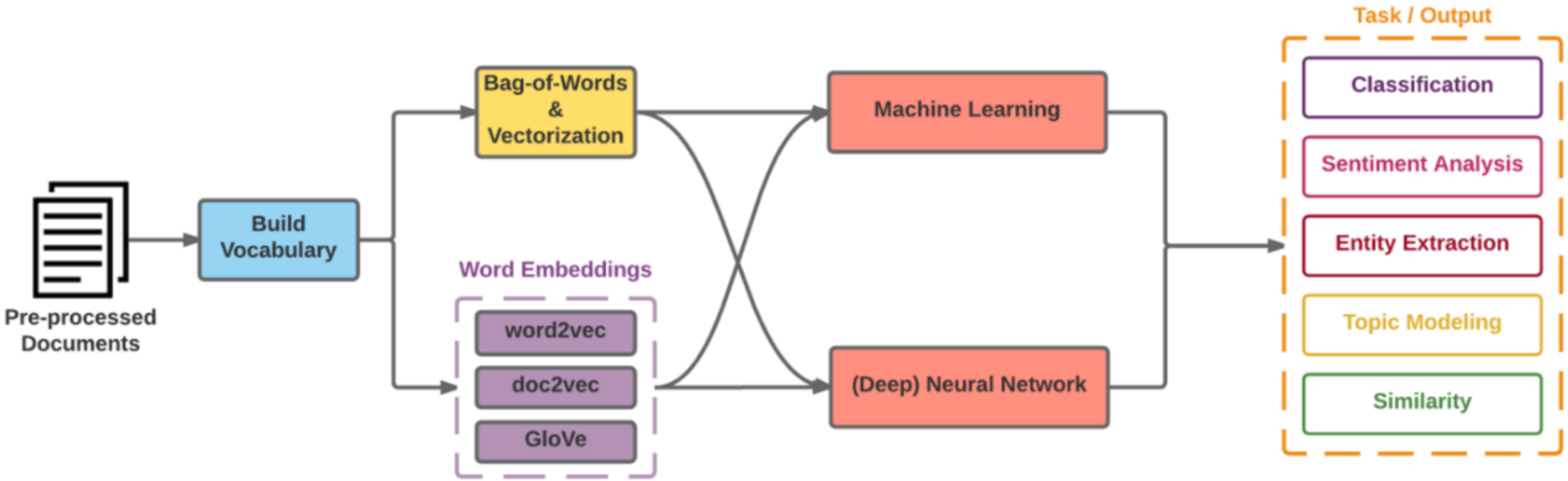
Tokenize

POS Tagging

...

Token Filtering

Pre-processed Documents



Task / Output

Pre-processed Documents

Build Vocabulary

Bag-of-Words & Vectorization

Word Embeddings

word2vec

doc2vec

GloVe

Machine Learning

(Deep) Neural Network

Classification

Sentiment Analysis

Entity Extraction

Topic Modeling

Similarity

Source: https://github.com/fortiema/talks/blob/master/opendata2016sh/pragmatic-nlp-opendata2016sh.pdf

Facebook Research FastText

Pre-trained word vectors
Word2Vec
wiki.zh.vec (861MB)
332647 word
300 vec

Pre-trained word vectors for 90 languages, trained on Wikipedia using fastText.

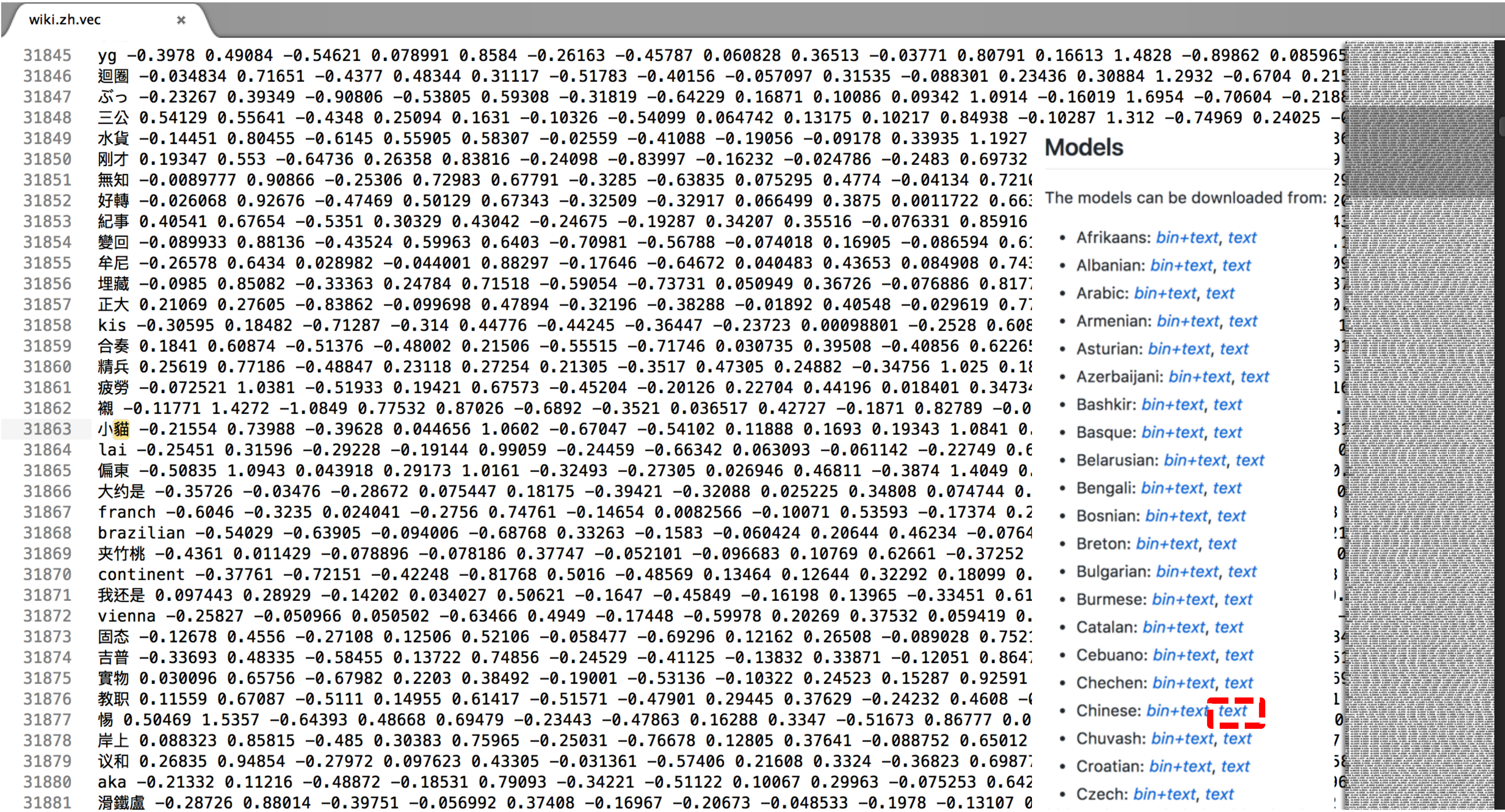
These vectors in dimension 300 were obtained using the skip-gram model with default parameters.

https://github.com/facebookresearch/fastText/blob/master/pretrained-vectors.md

Source: Bojanowski, Piotr, Edouard Grave, Armand Joulin, and Tomas Mikolov. "Enriching word vectors with subword information." *arXiv preprint arXiv:1607.04606* (2016).

Facebook Research FastText Word2Vec: wiki.zh.vec

(861MB) (332647 word 300 vec)



```
yg -0.3978 0.49084 -0.54621 0.078991 0.8584 -0.26163 -0.45787 0.060828 0.36513 -0.03771 0.80791 0.16613 1.4828 -0.89862 0.085965
迴圈 -0.034834 0.71651 -0.4377 0.48344 0.31117 -0.51783 -0.40156 -0.057097 0.31535 -0.088301 0.23436 0.30884 1.2932 -0.6704 0.21
ぶっ -0.23267 0.39349 -0.90806 -0.53805 0.59308 -0.31819 -0.64229 0.16871 0.10086 0.09342 1.0914 -0.16019 1.6954 -0.70604 -0.218
三公 0.54129 0.55641 -0.4348 0.25094 0.1631 -0.10326 -0.54099 0.064742 0.13175 0.10217 0.84938 -0.10287 1.312 -0.74969 0.24025 -
水貨 -0.14451 0.80455 -0.6145 0.55905 0.58307 -0.02559 -0.41088 -0.19056 -0.09178 0.33935 1.1927
刚才 0.19347 0.553 -0.64736 0.26358 0.83816 -0.24098 -0.83997 -0.16232 -0.024786 -0.2483 0.69732
無知 -0.0089777 0.90866 -0.25306 0.72983 0.67791 -0.3285 -0.63835 0.075295 0.4774 -0.04134 0.721
好轉 -0.026068 0.92676 -0.47469 0.50129 0.67343 -0.32509 -0.32917 0.066499 0.3875 0.0011722 0.66
紀事 0.40541 0.67654 -0.5351 0.30329 0.43042 -0.24675 -0.19287 0.34207 0.35516 -0.076331 0.85916
變回 -0.089933 0.88136 -0.43524 0.59963 0.6403 -0.70981 -0.56788 -0.074018 0.16905 -0.086594 0.6
牟尼 -0.26578 0.6434 0.028982 -0.044001 0.88297 -0.17646 -0.64672 0.040483 0.43653 0.084908 0.74
埋藏 -0.0985 0.85082 -0.33363 0.24784 0.71518 -0.59054 -0.73731 0.050949 0.36726 -0.076886 0.817
正大 0.21069 0.27605 -0.83862 -0.099698 0.47894 -0.32196 -0.38288 -0.01892 0.40548 -0.029619 0.7
kis -0.30595 0.18482 -0.71287 -0.314 0.44776 -0.44245 -0.36447 -0.23723 0.00098801 -0.2528 0.608
合奏 0.1841 0.60874 -0.51376 -0.48002 0.21506 -0.55515 -0.71746 0.030735 0.39508 -0.40856 0.6226
精兵 0.25619 0.77186 -0.48847 0.23118 0.27254 0.21305 -0.3517 0.47305 0.24882 -0.34756 1.025 0.1
疲勞 -0.072521 1.0381 -0.51933 0.19421 0.67573 -0.45204 -0.20126 0.22704 0.44196 0.018401 0.3473
襯 -0.11771 1.4272 -1.0849 0.77532 0.87026 -0.6892 -0.3521 0.036517 0.42727 -0.1871 0.82789 -0.0
小貓 -0.21554 0.73988 -0.39628 0.044656 1.0602 -0.67047 -0.54102 0.11888 0.1693 0.19343 1.0841 0.
lai -0.25451 0.31596 -0.29228 -0.19144 0.99059 -0.24459 -0.66342 0.063093 -0.061142 -0.22749 0.6
偏東 -0.50835 1.0943 0.043918 0.29173 1.0161 -0.32493 -0.27305 0.026946 0.46811 -0.3874 1.4049 0.
大约是 -0.35726 -0.03476 -0.28672 0.075447 0.18175 -0.39421 -0.32088 0.025225 0.34808 0.074744 0.
franch -0.6046 -0.3235 0.024041 -0.2756 0.74761 -0.14654 0.0082566 -0.10071 0.53593 -0.17374 0.2
brazilian -0.54029 -0.63905 -0.094006 -0.68768 0.33263 -0.1583 -0.060424 0.20644 0.46234 -0.0764
夹竹桃 -0.4361 0.011429 -0.078896 -0.078186 0.37747 -0.052101 -0.096683 0.10769 0.62661 -0.37252
continent -0.37761 -0.72151 -0.42248 -0.81768 0.5016 -0.48569 0.13464 0.12644 0.32292 0.18099 0.
我还是 0.097443 0.28929 -0.14202 0.034027 0.50621 -0.1647 -0.45849 -0.16198 0.13965 -0.33451 0.61
vienna -0.25827 -0.050966 0.050502 -0.63466 0.4949 -0.17448 -0.59978 0.20269 0.37532 0.059419 0.
固态 -0.12678 0.4556 -0.27108 0.12506 0.52106 -0.058477 -0.69296 0.12162 0.26508 -0.089028 0.752
吉普 -0.33693 0.48335 -0.58455 0.13722 0.74856 -0.24529 -0.41125 -0.13832 0.33871 -0.12051 0.864
實物 0.030096 0.65756 -0.67982 0.2203 0.38492 -0.19001 -0.53136 -0.10322 0.24523 0.15287 0.92591
教职 0.11559 0.67087 -0.5111 0.14955 0.61417 -0.51571 -0.47901 0.29445 0.37629 -0.24232 0.4608 -
惕 0.50469 1.5357 -0.64393 0.48668 0.69479 -0.23443 -0.47863 0.16288 0.3347 -0.51673 0.86777 0.0
岸上 0.088323 0.85815 -0.485 0.30383 0.75965 -0.25031 -0.76678 0.12805 0.37641 -0.088752 0.65012
议和 0.26835 0.94854 -0.27972 0.097623 0.43305 -0.031361 -0.57406 0.21608 0.3324 -0.36823 0.698
aka -0.21332 0.11216 -0.48872 -0.18531 0.79093 -0.34221 -0.51122 0.10067 0.29963 -0.075253 0.642
滑鐵盧 -0.28726 0.88014 -0.39751 -0.056992 0.37408 -0.16967 -0.20673 -0.048533 -0.1978 -0.13107 0
```

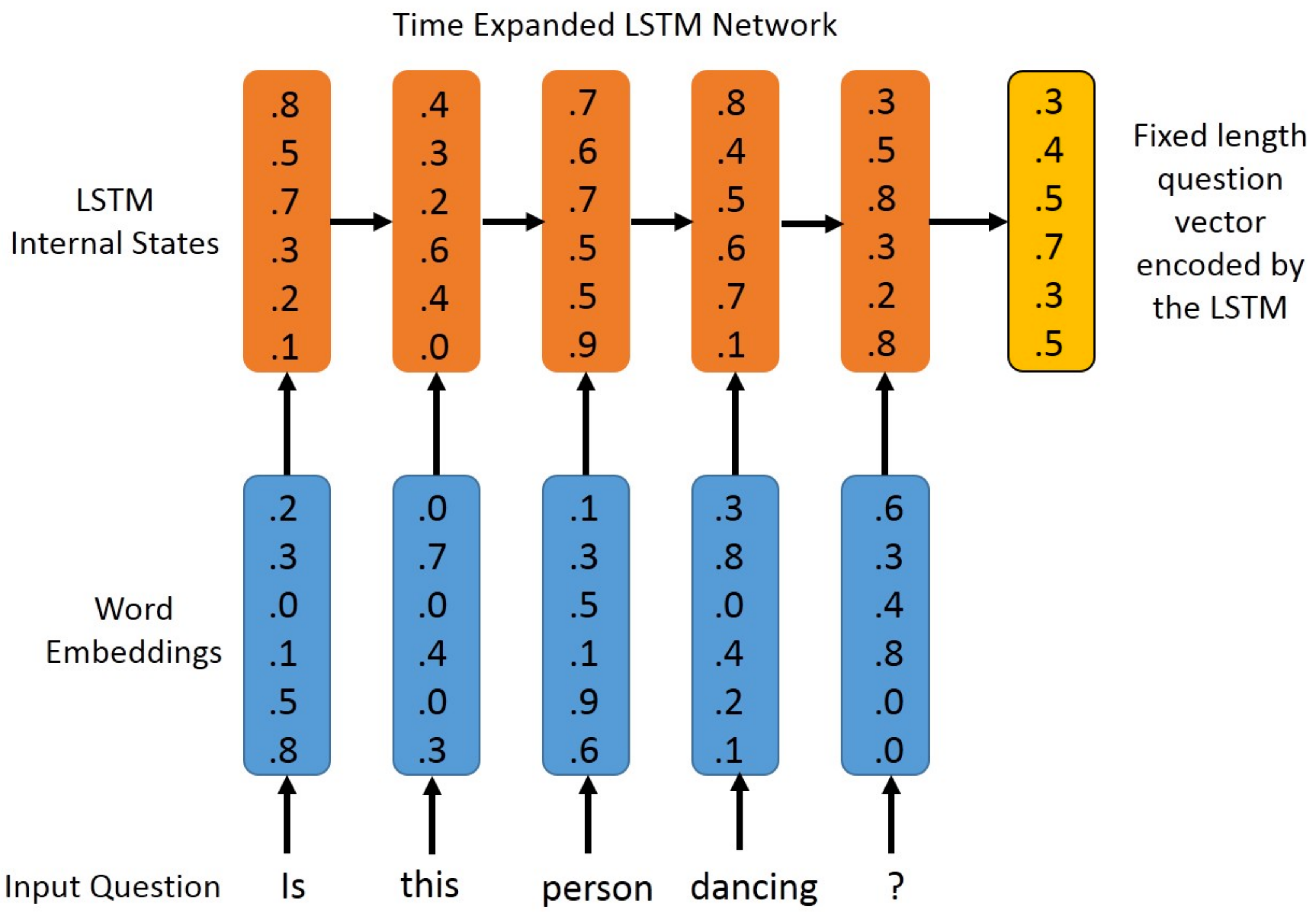
Models

The models can be downloaded from:

- Afrikaans: *bin+text*, *text*
- Albanian: *bin+text*, *text*
- Arabic: *bin+text*, *text*
- Armenian: *bin+text*, *text*
- Asturian: *bin+text*, *text*
- Azerbaijani: *bin+text*, *text*
- Bashkir: *bin+text*, *text*
- Basque: *bin+text*, *text*
- Belarusian: *bin+text*, *text*
- Bengali: *bin+text*, *text*
- Bosnian: *bin+text*, *text*
- Breton: *bin+text*, *text*
- Bulgarian: *bin+text*, *text*
- Burmese: *bin+text*, *text*
- Catalan: *bin+text*, *text*
- Cebuano: *bin+text*, *text*
- Chechen: *bin+text*, *text*
- Chinese: *bin+text*, *text*
- Chuvash: *bin+text*, *text*
- Croatian: *bin+text*, *text*
- Czech: *bin+text*, *text*

https://github.com/facebookresearch/fastText/blob/master/pretrained-vectors.md

Word Embeddings in LSTM RNN



Time Expanded LSTM Network

LSTM Internal States

.8	.4	.7	.8	.3	.3
.5	.3	.6	.4	.5	.4
.7	.2	.7	.5	.8	.5
.3	.6	.5	.6	.3	.7
.2	.4	.5	.7	.2	.3
.1	.0	.9	.1	.8	.5

Fixed length question vector encoded by the LSTM

Word Embeddings

.2	.0	.1	.3	.6
.3	.7	.3	.8	.3
.0	.0	.5	.0	.4
.1	.4	.1	.4	.8
.5	.0	.9	.2	.0
.8	.3	.6	.1	.0

Input Question Is this person dancing ?

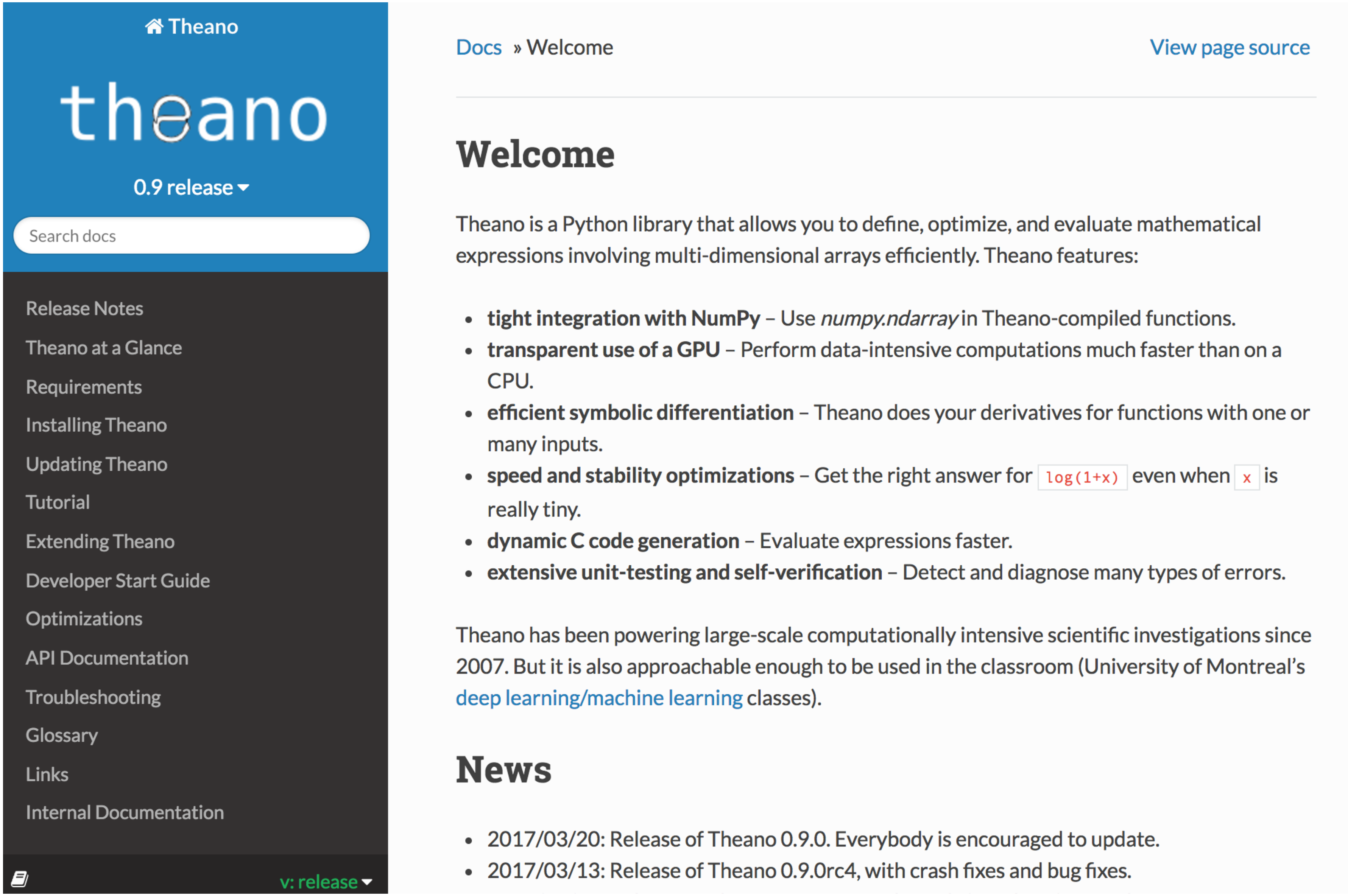
Source: https://avisingh599.github.io/deeplearning/visual-qa/

Deep Learning Software

- Theano
  - CPU/GPU symbolic expression compiler in python (from MILA lab at University of Montreal)
- Keras
  - Deep Learning library for Theano and TensorFlow
- Tensorflow
  - TensorFlow™ is an open source software library for numerical computation using data flow graphs.

Source: http://deeplearning.net/software_links/

Theano



Welcome

Theano is a Python library that allows you to define, optimize, and evaluate mathematical expressions involving multi-dimensional arrays efficiently. Theano features:

- **tight integration with NumPy** – Use *numpy.ndarray* in Theano-compiled functions.
- **transparent use of a GPU** – Perform data-intensive computations much faster than on a CPU.
- **efficient symbolic differentiation** – Theano does your derivatives for functions with one or many inputs.
- **speed and stability optimizations** – Get the right answer for `log(1+x)` even when `x` is really tiny.
- **dynamic C code generation** – Evaluate expressions faster.
- **extensive unit-testing and self-verification** – Detect and diagnose many types of errors.

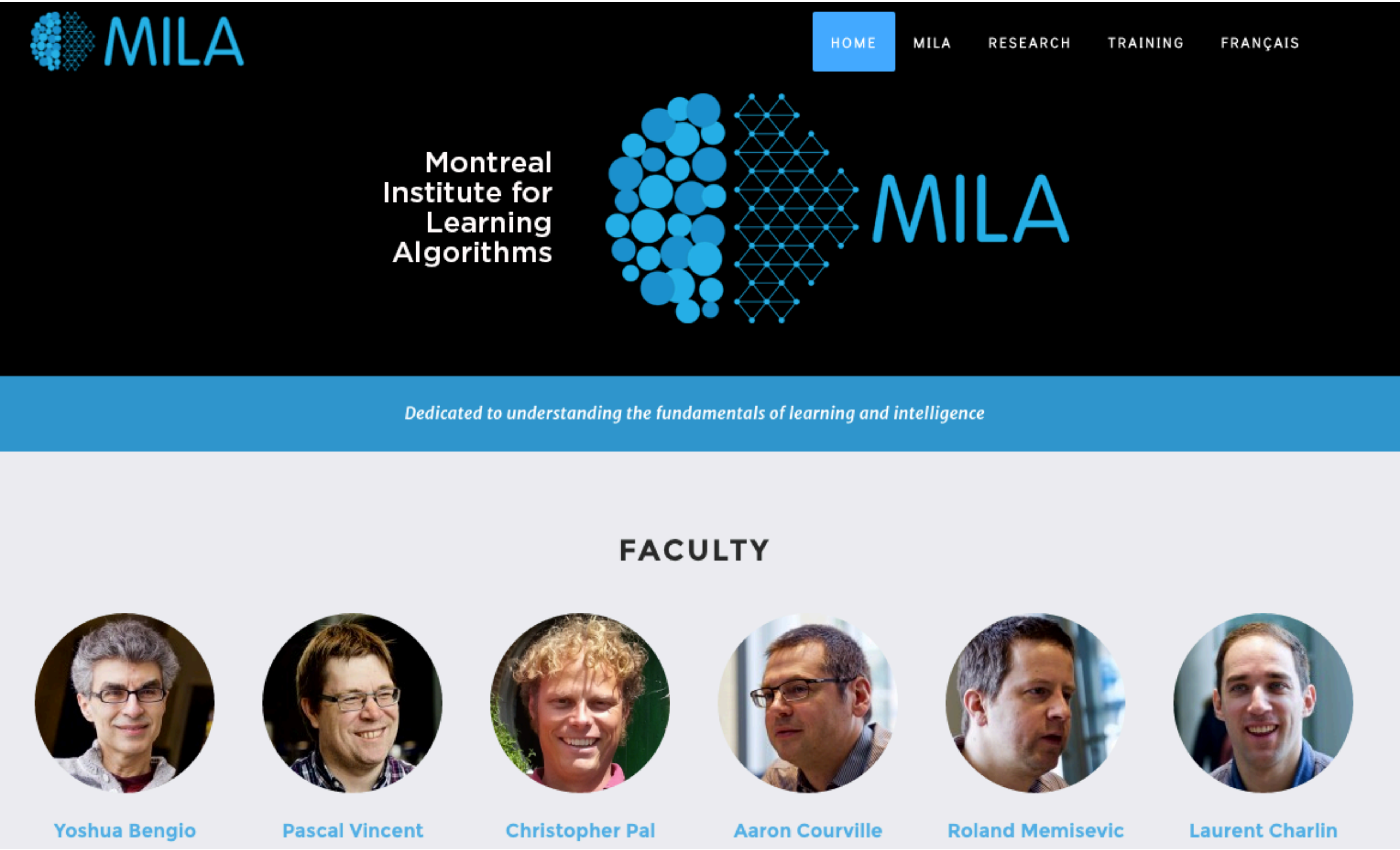
Theano has been powering large-scale computationally intensive scientific investigations since 2007. But it is also approachable enough to be used in the classroom (University of Montreal's deep learning/machine learning classes).

News

- 2017/03/20: Release of Theano 0.9.0. Everybody is encouraged to update.
- 2017/03/13: Release of Theano 0.9.0rc4, with crash fixes and bug fixes.

http://deeplearning.net/software/theano/

Université de Montréal | **Montreal Institute for Learning Algorithms**



Dedicated to understanding the fundamentals of learning and intelligence

FACULTY

Yoshua Bengio

Pascal Vincent

Christopher Pal

Aaron Courville

Roland Memisevic

Laurent Charlin

https://mila.umontreal.ca/en/

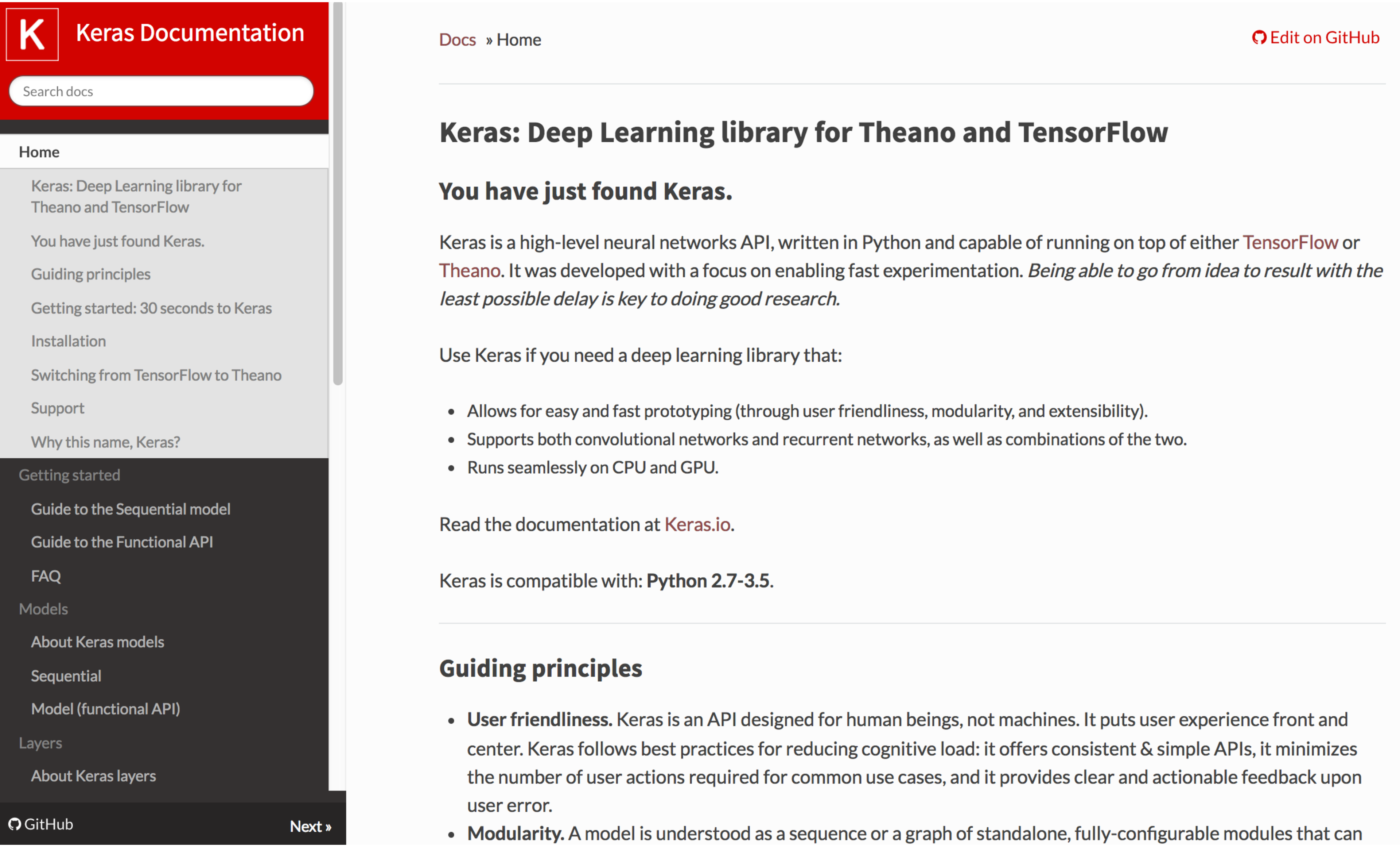
Keras

Keras

- Keras is a high-level neural networks API
- Written in Python and capable of running on top of either TensorFlow or Theano.
- It was developed with a focus on enabling fast experimentation.
- Being able to go from idea to result with the least possible delay is key to doing good research.

Source: https://keras.io/

Keras



Keras: Deep Learning library for Theano and TensorFlow

You have just found Keras.

Keras is a high-level neural networks API, written in Python and capable of running on top of either TensorFlow or Theano. It was developed with a focus on enabling fast experimentation. *Being able to go from idea to result with the least possible delay is key to doing good research.*

Use Keras if you need a deep learning library that:

- Allows for easy and fast prototyping (through user friendliness, modularity, and extensibility).
- Supports both convolutional networks and recurrent networks, as well as combinations of the two.
- Runs seamlessly on CPU and GPU.

Read the documentation at Keras.io.

Keras is compatible with: **Python 2.7-3.5**.

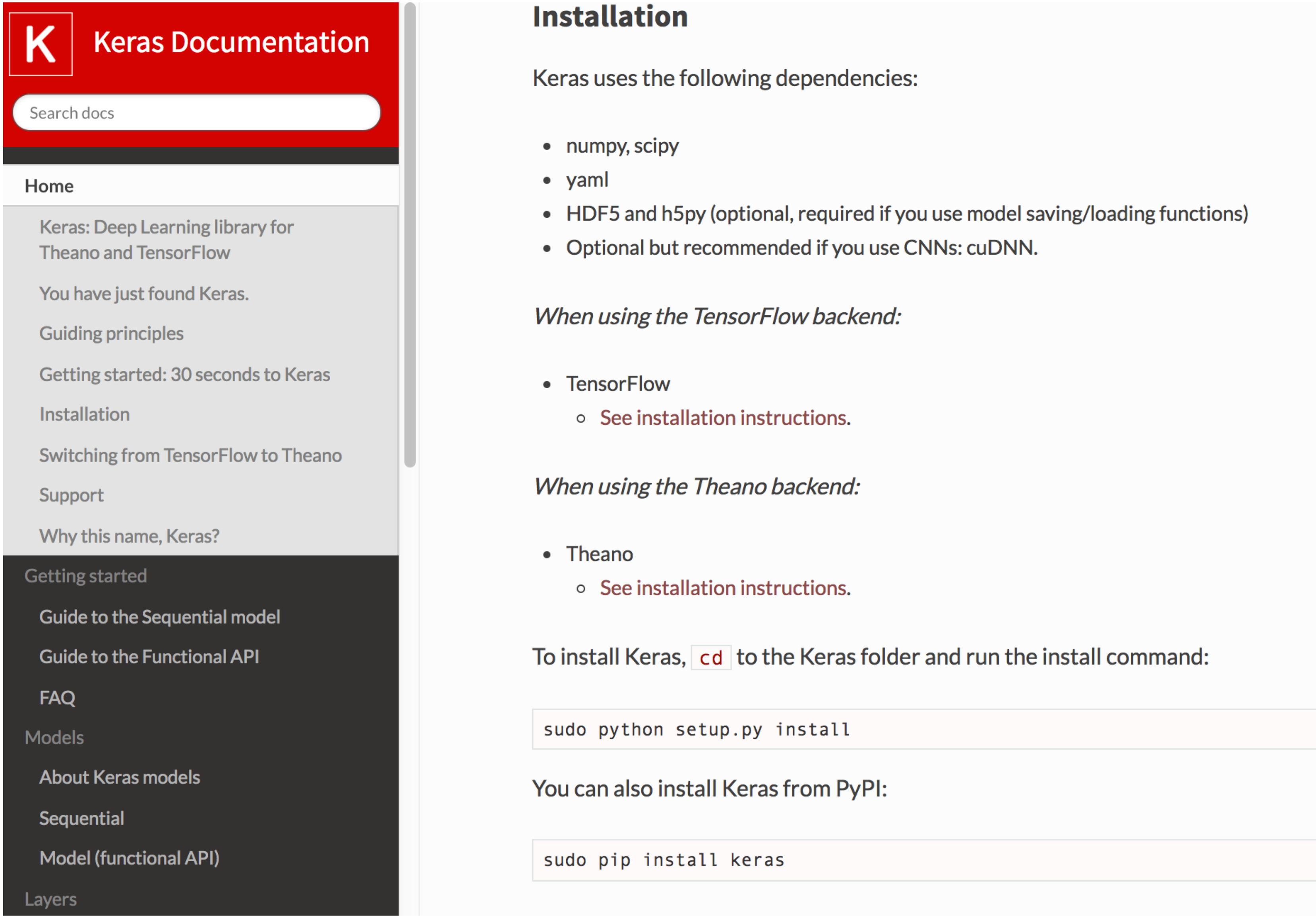
Guiding principles

- **User friendliness.** Keras is an API designed for human beings, not machines. It puts user experience front and center. Keras follows best practices for reducing cognitive load: it offers consistent & simple APIs, it minimizes the number of user actions required for common use cases, and it provides clear and actionable feedback upon user error.
- **Modularity.** A model is understood as a sequence or a graph of standalone, fully-configurable modules that can

http://keras.io/

Deep Learning
with
Keras

Keras Installation


K
Keras Documentation
Search docs
Home
Keras: Deep Learning library for Theano and TensorFlow
You have just found Keras.
Guiding principles
Getting started: 30 seconds to Keras
Installation
Switching from TensorFlow to Theano
Support
Why this name, Keras?
Getting started
Guide to the Sequential model
Guide to the Functional API
FAQ
Models
About Keras models
Sequential
Model (functional API)
Layers

Installation

Keras uses the following dependencies:

- numpy, scipy
- yaml
- HDF5 and h5py (optional, required if you use model saving/loading functions)
- Optional but recommended if you use CNNs: cuDNN.

When using the TensorFlow backend:

- TensorFlow
  - See installation instructions.

When using the Theano backend:

- Theano
  - See installation instructions.

To install Keras, `cd` to the Keras folder and run the install command:

```
sudo python setup.py install
```

You can also install Keras from PyPI:

```
sudo pip install keras
```

https://keras.io/#installation

```
conda info --envs
```

```
conda --version
python --version
```

```
conda list
```

```
conda create -n tensorflow python=3.5
```

```
source activate tensorflow
```

```
activate tensorflow
```

Source: http://deeplearning.net/software/theano/install.html#anaconda

```
pip install Theano
```

```
conda install pydot
```

```
sudo pip install keras
```

```
pip install keras
```

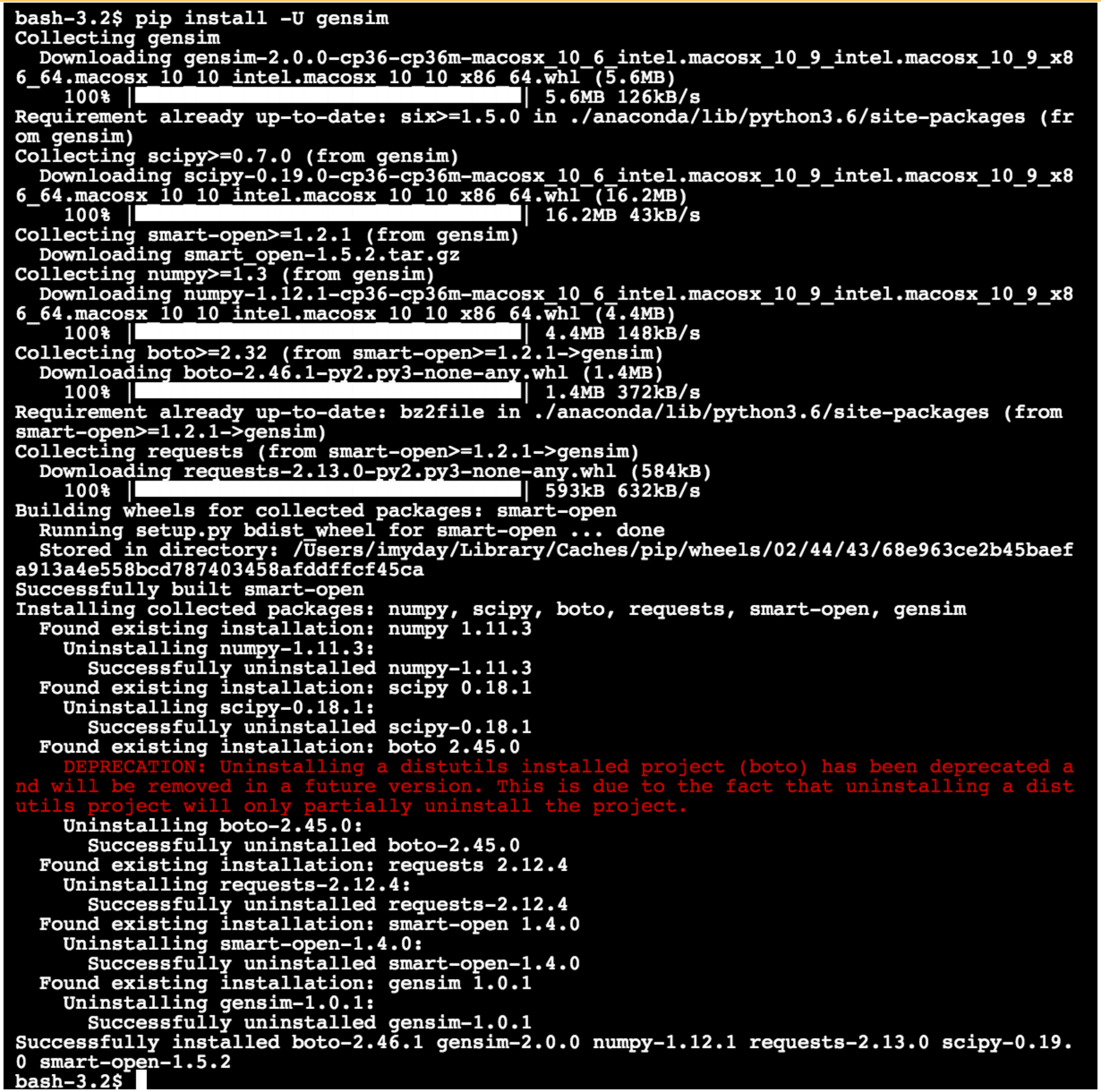
```
pip install tensorflow
```

```
pip install ipython[all]
```

Source: http://deeplearning.net/software/theano/install.html#anaconda

Gensim

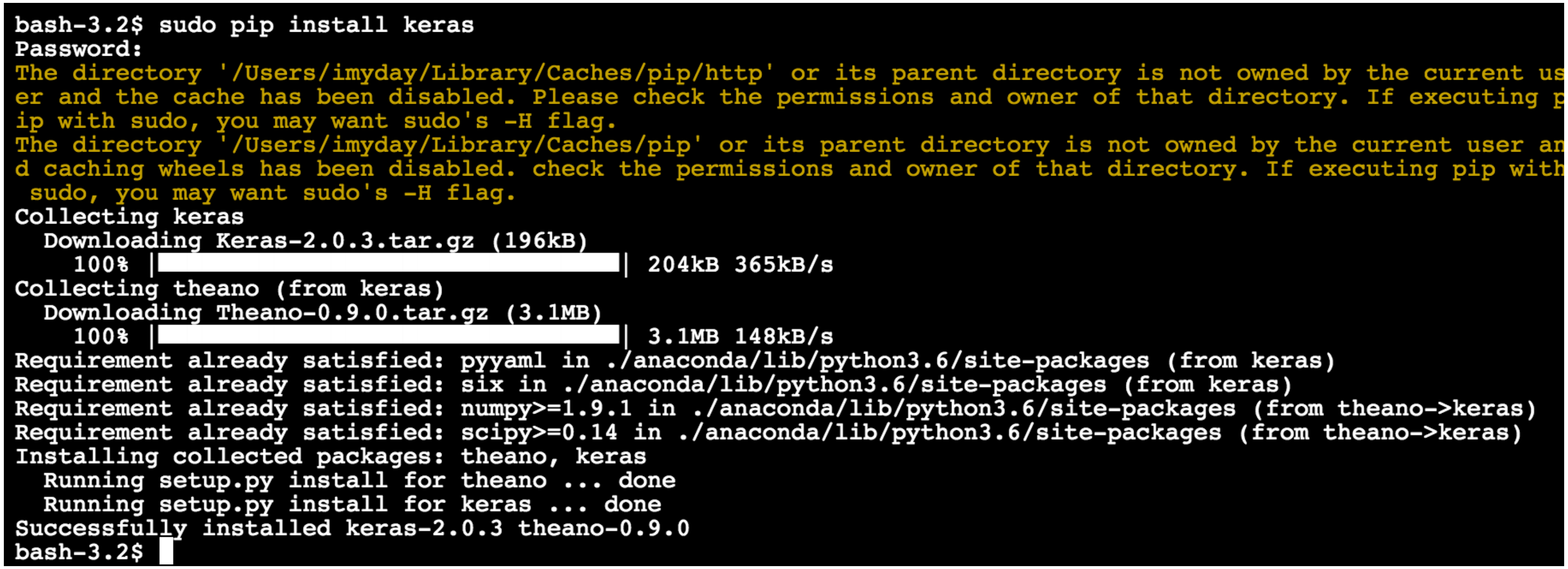
pip install -U gensim



```
bash-3.2$ pip install -U gensim
Collecting gensim
  Downloading gensim-2.0.0-cp36-cp36m-macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x8
6_64.macosx_10_10_intel.macosx_10_10_x86_64.whl (5.6MB)
    100% |████████████████████████████████| 5.6MB 126kB/s
Requirement already up-to-date: six>=1.5.0 in ./anaconda/lib/python3.6/site-packages (fr
om gensim)
Collecting scipy>=0.7.0 (from gensim)
  Downloading scipy-0.19.0-cp36-cp36m-macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x8
6_64.macosx_10_10_intel.macosx_10_10_x86_64.whl (16.2MB)
    100% |████████████████████████████████| 16.2MB 43kB/s
Collecting smart-open>=1.2.1 (from gensim)
  Downloading smart_open-1.5.2.tar.gz
Collecting numpy>=1.3 (from gensim)
  Downloading numpy-1.12.1-cp36-cp36m-macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x8
6_64.macosx_10_10_intel.macosx_10_10_x86_64.whl (4.4MB)
    100% |████████████████████████████████| 4.4MB 148kB/s
Collecting boto>=2.32 (from smart-open>=1.2.1->gensim)
  Downloading boto-2.46.1-py2.py3-none-any.whl (1.4MB)
    100% |████████████████████████████████| 1.4MB 372kB/s
Requirement already up-to-date: bz2file in ./anaconda/lib/python3.6/site-packages (from
smart-open>=1.2.1->gensim)
Collecting requests (from smart-open>=1.2.1->gensim)
  Downloading requests-2.13.0-py2.py3-none-any.whl (584kB)
    100% |████████████████████████████████| 593kB 632kB/s
Building wheels for collected packages: smart-open
  Running setup.py bdist_wheel for smart-open ... done
  Stored in directory: /Users/imyday/Library/Caches/pip/wheels/02/44/43/68e963ce2b45baef
a913a4e558bcd787403458afddffcf45ca
Successfully built smart-open
Installing collected packages: numpy, scipy, boto, requests, smart-open, gensim
  Found existing installation: numpy 1.11.3
    Uninstalling numpy-1.11.3:
      Successfully uninstalled numpy-1.11.3
  Found existing installation: scipy 0.18.1
    Uninstalling scipy-0.18.1:
      Successfully uninstalled scipy-0.18.1
  Found existing installation: boto 2.45.0
    DEPRECATION: Uninstalling a distutils installed project (boto) has been deprecated a
nd will be removed in a future version. This is due to the fact that uninstalling a dist
utils project will only partially uninstall the project.
    Uninstalling boto-2.45.0:
      Successfully uninstalled boto-2.45.0
  Found existing installation: requests 2.12.4
    Uninstalling requests-2.12.4:
      Successfully uninstalled requests-2.12.4
  Found existing installation: smart-open 1.4.0
    Uninstalling smart-open-1.4.0:
      Successfully uninstalled smart-open-1.4.0
  Found existing installation: gensim 1.0.1
    Uninstalling gensim-1.0.1:
      Successfully uninstalled gensim-1.0.1
Successfully installed boto-2.46.1 gensim-2.0.0 numpy-1.12.1 requests-2.13.0 scipy-0.19.
0 smart-open-1.5.2
bash-3.2$ █
```

Keras

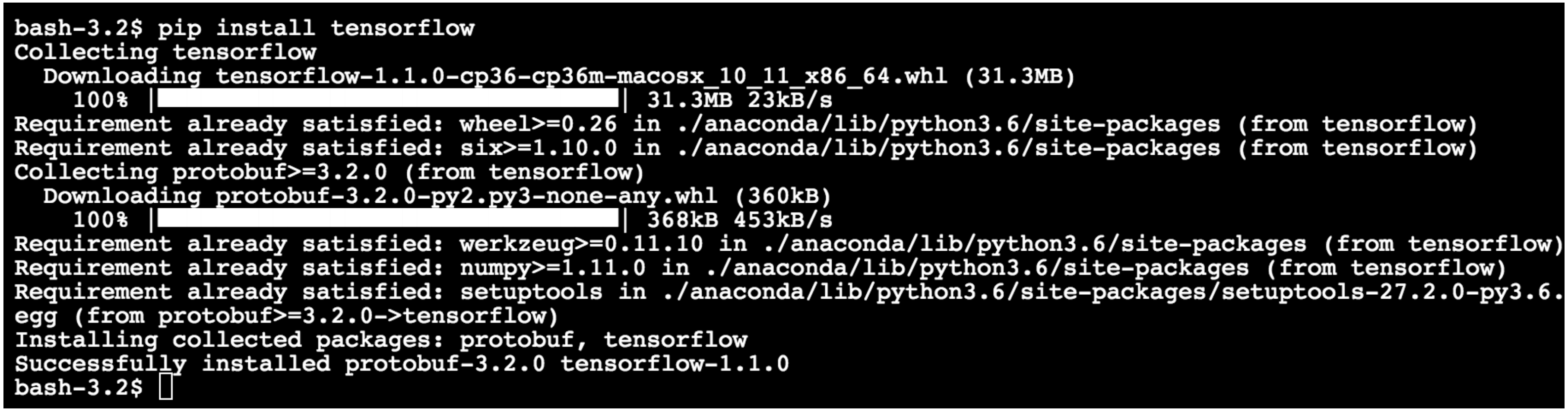
sudo pip install keras



```
bash-3.2$ sudo pip install keras
Password:
The directory '/Users/imyday/Library/Caches/pip/http' or its parent directory is not owned by the current us
er and the cache has been disabled. Please check the permissions and owner of that directory. If executing p
ip with sudo, you may want sudo's -H flag.
The directory '/Users/imyday/Library/Caches/pip' or its parent directory is not owned by the current user an
d caching wheels has been disabled. check the permissions and owner of that directory. If executing pip with
 sudo, you may want sudo's -H flag.
Collecting keras
  Downloading Keras-2.0.3.tar.gz (196kB)
    100% |████████████████████████████████| 204kB 365kB/s
Collecting theano (from keras)
  Downloading Theano-0.9.0.tar.gz (3.1MB)
    100% |████████████████████████████████| 3.1MB 148kB/s
Requirement already satisfied: pyyaml in ./anaconda/lib/python3.6/site-packages (from keras)
Requirement already satisfied: six in ./anaconda/lib/python3.6/site-packages (from keras)
Requirement already satisfied: numpy>=1.9.1 in ./anaconda/lib/python3.6/site-packages (from theano->keras)
Requirement already satisfied: scipy>=0.14 in ./anaconda/lib/python3.6/site-packages (from theano->keras)
Installing collected packages: theano, keras
  Running setup.py install for theano ... done
  Running setup.py install for keras ... done
Successfully installed keras-2.0.3 theano-0.9.0
bash-3.2$ █
```

TensorFlow

pip install tensorflow



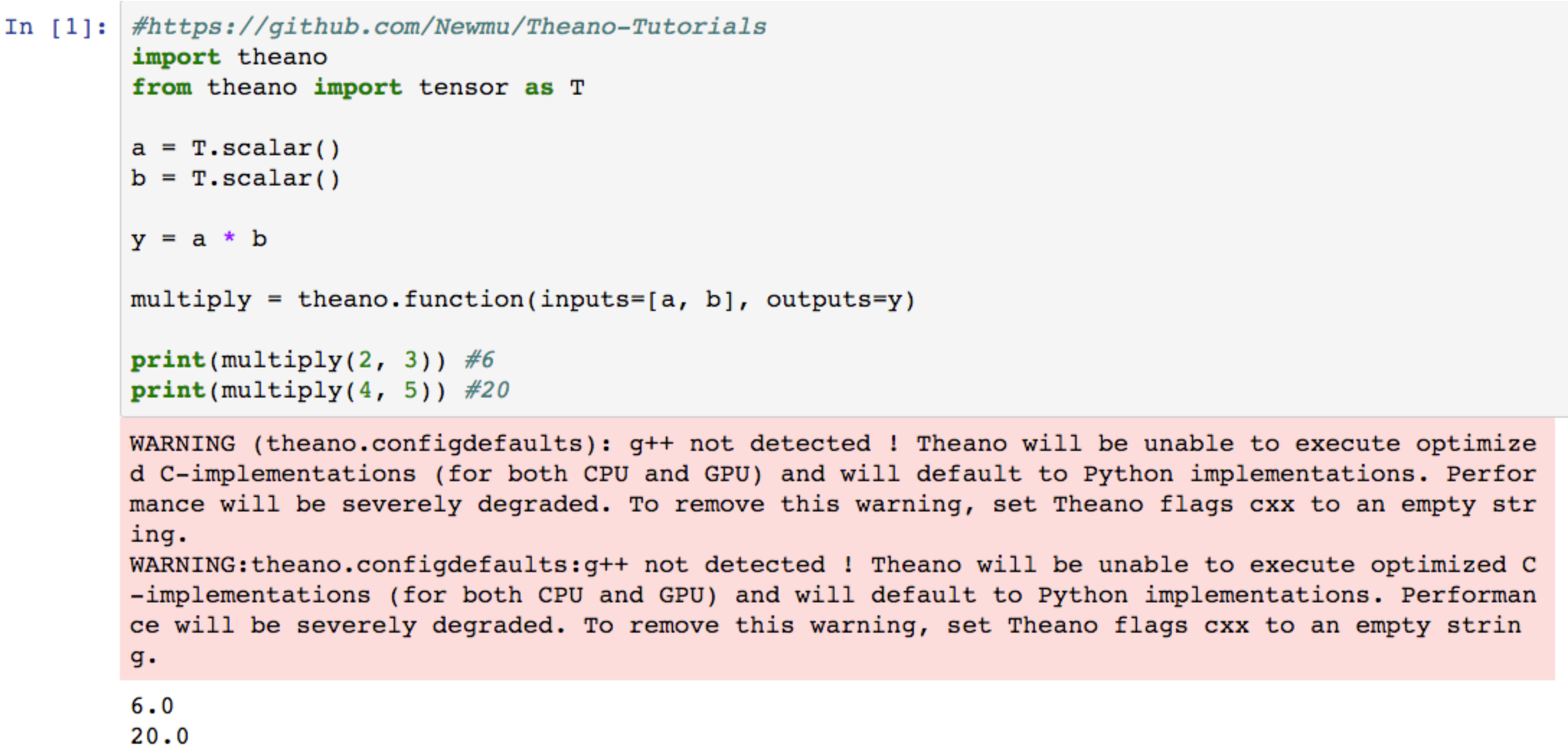
```
bash-3.2$ pip install tensorflow
Collecting tensorflow
  Downloading tensorflow-1.1.0-cp36-cp36m-macosx_10_11_x86_64.whl (31.3MB)
    100% |████████████████████████████████| 31.3MB 23kB/s
Requirement already satisfied: wheel>=0.26 in ./anaconda/lib/python3.6/site-packages (from tensorflow)
Requirement already satisfied: six>=1.10.0 in ./anaconda/lib/python3.6/site-packages (from tensorflow)
Collecting protobuf>=3.2.0 (from tensorflow)
  Downloading protobuf-3.2.0-py2.py3-none-any.whl (360kB)
    100% |████████████████████████████████| 368kB 453kB/s
Requirement already satisfied: werkzeug>=0.11.10 in ./anaconda/lib/python3.6/site-packages (from tensorflow)
Requirement already satisfied: numpy>=1.11.0 in ./anaconda/lib/python3.6/site-packages (from tensorflow)
Requirement already satisfied: setuptools in ./anaconda/lib/python3.6/site-packages/setuptools-27.2.0-py3.6.
egg (from protobuf>=3.2.0->tensorflow)
Installing collected packages: protobuf, tensorflow
Successfully installed protobuf-3.2.0 tensorflow-1.1.0
bash-3.2$ 
```

Theano Example

```
import theano
from theano import tensor as T

a = T.scalar()
b = T.scalar()

y = a * b

multiply = theano.function(inputs=[a, b], outputs=y)

print(multiply(2, 3)) #6
print(multiply(4, 5)) #20
```

Source: https://github.com/Newmu/Theano-Tutorials

Theano Example



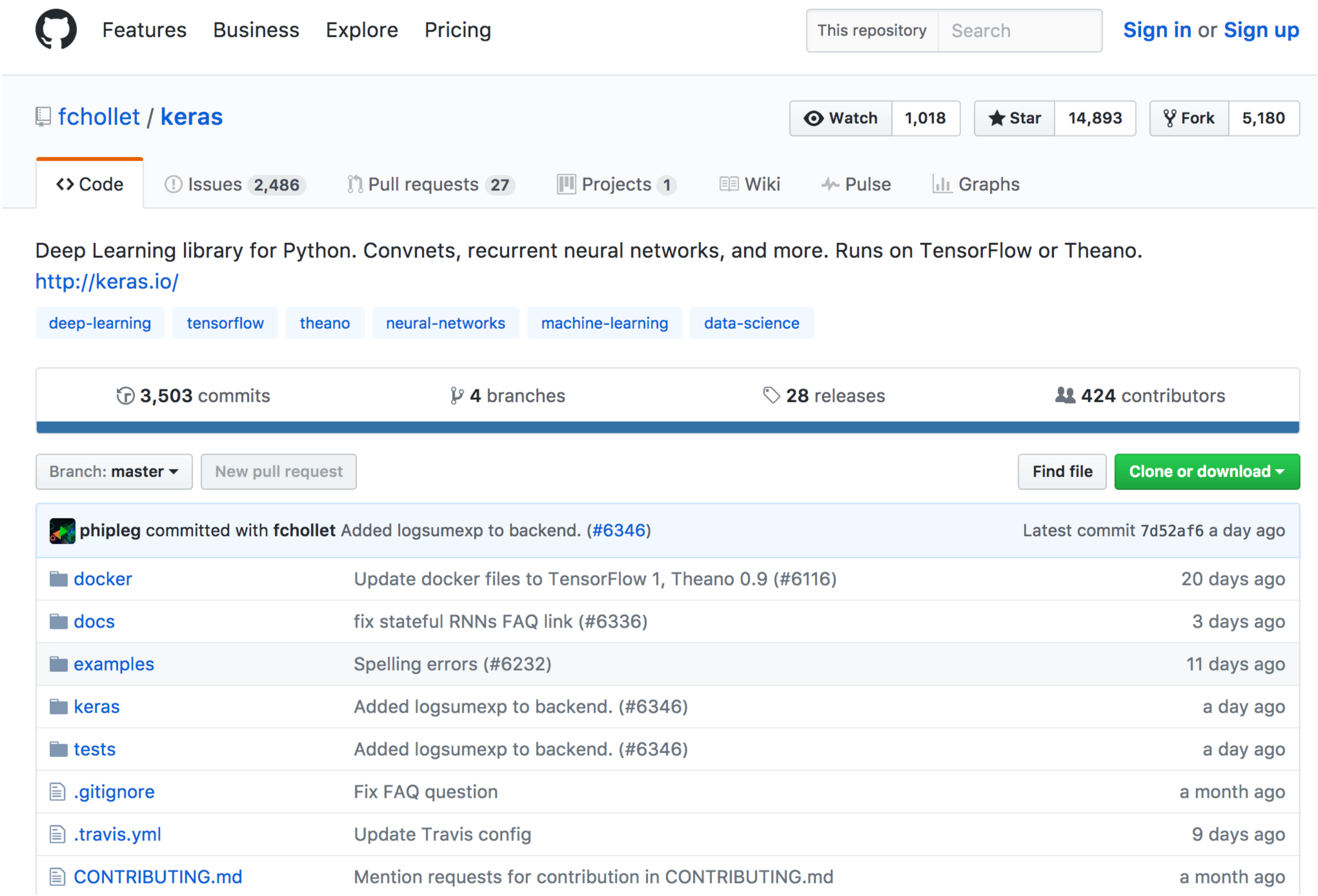
```
In [1]:
#https://github.com/Newmu/Theano-Tutorials
import theano
from theano import tensor as T

a = T.scalar()
b = T.scalar()

y = a * b

multiply = theano.function(inputs=[a, b], outputs=y)

print(multiply(2, 3)) #6
print(multiply(4, 5)) #20
```

```
WARNING (theano.configdefaults): g++ not detected ! Theano will be unable to execute optimize
d C-implementations (for both CPU and GPU) and will default to Python implementations. Perfor
mance will be severely degraded. To remove this warning, set Theano flags cxx to an empty str
ing.
WARNING:theano.configdefaults:g++ not detected ! Theano will be unable to execute optimized C
-implementations (for both CPU and GPU) and will default to Python implementations. Performan
ce will be severely degraded. To remove this warning, set Theano flags cxx to an empty strin
g.
```

```
6.0
20.0
```

Source: https://github.com/Newmu/Theano-Tutorials

Keras Github



Deep Learning library for Python. Convnets, recurrent neural networks, and more. Runs on TensorFlow or Theano.

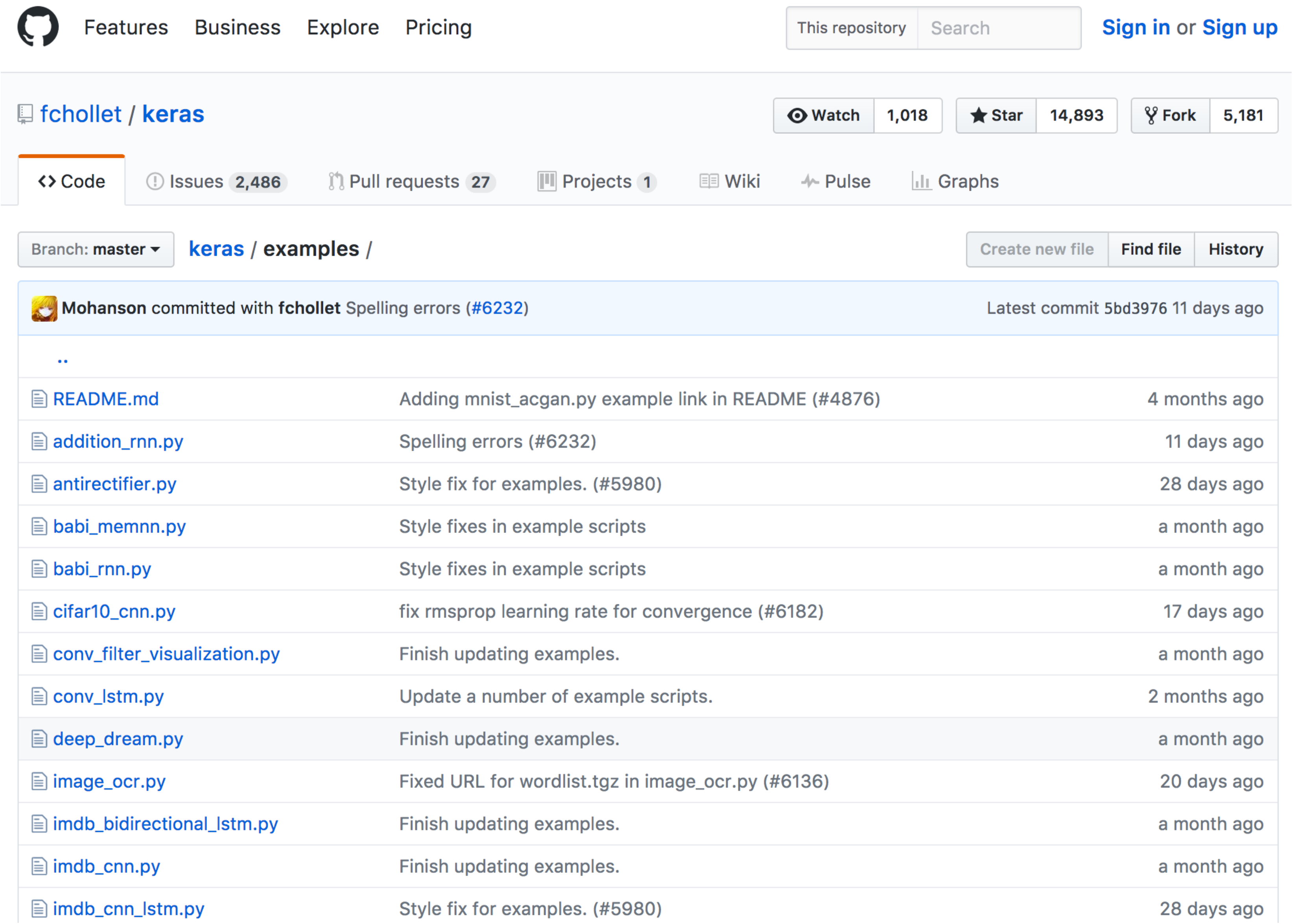
http://keras.io/

phipleg committed with **fchollet** Added logsumexp to backend. (#6346) Latest commit 7d52af6 a day ago

docker	Update docker files to TensorFlow 1, Theano 0.9 (#6116)	20 days ago
docs	fix stateful RNNs FAQ link (#6336)	3 days ago
examples	Spelling errors (#6232)	11 days ago
keras	Added logsumexp to backend. (#6346)	a day ago
tests	Added logsumexp to backend. (#6346)	a day ago
.gitignore	Fix FAQ question	a month ago
.travis.yml	Update Travis config	9 days ago
CONTRIBUTING.md	Mention requests for contribution in CONTRIBUTING.md	a month ago

https://github.com/fchollet/keras

Keras Examples

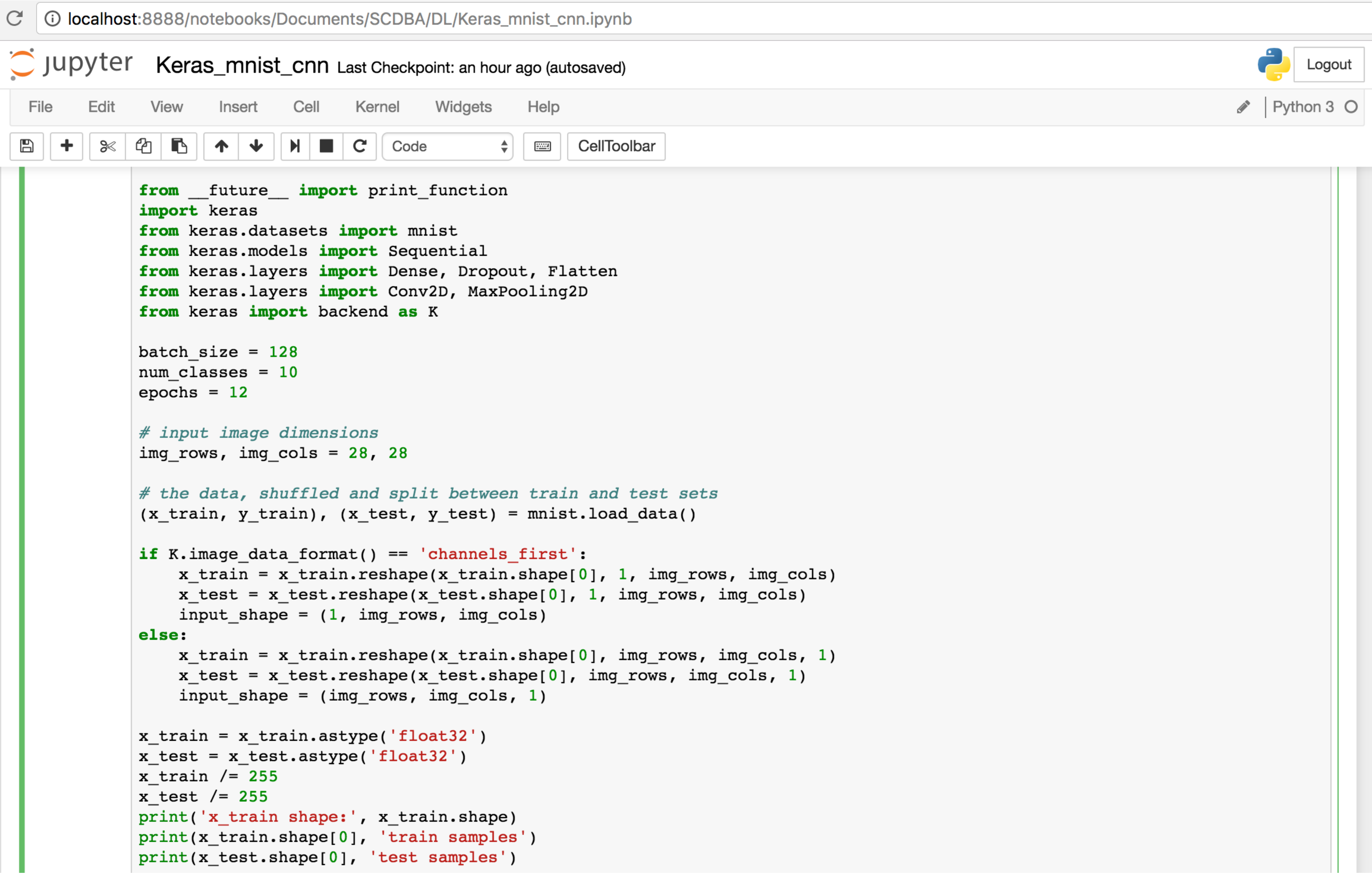


Mohanson committed with fchollet Spelling errors (#6232) Latest commit 5bd3976 11 days ago

..		
README.md	Adding mnist_acgan.py example link in README (#4876)	4 months ago
addition_rnn.py	Spelling errors (#6232)	11 days ago
antirectifier.py	Style fix for examples. (#5980)	28 days ago
babi_memnn.py	Style fixes in example scripts	a month ago
babi_rnn.py	Style fixes in example scripts	a month ago
cifar10_cnn.py	fix rmsprop learning rate for convergence (#6182)	17 days ago
conv_filter_visualization.py	Finish updating examples.	a month ago
conv_lstm.py	Update a number of example scripts.	2 months ago
deep_dream.py	Finish updating examples.	a month ago
image_ocr.py	Fixed URL for wordlist.tgz in image_ocr.py (#6136)	20 days ago
imdb_bidirectional_lstm.py	Finish updating examples.	a month ago
imdb_cnn.py	Finish updating examples.	a month ago
imdb_cnn_lstm.py	Style fix for examples. (#5980)	28 days ago

https://github.com/fchollet/keras/tree/master/examples

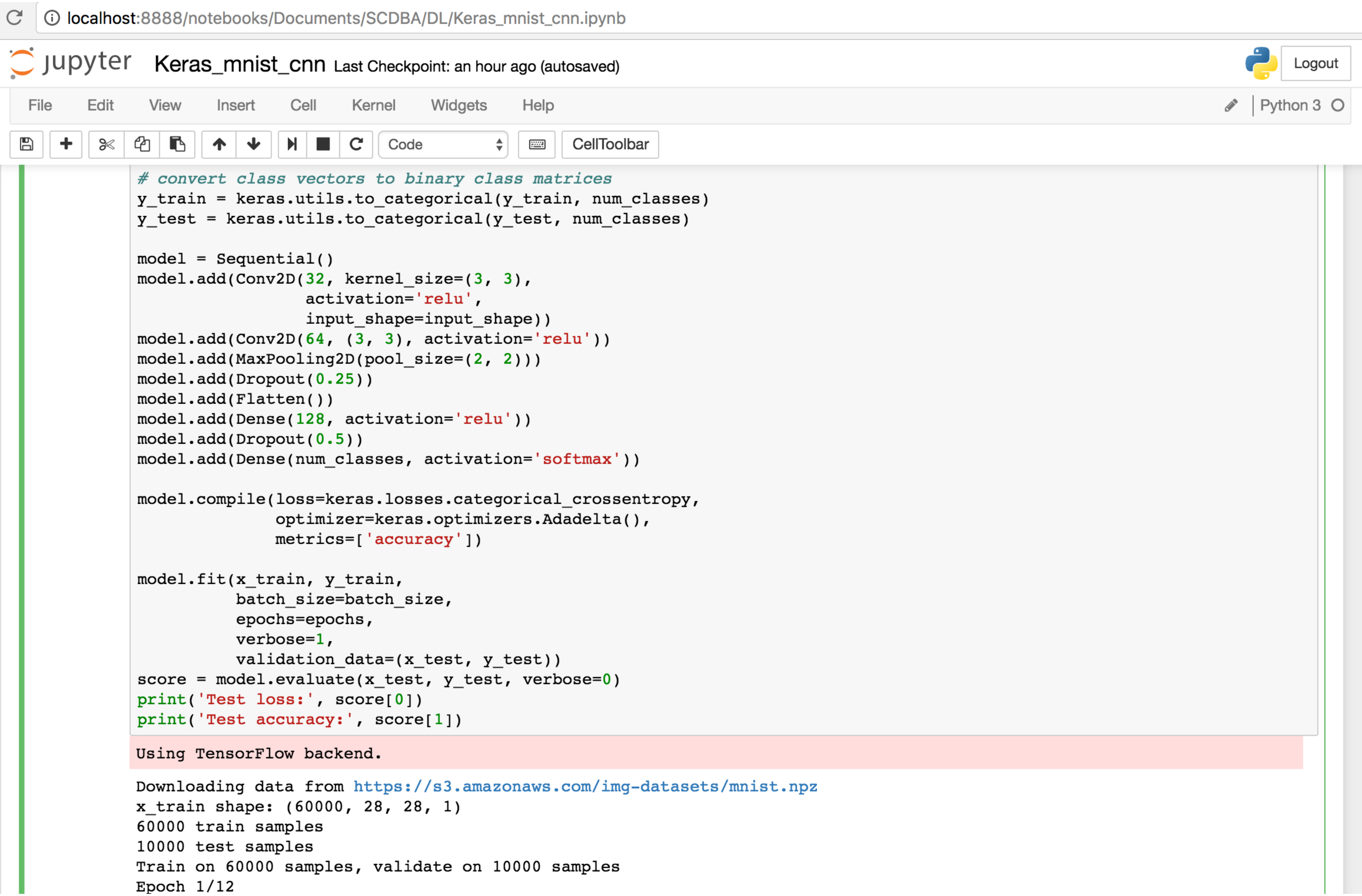
Keras MINST CNN


localhost:8888/notebooks/Documents/SCDBA/DL/Keras_mnist_cnn.ipynb
jupyter
Keras_mnist_cnn Last Checkpoint: an hour ago (autosaved)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Python 3
Code
CellToolbar

```
from __future__ import print_function
import keras
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
from keras import backend as K

batch_size = 128
num_classes = 10
epochs = 12

# input image dimensions
img_rows, img_cols = 28, 28

# the data, shuffled and split between train and test sets
(x_train, y_train), (x_test, y_test) = mnist.load_data()

if K.image_data_format() == 'channels_first':
    x_train = x_train.reshape(x_train.shape[0], 1, img_rows, img_cols)
    x_test = x_test.reshape(x_test.shape[0], 1, img_rows, img_cols)
    input_shape = (1, img_rows, img_cols)
else:
    x_train = x_train.reshape(x_train.shape[0], img_rows, img_cols, 1)
    x_test = x_test.reshape(x_test.shape[0], img_rows, img_cols, 1)
    input_shape = (img_rows, img_cols, 1)

x_train = x_train.astype('float32')
x_test = x_test.astype('float32')
x_train /= 255
x_test /= 255
print('x_train shape:', x_train.shape)
print(x_train.shape[0], 'train samples')
print(x_test.shape[0], 'test samples')
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN


localhost:8888/notebooks/Documents/SCDBA/DL/Keras_mnist_cnn.ipynb
jupyter
Keras_mnist_cnn Last Checkpoint: an hour ago (autosaved)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Python 3
Code
CellToolbar

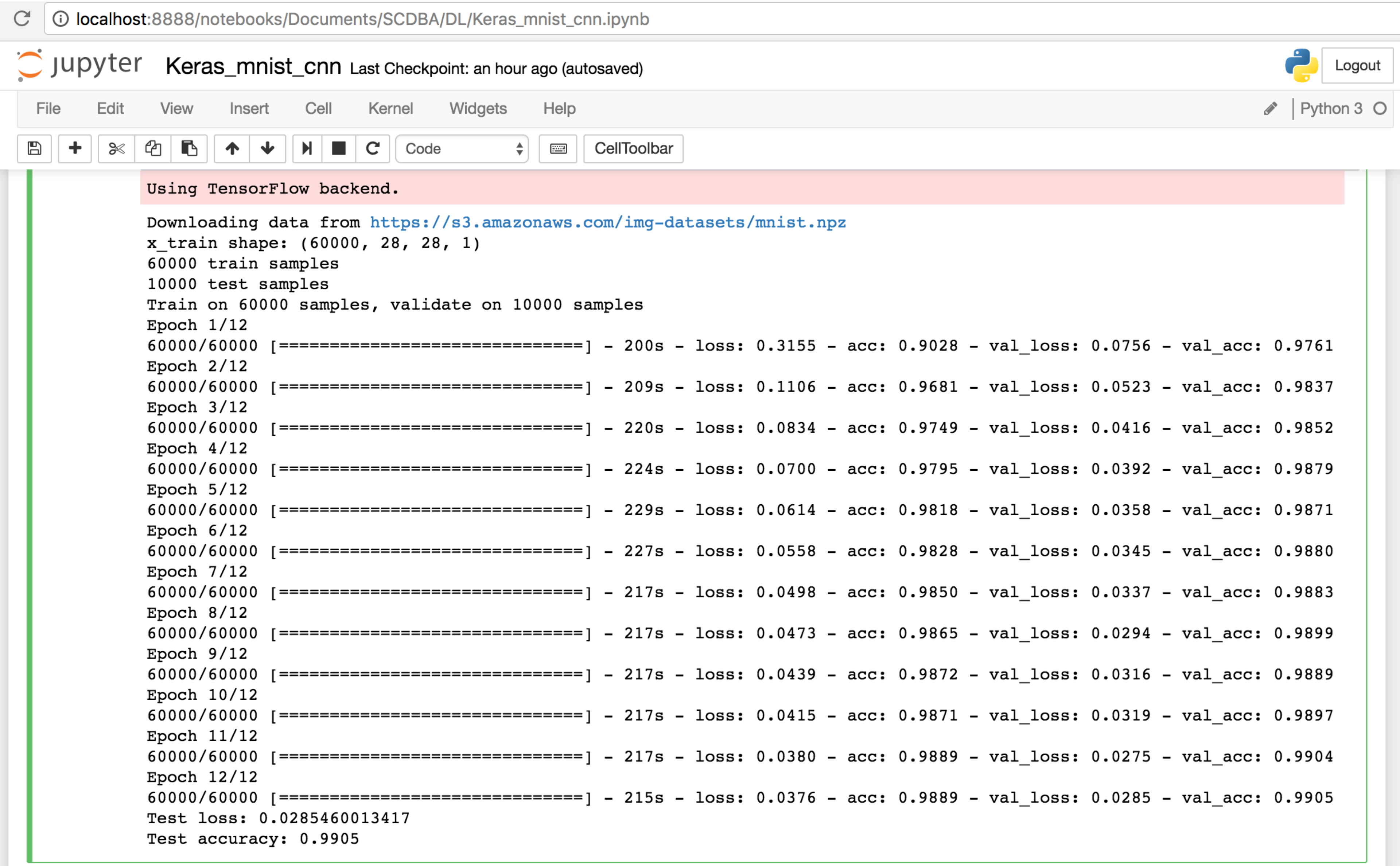
```
# convert class vectors to binary class matrices
y_train = keras.utils.to_categorical(y_train, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)

model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3),
                 activation='relu',
                 input_shape=input_shape))
model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))

model.compile(loss=keras.losses.categorical_crossentropy,
              optimizer=keras.optimizers.Adadelta(),
              metrics=['accuracy'])

model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=epochs,
          verbose=1,
          validation_data=(x_test, y_test))
score = model.evaluate(x_test, y_test, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
Using TensorFlow backend.
```

```
Downloading data from https://s3.amazonaws.com/img-datasets/mnist.npz
x_train shape: (60000, 28, 28, 1)
60000 train samples
10000 test samples
Train on 60000 samples, validate on 10000 samples
Epoch 1/12
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN


localhost:8888/notebooks/Documents/SCDBA/DL/Keras_mnist_cnn.ipynb
jupyter
Keras_mnist_cnn Last Checkpoint: an hour ago (autosaved)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Python 3
Code
CellToolbar

```
Using TensorFlow backend.

Downloading data from https://s3.amazonaws.com/img-datasets/mnist.npz
x_train shape: (60000, 28, 28, 1)
60000 train samples
10000 test samples
Train on 60000 samples, validate on 10000 samples
Epoch 1/12
60000/60000 [==============================] - 200s - loss: 0.3155 - acc: 0.9028 - val_loss: 0.0756 - val_acc: 0.9761
Epoch 2/12
60000/60000 [==============================] - 209s - loss: 0.1106 - acc: 0.9681 - val_loss: 0.0523 - val_acc: 0.9837
Epoch 3/12
60000/60000 [==============================] - 220s - loss: 0.0834 - acc: 0.9749 - val_loss: 0.0416 - val_acc: 0.9852
Epoch 4/12
60000/60000 [==============================] - 224s - loss: 0.0700 - acc: 0.9795 - val_loss: 0.0392 - val_acc: 0.9879
Epoch 5/12
60000/60000 [==============================] - 229s - loss: 0.0614 - acc: 0.9818 - val_loss: 0.0358 - val_acc: 0.9871
Epoch 6/12
60000/60000 [==============================] - 227s - loss: 0.0558 - acc: 0.9828 - val_loss: 0.0345 - val_acc: 0.9880
Epoch 7/12
60000/60000 [==============================] - 217s - loss: 0.0498 - acc: 0.9850 - val_loss: 0.0337 - val_acc: 0.9883
Epoch 8/12
60000/60000 [==============================] - 217s - loss: 0.0473 - acc: 0.9865 - val_loss: 0.0294 - val_acc: 0.9899
Epoch 9/12
60000/60000 [==============================] - 217s - loss: 0.0439 - acc: 0.9872 - val_loss: 0.0316 - val_acc: 0.9889
Epoch 10/12
60000/60000 [==============================] - 217s - loss: 0.0415 - acc: 0.9871 - val_loss: 0.0319 - val_acc: 0.9897
Epoch 11/12
60000/60000 [==============================] - 217s - loss: 0.0380 - acc: 0.9889 - val_loss: 0.0275 - val_acc: 0.9904
Epoch 12/12
60000/60000 [==============================] - 215s - loss: 0.0376 - acc: 0.9889 - val_loss: 0.0285 - val_acc: 0.9905
Test loss: 0.0285460013417
Test accuracy: 0.9905
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN

```
from __future__ import print_function
import keras
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
from keras import backend as K

batch_size = 128
num_classes = 10
epochs = 12

# input image dimensions
img_rows, img_cols = 28, 28

# the data, shuffled and split between train and test sets
(x_train, y_train), (x_test, y_test) = mnist.load_data()

if K.image_data_format() == 'channels_first':
    x_train = x_train.reshape(x_train.shape[0], 1, img_rows, img_cols)
    x_test = x_test.reshape(x_test.shape[0], 1, img_rows, img_cols)
    input_shape = (1, img_rows, img_cols)
else:
    x_train = x_train.reshape(x_train.shape[0], img_rows, img_cols, 1)
    x_test = x_test.reshape(x_test.shape[0], img_rows, img_cols, 1)
    input_shape = (img_rows, img_cols, 1)

x_train = x_train.astype('float32')
x_test = x_test.astype('float32')
x_train /= 255
x_test /= 255
print('x_train shape:', x_train.shape)
print(x_train.shape[0], 'train samples')
print(x_test.shape[0], 'test samples')

# convert class vectors to binary class matrices
y_train = keras.utils.to_categorical(y_train, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)

model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3),
                 activation='relu',
                 input_shape=input_shape))
model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))

model.compile(loss=keras.losses.categorical_crossentropy,
              optimizer=keras.optimizers.Adadelta(),
              metrics=['accuracy'])

model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=epochs,
          verbose=1,
          validation_data=(x_test, y_test))
score = model.evaluate(x_test, y_test, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN

```
from __future__ import print_function
import keras
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
from keras import backend as K
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN

```
batch_size = 128
num_classes = 10
epochs = 12

# input image dimensions
img_rows, img_cols = 28, 28

# the data, shuffled and split between train and test sets
(x_train, y_train), (x_test, y_test) = mnist.load_data()

if K.image_data_format() == 'channels_first':
    x_train = x_train.reshape(x_train.shape[0], 1, img_rows, img_cols)
    x_test = x_test.reshape(x_test.shape[0], 1, img_rows, img_cols)
    input_shape = (1, img_rows, img_cols)
else:
    x_train = x_train.reshape(x_train.shape[0], img_rows, img_cols, 1)
    x_test = x_test.reshape(x_test.shape[0], img_rows, img_cols, 1)
    input_shape = (img_rows, img_cols, 1)
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN

```
x_train = x_train.astype('float32')
x_test = x_test.astype('float32')
x_train /= 255
x_test /= 255
print('x_train shape:', x_train.shape)
print(x_train.shape[0], 'train samples')
print(x_test.shape[0], 'test samples')

# convert class vectors to binary class matrices
y_train = keras.utils.to_categorical(y_train, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN

```
model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3),
                 activation='relu',
                 input_shape=input_shape))
model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))

model.compile(loss=keras.losses.categorical_crossentropy,
              optimizer=keras.optimizers.Adadelta(),
              metrics=['accuracy'])
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN

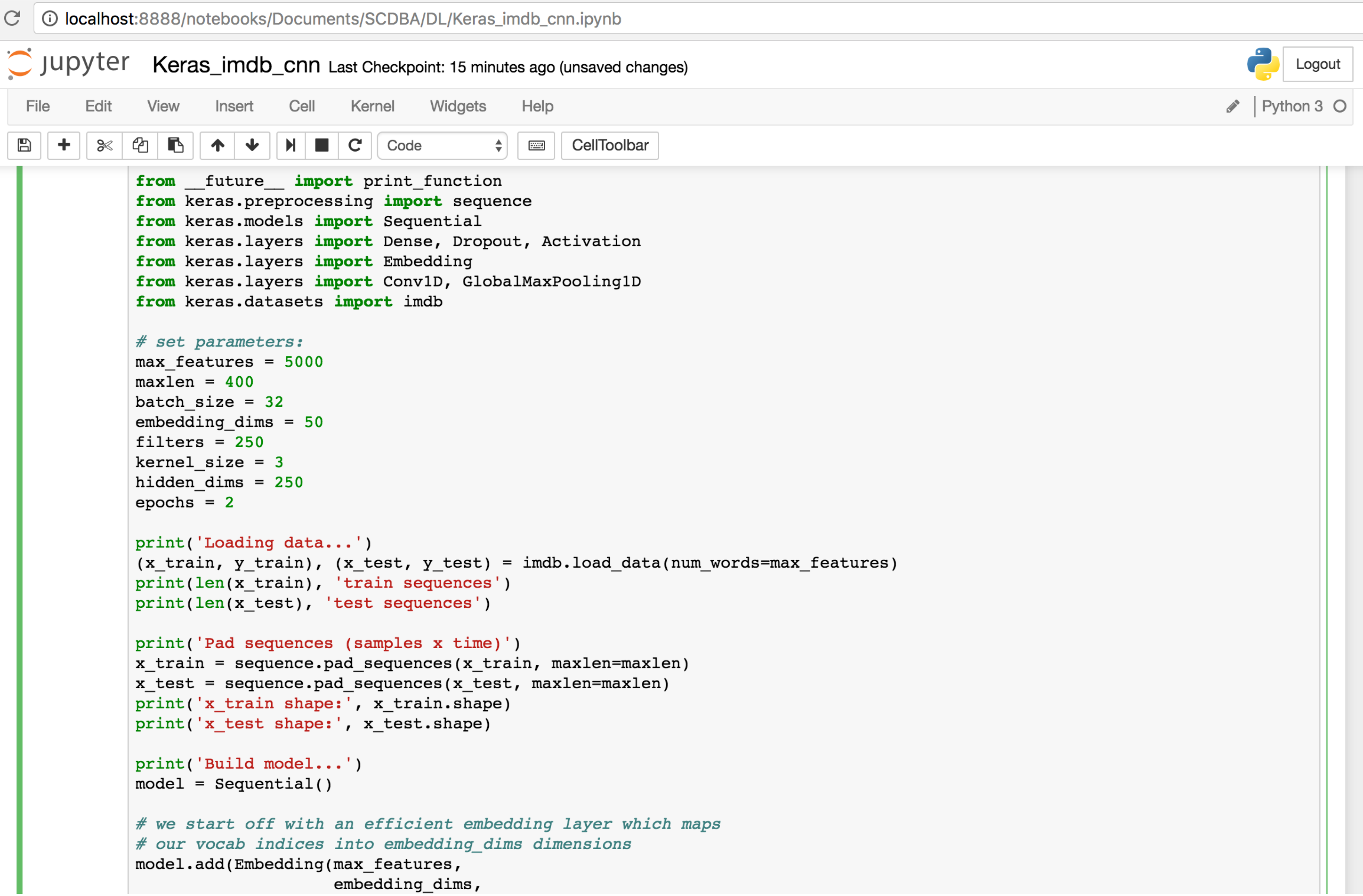
```
model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=epochs,
          verbose=1,
          validation_data=(x_test, y_test))
score = model.evaluate(x_test, y_test, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_cnn.py

Keras MINST CNN

```
python mnist_cnn.py
Using TensorFlow backend.
Downloading data from https://s3.amazonaws.com/img-datasets/mnist.npz
x_train shape: (60000, 28, 28, 1)
60000 train samples
10000 test samples
Train on 60000 samples, validate on 10000 samples
Epoch 1/12
60000/60000 [==============================] - 108s - loss: 0.3510 - acc: 0.8921 - val_loss: 0.0880 - val_acc: 0.9738
Epoch 2/12
60000/60000 [==============================] - 106s - loss: 0.1200 - acc: 0.9649 - val_loss: 0.0567 - val_acc: 0.9820
Epoch 3/12
60000/60000 [==============================] - 104s - loss: 0.0889 - acc: 0.9735 - val_loss: 0.0438 - val_acc: 0.9856
Epoch 4/12
60000/60000 [==============================] - 106s - loss: 0.0744 - acc: 0.9783 - val_loss: 0.0392 - val_acc: 0.9862
Epoch 5/12
60000/60000 [==============================] - 106s - loss: 0.0648 - acc: 0.9807 - val_loss: 0.0363 - val_acc: 0.9873
Epoch 6/12
60000/60000 [==============================] - 109s - loss: 0.0574 - acc: 0.9840 - val_loss: 0.0348 - val_acc: 0.9884
Epoch 7/12
60000/60000 [==============================] - 104s - loss: 0.0522 - acc: 0.9842 - val_loss: 0.0324 - val_acc: 0.9890
Epoch 8/12
60000/60000 [==============================] - 104s - loss: 0.0484 - acc: 0.9856 - val_loss: 0.0315 - val_acc: 0.9894
Epoch 9/12
60000/60000 [==============================] - 104s - loss: 0.0447 - acc: 0.9870 - val_loss: 0.0296 - val_acc: 0.9902
Epoch 10/12
60000/60000 [==============================] - 109s - loss: 0.0419 - acc: 0.9877 - val_loss: 0.0338 - val_acc: 0.9894
Epoch 11/12
60000/60000 [==============================] - 104s - loss: 0.0405 - acc: 0.9879 - val_loss: 0.0301 - val_acc: 0.9896
Epoch 12/12
60000/60000 [==============================] - 127s - loss: 0.0391 - acc: 0.9883 - val_loss: 0.0304 - val_acc: 0.9899
Test loss: 0.030424870987
Test accuracy: 0.9899
```

Keras IMDB CNN


localhost:8888/notebooks/Documents/SCDBA/DL/Keras_imdb_cnn.ipynb
jupyter
Keras_imdb_cnn Last Checkpoint: 15 minutes ago (unsaved changes)
Logout
File
Edit
View
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Cell
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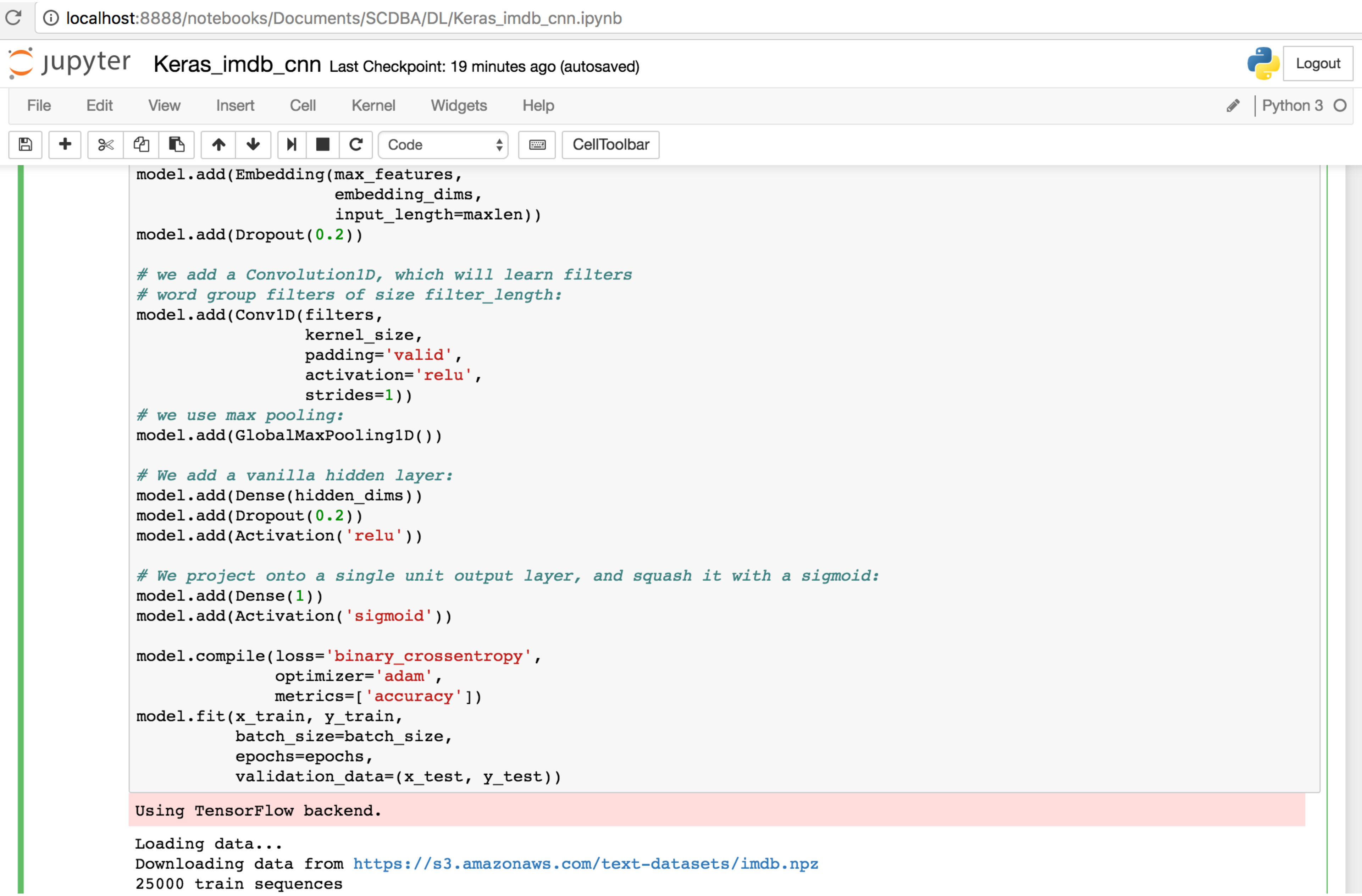
Python 3
Code
CellToolbar

```python
from __future__ import print_function
from keras.preprocessing import sequence
from keras.models import Sequential
from keras.layers import Dense, Dropout, Activation
from keras.layers import Embedding
from keras.layers import Conv1D, GlobalMaxPooling1D
from keras.datasets import imdb

# set parameters:
max_features = 5000
maxlen = 400
batch_size = 32
embedding_dims = 50
filters = 250
kernel_size = 3
hidden_dims = 250
epochs = 2

print('Loading data...')
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)
print(len(x_train), 'train sequences')
print(len(x_test), 'test sequences')

print('Pad sequences (samples x time)')
x_train = sequence.pad_sequences(x_train, maxlen=maxlen)
x_test = sequence.pad_sequences(x_test, maxlen=maxlen)
print('x_train shape:', x_train.shape)
print('x_test shape:', x_test.shape)

print('Build model...')
model = Sequential()

# we start off with an efficient embedding layer which maps
# our vocab indices into embedding_dims dimensions
model.add(Embedding(max_features,
                    embedding_dims,
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_cnn.py

Keras IMDB CNN


localhost:8888/notebooks/Documents/SCDBA/DL/Keras_imdb_cnn.ipynb
jupyter
Keras_imdb_cnn Last Checkpoint: 19 minutes ago (autosaved)
Logout
File
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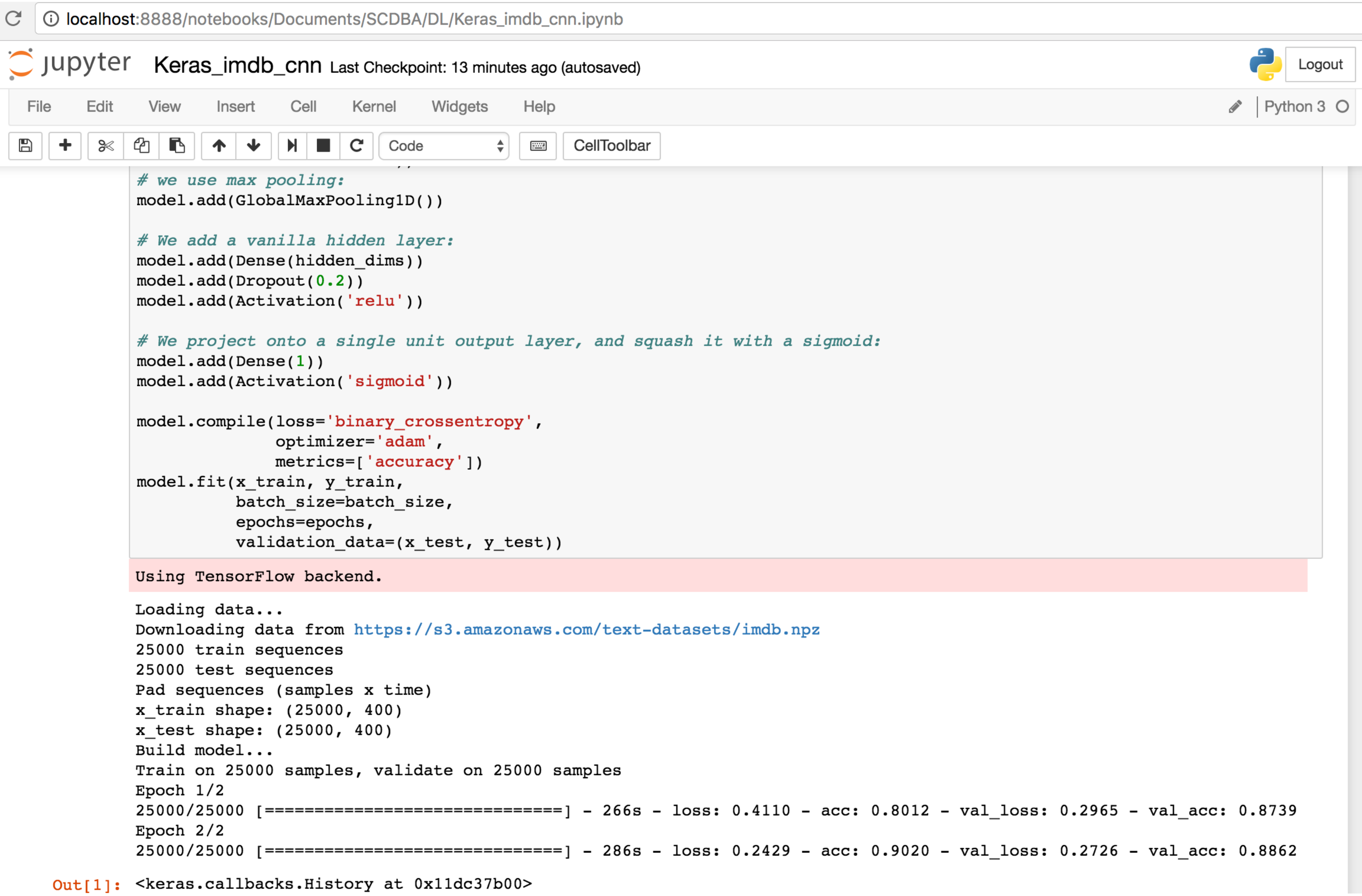
```
model.add(Embedding(max_features,
                    embedding_dims,
                    input_length=maxlen))
model.add(Dropout(0.2))

# we add a Convolution1D, which will learn filters
# word group filters of size filter_length:
model.add(Conv1D(filters,
                 kernel_size,
                 padding='valid',
                 activation='relu',
                 strides=1))
# we use max pooling:
model.add(GlobalMaxPooling1D())

# We add a vanilla hidden layer:
model.add(Dense(hidden_dims))
model.add(Dropout(0.2))
model.add(Activation('relu'))

# We project onto a single unit output layer, and squash it with a sigmoid:
model.add(Dense(1))
model.add(Activation('sigmoid'))

model.compile(loss='binary_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])
model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=epochs,
          validation_data=(x_test, y_test))
```

```
Using TensorFlow backend.
```

```
Loading data...
Downloading data from https://s3.amazonaws.com/text-datasets/imdb.npz
25000 train sequences
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_cnn.py

Keras IMDB CNN


localhost:8888/notebooks/Documents/SCDBA/DL/Keras_imdb_cnn.ipynb
jupyter
Keras_imdb_cnn Last Checkpoint: 13 minutes ago (autosaved)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Python 3
Code
CellToolbar

```
# we use max pooling:
model.add(GlobalMaxPooling1D())

# We add a vanilla hidden layer:
model.add(Dense(hidden_dims))
model.add(Dropout(0.2))
model.add(Activation('relu'))

# We project onto a single unit output layer, and squash it with a sigmoid:
model.add(Dense(1))
model.add(Activation('sigmoid'))

model.compile(loss='binary_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])
model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=epochs,
          validation_data=(x_test, y_test))
```

```
Using TensorFlow backend.
```

```
Loading data...
Downloading data from https://s3.amazonaws.com/text-datasets/imdb.npz
25000 train sequences
25000 test sequences
Pad sequences (samples x time)
x_train shape: (25000, 400)
x_test shape: (25000, 400)
Build model...
Train on 25000 samples, validate on 25000 samples
Epoch 1/2
25000/25000 [==============================] - 266s - loss: 0.4110 - acc: 0.8012 - val_loss: 0.2965 - val_acc: 0.8739
Epoch 2/2
25000/25000 [==============================] - 286s - loss: 0.2429 - acc: 0.9020 - val_loss: 0.2726 - val_acc: 0.8862
```

```
Out[1]: <keras.callbacks.History at 0x11dc37b00>
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_cnn.py

Keras IMDB CNN

```
python imdb_cnn.py
Using TensorFlow backend.
Loading data...
Downloading data from https://s3.amazonaws.com/text-datasets/imdb.npz
25000 train sequences
25000 test sequences
Pad sequences (samples x time)
x_train shape: (25000, 400)
x_test shape: (25000, 400)
Build model...
Train on 25000 samples, validate on 25000 samples
Epoch 1/2
25000/25000 [==============================] - 157s - loss: 0.4050 - acc: 0.8065 - val_loss: 0.2924 - val_acc: 0.8750
Epoch 2/2
25000/25000 [==============================] - 128s - loss: 0.2433 - acc: 0.9040 - val_loss: 0.2701 - val_acc: 0.8865
Exception ignored in: <bound method BaseSession.__del__ of <tensorflow.python.client.session.Session object at 0x0000019F153C2A20>>
Traceback (most recent call last):
  File "C:\Program Files\Anaconda3\lib\site-packages\tensorflow\python\client\session.py", line 587, in __del__
AttributeError: 'NoneType' object has no attribute 'TF_NewStatus'
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_cnn.py

Keras IMDB LSTM

```
from __future__ import print_function
from keras.preprocessing import sequence
from keras.models import Sequential
from keras.layers import Dense, Embedding
from keras.layers import LSTM
from keras.datasets import imdb

max_features = 20000
maxlen = 80  # cut texts after this number of words (among top max_features most common words)
batch_size = 32

print('Loading data...')
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)
print(len(x_train), 'train sequences')
print(len(x_test), 'test sequences')

print('Pad sequences (samples x time)')
x_train = sequence.pad_sequences(x_train, maxlen=maxlen)
x_test = sequence.pad_sequences(x_test, maxlen=maxlen)
print('x_train shape:', x_train.shape)
print('x_test shape:', x_test.shape)

print('Build model...')
model = Sequential()
model.add(Embedding(max_features, 128))
model.add(LSTM(128, dropout=0.2, recurrent_dropout=0.2))
model.add(Dense(1, activation='sigmoid'))

# try using different optimizers and different optimizer configs
model.compile(loss='binary_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])

print('Train...')
model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=15,
          validation_data=(x_test, y_test))
score, acc = model.evaluate(x_test, y_test,
                            batch_size=batch_size)
print('Test score:', score)
print('Test accuracy:', acc)
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_lstm.py

Keras IMDB LSTM

```
from __future__ import print_function
from keras.preprocessing import sequence
from keras.models import Sequential
from keras.layers import Dense, Embedding
from keras.layers import LSTM
from keras.datasets import imdb
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_lstm.py

Keras IMDB LSTM

```
max_features = 20000
maxlen = 80  # cut texts after this number of words (among top
max_features most common words)
batch_size = 32

print('Loading data...')
(x_train, y_train), (x_test, y_test) =
imdb.load_data(num_words=max_features)
print(len(x_train), 'train sequences')
print(len(x_test), 'test sequences')

print('Pad sequences (samples x time)')
x_train = sequence.pad_sequences(x_train, maxlen=maxlen)
x_test = sequence.pad_sequences(x_test, maxlen=maxlen)
print('x_train shape:', x_train.shape)
print('x_test shape:', x_test.shape)
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_lstm.py

Keras IMDB LSTM

```
print('Build model...')
model = Sequential()
model.add(Embedding(max_features, 128))
model.add(LSTM(128, dropout=0.2, recurrent_dropout=0.2))
model.add(Dense(1, activation='sigmoid'))

# try using different optimizers and different optimizer configs
model.compile(loss='binary_crossentropy',
                   optimizer='adam',
                   metrics=['accuracy'])
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_lstm.py

Keras IMDB LSTM

```
print('Train...')
model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=15,
          validation_data=(x_test, y_test))
score, acc = model.evaluate(x_test, y_test,

batch_size=batch_size)
print('Test score:', score)
print('Test accuracy:', acc)
```

Source: https://github.com/fchollet/keras/blob/master/examples/imdb_lstm.py

Keras IMDB LSTM

```
python imdb_lstm.py
Using TensorFlow backend.
Loading data...
25000 train sequences
25000 test sequences
Pad sequences (samples x time)
x_train shape: (25000, 80)
x_test shape: (25000, 80)
Build model...
Train...
Train on 25000 samples, validate on 25000 samples
Epoch 1/15
25000/25000 [==============================] - 111s - loss: 0.4561 - acc: 0.7837 - val_loss: 0.3892 - val_acc: 0.8275
Epoch 2/15
25000/25000 [==============================] - 112s - loss: 0.2947 - acc: 0.8792 - val_loss: 0.4266 - val_acc: 0.8353
Epoch 3/15
25000/25000 [==============================] - 111s - loss: 0.2122 - acc: 0.9178 - val_loss: 0.4133 - val_acc: 0.8284
Epoch 4/15
25000/25000 [==============================] - 112s - loss: 0.1461 - acc: 0.9450 - val_loss: 0.4670 - val_acc: 0.8260
Epoch 5/15
25000/25000 [==============================] - 113s - loss: 0.1038 - acc: 0.9633 - val_loss: 0.5580 - val_acc: 0.8203
Epoch 6/15
25000/25000 [==============================] - 113s - loss: 0.0739 - acc: 0.9749 - val_loss: 0.6738 - val_acc: 0.8174
Epoch 7/15
25000/25000 [==============================] - 113s - loss: 0.0542 - acc: 0.9810 - val_loss: 0.7463 - val_acc: 0.8154
Epoch 8/15
25000/25000 [==============================] - 113s - loss: 0.0428 - acc: 0.9856 - val_loss: 0.8131 - val_acc: 0.8157
Epoch 9/15
25000/25000 [==============================] - 115s - loss: 0.0334 - acc: 0.9889 - val_loss: 0.8566 - val_acc: 0.8165
Epoch 10/15
25000/25000 [==============================] - 114s - loss: 0.0248 - acc: 0.9920 - val_loss: 0.9186 - val_acc: 0.8165
Epoch 11/15
25000/25000 [==============================] - 116s - loss: 0.0156 - acc: 0.9955 - val_loss: 0.9016 - val_acc: 0.8082
Epoch 12/15
25000/25000 [==============================] - 117s - loss: 0.0196 - acc: 0.9942 - val_loss: 0.9720 - val_acc: 0.8124
Epoch 13/15
25000/25000 [==============================] - 120s - loss: 0.0152 - acc: 0.9957 - val_loss: 1.0064 - val_acc: 0.8148
Epoch 14/15
25000/25000 [==============================] - 121s - loss: 0.0128 - acc: 0.9961 - val_loss: 1.1103 - val_acc: 0.8121
Epoch 15/15
25000/25000 [==============================] - 114s - loss: 0.0110 - acc: 0.9970 - val_loss: 1.0173 - val_acc: 0.8132
25000/25000 [==============================] - 23s
Test score: 1.01734088922
Test accuracy: 0.8132
```

Keras IMDB FastText

```
python imdb_fasttext.py
Using TensorFlow backend.
Loading data...
25000 train sequences
25000 test sequences
Average train sequence length: 238
Average test sequence length: 230
Pad sequences (samples x time)
x_train shape: (25000, 400)
x_test shape: (25000, 400)
Build model...
Train on 25000 samples, validate on 25000 samples
Epoch 1/5
25000/25000 [==============================] - 14s - loss: 0.6102 - acc: 0.7397 - val_loss: 0.5034 - val_acc: 0.8105
Epoch 2/5
25000/25000 [==============================] - 14s - loss: 0.4019 - acc: 0.8656 - val_loss: 0.3697 - val_acc: 0.8654
Epoch 3/5
25000/25000 [==============================] - 14s - loss: 0.3025 - acc: 0.8959 - val_loss: 0.3199 - val_acc: 0.8791
Epoch 4/5
25000/25000 [==============================] - 14s - loss: 0.2521 - acc: 0.9113 - val_loss: 0.2971 - val_acc: 0.8848
Epoch 5/5
25000/25000 [==============================] - 14s - loss: 0.2181 - acc: 0.9249 - val_loss: 0.2899 - val_acc: 0.8855
Exception ignored in: <bound method BaseSession.__del__ of <tensorflow.python.client.session.Session object at 0x000001E3257DB438>>
Traceback (most recent call last):
  File "C:\Program Files\Anaconda3\lib\site-packages\tensorflow\python\client\session.py", line 587, in __del__
AttributeError: 'NoneType' object has no attribute 'TF_NewStatus'
```

Keras IMDB CNN LSTM

```
python imdb_cnn_lstm_2.py
Using TensorFlow backend.
Loading data...
25000 train sequences
25000 test sequences
Pad sequences (samples x time)
x_train shape: (25000, 100)
x_test shape: (25000, 100)
Build model...
Train...
Train on 25000 samples, validate on 25000 samples
Epoch 1/2
25000/25000 [==============================] - 64s - loss: 0.3824 - acc: 0.8238 - val_loss: 0.3591 - val_acc: 0.8467
Epoch 2/2
25000/25000 [==============================] - 63s - loss: 0.1953 - acc: 0.9261 - val_loss: 0.3827 - val_acc: 0.8488
24990/25000 [============================>.] - ETA: 0s
Test score: 0.382728585386
Test accuracy: 0.848799994493
```

imdb_lstm_2.py

```
from __future__ import print_function

from keras.preprocessing import sequence
from keras.models import Sequential
from keras.layers import Dense, Embedding
from keras.layers import LSTM
from keras.datasets import imdb

py_filename = 'imdb_lstm_2.py'
max_features = 20000
maxlen = 80  # cut texts after this number of words (among top max_features
most common words)
batch_size = 32
epochs = 20 #60

#%matplotlib inline
import matplotlib
import matplotlib.pyplot as plt
import numpy as np

import codecs
import datetime
import timeit
timer_start = timeit.default_timer()
#timer_end = timeit.default_timer()
#print('timer_end - timer_start', timer_end - timer_start)
```

imdb_lstm_2.py

```
def getDateTimeNow():
    strnow = datetime.datetime.now().strftime("%Y%m%d_%H%M%S")
    return strnow

def read_file_utf8(filename):
    with codecs.open(filename,'r',encoding='utf-8') as f:
        text = f.read()
    return text

def write_file_utf8(filename,text):
    with codecs.open(filename, 'w', encoding='utf-8') as f:
        f.write(text)
        f.close()

def log_file_utf8(filename, text):
    with codecs.open(filename, 'a', encoding='utf-8') as f:
        #append file
        f.write(text + '\n')
        f.close()

log_file_utf8("logfile.txt", '***** ' + py_filename + ' *****')
log_file_utf8("logfile.txt", '***** Start DateTime: ' + getDateTimeNow())

print('Start: ', datetime.datetime.now().strftime("%Y%m%d_%H%M%S"))
```

imdb_lstm_2.py

```
print('Loading data...')
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)
print(len(x_train), 'train sequences')
print(len(x_test), 'test sequences')

print('Pad sequences (samples x time)')
x_train = sequence.pad_sequences(x_train, maxlen=maxlen)
x_test = sequence.pad_sequences(x_test, maxlen=maxlen)
print('x_train shape:', x_train.shape)
print('x_test shape:', x_test.shape)

print('Build model...')
model = Sequential()
model.add(Embedding(max_features, 128))
model.add(LSTM(128, dropout=0.2, recurrent_dropout=0.2))
model.add(Dense(1, activation='sigmoid'))

# try using different optimizers and different optimizer configs
model.compile(loss='binary_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])
```

imdb_lstm_2.py

```
print('Train...')
print('model.fit: ', datetime.datetime.now().strftime("%Y%m%d_%H%M%S"))
history = model.fit(x_train, y_train,
          batch_size = batch_size,
          epochs = epochs,
          validation_data = (x_test, y_test))

score, acc = model.evaluate(x_test, y_test,
                            batch_size=batch_size)
print('Test score:', score)
print('Test accuracy:', acc)
```

imdb_lstm_2.py

```
timer_end = timeit.default_timer()
print('Timer: ', str(round(timer_end - timer_start, 2)), 's')
print('DateTime: ', datetime.datetime.now().strftime("%Y%m%d_%H%M%S"))
log_file_utf8("logfile.txt", 'Timer: ' + str(round(timer_end - timer_start, 2))
+ ' s')
log_file_utf8("logfile.txt", '***** End Datetime: ' +
datetime.datetime.now().strftime("%Y%m%d_%H%M%S"))

# summarize history for accuracy
#http://machinelearningmastery.com/display-deep-learning-model-training-history-in-keras/
print('history.history.keys():', history.history.keys())
print('history.history:', history.history)
log_file_utf8("logfile.txt", 'history.history:' + str(history.history))
```

imdb_lstm_2.py

```
# Deep Learning Training Visualization
plt.figure(figsize=(10, 8))  # make separate figure
ax1 = plt.subplot(2, 1, 1)
plt.plot(history.history['acc'])
plt.plot(history.history['val_acc'])
plt.title('model accuracy')
plt.ylabel('accuracy')
ax1.xaxis.set_major_locator(plt.NullLocator())
#plt.xlabel('epoch')
plt.legend(['train acc', 'test val_acc'], loc='upper left')
#plt.show()
ax2 = plt.subplot(2, 1, 2)
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train loss', 'test val_loss'], loc='upper left')
plt.savefig("training_accuacy_loss_" + py_filename + "_" + str(epochs) +
".png", dpi= 300)
```

imdb_lstm_2.py

```
#Log File for Deep Learning Summary Analysis
log_file_utf8("logfile.txt", 'DL_Summary:\tpy_filename\t'  + py_filename +
    '\tepochs\t' + str(epochs) +
    '\tscore\t' + str(score) +
    '\taccuracy\t' + str(acc) +
    '\tTimer\t ' + str(round(timer_end - timer_start, 2)) +
    '\thistory\t' + str(history.history))
#plt.show()
```

python filename.py

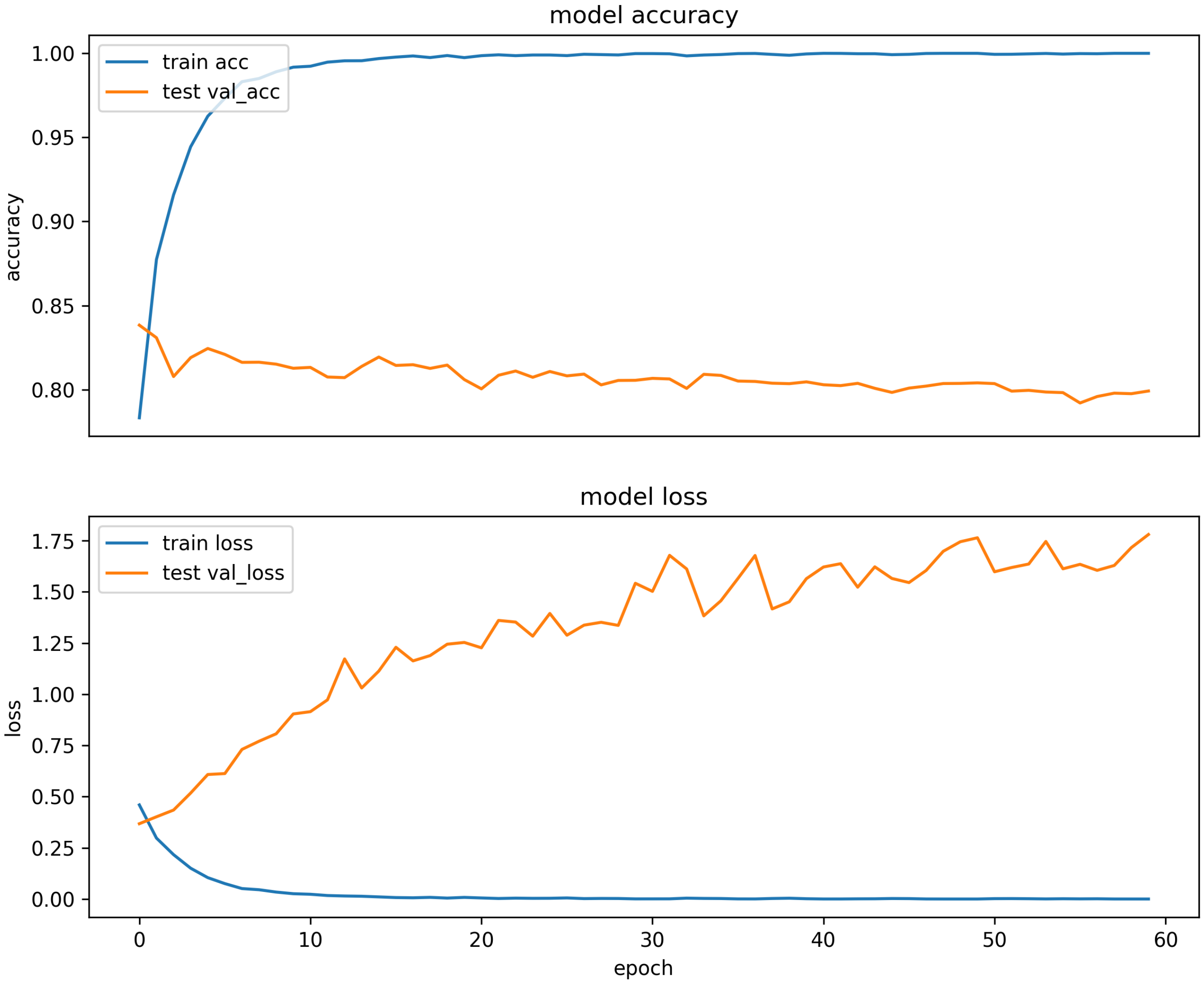
```
python imdb_fasttext_2.py
python imdb_cnn_2.py
python imdb_lstm_2.py
python imdb_cnn_lstm_2.py
python imdb_bidirectional_lstm_2.py
```

Deep Learning Summary

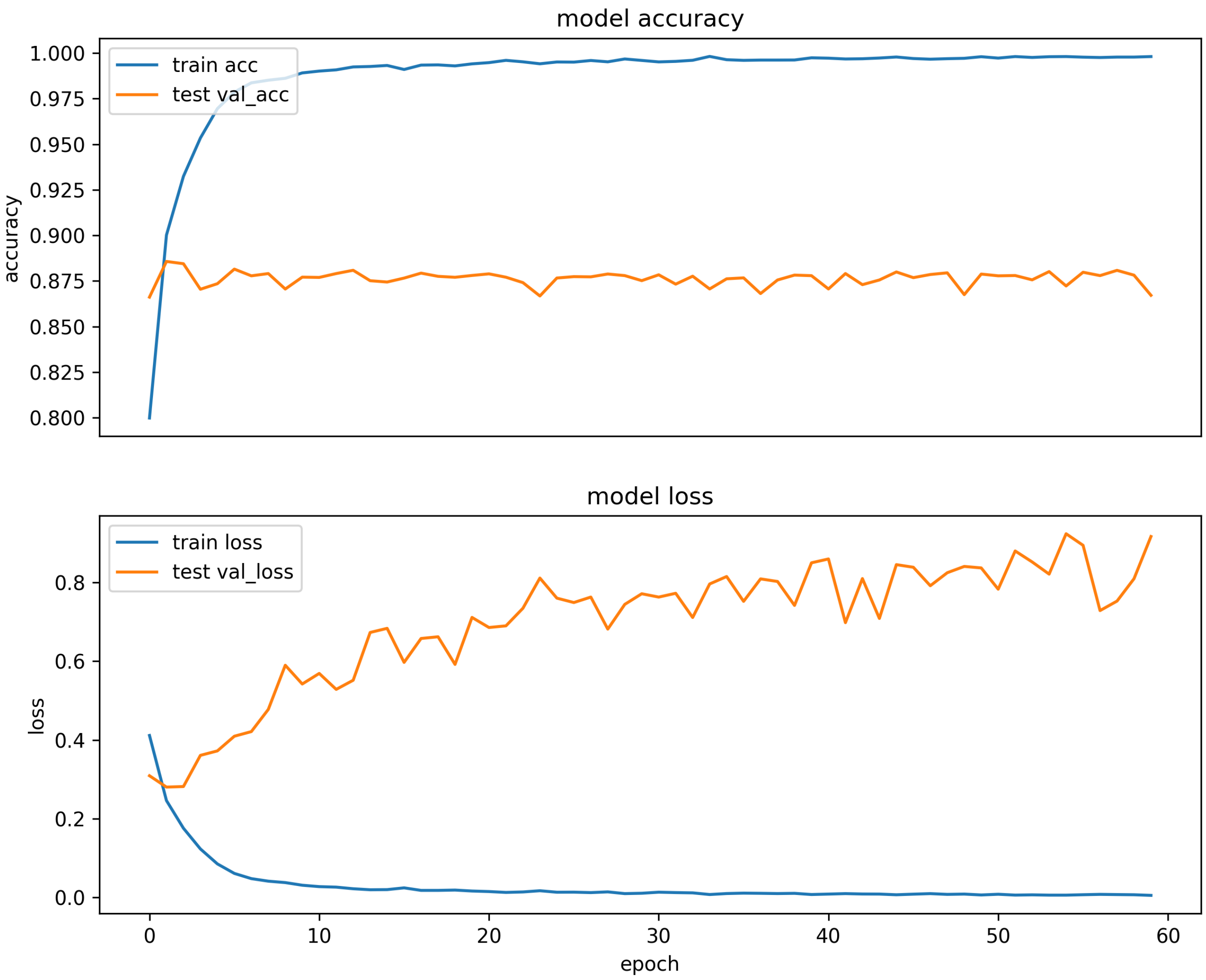
```
 #Log File for Deep Learning Summary Analysis
log_file_utf8("logfile.txt", 'DL_Summary:\tpy_filename\t'  + py_filename +
    '\tepochs\t' + str(epochs) +
    '\tscore\t' + str(score) +
    '\taccuracy\t' + str(acc) +
    '\tTimer\t ' + str(round(timer_end - timer_start, 2)) +
    '\thistory\t' + str(history.history))
```

Model	epochs	Score	Accuracy	Timer (s)
imdb_lstm_2.py	30	0.6440	0.8540	**682.57**
imdb_cnn_2.py	30	0.7186	**0.8775**	4320.38
imdb_lstm_2.py	30	1.5716	0.8052	3958.93
imdb_cnn_lstm_2.py	30	1.3105	0.8240	2471.65
imdb_bidirectional_lstm_2.py	30	1.4083	0.8255	4344.36
imdb_fasttext_2.py	30	**0.6439**	0.8540	1117.78
imdb_fasttext_2.py	60	1.2335	0.8407	1297.02
imdb_cnn_2.py	60	0.9170	0.8672	8507.48
imdb_lstm_2.py	60	1.7803	0.7992	8039.67
imdb_cnn_lstm_2.py	60	1.4623	0.8137	4912.25
imdb_bidirectional_lstm_2.py	60	1.8975	0.8138	8589.17

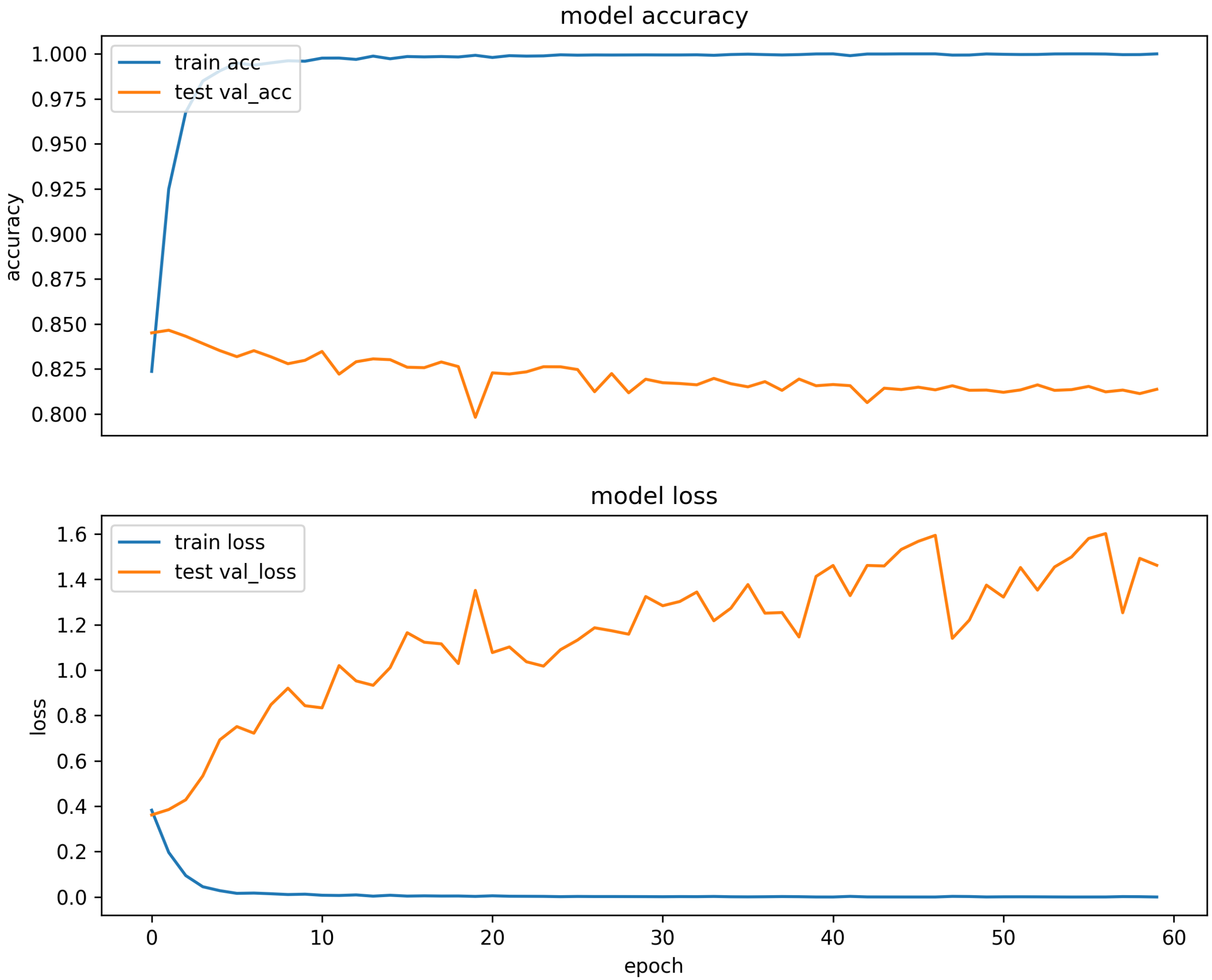
imdb_lstm_2.py



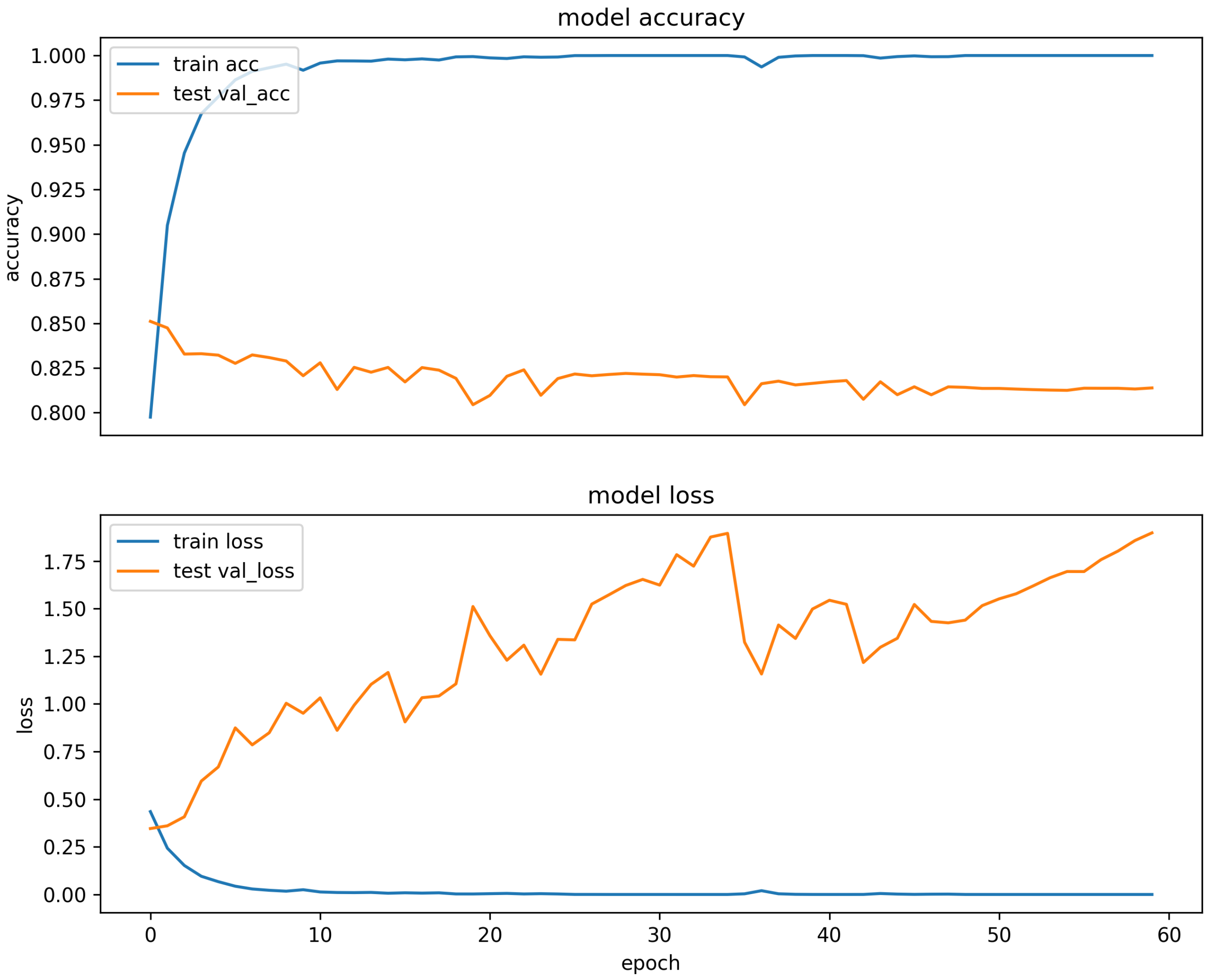
imdb_cnn_2.py


model accuracy
train acc
test val_acc
accuracy
1.000
0.975
0.950
0.925
0.900
0.875
0.850
0.825
0.800
model loss
train loss
test val_loss
loss
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
60
epoch

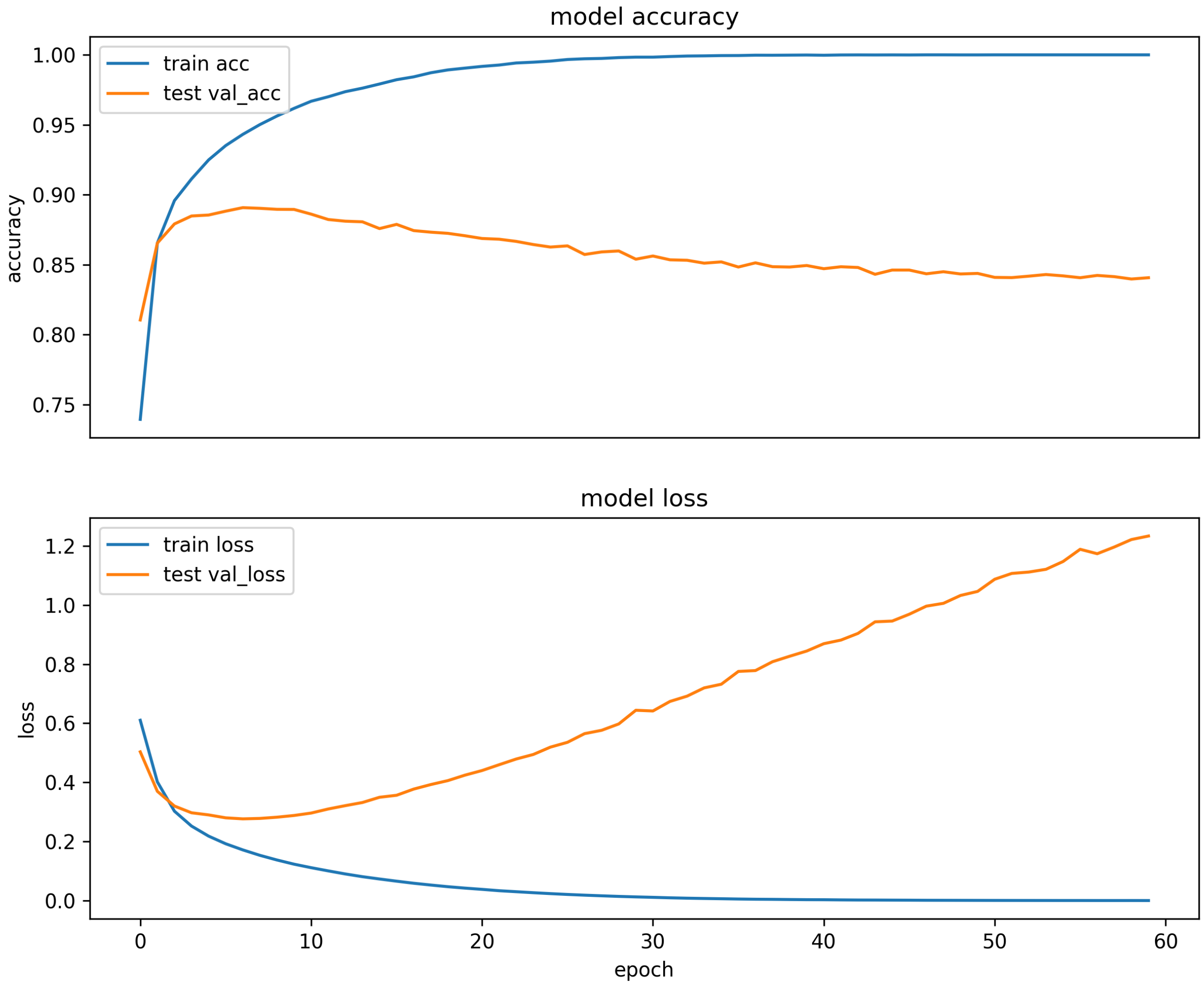
imdb_cnn_lstm_2.py



imdb_bidirectional_lstm_2.py



imdb_fasttext_2.py

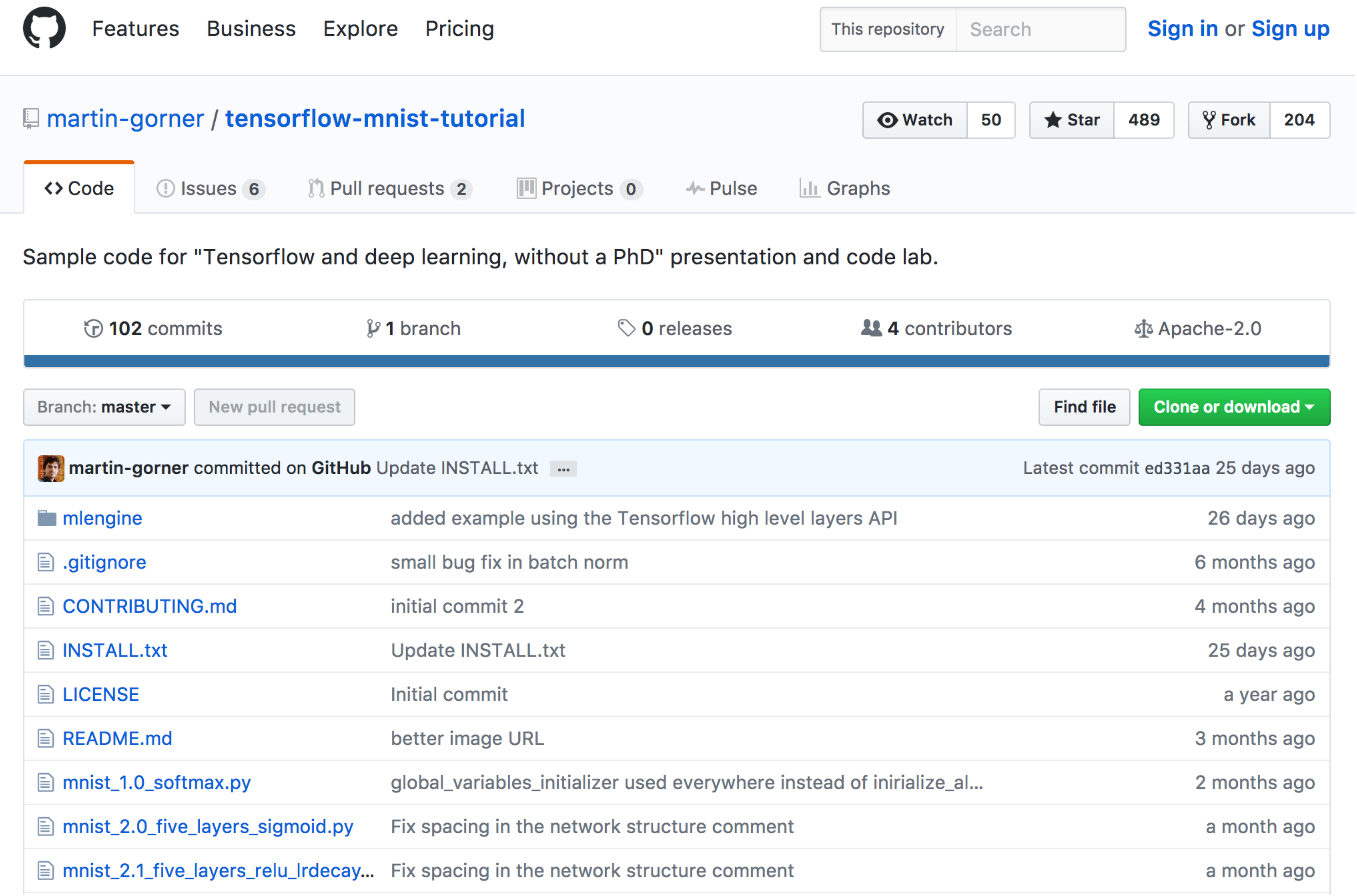


Deep Learning with CPU vs. GPU

```
Timings:
Hardware           | Backend | Time / Epoch
-------------------------------------------
 CPU               | TF      | 3 hrs
 Titan X (maxwell) | TF      | 4 min
 Titan X (maxwell) | TH      | 7 min
```

Source: https://github.com/fchollet/keras/blob/master/examples/mnist_acgan.py

TensorFlow MNIST Tutorial



martin-gorner / tensorflow-mnist-tutorial

Sample code for "Tensorflow and deep learning, without a PhD" presentation and code lab.

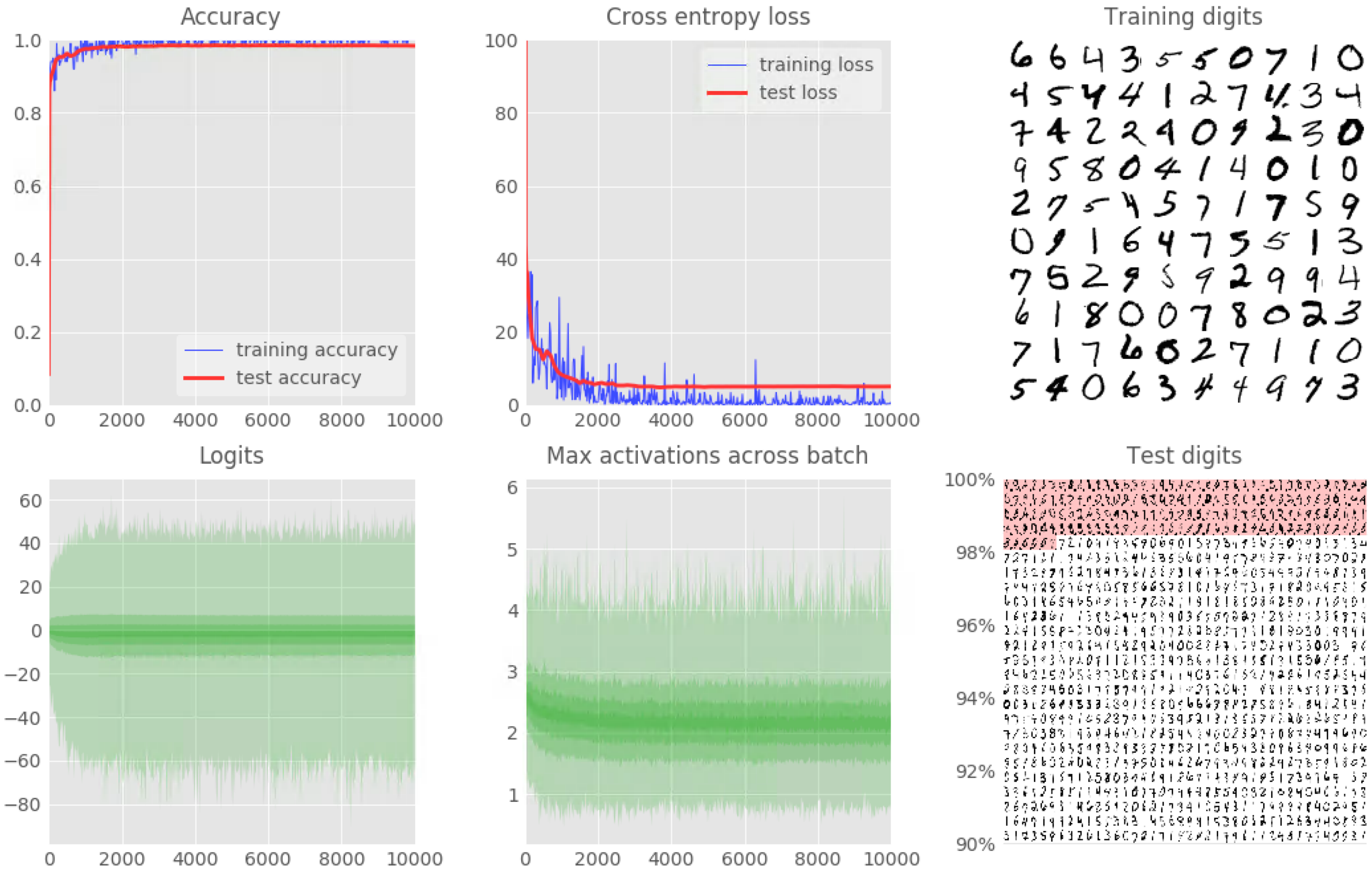
102 commits | 1 branch | 0 releases | 4 contributors | Apache-2.0

martin-gorner committed on GitHub Update INSTALL.txt ... Latest commit ed331aa 25 days ago

mlengine	added example using the Tensorflow high level layers API	26 days ago
.gitignore	small bug fix in batch norm	6 months ago
CONTRIBUTING.md	initial commit 2	4 months ago
INSTALL.txt	Update INSTALL.txt	25 days ago
LICENSE	Initial commit	a year ago
README.md	better image URL	3 months ago
mnist_1.0_softmax.py	global_variables_initializer used everywhere instead of inirialize_al...	2 months ago
mnist_2.0_five_layers_sigmoid.py	Fix spacing in the network structure comment	a month ago
mnist_2.1_five_layers_relu_lrdecay...	Fix spacing in the network structure comment	a month ago

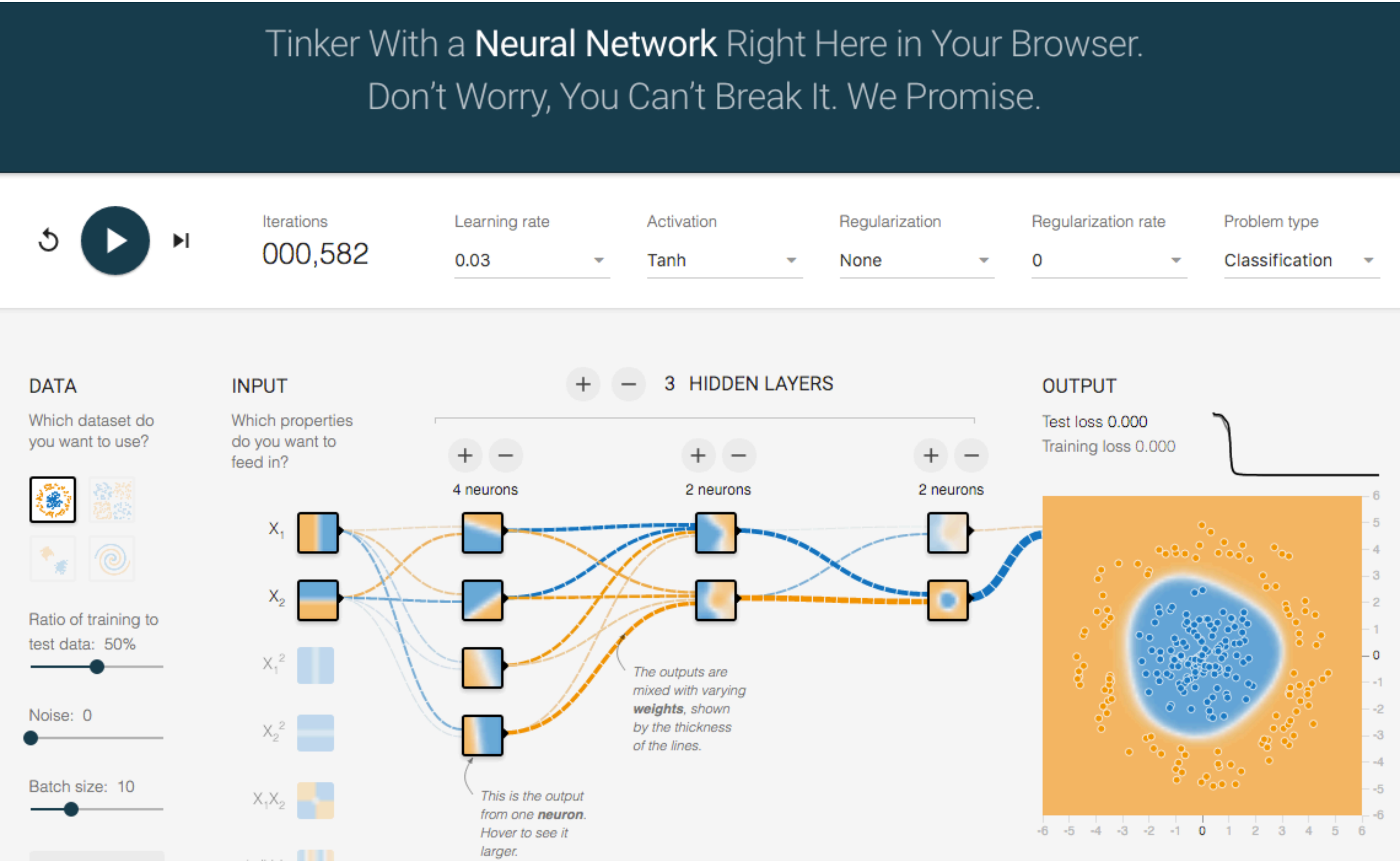
https://github.com/martin-gorner/tensorflow-mnist-tutorial/

TensorFlow MNIST Tutorial



Source: https://github.com/martin-gorner/tensorflow-mnist-tutorial/

TensorFlow Playground



Tinker With a **Neural Network** Right Here in Your Browser.
Don't Worry, You Can't Break It. We Promise.

Iterations 000,582

Learning rate 0.03

Activation Tanh

Regularization None

Regularization rate 0

Problem type Classification

DATA

Which dataset do you want to use?

Ratio of training to test data: 50%

Noise: 0

Batch size: 10

INPUT

Which properties do you want to feed in?

3 HIDDEN LAYERS

4 neurons

2 neurons

2 neurons

*The outputs are mixed with varying **weights**, shown by the thickness of the lines.*

*This is the output from one **neuron**. Hover to see it larger.*

OUTPUT

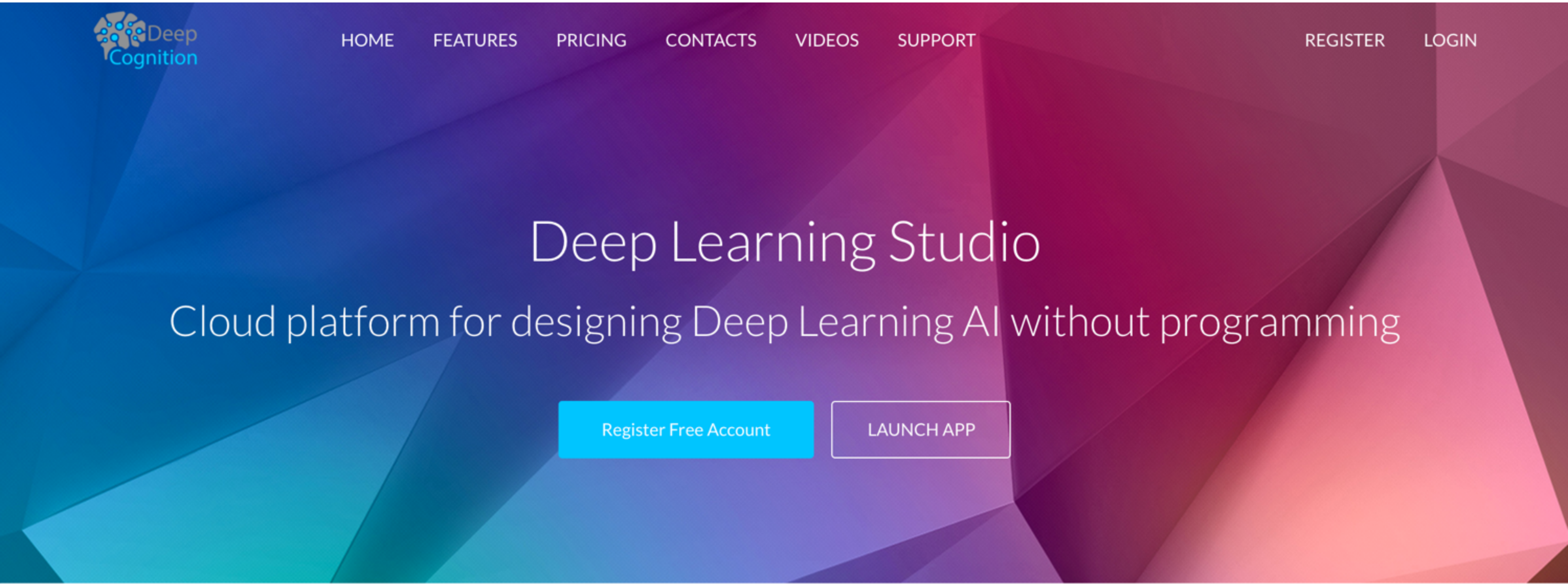
Test loss 0.000

Training loss 0.000

http://playground.tensorflow.org/

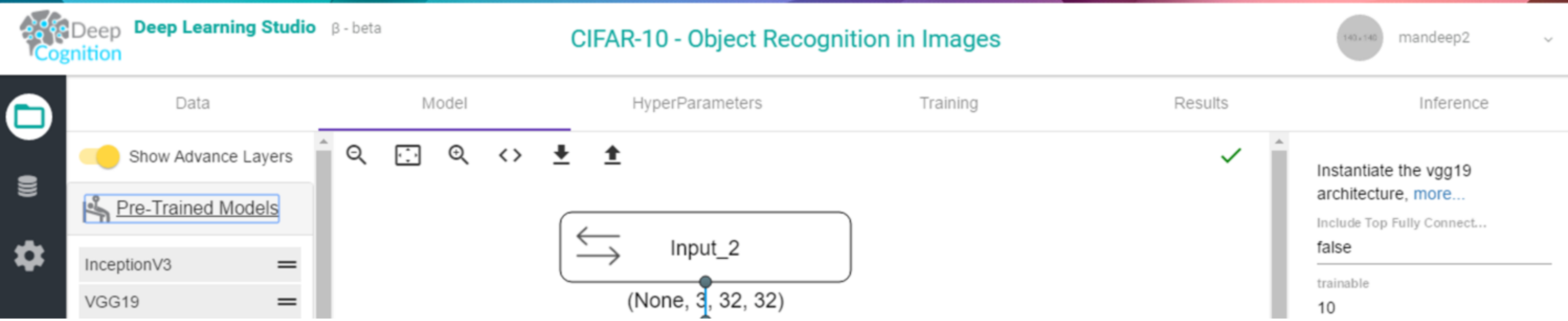
Deep Learning Studio

Cloud platform for designing Deep Learning AI without programming



Deep Learning Studio

Cloud platform for designing Deep Learning AI without programming



CIFAR-10 - Object Recognition in Images

Instantiate the vgg19 architecture, more...

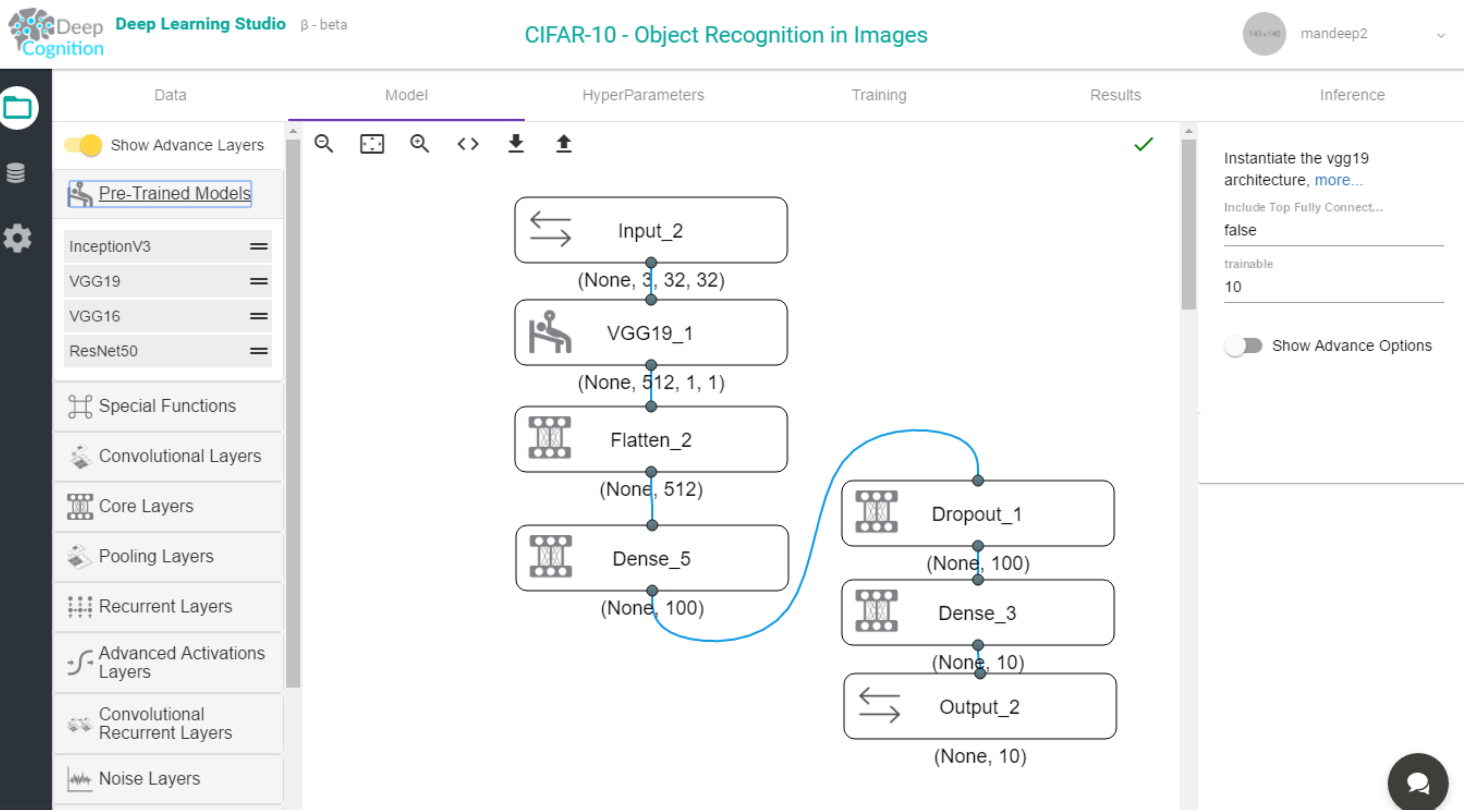
Include Top Fully Connect...
false

trainable
10

http://deepcognition.ai/

Deep Learning Studio

Cloud platform for designing Deep Learning AI without programming



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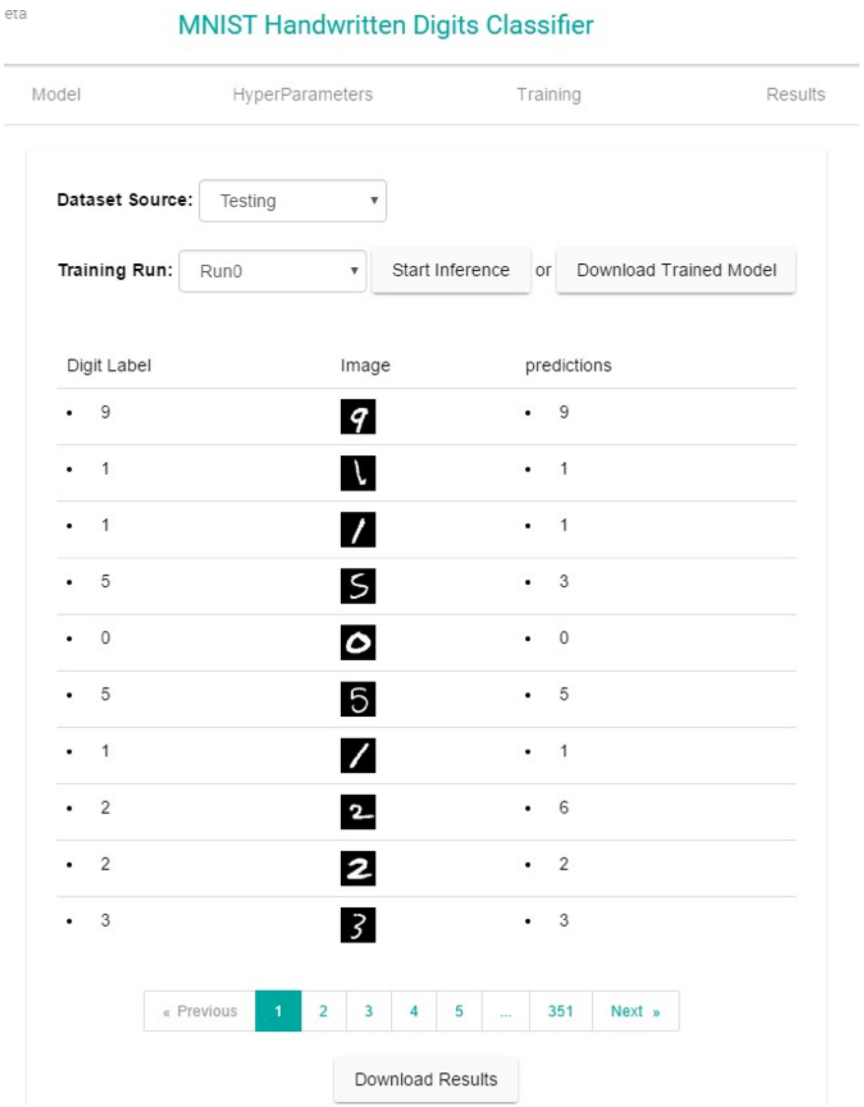

eta

MNIST Handwritten Digits Classifier

Dataset Source: Testing

Training Run: Run0

Digit Label	Image	predictions
• 9		• 9
• 1		• 1
• 1		• 1
• 5		• 3
• 0		• 0
• 5		• 5
• 1		• 1
• 2		• 6
• 2		• 2
• 3		• 3

http://deepcognition.ai/

References

- Sunila Gollapudi (2016), Practical Machine Learning, Packt Publishing
- Sebastian Raschka (2015), Python Machine Learning, Packt Publishing
- Martin Gorner (2017), TensorFlow and Deep Learning without a PhD, Part 1 (Google Cloud Next '17), https://www.youtube.com/watch?v=u4alGiomYP4
- Martin Gorner (2017), TensorFlow and Deep Learning without a PhD, Part 2 (Google Cloud Next '17), https://www.youtube.com/watch?v=fTUwdXUFfI8
- Deep Learning Basics: Neural Networks Demystified, https://www.youtube.com/playlist?list=PLiaHhY2iBX9hdHaRr6b7XevZtgZRa1PoU
- Deep Learning SIMPLIFIED, https://www.youtube.com/playlist?list=PLjJh1vlSEYgvGod9wWiydumYl8hOXixNu
- TensorFlow: https://www.tensorflow.org/
- Theano: http://deeplearning.net/software/theano/
- Keras: http://keras.io/
- Deep Learning Studio: Cloud platform for designing Deep Learning AI without programming, http://deepcognition.ai/