Deep Learning

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Computers are incredibly fast, accurate and stupid; humans are incredibly slow, inaccurate and brilliant; together they are powerful beyond imagination

What exactly is deep learning ?

Deep learning (also known as deep structured learning or hierarchical learning) is part of a broader family of machine learning methods based on learning data representations, as opposed to task-specific algorithms.

Idea:

Most perception (input processing) in the brain may be due to one learning algorithm.

Build learning algorithms that mimic the brain

Why is it generally better?

Computers are incredibly fast, accurate and stupid; humans are incredibly slow, inaccurate and brilliant; together they are powerful beyond imagination

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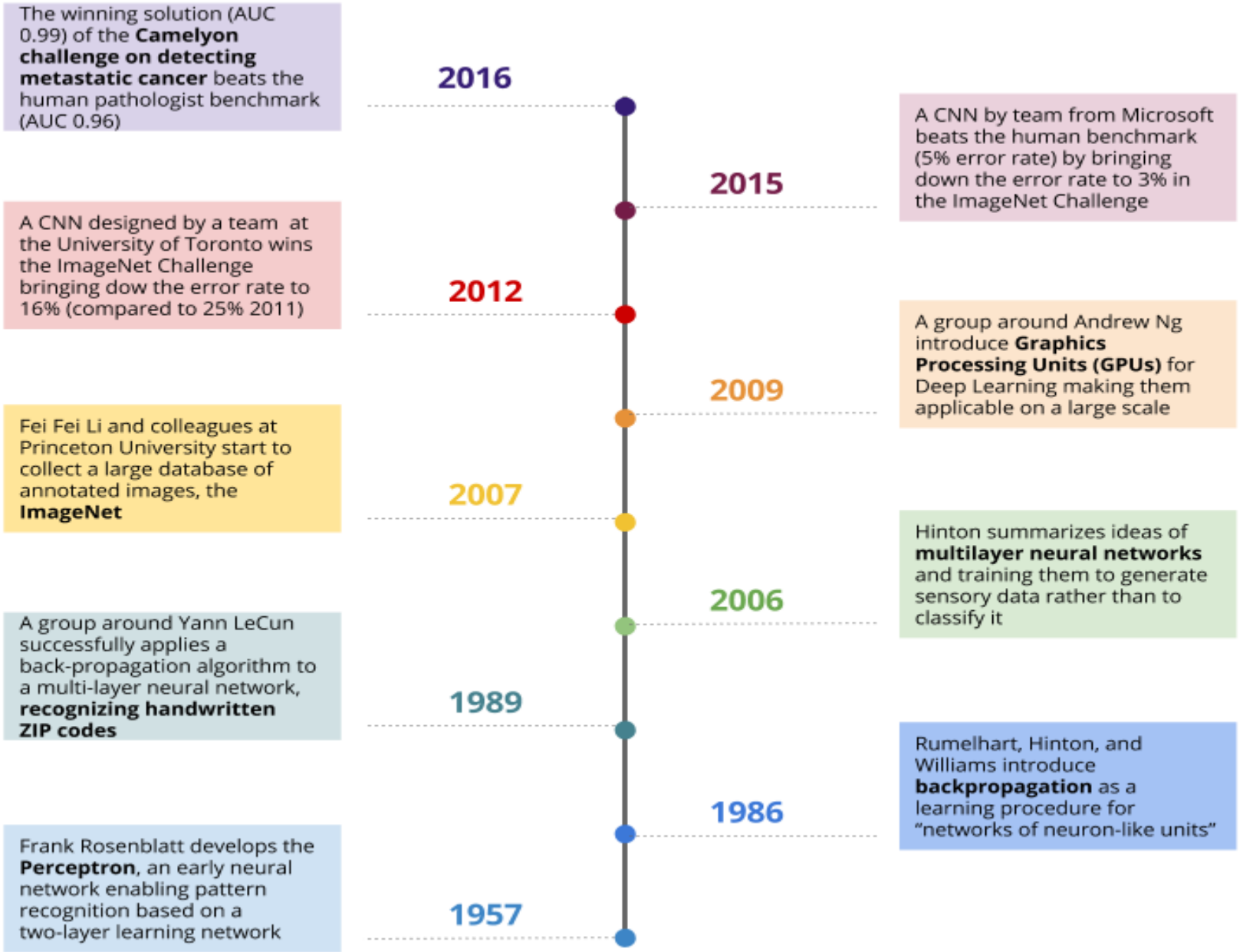
The winning solution (AUC 0.99) of the **Camelyon challenge on detecting metastatic cancer** beats the human pathologist benchmark (AUC 0.96)
2016
A CNN by team from Microsoft beats the human benchmark (5% error rate) by bringing down the error rate to 3% in the ImageNet Challenge
2015
A CNN designed by a team at the University of Toronto wins the ImageNet Challenge bringing dow the error rate to 16% (compared to 25% 2011)
2012
A group around Andrew Ng introduce **Graphics Processing Units (GPUs)** for Deep Learning making them applicable on a large scale
2009
Fei Fei Li and colleagues at Princeton University start to collect a large database of annotated images, the **ImageNet**
2007
Hinton summarizes ideas of **multilayer neural networks** and training them to generate sensory data rather than to classify it
2006
A group around Yann LeCun successfully applies a back-propagation algorithm to a multi-layer neural network, **recognizing handwritten ZIP codes**
1989
Rumelhart, Hinton, and Williams introduce **backpropagation** as a learning procedure for "networks of neuron-like units"
1986
Frank Rosenblatt develops the **Perceptron**, an early neural network enabling pattern recognition based on a two-layer learning network
1957

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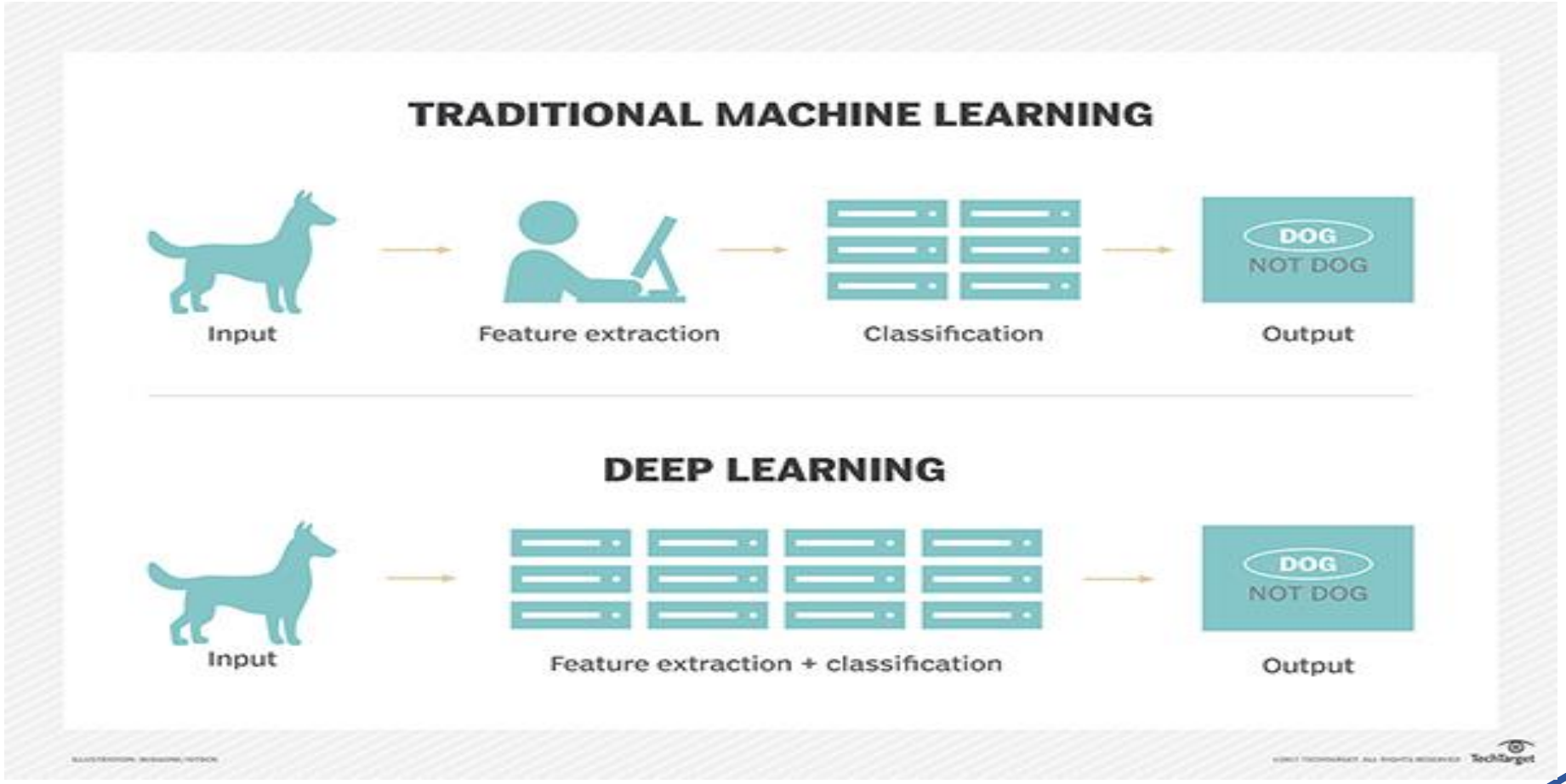
Deep vs Traditional learning



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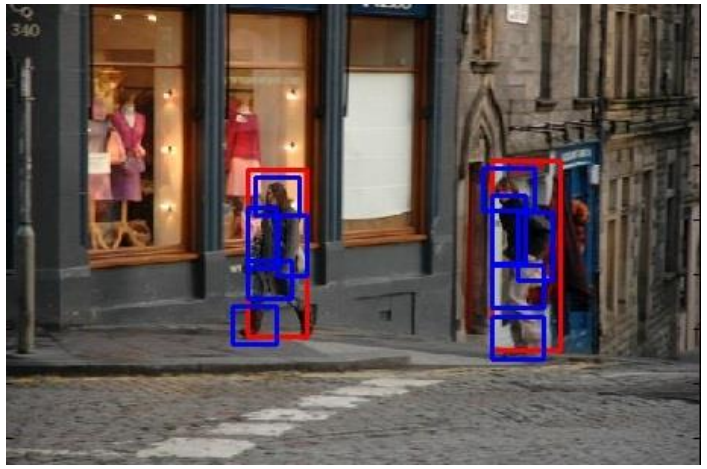
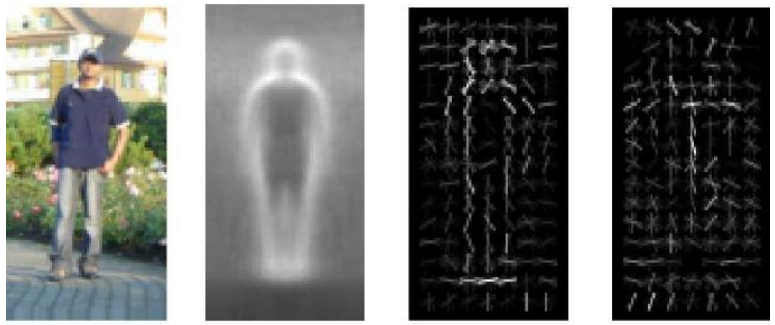
- SIFT
- HOG
- DPM
- ….





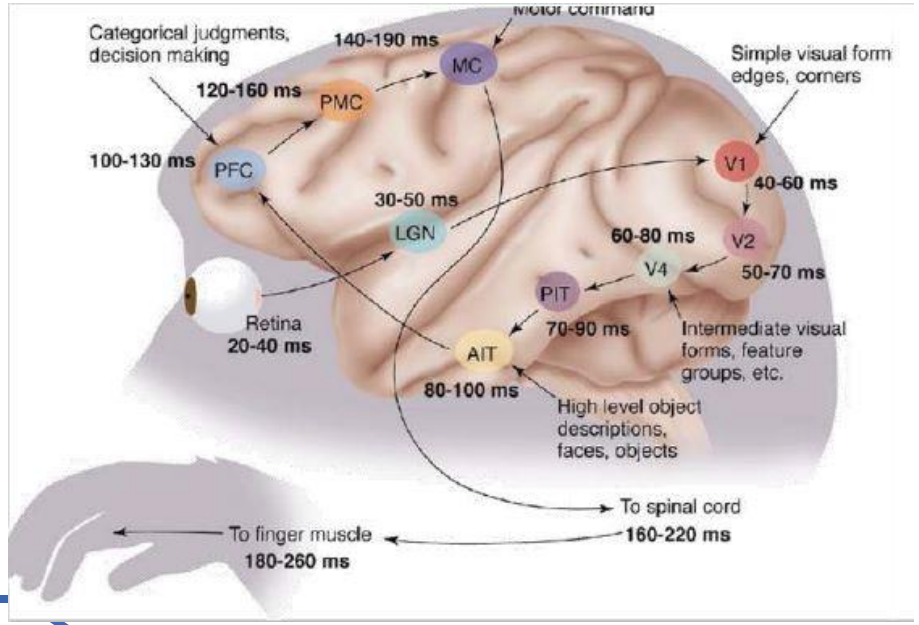
Application?

How deep network work?

Inspired by the Brain

- The first hierarchy of neurons that receives information in the visual cortex are sensitive to specific edges while brain regions further down the visual pipeline are sensitive to more complex structures such as faces.

- Our brain has lots of neurons connected together and the strength of the connections between neurons represents long term knowledge.



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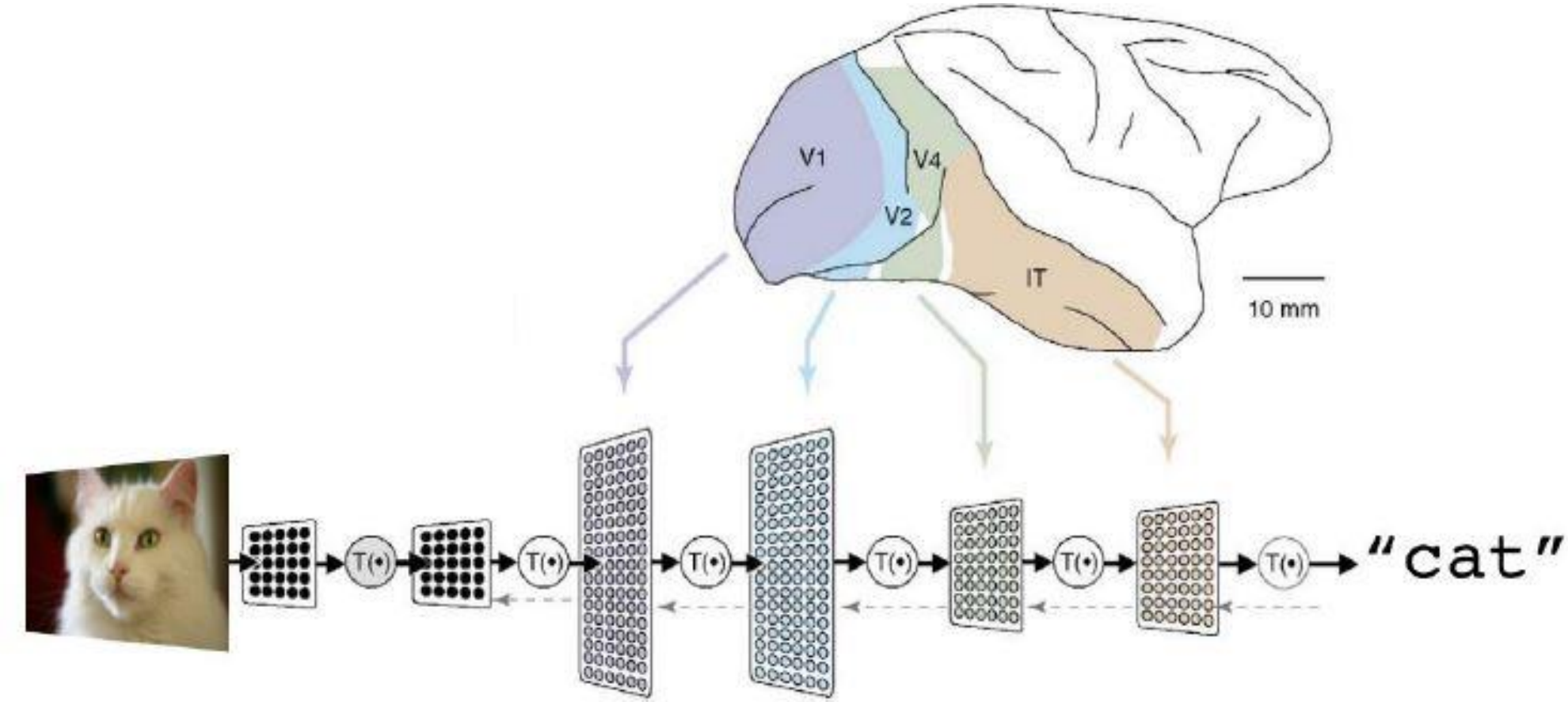
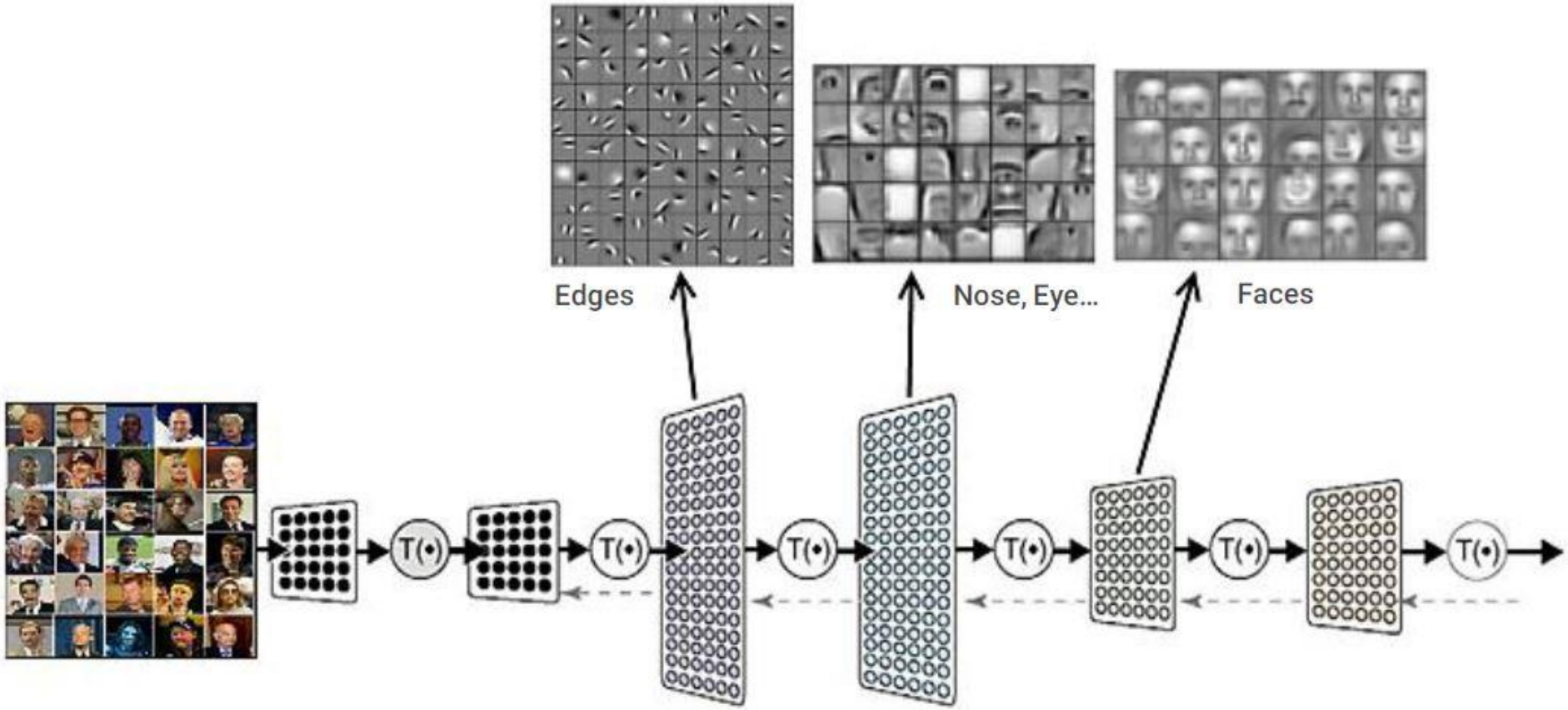


hierarchy

Learned features?



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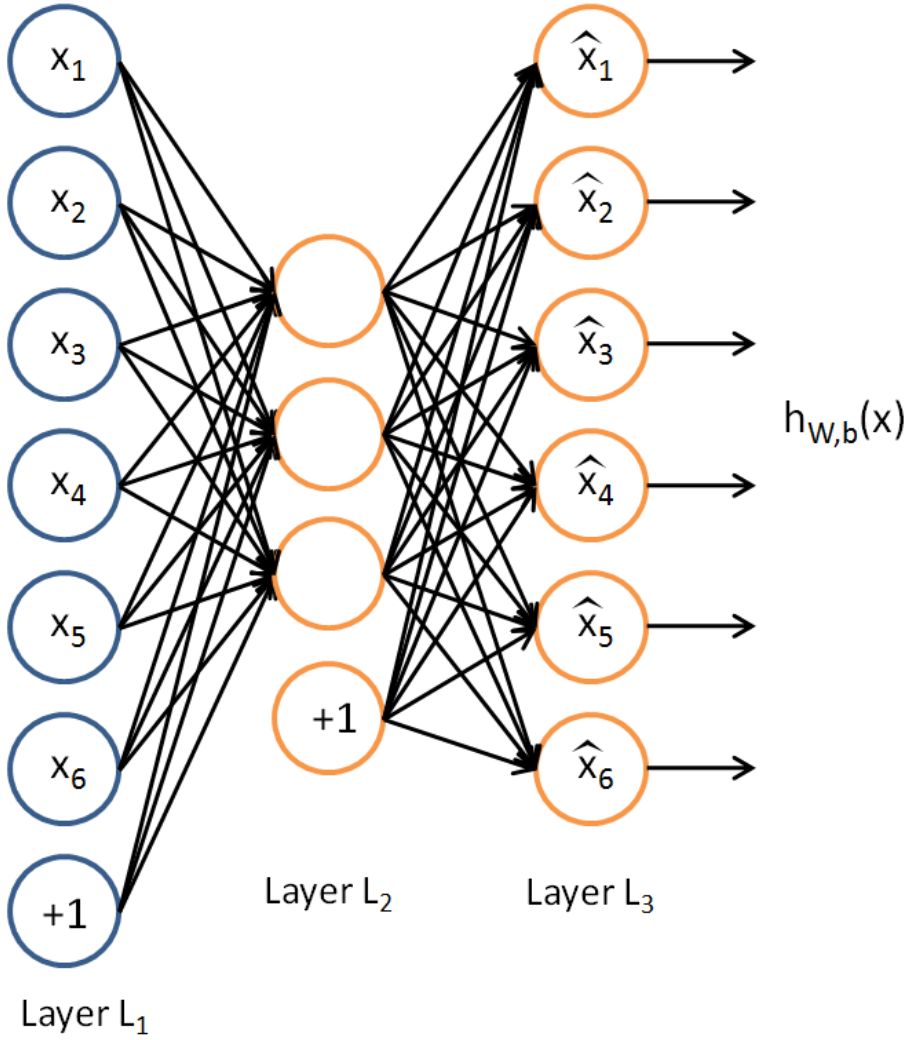
Deep networks

- Auto-encoder
- Convolutional Neural network
- Recurrent Neural Network
- Generative deep Network
- Reinforcement deep learning

Feature learning



In machine learning, “sometimes it’s not who has the best algorithm that wins; it’s who has the most data.”

Self Taught Learning

UFLDL Tutorial

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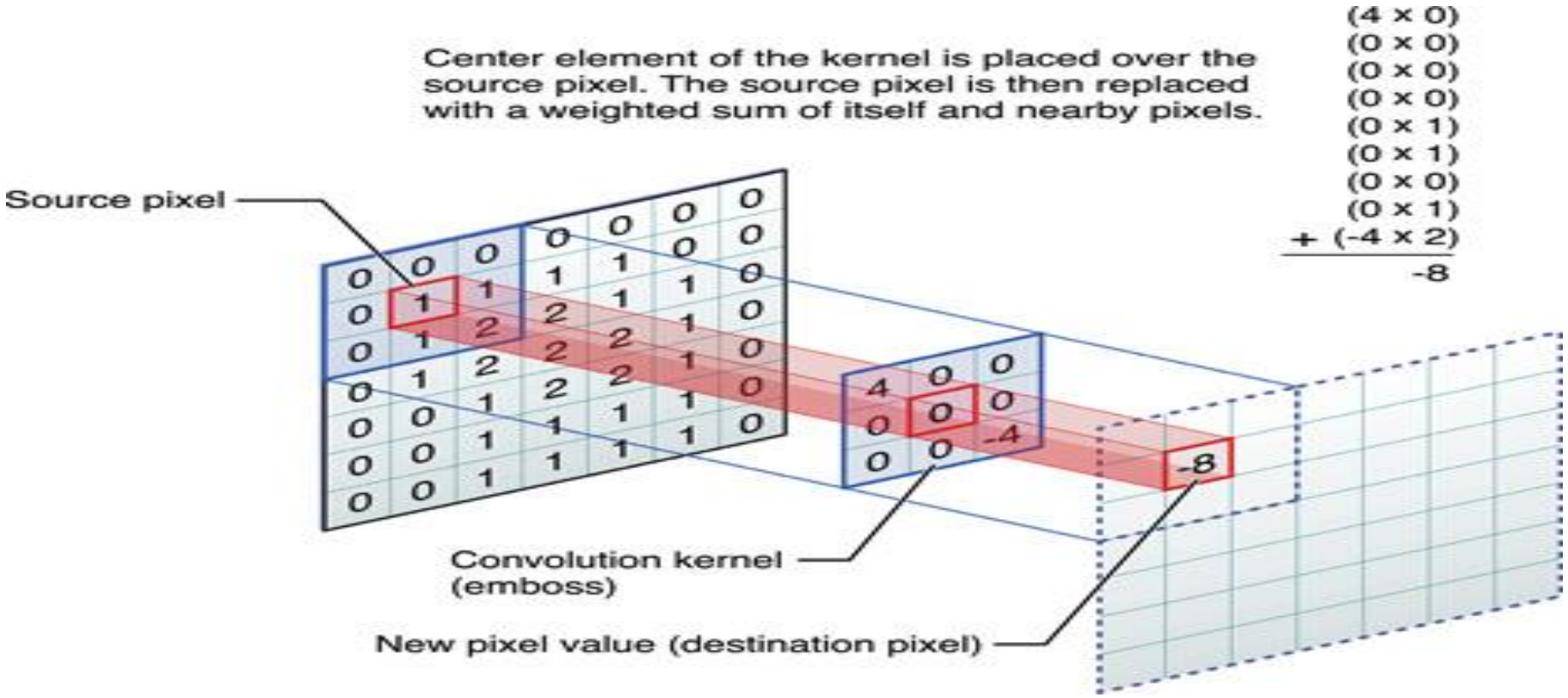
Convolution and Pooling for large data



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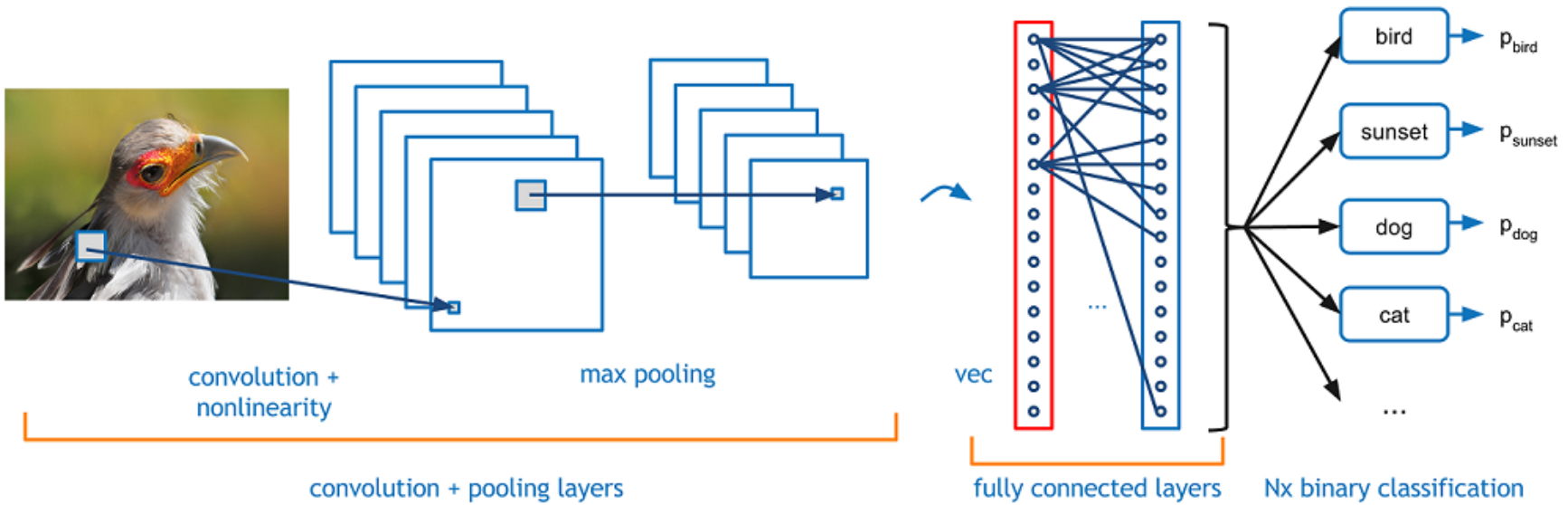
Convolutional neural network?

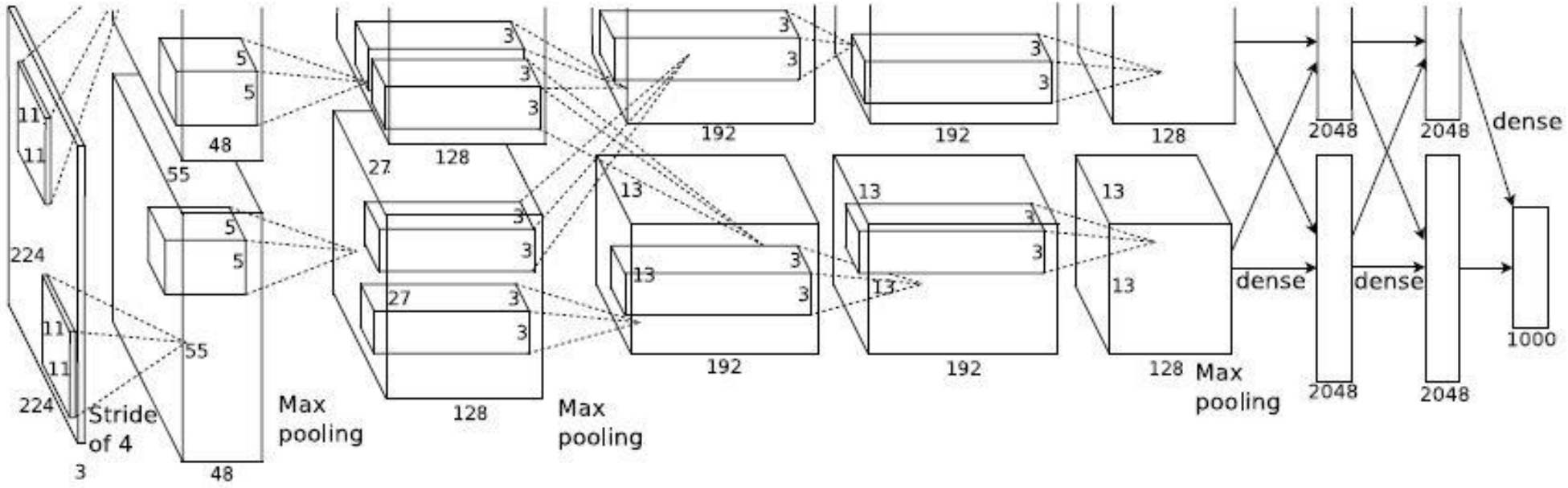
The motivation for ConvNets and Deep Learning: end-to-end learning
Integrating feature extractor, classifier, contextual post-processor



[Adit Deshpande weblog]

2012 and Alexnet!

- The one that started it all
- Cited by 1770!
- win the 2012 ILSVRC (ImageNet Large-Scale Visual Recognition Challenge)
- top 5 test error rate of 15.4%



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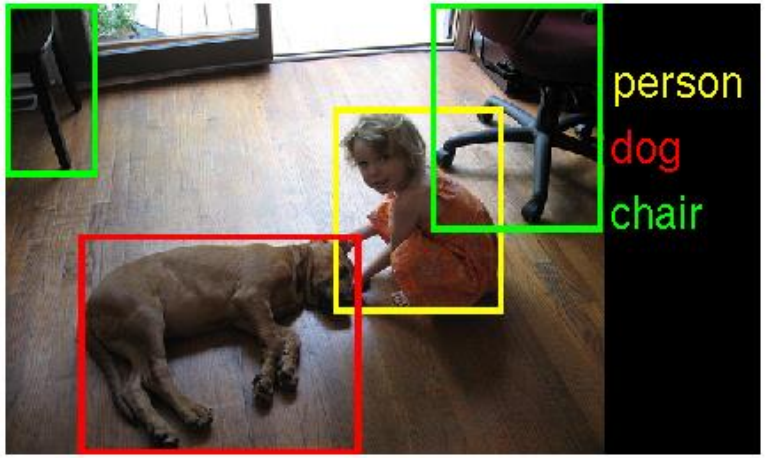
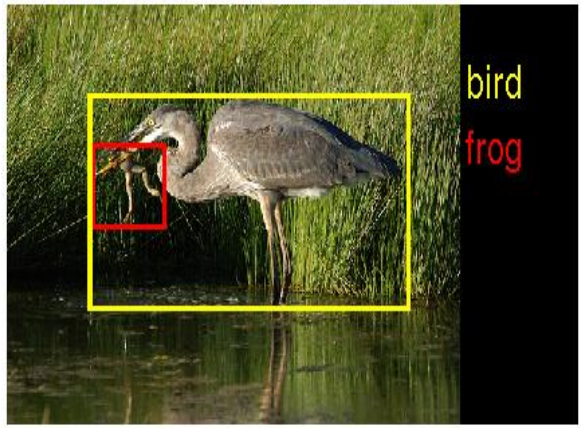
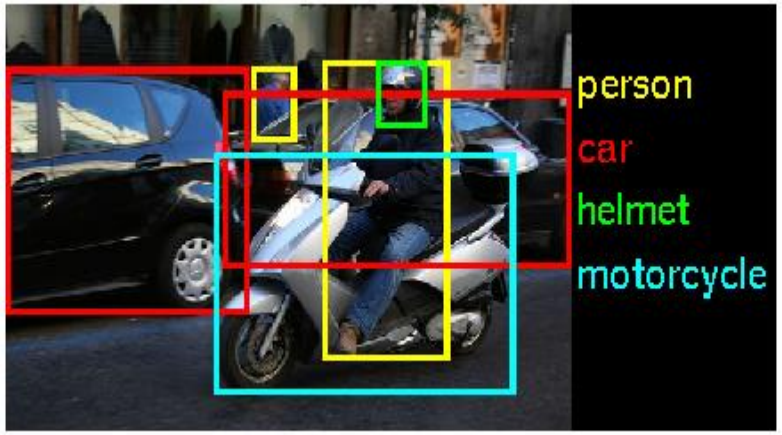
Object Detection







- R-CNN
- Fast-RCNN
- Faster-RCNN
- Yolo
- Yolo1000

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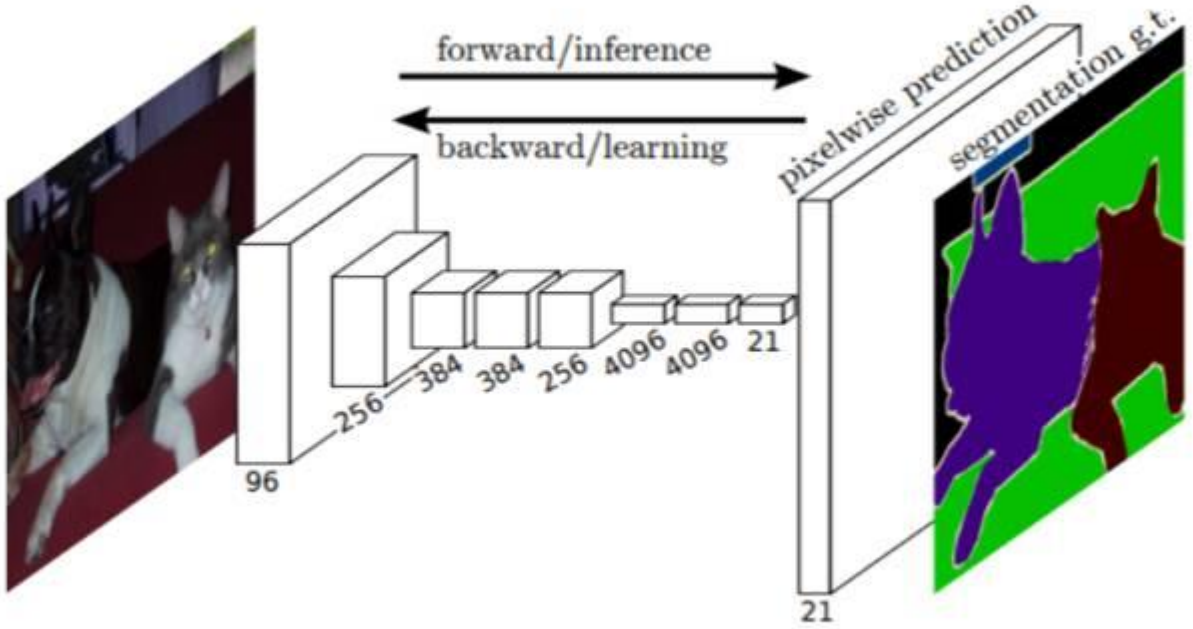
Video/Image Segmentation



Fully Convolutional Network

SegNet

Bayesian SegNet

DeepLab

DeepMask

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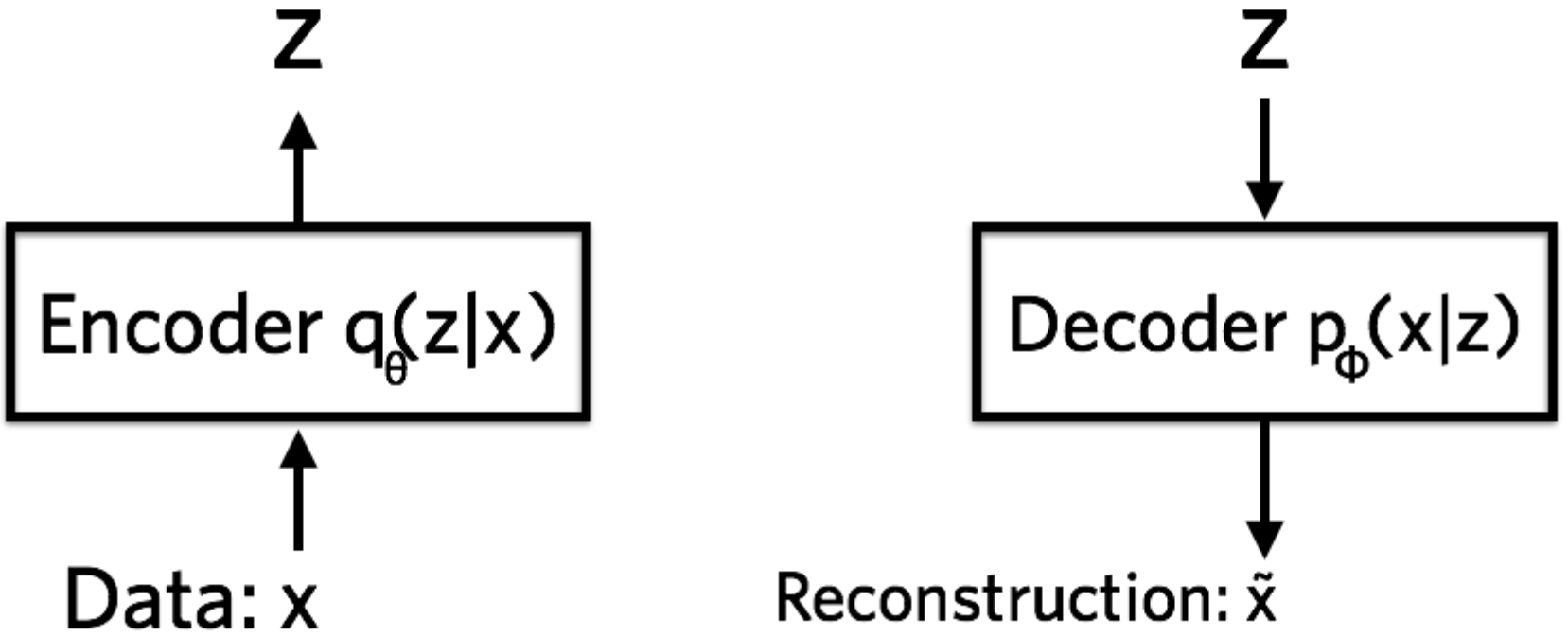
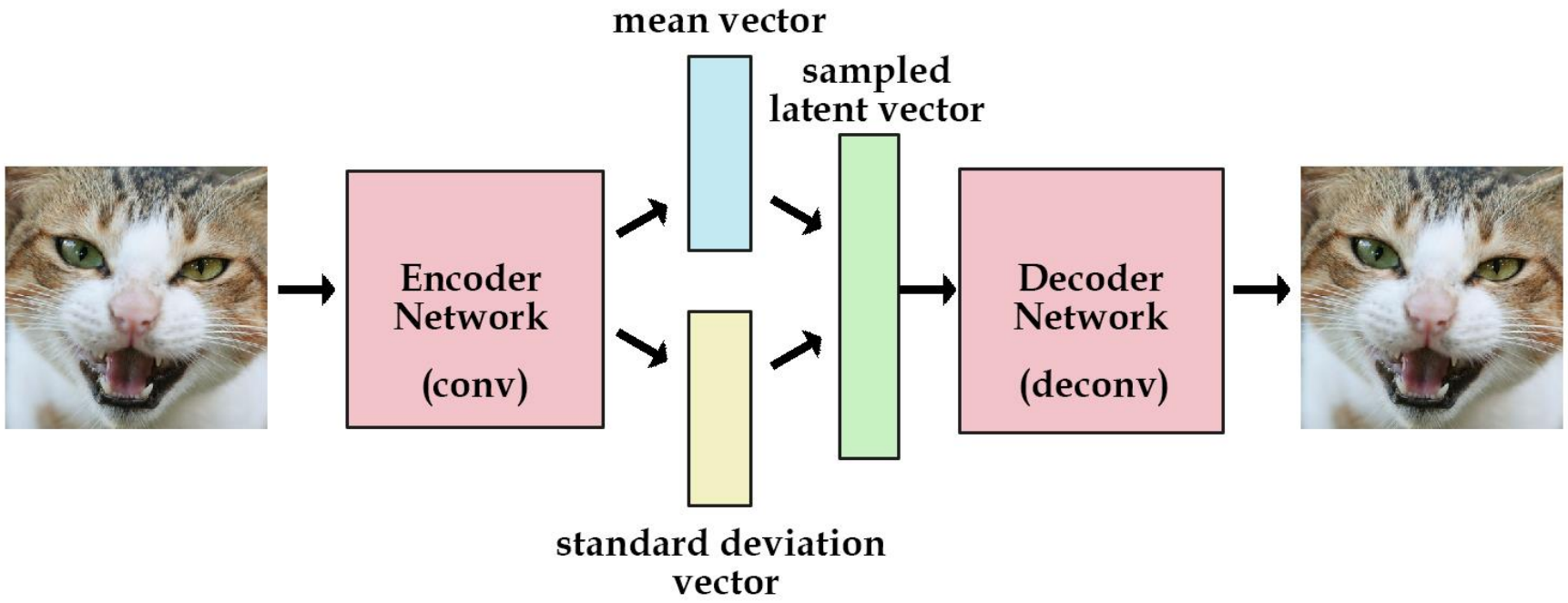
Generative network

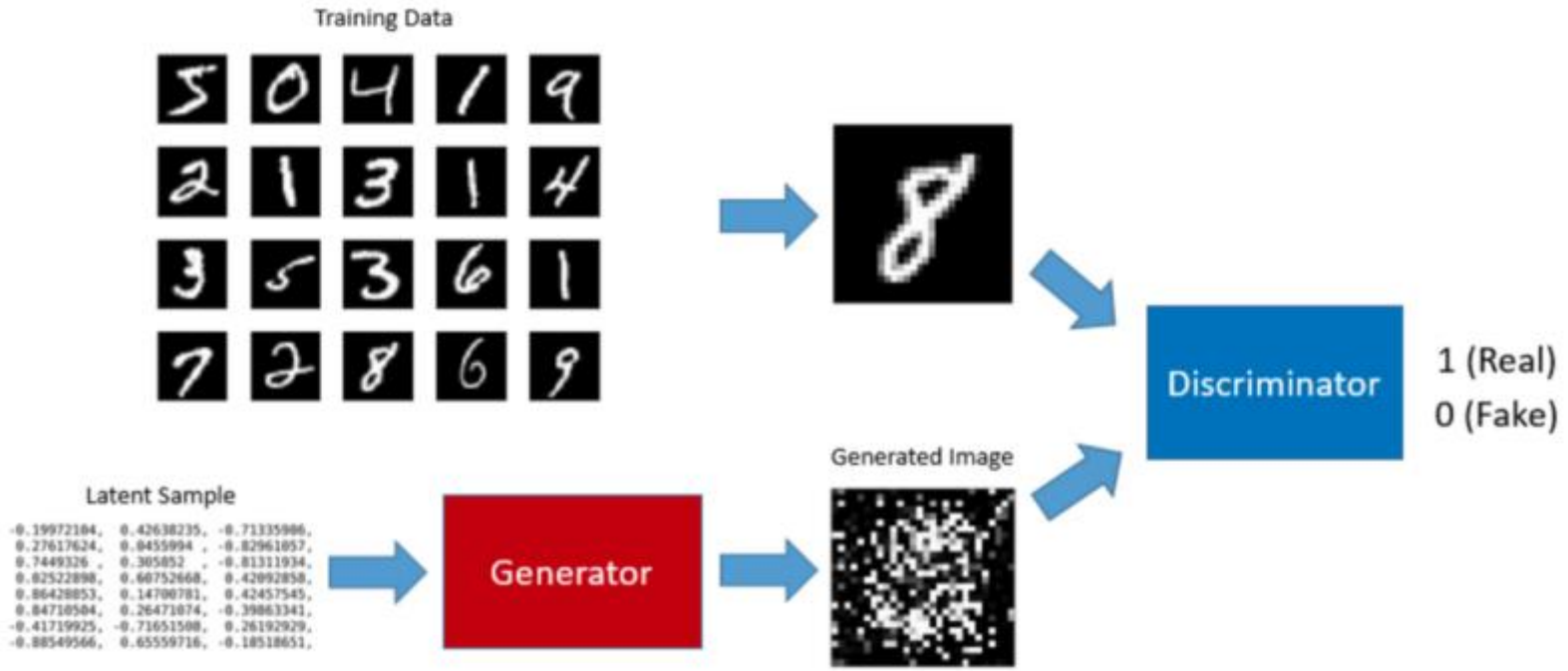


Variational Autoencoder

- Variational Autoencoder



Generative Adversarial Networks (GAN)



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Advanced topic on deep learning?

How to Design a CNN?
Video analyzing
Deep Generative adversarial network
Unsupervised Learning
Domain adaptation
Art
Deep Reinforcement Learning
Outlier detection, Image segmentation, Autonomies driver