Computational Intelligence

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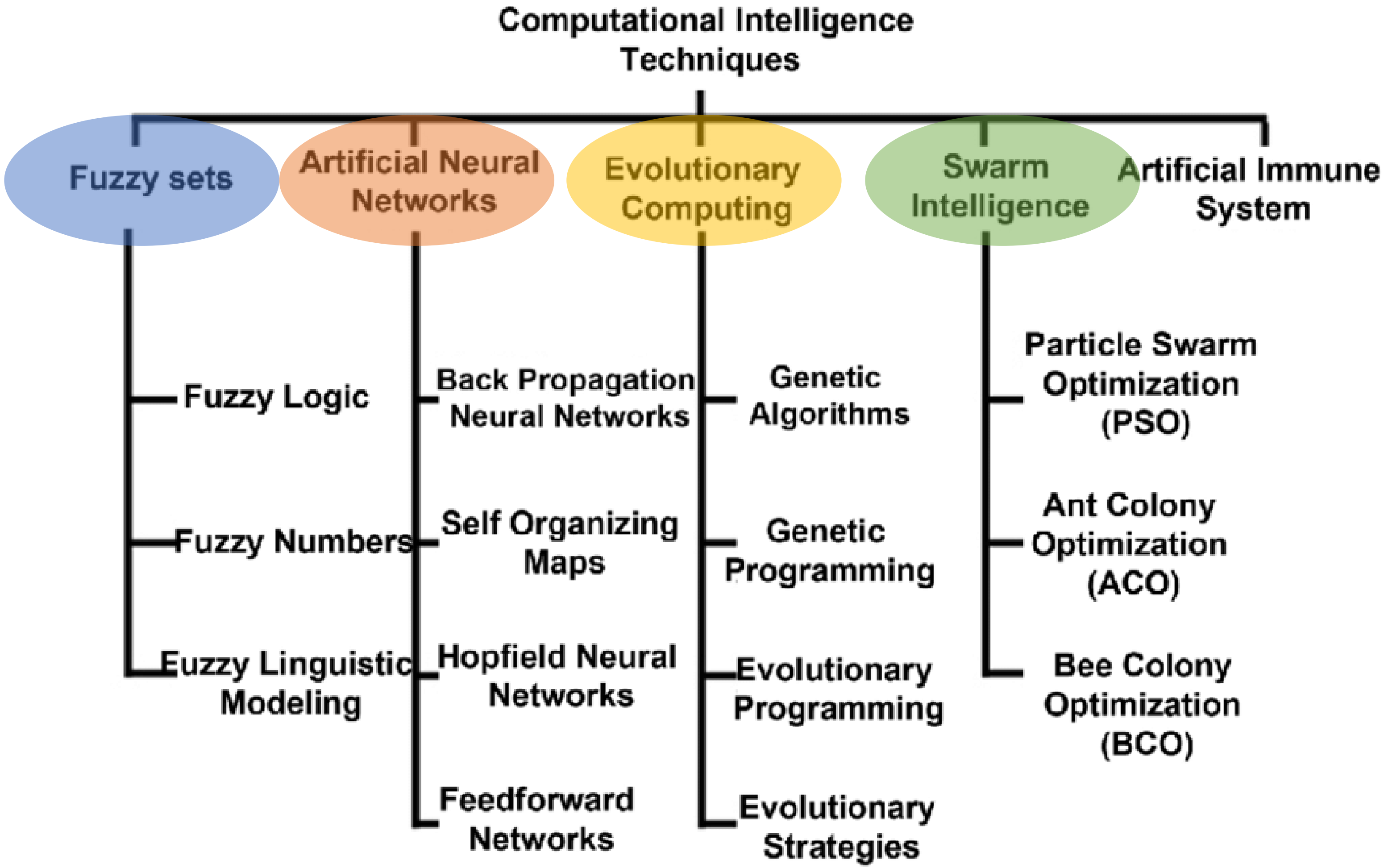
Outline

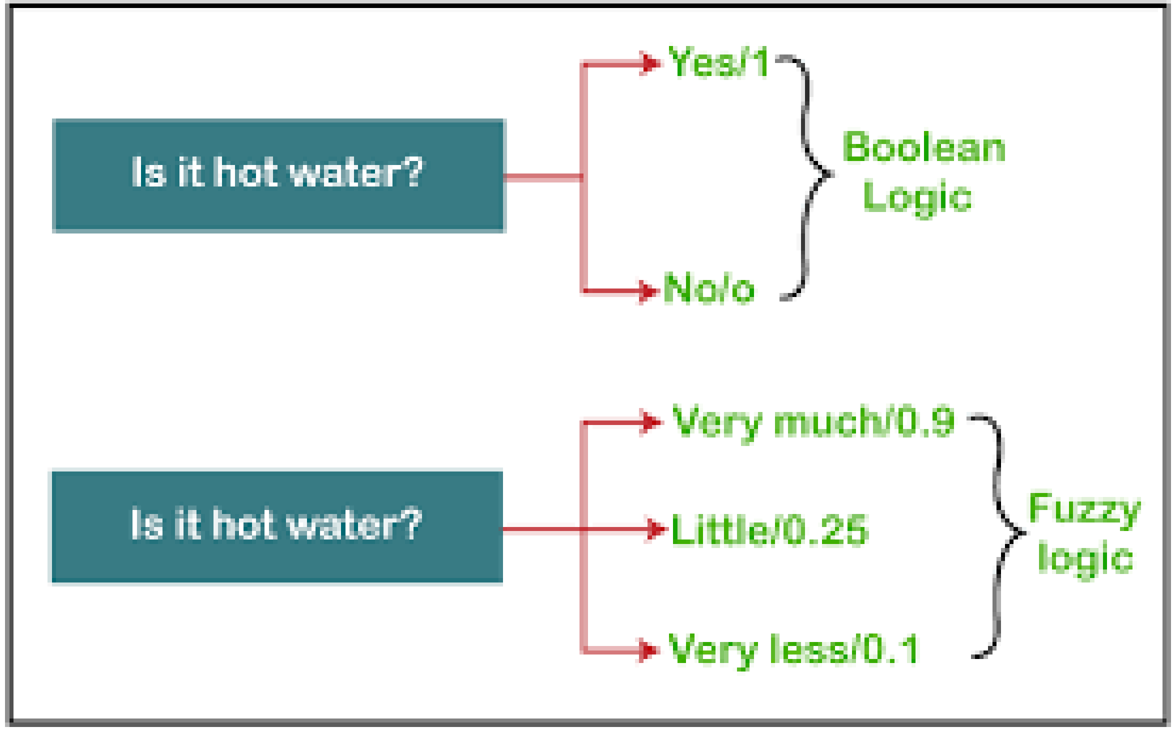
- What is Computational Intelligence?
- Computational Intelligence Applications
- Why Computational Intelligence and Why now?
- Course administrations

What is Computational Intelligence?



Fuzzy logic introduction

- The term fuzzy refers to things that are not clear or are vague

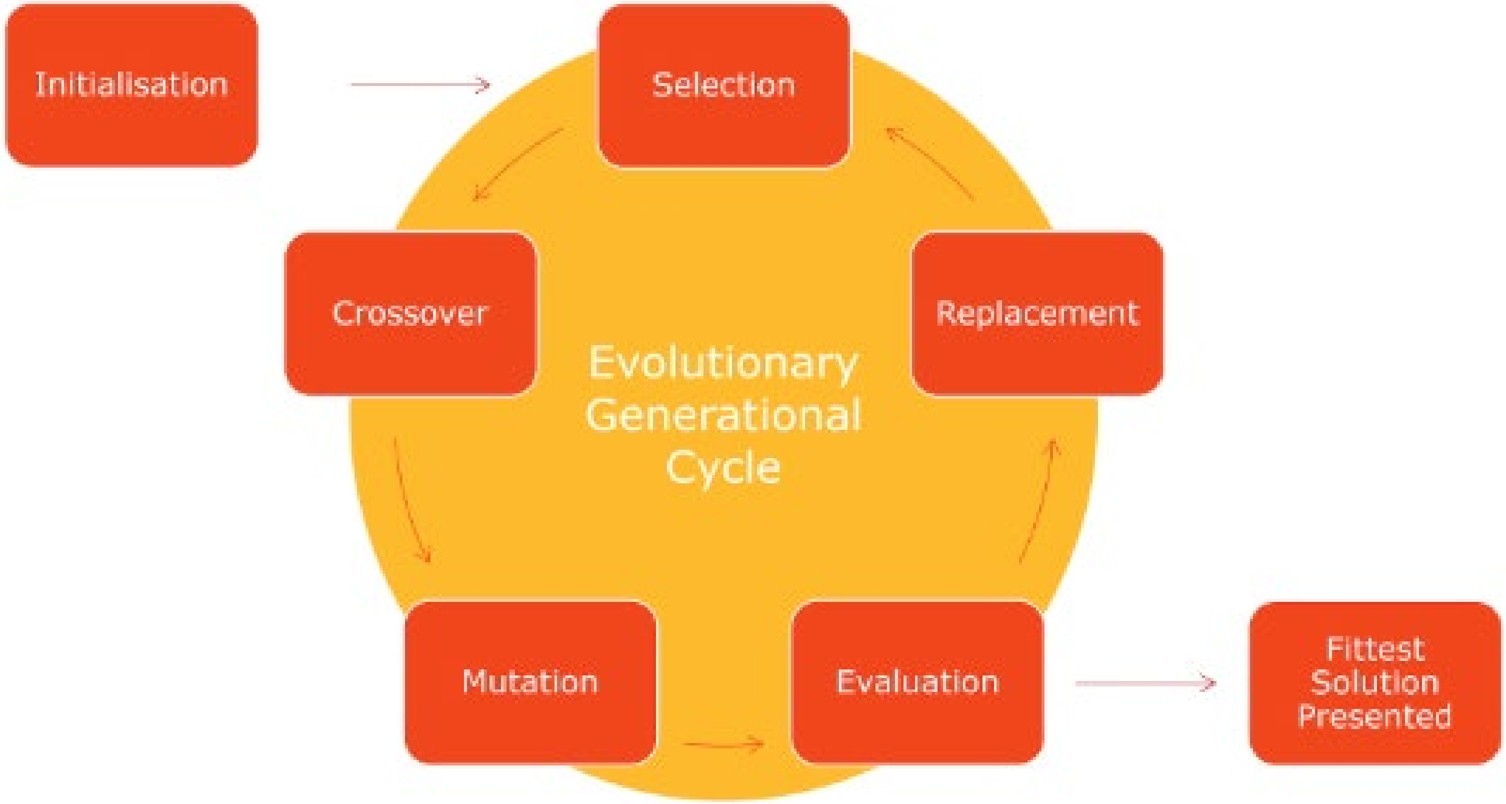


Evolutionary Computing

- simulate physical and/or biological behavior in nature to solve optimization problems.
- Try to solve problems that:
  1. Very difficult to model mathematically.
  2. Computationally expensive to solve.
  3. Involves a large number of parameters.

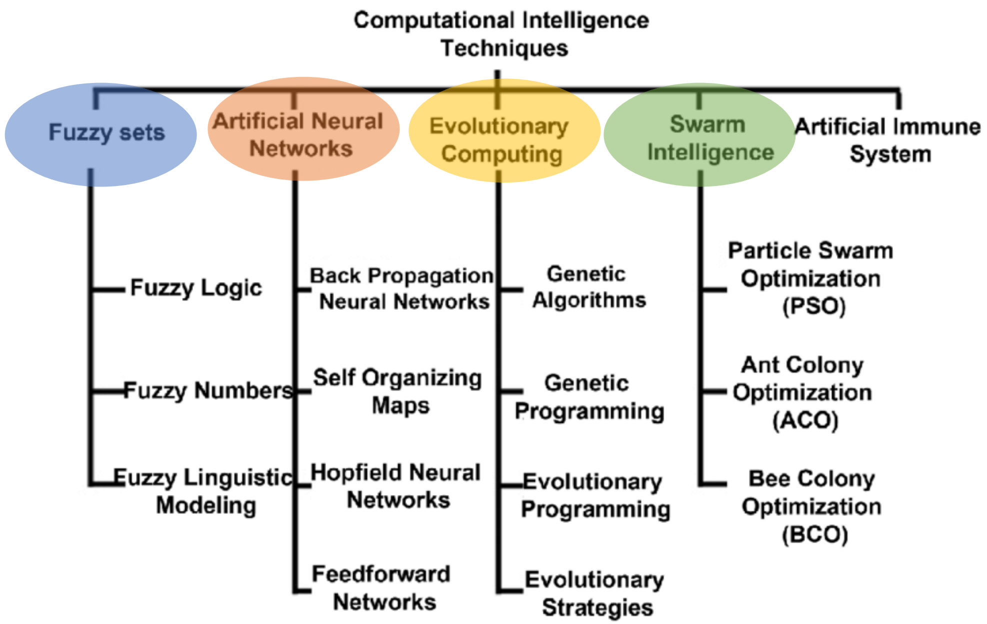
Genetic Algorithms

- a subset of evolutionary algorithms
- simulates Genetics and Evolution (biological behavior)



Swarm intelligence

What is Computational Intelligence?



L1-Introduction
L2-Neuron math model
L3-Perceptron
L4-Building and Applying NN
L5-Gradient descent
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L9-Regularization II
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L22- PSO
L23-Discrete PSO
L24-PSO Hyper-parameters tuning
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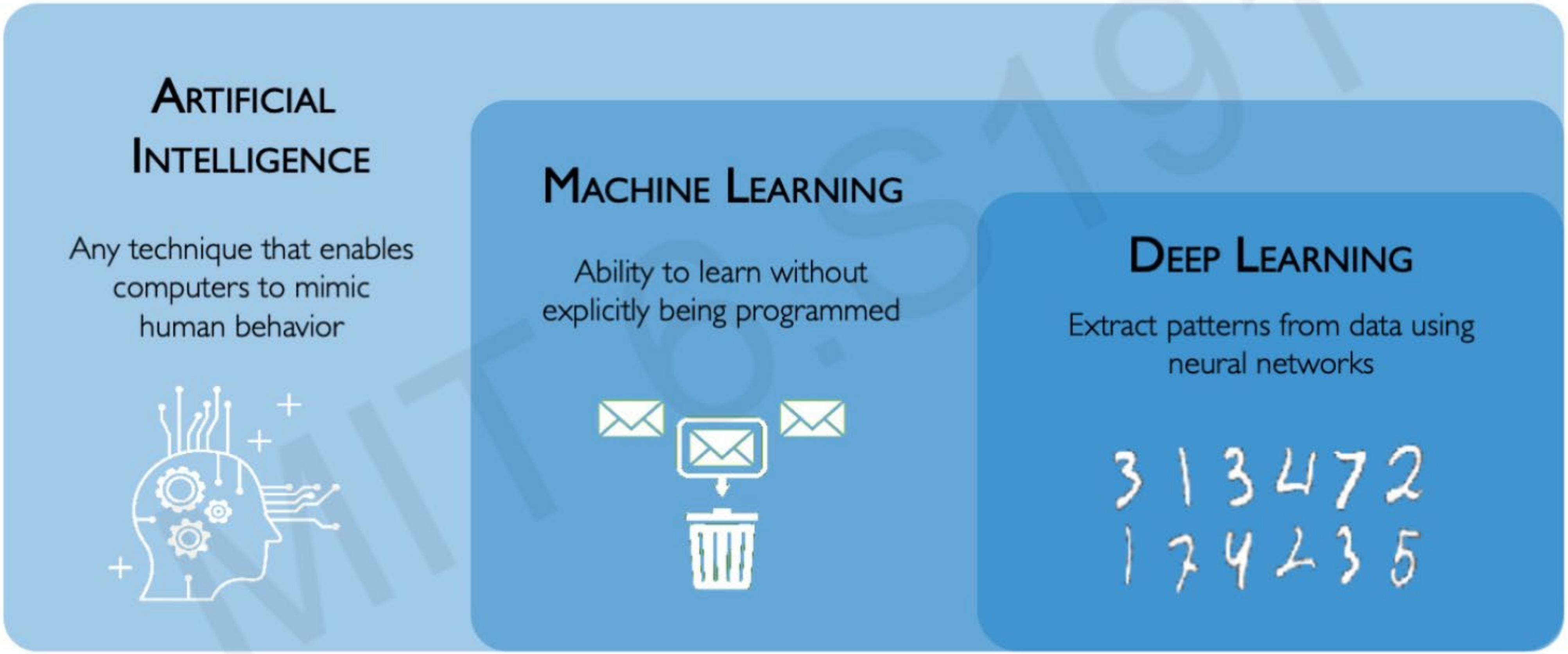
L26- ACO
L27- Introduction
L28- Fuzzy Inference Systems
L-29 Fuzzy Inference Systems
L-30 Defuzzification

What is Neural Network?

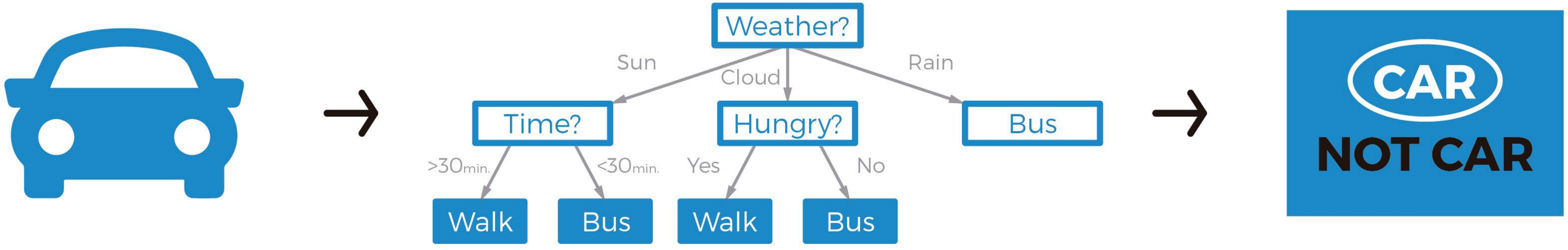


MIT 6.S191

Why do we need to neural networks?

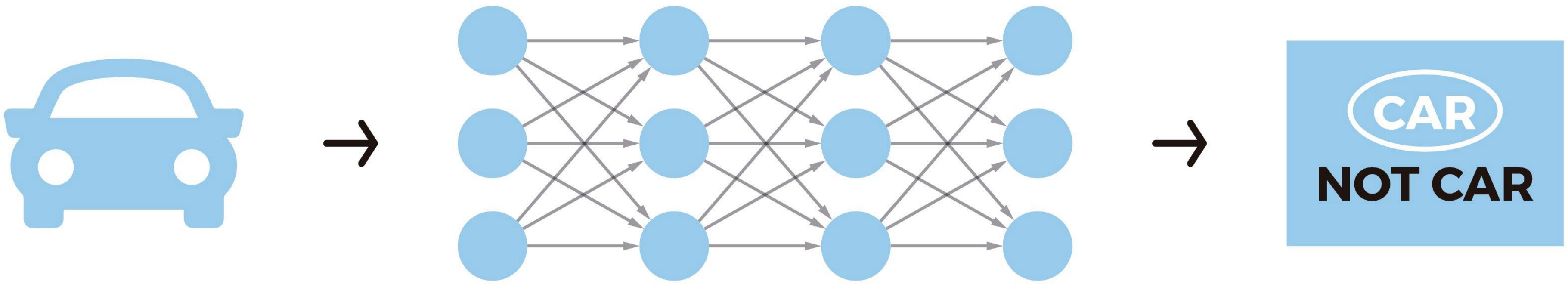
- ML algorithms are mathematical algorithms that allow machines to learn by imitating the way humans learn,
- Machine learning is basically a way to get artificial intelligence.
- Instead of writing a program by hand, we collect lots of examples that specify the correct output for a given input.
- A machine learning algorithm then takes these examples and produces a program that does the job.

Machine Learning



Input | Decision tree | Output

Deep Learning



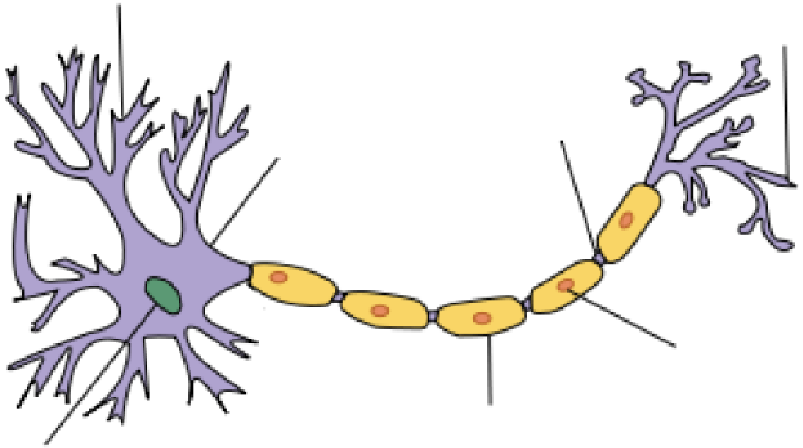
Input | Feature extraction + Classification | Output

What is Neural Networks?

- Neural Networks attempts to learn representations of data with multiple levels of abstraction.
- Neural Networks usually refers to a set of algorithms and computational models that are composed of multiple processing layers.
- These methods have significantly improved the state-of-the-art in many domains including, speech recognition, classification, pattern recognition, drug discovery, and genomics.

Human brains

- A brain is a set of densely connected neurons.
- Components of a neuron: dendrites, soma, axon, synapse
- Depending on the input signals, the neuron performs computations and decides to fire or not.



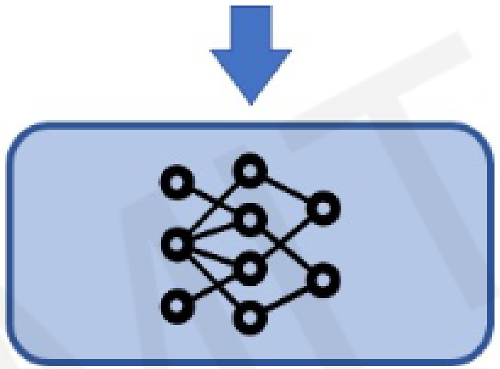
Applications

- Medical diagnosis
- Spam filtering
- Facial recognition
- Speech understanding
- Handwriting recognition

Success Stories

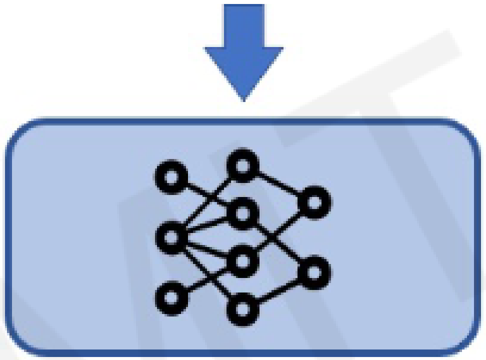
Generating Images from natural language

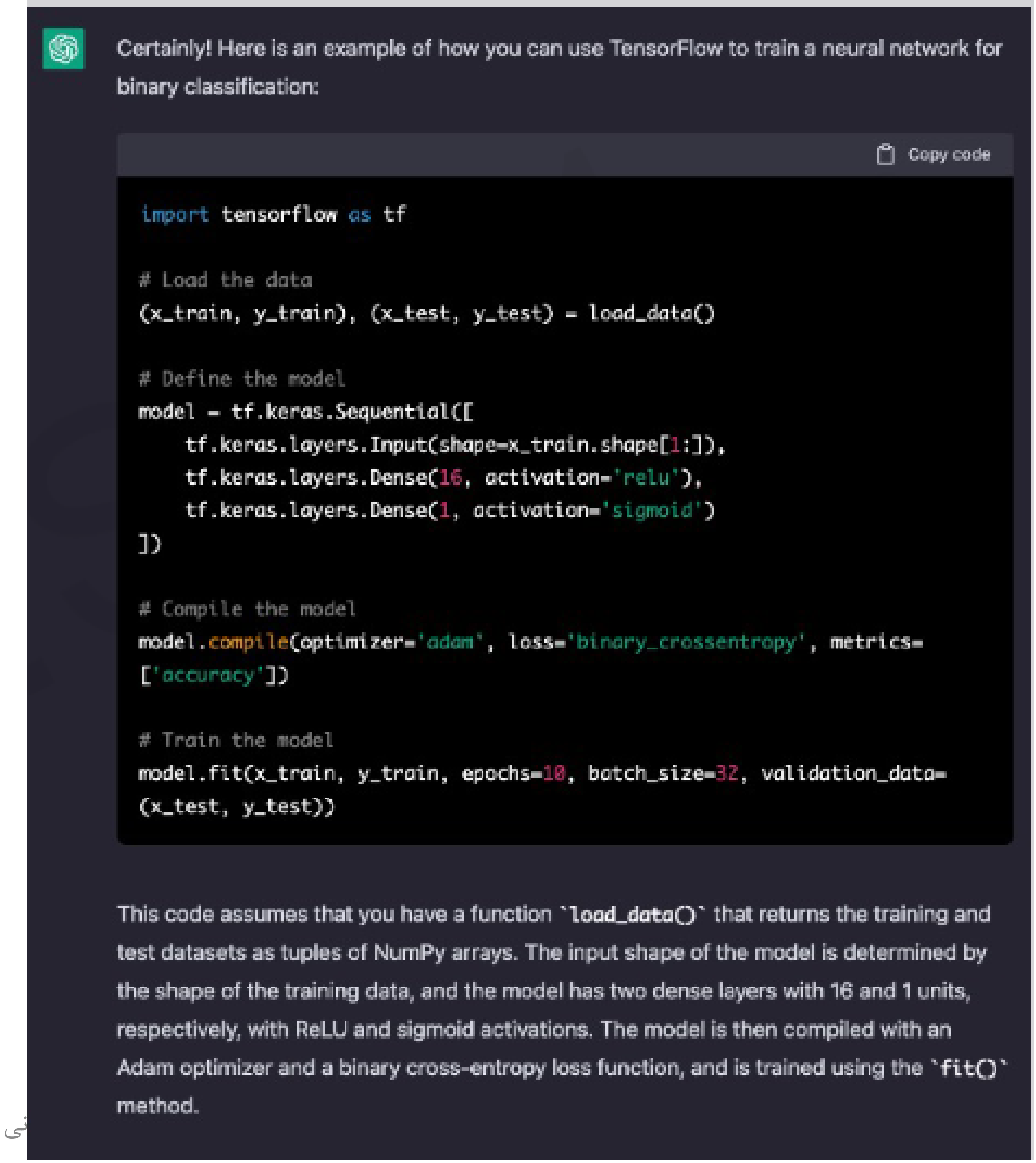
"A photo of an astronaut riding a horse."



Generating Images from natural language

"Write code in TensorFlow to train a neural network."





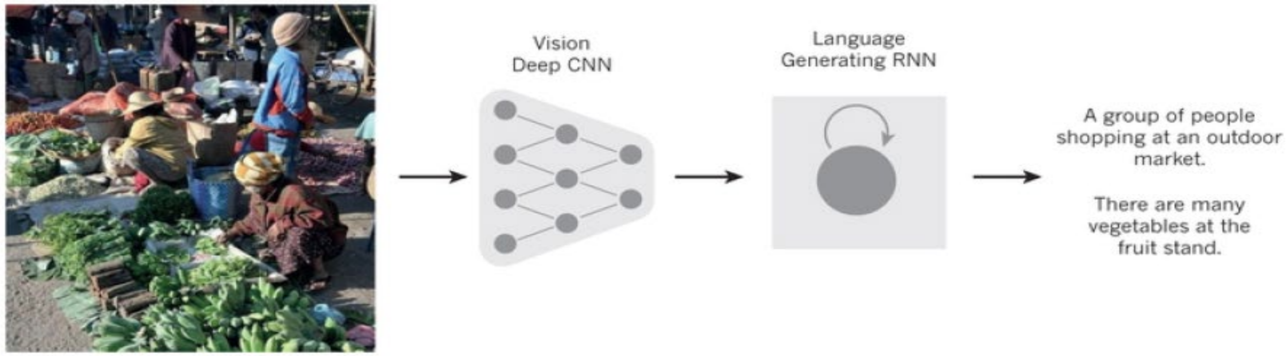
Video Generation

Games

Deep Learning Machine Teaches Itself Chess in 72 Hours, Plays at International Master Level.

An artificial intelligence machine plays chess by evaluating the board rather than using brute force to work out every possible move.

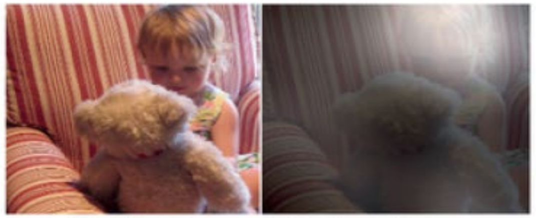
Caption Generation



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.

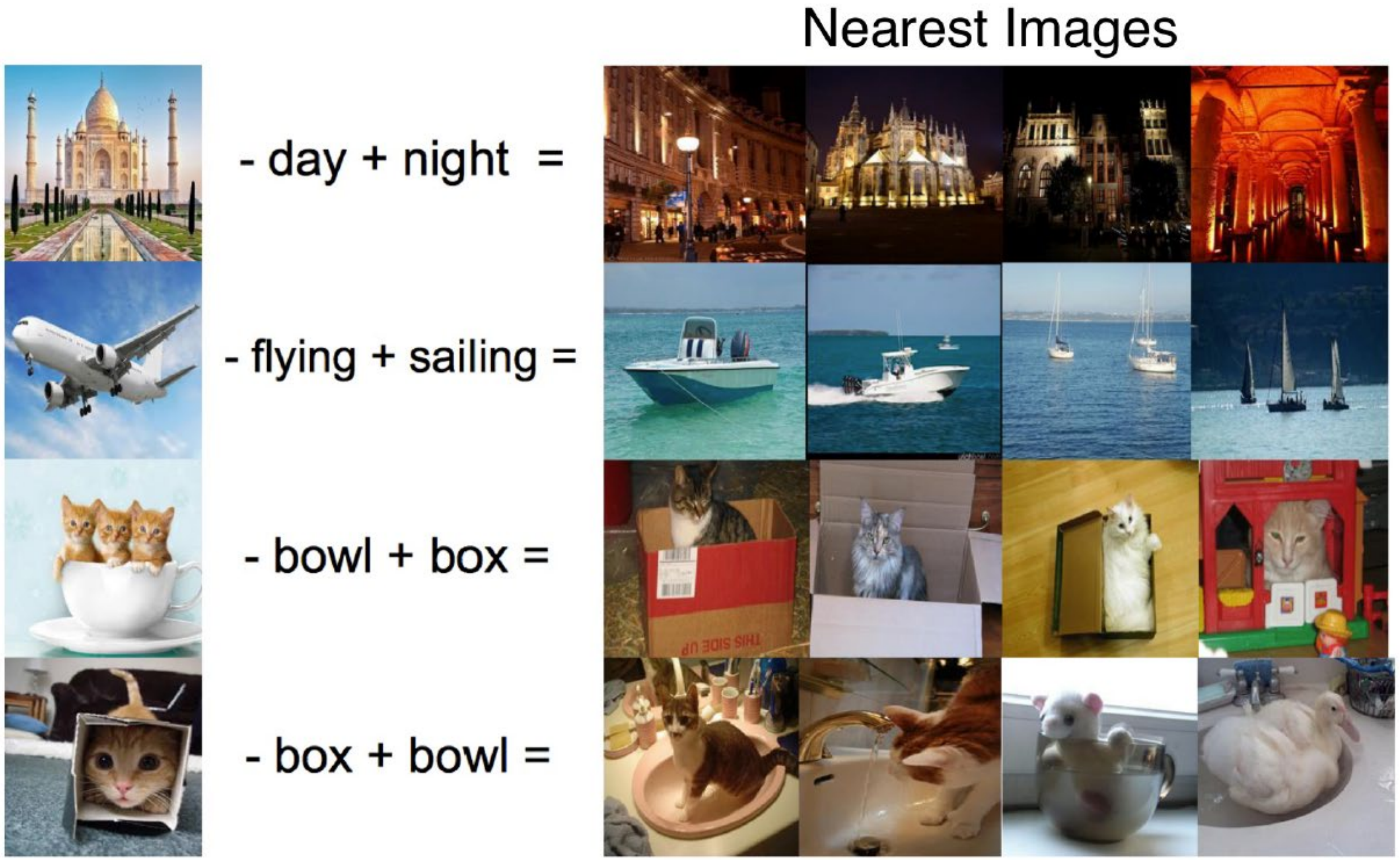
A giraffe standing in a forest with **trees** in the background.

Word embeding

Word2vec , Mikolov, 2013.

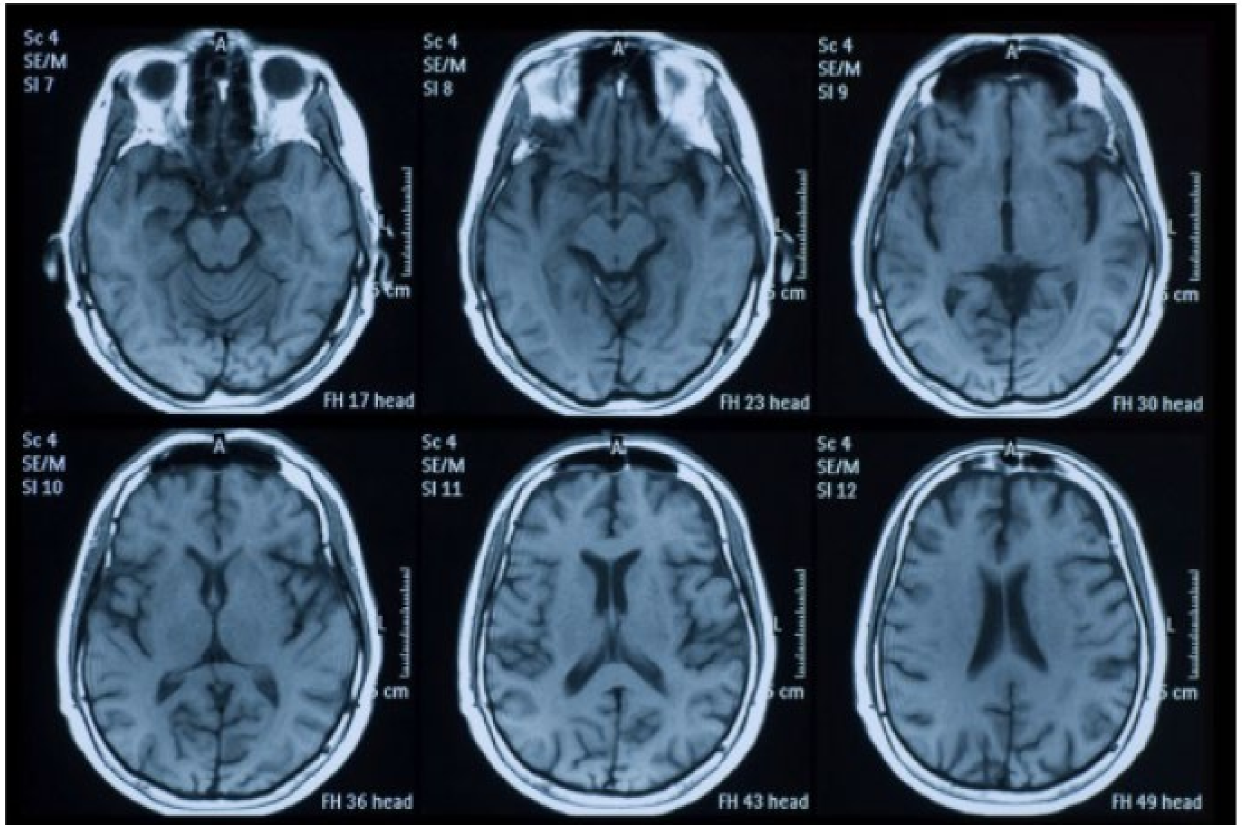
$$\text{king} - \text{man} + \text{woman} = \text{queen}$$

Word embeding



(Kiros, Salakhutdinov, Zemel, TACL 2015)

Medical Image processing



Success Stories

PASCAL Visual Object Challenge
(20 object categories)
[Everingham et al. 2006-2012]

Image is CC0 1.0 public domain

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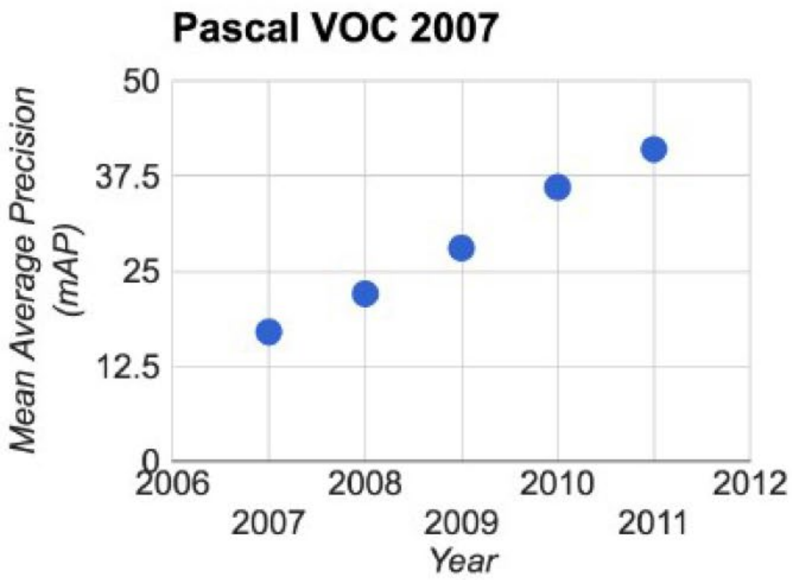
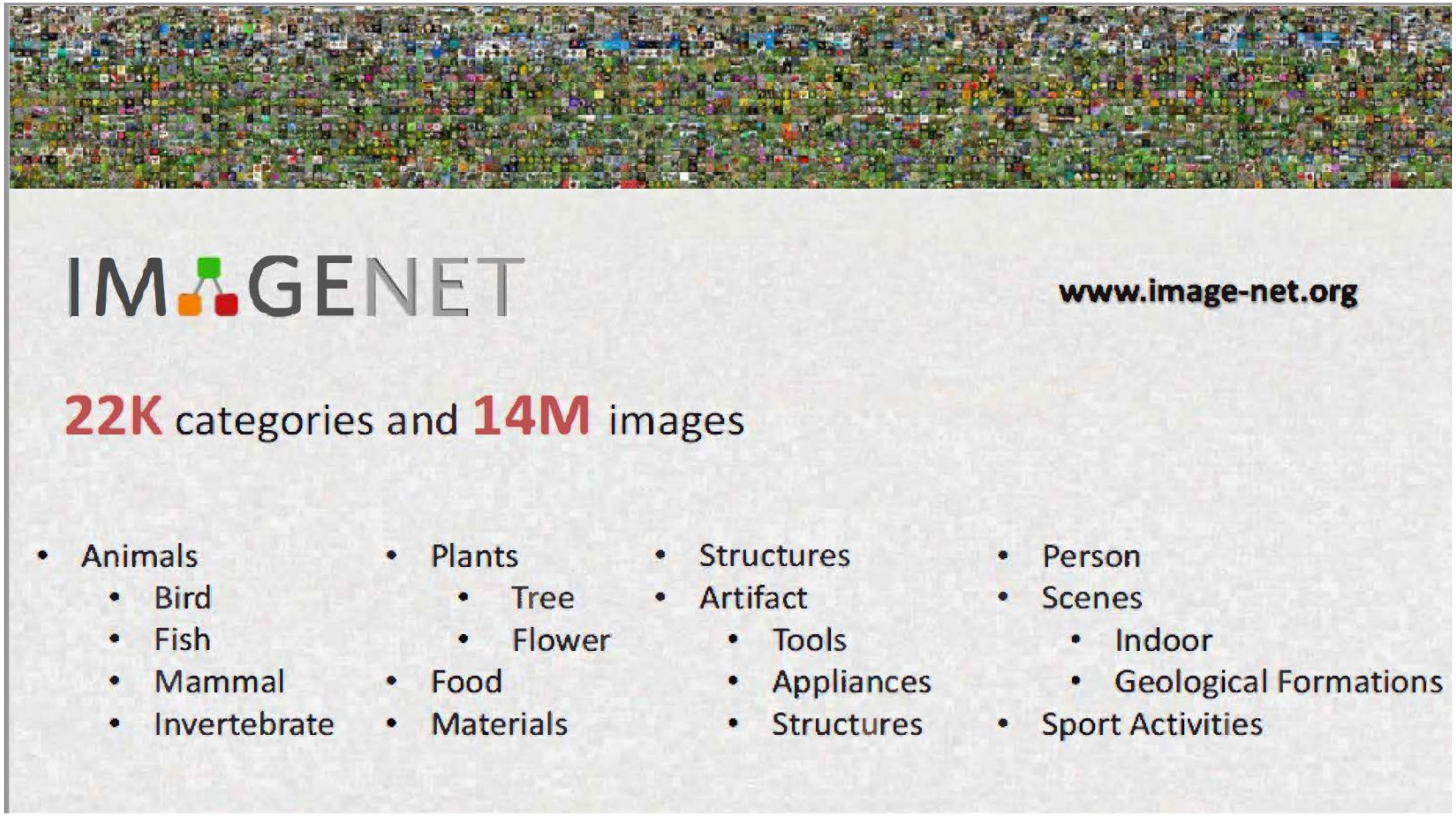
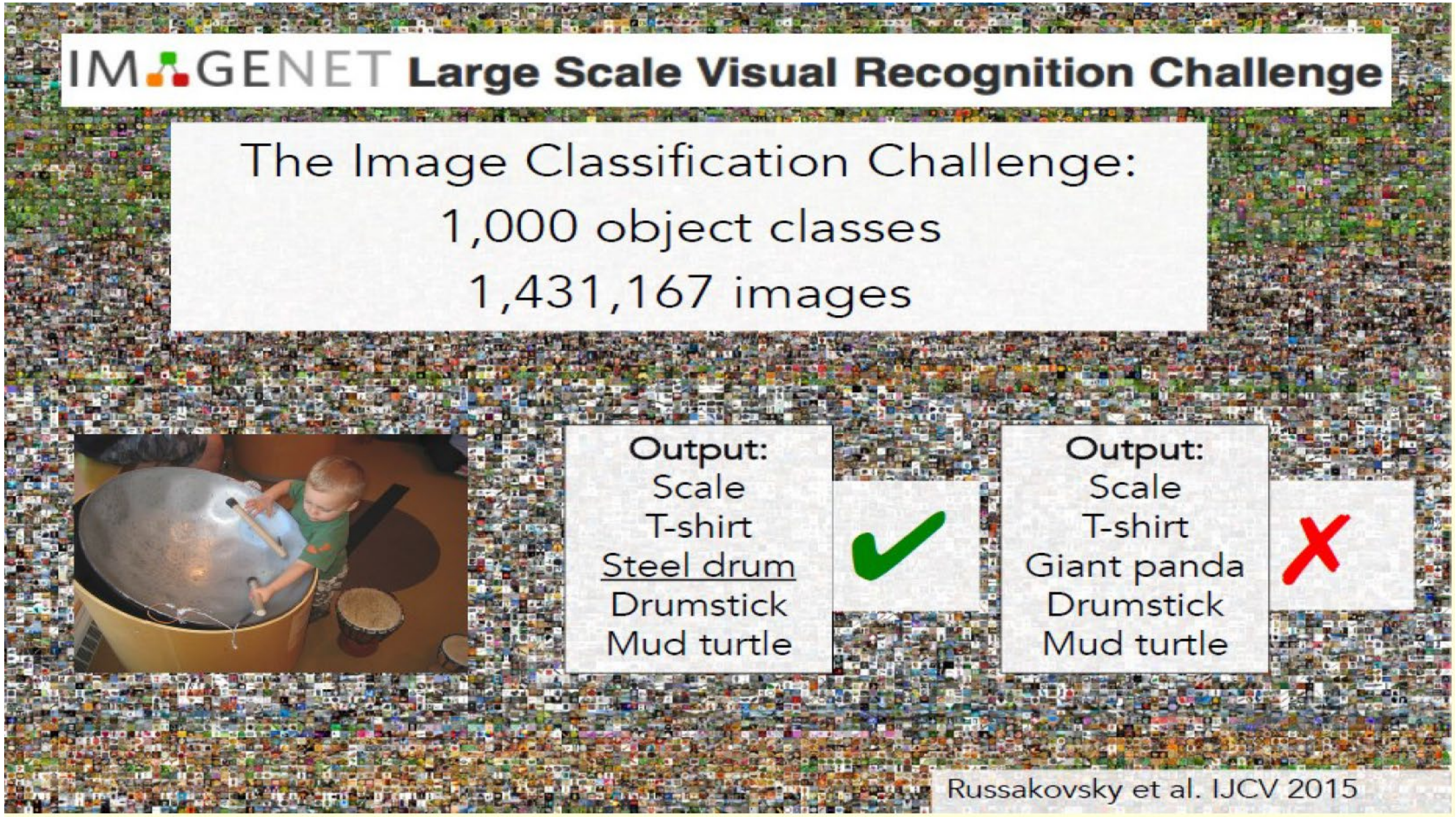


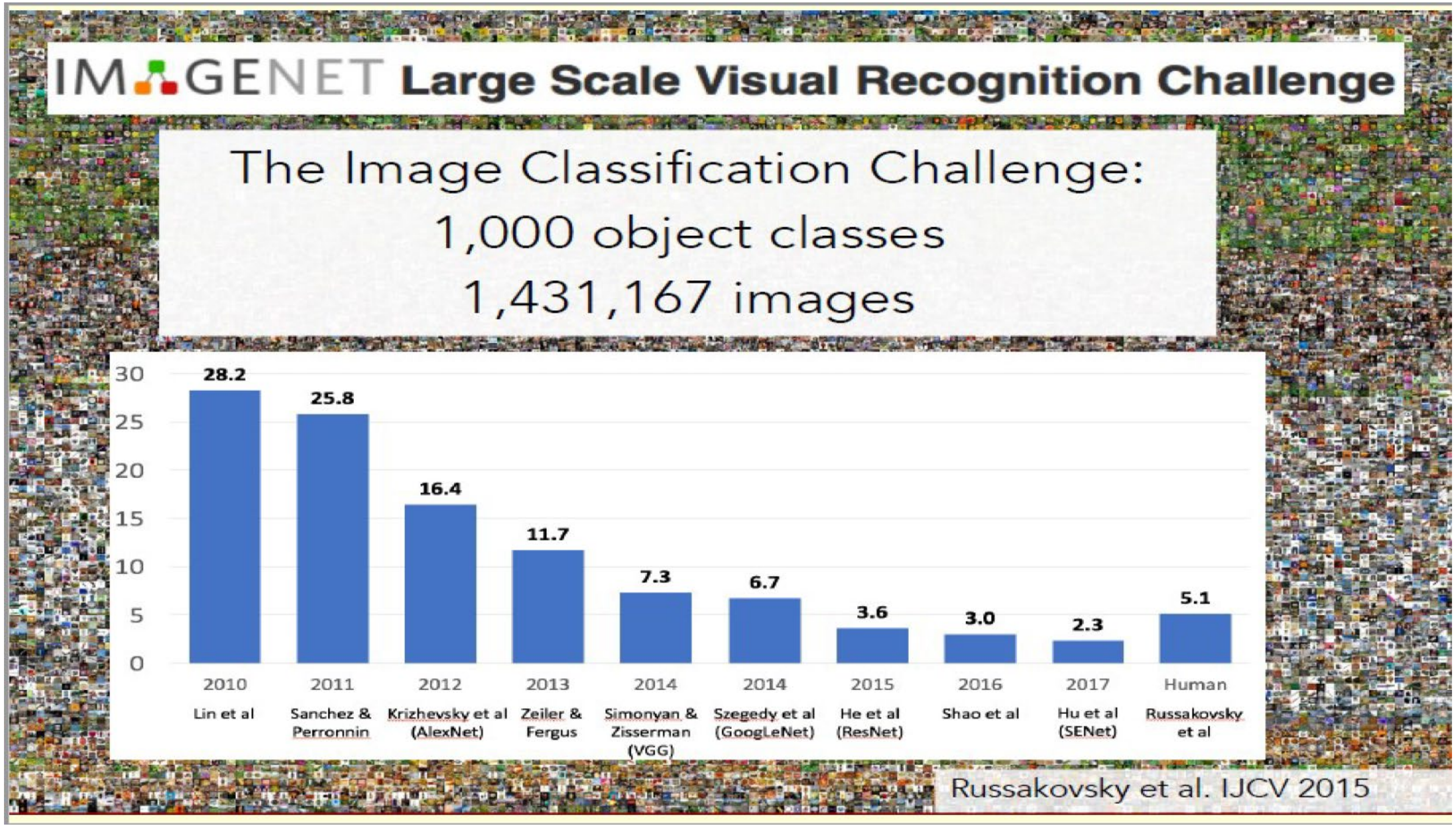
Success Stories



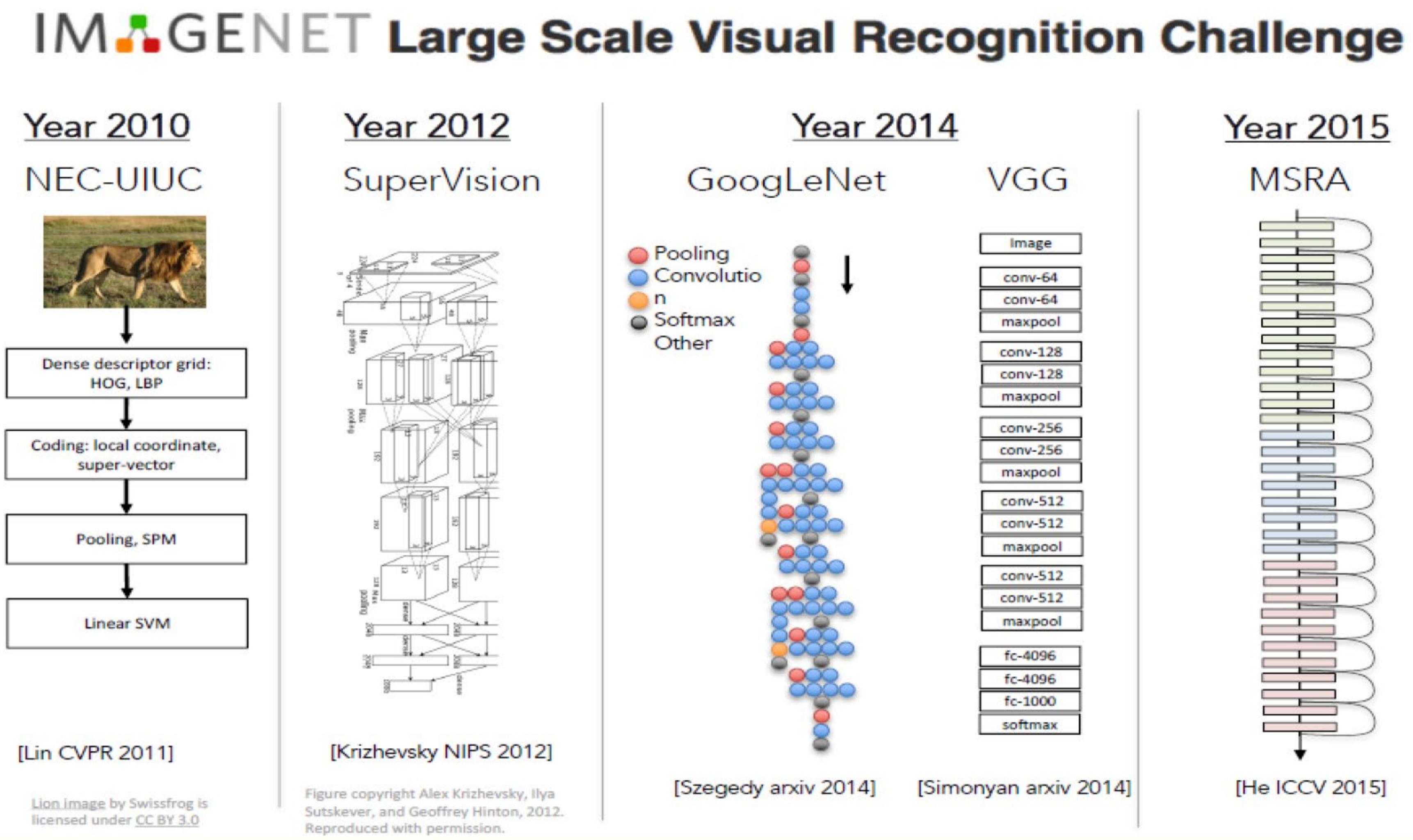
Success Stories



Success Stories



Success Stories



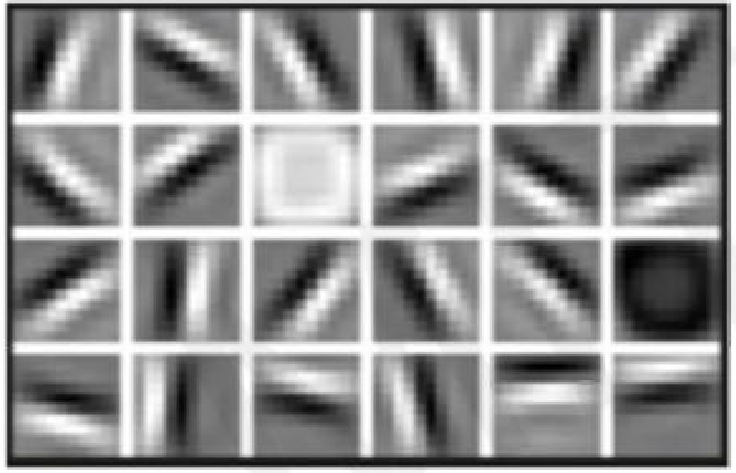
Why Deep Learning and Why now?

Why Neural Networks?

Hand engineered features are time consuming, brittle, and not scalable in practice

Can we learn the **underlying features** directly from data?

Low Level Features



Lines & Edges

Mid Level Features

Eyes & Nose & Ears

High Level Features

Facial Structure

Why Now?

1952	Stochastic Gradient Descent
1958	Perceptron • Learnable Weights
⋮	
1986	Backpropagation • Multi-Layer Perceptron
1995	Deep Convolutional NN • Digit Recognition
⋮	

Neural Networks date back decades, so why the resurgence?

1. Big Data

- Larger Datasets
- Easier Collection & Storage

IMAGENET

WIKIPEDIA
The Free Encyclopedia

2. Hardware

- Graphics Processing Units (GPUs)
- Massively Parallelizable

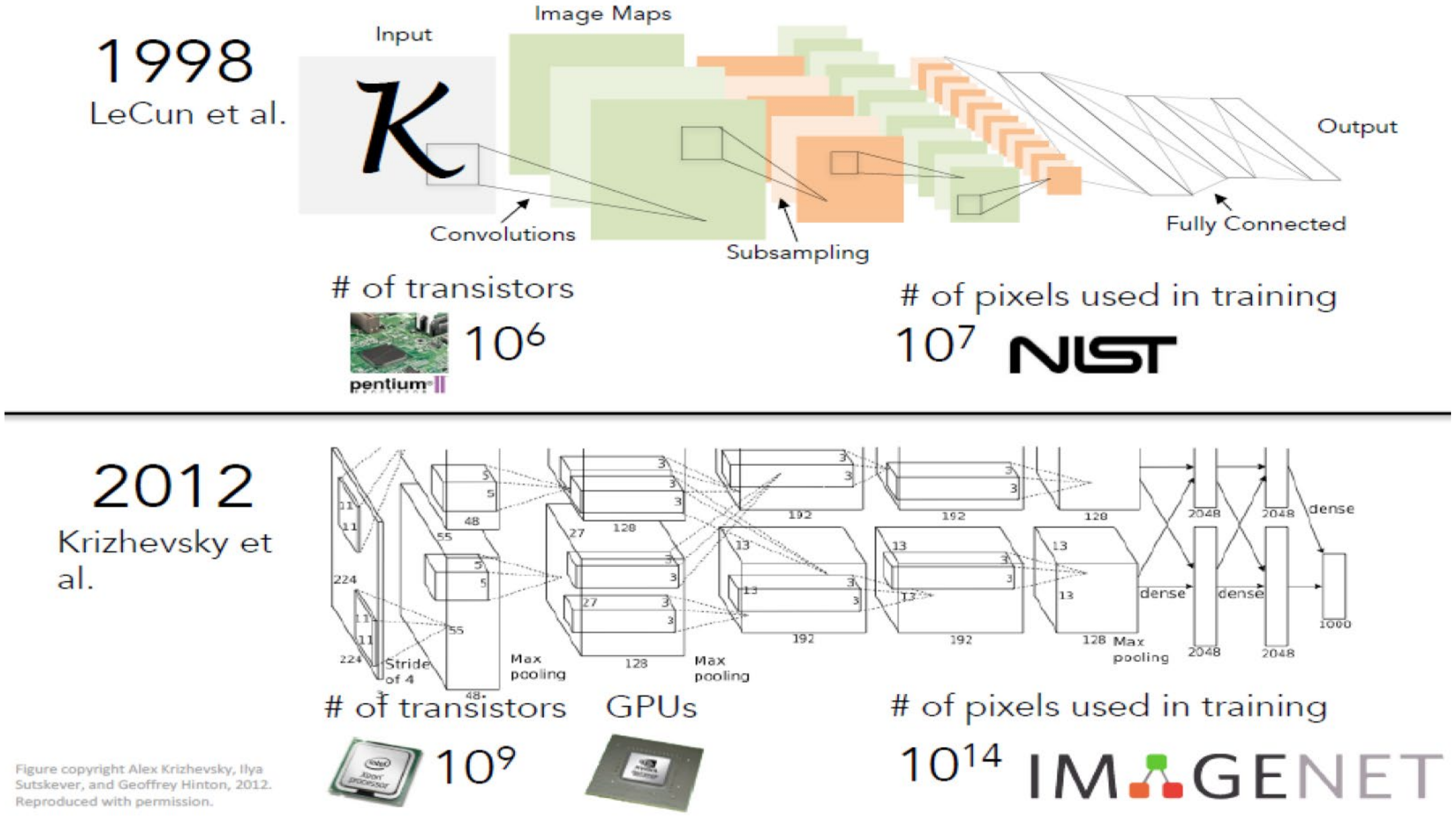
3. Software

- Improved Techniques
- New Models
- Toolboxes

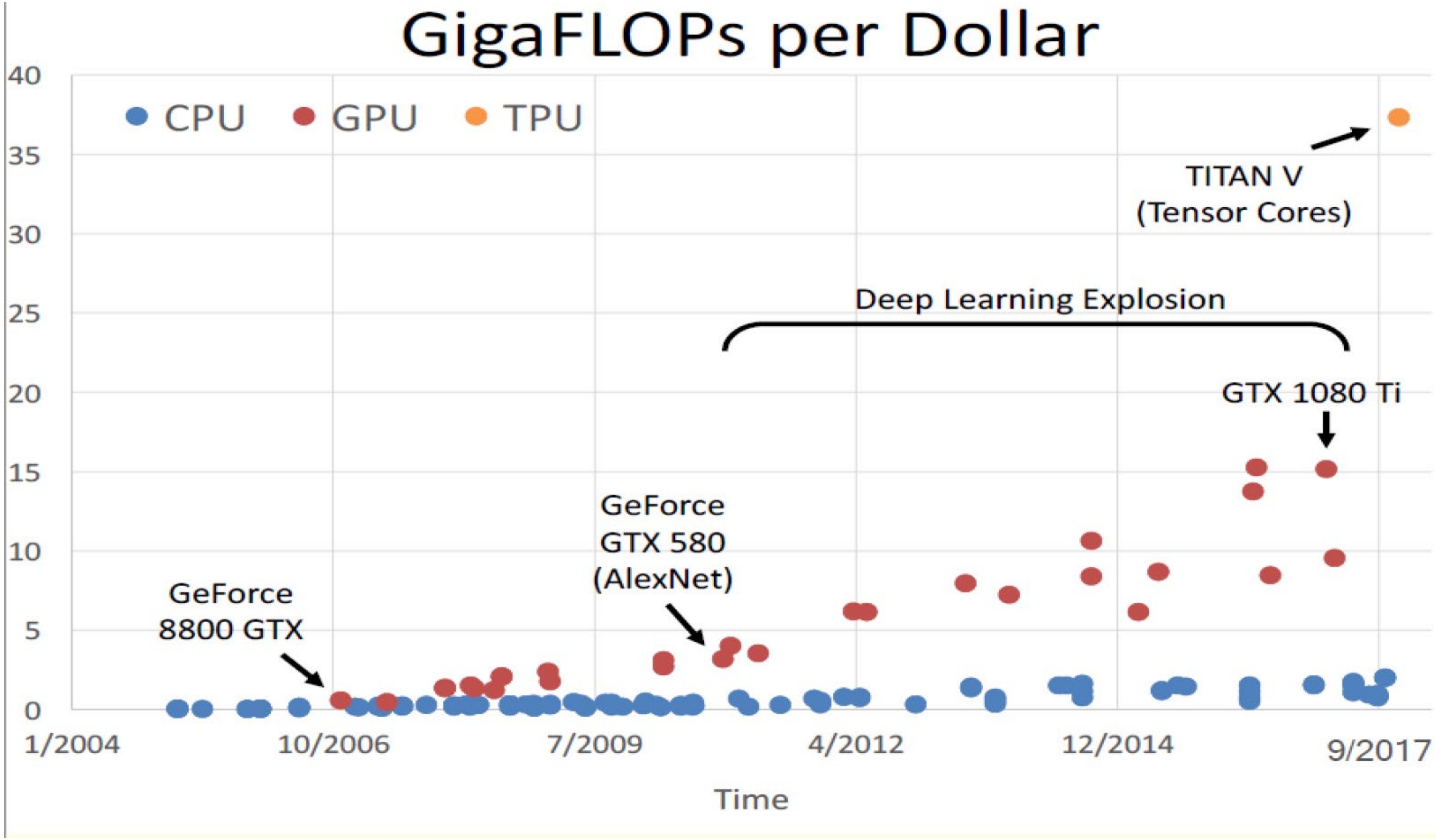
TensorFlow

MIT 6.S191

Why now?

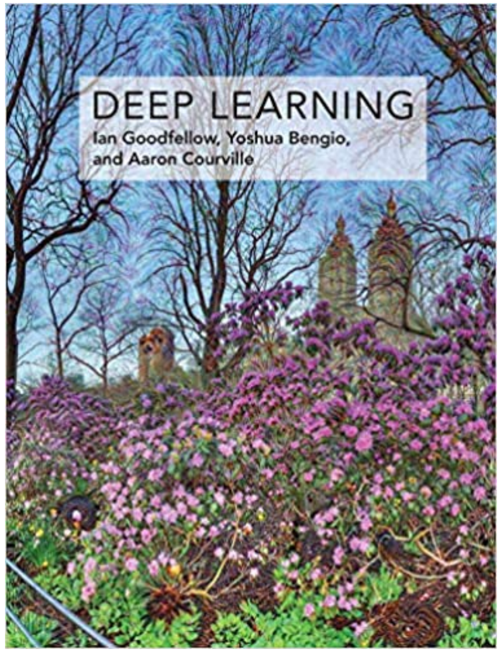

1998
LeCun et al.
Input
Image Maps
Output
Convolutions
Subsampling
Fully Connected
# of transistors
10^6
pentium II
# of pixels used in training
10^7
NIST
2012
Krizhevsky et al.
Stride of 4
Max pooling
dense
# of transistors
10^9
GPUs
# of pixels used in training
10^{14}
IMAGENET
Figure copyright Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton, 2012. Reproduced with permission.

Why now?


GigaFLOPs per Dollar
CPU
GPU
TPU
40
35
30
25
20
15
10
5
0
1/2004
10/2006
7/2009
4/2012
12/2014
9/2017
Time
TITAN V
(Tensor Cores)
Deep Learning Explosion
GTX 1080 Ti
GeForce
GTX 580
(AlexNet)
GeForce
8800 GTX

Text Books

- Deep learning, I. Goodfellow, j. Bengio MIT Press, 2016
- Neural Networks and deep learning, M. Nielsen Determination Press, 2015





Syllabus

L1-Introduction
L2-Neuron math model
L3-Perceptron
L4-Building and Applying NN
L5-Gradient descent
L6-Vectorization
L7-Overfitting
L8-Regularization I
L9-Regularization II
L10-Optimization Algorithms I (mini-batches)
L11-Optimization Algorithms II(exponentially weighted averages)
L12-Hyperparameter Tuning
L13-Batch Normalization
L14-Soiftmax
L15-Convolutional Neural Networks
L16-Padding, Strided convolution
L17-Simple Convolutional Network

Related Course

- Deep learning, Andrew Ng, Stanford University

- Intro to Deep Learning, MIT

- Neural Network for Machin Learning

Course administrations

Schedule

ردیف	تاریخ	موضوع
1	سه شنبه, 24 بهمن 1402	L1-Introduction
2	یکشنبه, 29 بهمن 1402	L2-Neuron math model
3	سه شنبه, 1 اسفند 1402	L3-Perceptron
4	یکشنبه, 6 اسفند 1402	L4-Building and Applying NN
5	سه شنبه, 8 اسفند 1402	L5-Gradient descent
6	یکشنبه, 13 اسفند 1402	L6-Vectorization
7	سه شنبه, 15 اسفند 1402	L7-Overfitting
8	یکشنبه, 20 اسفند 1402	L8-Regularization I
9	سه شنبه, 22 اسفند 1402	L9-Regularization II
10	یکشنبه, 27 اسفند 1402	L10-Optimization Algorithms I (mini-batches)
11	سه شنبه, 14 فروردین 1403	L11-Optimization Algorithms II(exponentially weighted averages)
12	یکشنبه, 19 فروردین 1403	L12-Hyperparameter Tuning
13	سه شنبه, 21 فروردین 1403	L13-Batch Normalization
14	یکشنبه, 26 فروردین 1403	L14-Soiftmax
15	سه شنبه, 28 فروردین 1403	L15-Convolutional Neural Networks
16	سه شنبه, 4 اردیبهشت 1403	L16-Padding, Strided convolution
17	یکشنبه, 9 اردیبهشت 1403	L17-Simple Convolutional Network
18	سه شنبه, 11 اردیبهشت 1403	L18- Genetic Algorithms
19	یکشنبه, 16 اردیبهشت 1403	L19- Genetic Algorithms
20	سه شنبه, 18 اردیبهشت 1403	L20- Swarm Intelligence Introduction
21	یکشنبه, 23 اردیبهشت 1403	L21-Particle Swarm Intelligence (PSO)
22	سه شنبه, 25 اردیبهشت 1403	L22- PSO
23	یکشنبه, 30 اردیبهشت 1403	L23-Discrete PSO
24	سه شنبه, 1 خرداد 1403	L24-PSO Hyper-parameters tuning
25	یکشنبه, 6 خرداد 1403	L25- Ant Colony Optimization (ACO)
26	سه شنبه, 8 خرداد 1403	L26- ACO
27	یکشنبه, 13 خرداد 1403	L27- Introduction
28	سه شنبه, 15 خرداد 1403	L28- Fuzzy Inference Systems
29	یکشنبه, 20 خرداد 1403	L-29 Fuzzy Inference Systems
30	سه شنبه, 22 خرداد 1403	L-30 Defuzzification

Course Staff

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Assignments

تاریخ	موضوع	تمرین ها	مسئول تنظیم تمرین
سه شنبه, 24 بهمن 1402	L1-Introduction		
یکشنبه, 29 بهمن 1402	L2-Neuron math model		
سه شنبه, 1 اسفند 1402	L3-Perceptron		
یکشنبه, 6 اسفند 1402	L4-Building and Applying NN		
سه شنبه, 8 اسفند 1402	L5-Gradient descent		
یکشنبه, 13 اسفند 1402	L6-Vectorization		
سه شنبه, 15 اسفند 1402	L7-Overfitting	تئوری و عملی A1	آعلی تمیزی فر
یکشنبه, 20 اسفند 1402	L8-Regularization I		
سه شنبه, 22 اسفند 1402	L9-Regularization II		
یکشنبه, 27 اسفند 1402	L10-Optimization Algorithms I (mini-batches)		
سه شنبه, 14 فروردین 1403	L11-Optimization Algorithms II(exponentially weighted averages)		
یکشنبه, 19 فروردین 1403	L12-Hyperparameter Tuning		
سه شنبه, 21 فروردین 1403	L13-Batch Normalization		
یکشنبه, 26 فروردین 1403	L14-Soiftmax		
سه شنبه, 28 فروردین 1403	L15-Convolutional Neural Networks		
سه شنبه, 4 اردیبهشت 1403	L16-Padding, Strided convolution		
یکشنبه, 9 اردیبهشت 1403	L17-Simple Convolutional Network	تئوری و عملیA2	آقای عظیمی دخت
سه شنبه, 11 اردیبهشت 1403	L18- Genetic Algorithms		
یکشنبه, 16 اردیبهشت 1403	L19- Genetic Algorithms		
سه شنبه, 18 اردیبهشت 1403	L20- Swarm Intelligence Introduction		
یکشنبه, 23 اردیبهشت 1403	L21-Particle Swarm Intelligence (PSO)		
سه شنبه, 25 اردیبهشت 1403	L22- PSO		
یکشنبه, 30 اردیبهشت 1403	L23-Discrete PSO	A3- عملیGA وPSO	آقای نصرتی-بزرگزاد
سه شنبه, 1 خرداد 1403	L24-PSO Hyper-parameters tuning		
یکشنبه, 6 خرداد 1403	L25- Ant Colony Optimization (ACO)		
سه شنبه, 8 خرداد 1403	L26- ACO		
یکشنبه, 13 خرداد 1403	L27- Introduction	A4- SWARM پروژه	آقای بزرگزاد
سه شنبه, 15 خرداد 1403	L28- Fuzzy Inference Systems		
یکشنبه, 20 خرداد 1403	L-29 Fuzzy Inference Systems		
سه شنبه, 22 خرداد 1403	L-30 Defuzzification	تئوری A5	آقای نصرتی

Calss Rules

- تمرین ها به صورت انفرادی انجام میشود.
- زمان تحویل هر تمرین ۲ هفته بعد از پست آن تمرین است
- زمان تحویل تمرین ها مطابق با فایل زمانبندی انجام میشود و قابل تغییر نیست
- تمرین ها با ۸ روز تاخیر در کل تمرین ها قابل تحویل هستند
- در صورتی که ۸ روز شما به اتمام رسید، تمرینهای بعدی را میتوانید هر کدام را تا ۳ روز به ازای هر روز کسر ۱۰ درصد تحویل دهید.
- بعد از ۸ روز جواب تمرین توسط تی ای ها در سامانه بازگزاری میشود.
- بعد از پست پاسخ تمرین ها تحویل تمرین مجاز نیست.

Calss Rules

- نمره امتیازی برای هر تمرین عملی به صورتی انتخاب شود که رقابت بین گروه ها ایجاد شود.
- نمره امتیازی برای کل تکالیف بین ۰.۵ تا ۱ نمره خواهد بود
- تکالیف عملی توسط سیستم های چک تشابه بررسی می شوند و در صورت مشابهت بالا به هر دو نفر نمره ۰ تعلق می گیرد.
- تکالیف تئوری در صورت مشاهده تشابه بالا برای هر دو نفر نمره ۰ در نظر گرفته می شود.

Marking Scheme

- Assignments and Project: 5-7 marks
- Midterm: 5-7 marks
- Final: 5-7 marks
- Clicker Questions: 1 mark