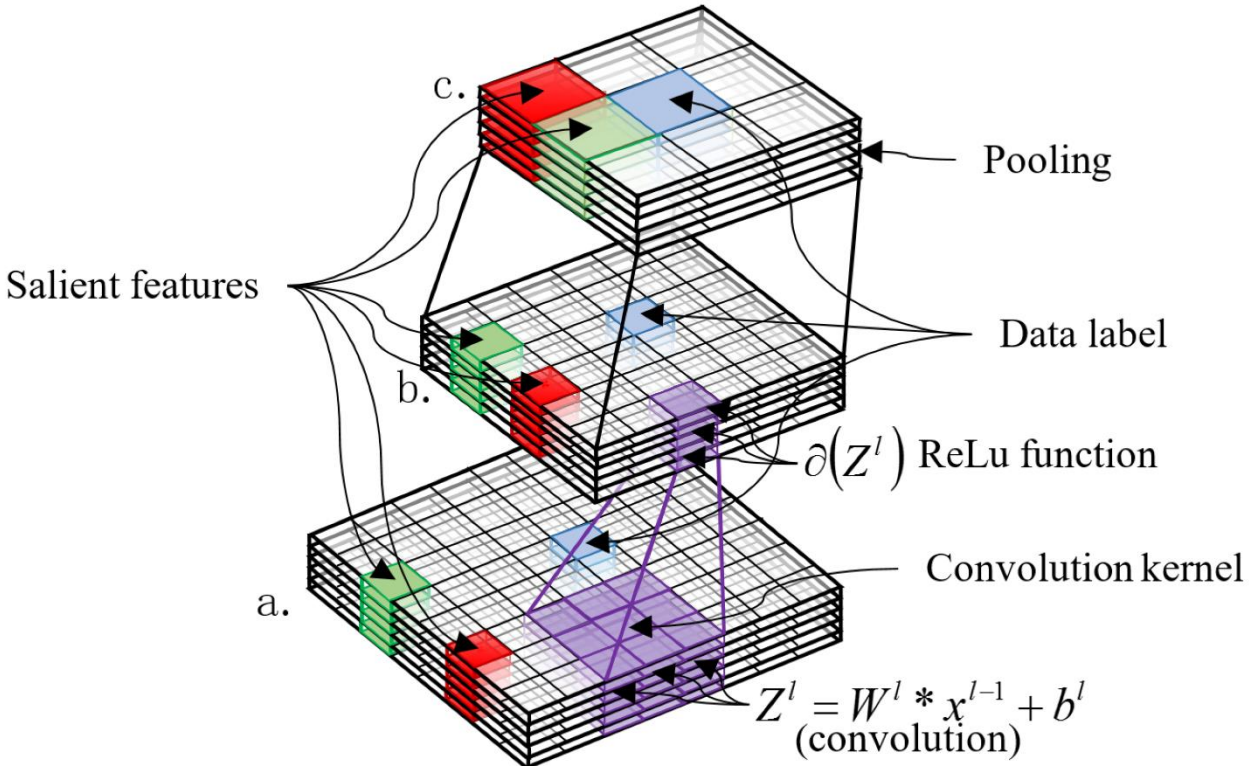
PyTorch Tutorial

01. Overview

Goal of this tutorial

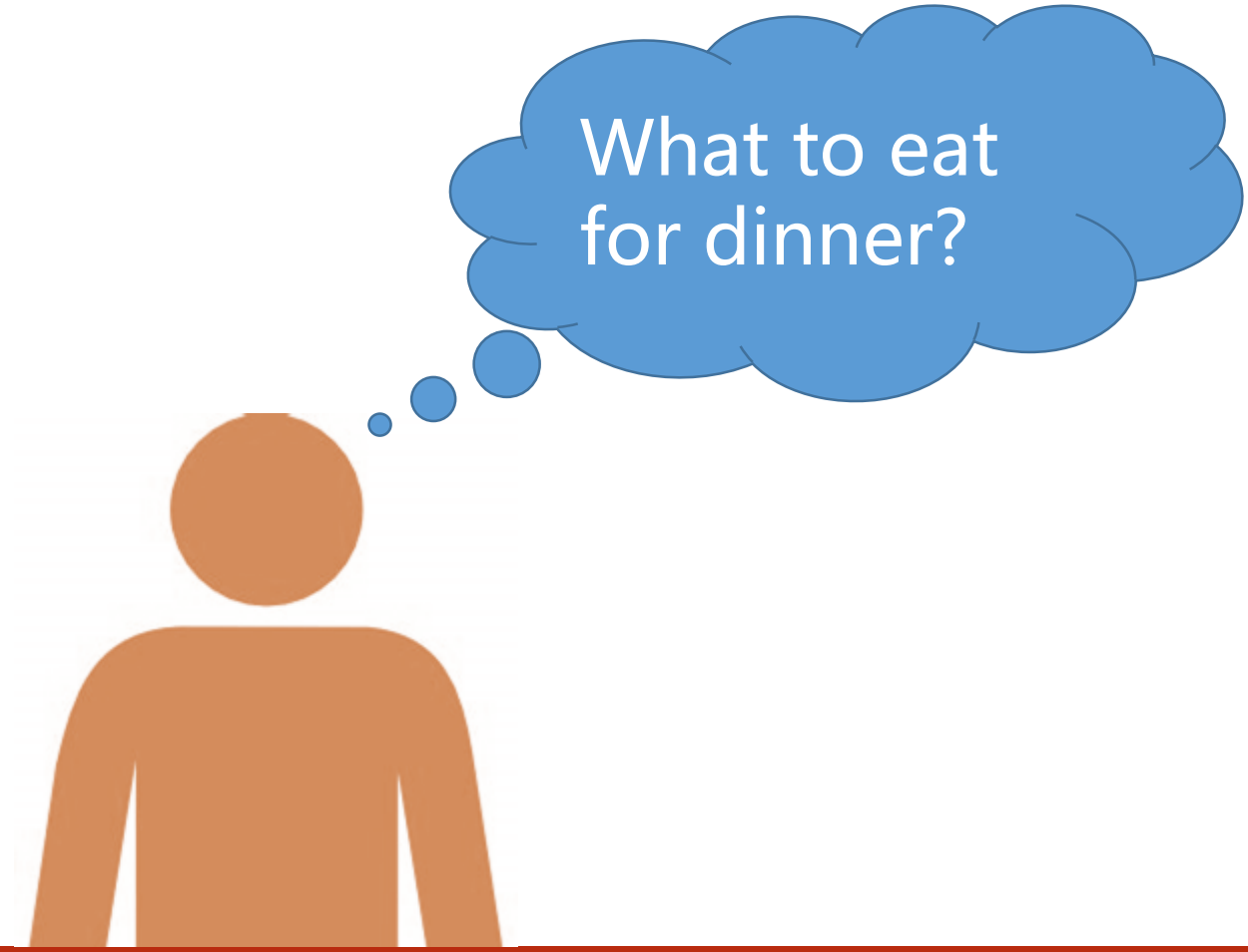
- How to implement learning system using PyTorch
- Understand the basic of neural networks / deep learning

- Requirements
  - Algebra + Probability
  - Python



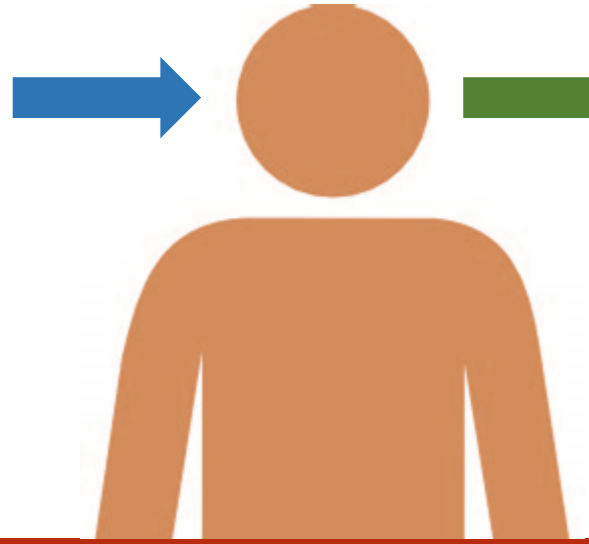
Gao F, Huang T, Wang J, et al. Dual-Branch Deep Convolution Neural Network for Polarimetric SAR Image Classification[J]. Applied Sciences, 2017, 7(5):447.

Human Intelligence



Human Intelligence

Information

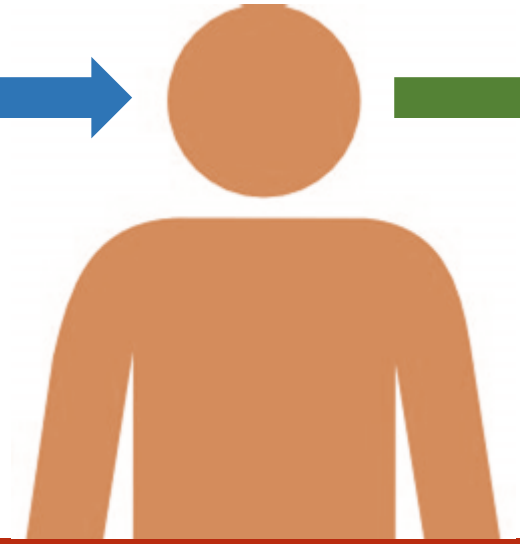


Infer

Human Intelligence

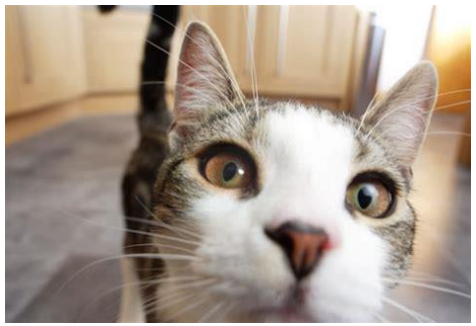
Human Intelligence

Information



Infer

Human Intelligence



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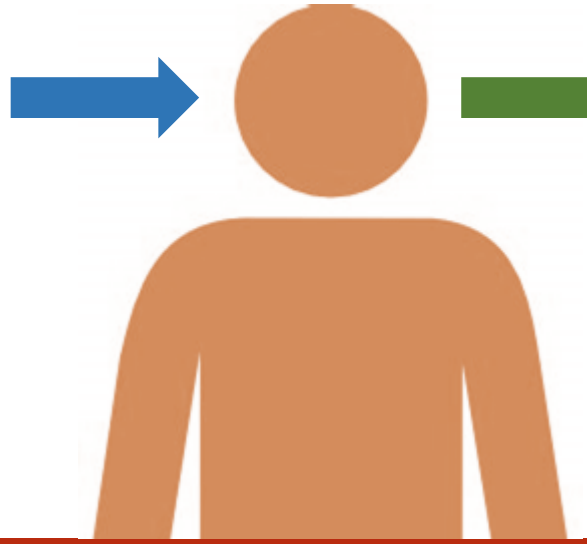
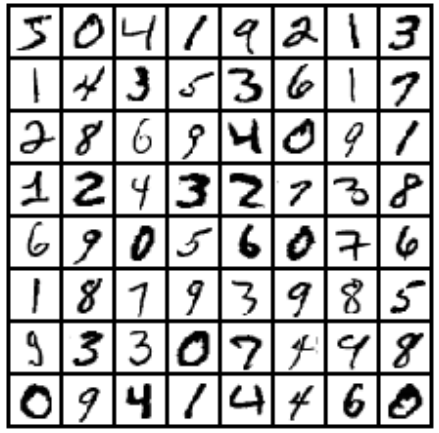


Prediction

Human Intelligence



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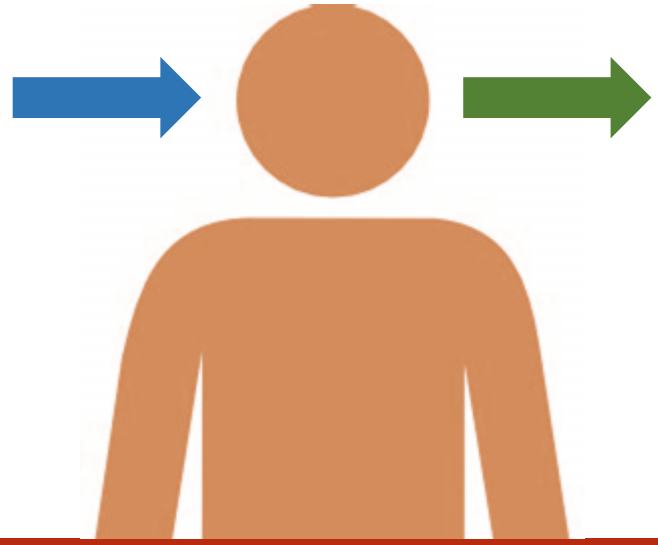

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1	4	3	5	3	6	1	7
2	8	6	9	4	0	9	1
1	2	4	3	2	7	3	8
6	9	0	5	6	0	7	4
1	8	7	9	3	9	8	5
9	3	3	0	7	4	9	8
0	9	4	1	4	4	6	0

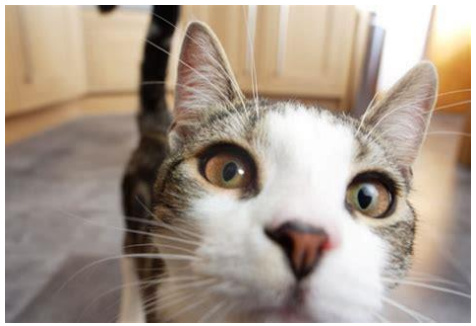
Prediction

Machine learning

Information

Infer

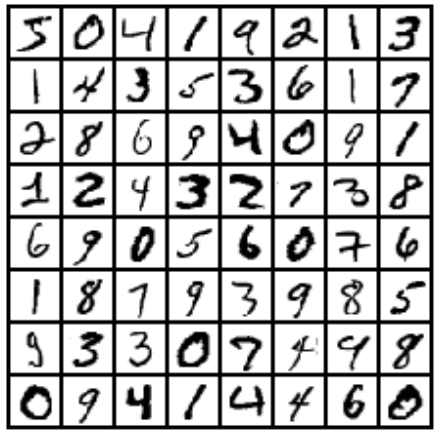
Machine learning



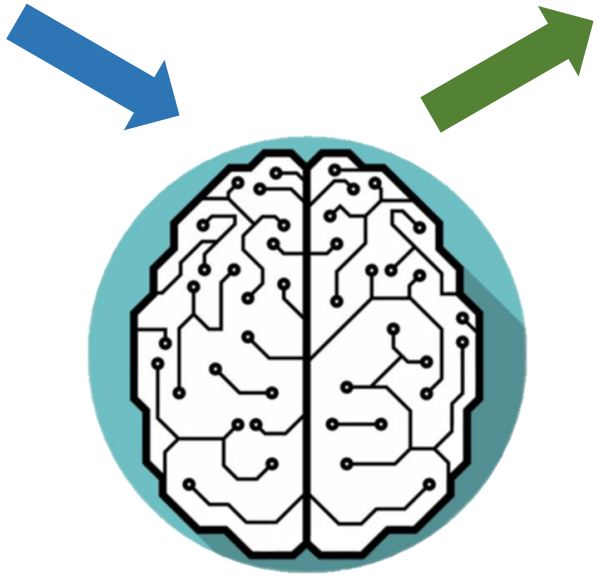
Image

Prediction

Machine learning



Image



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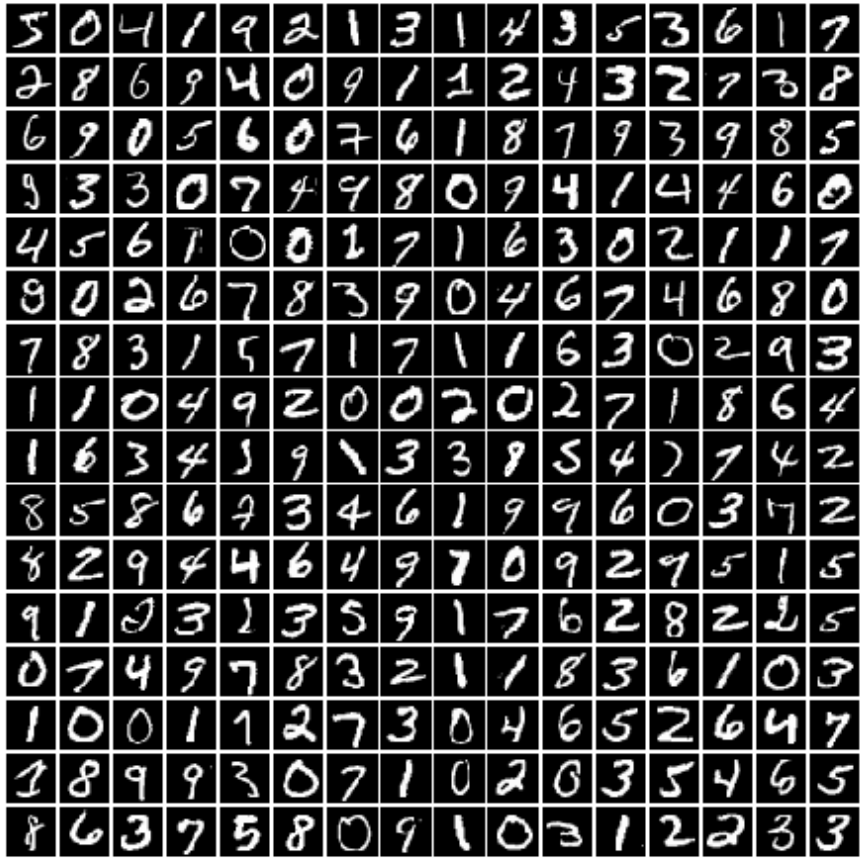
9	3	3	0	7	4	9	8
0	9	4	1	4	4	6	0

Prediction

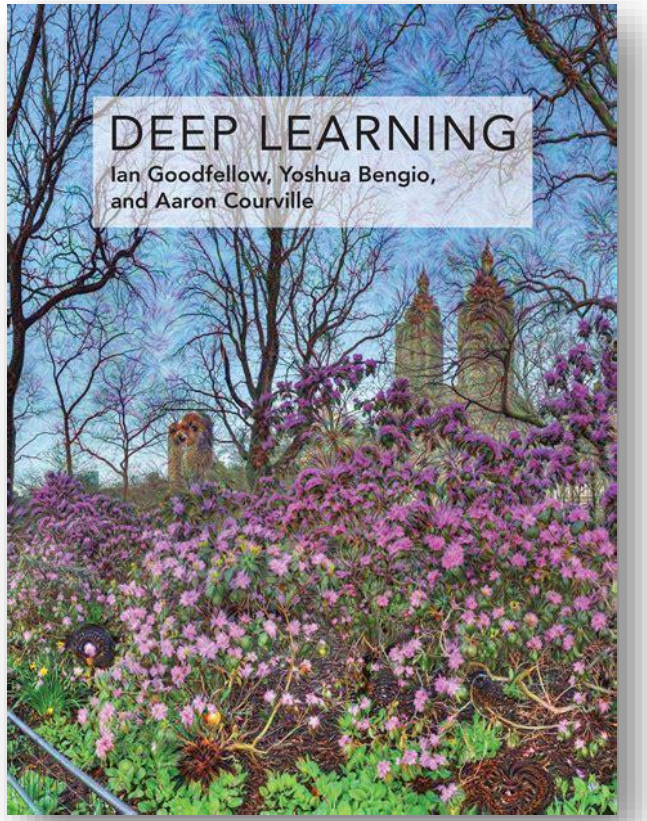
Machine learning

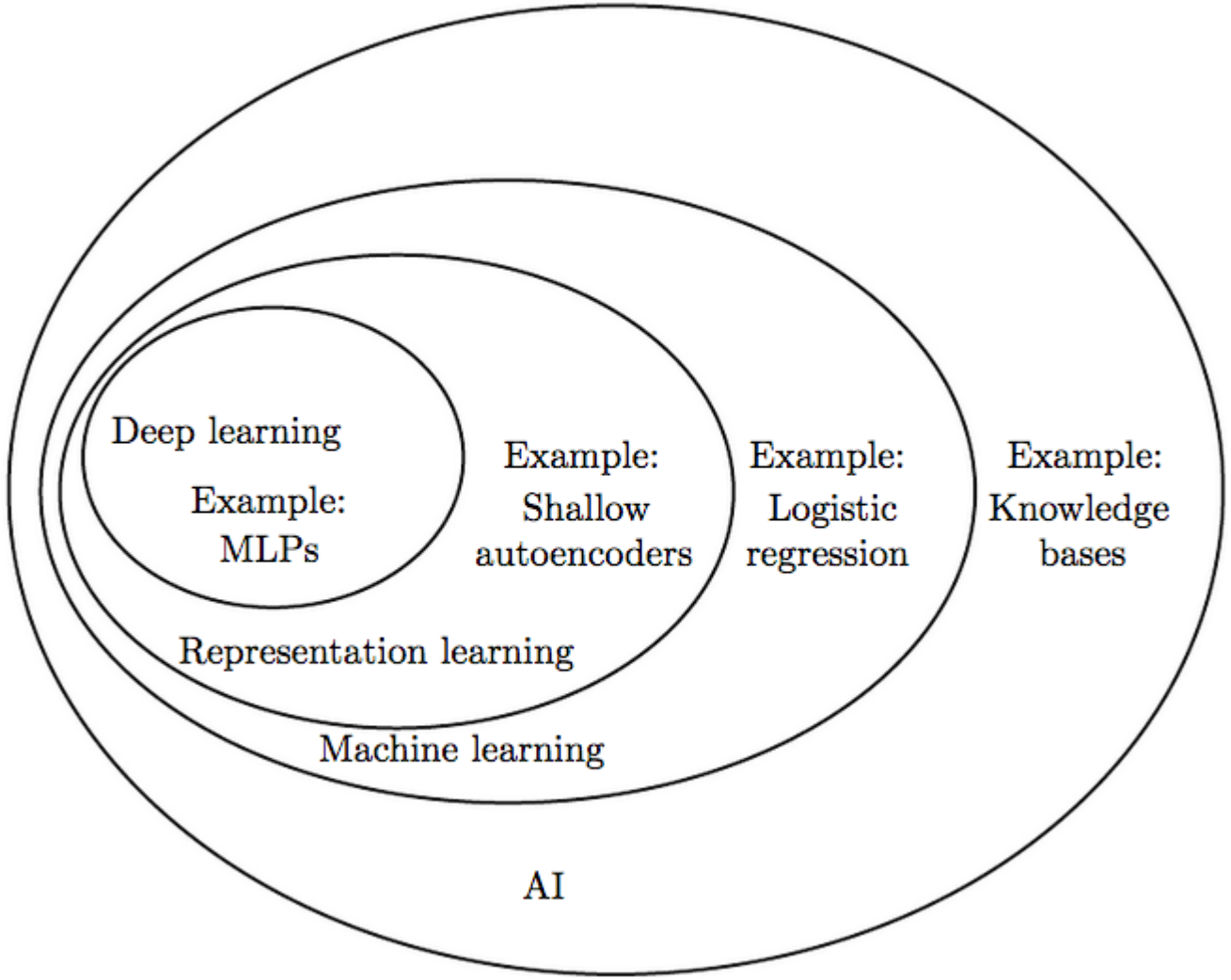


Labeled Dataset

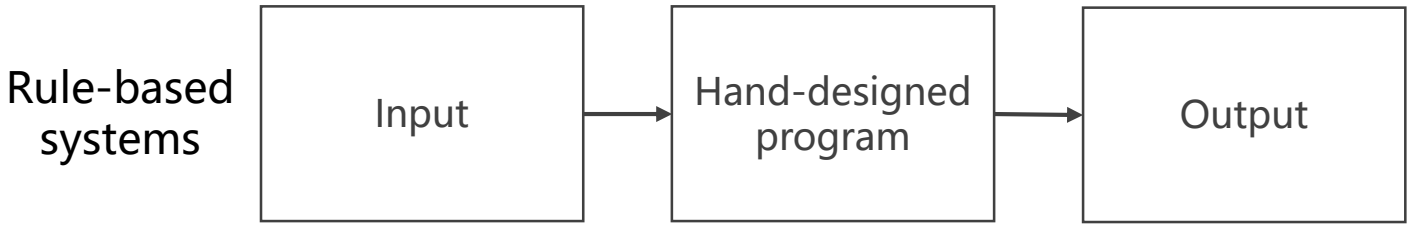
Training

Machine learning





How to develop learning system?



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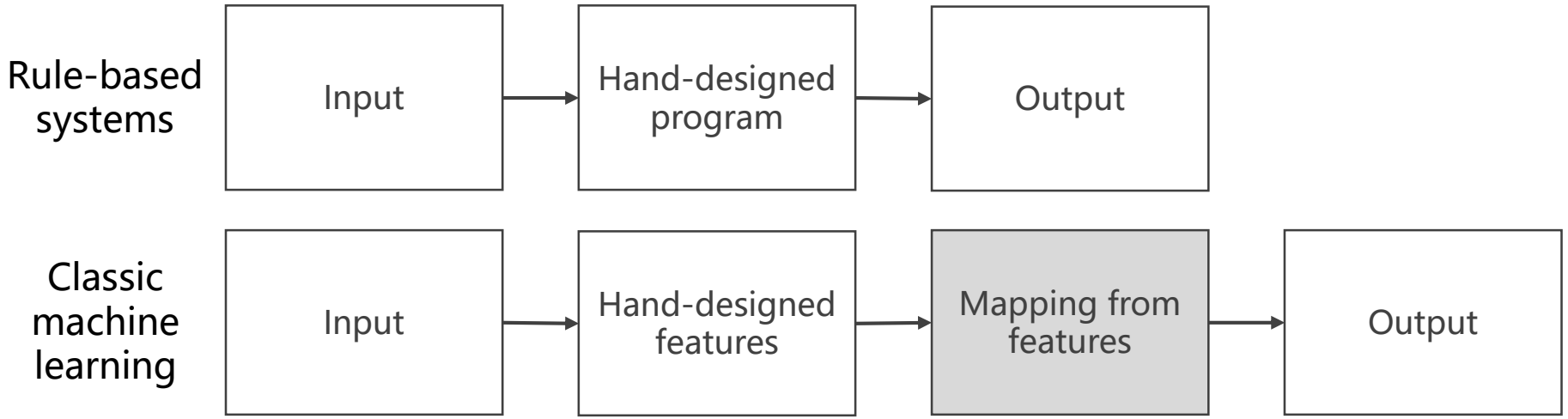

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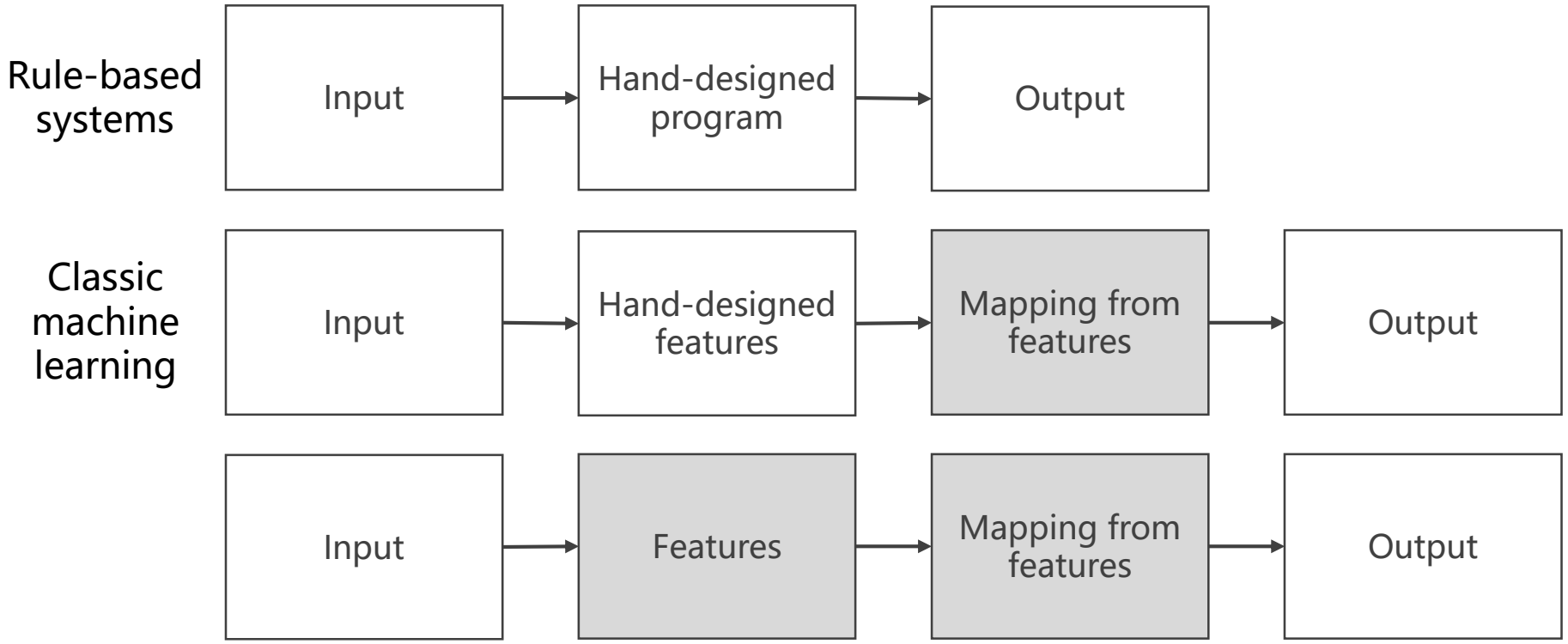

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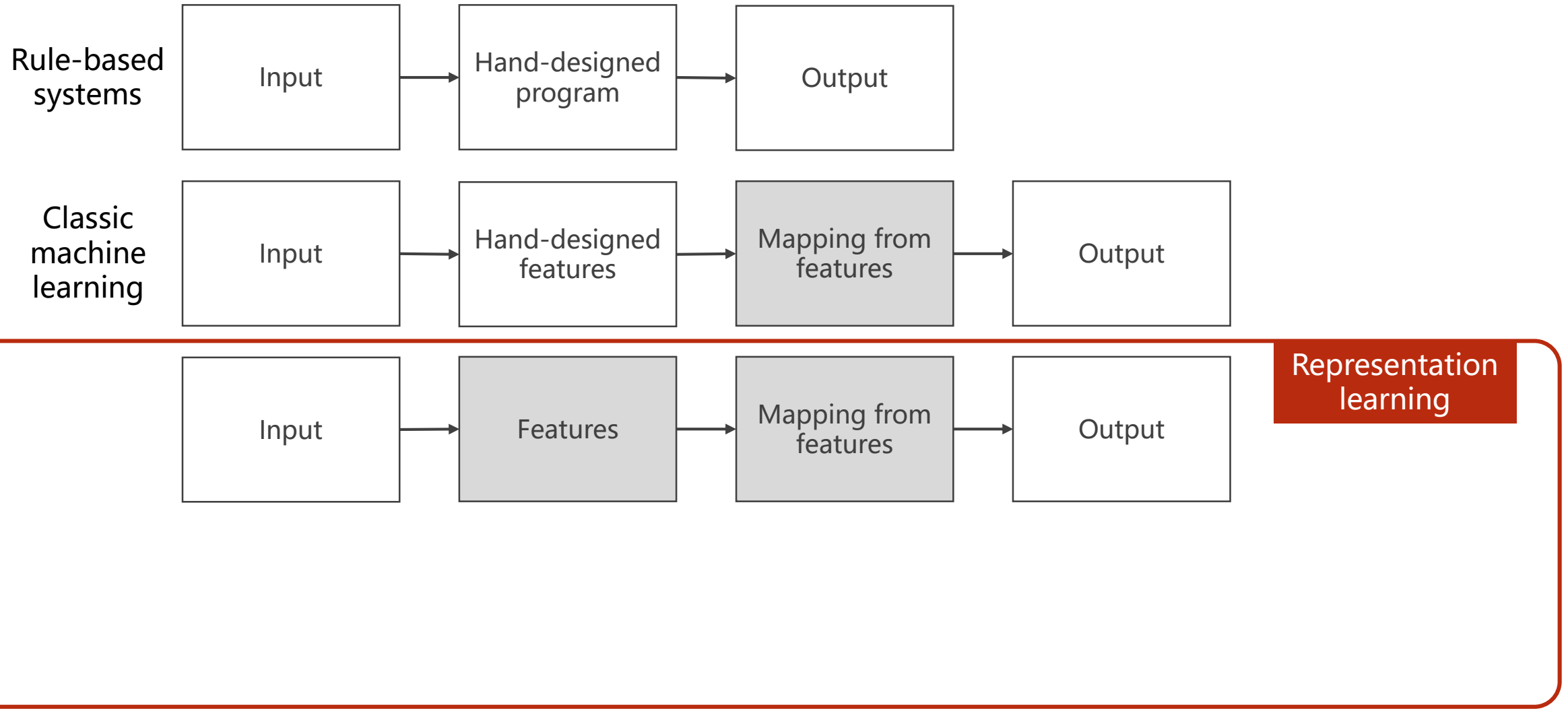
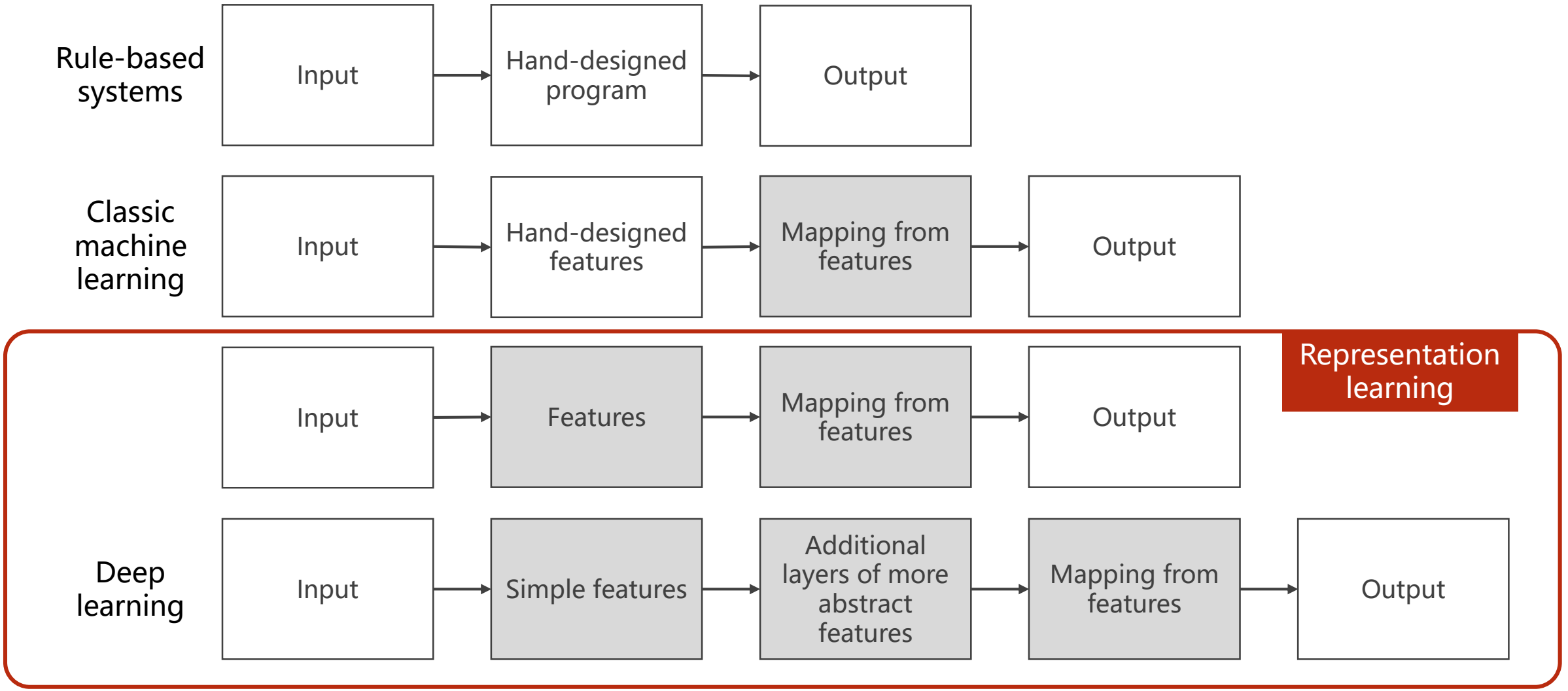
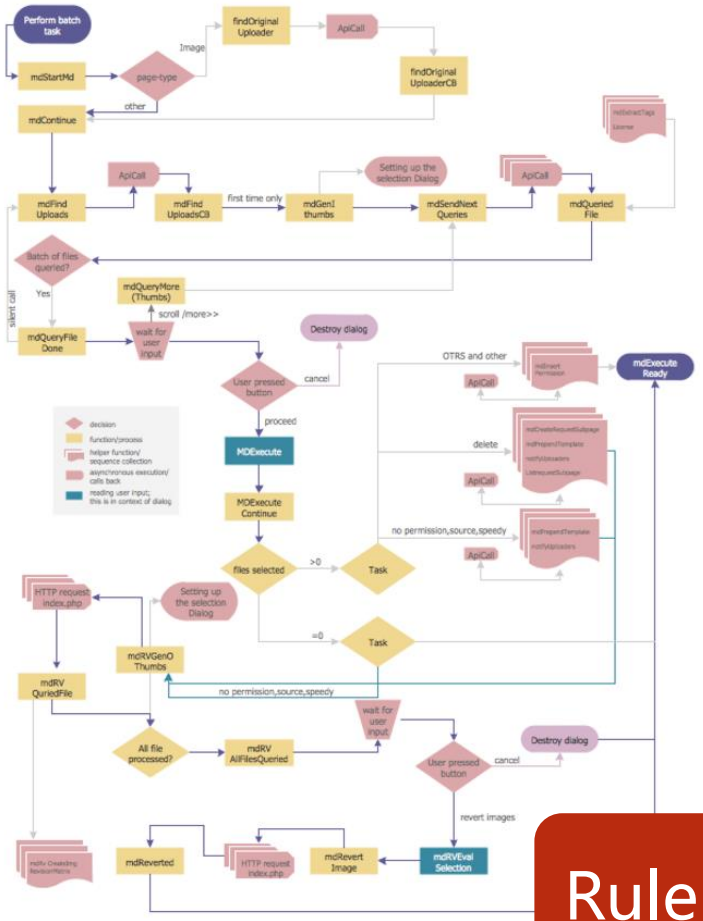


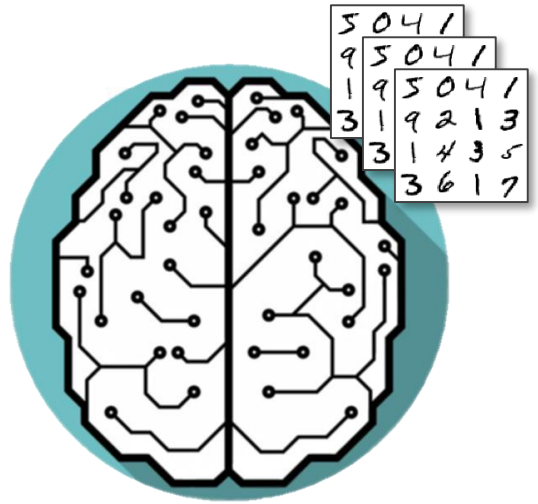
How to develop learning system?



Rule-based system VS Representation learning

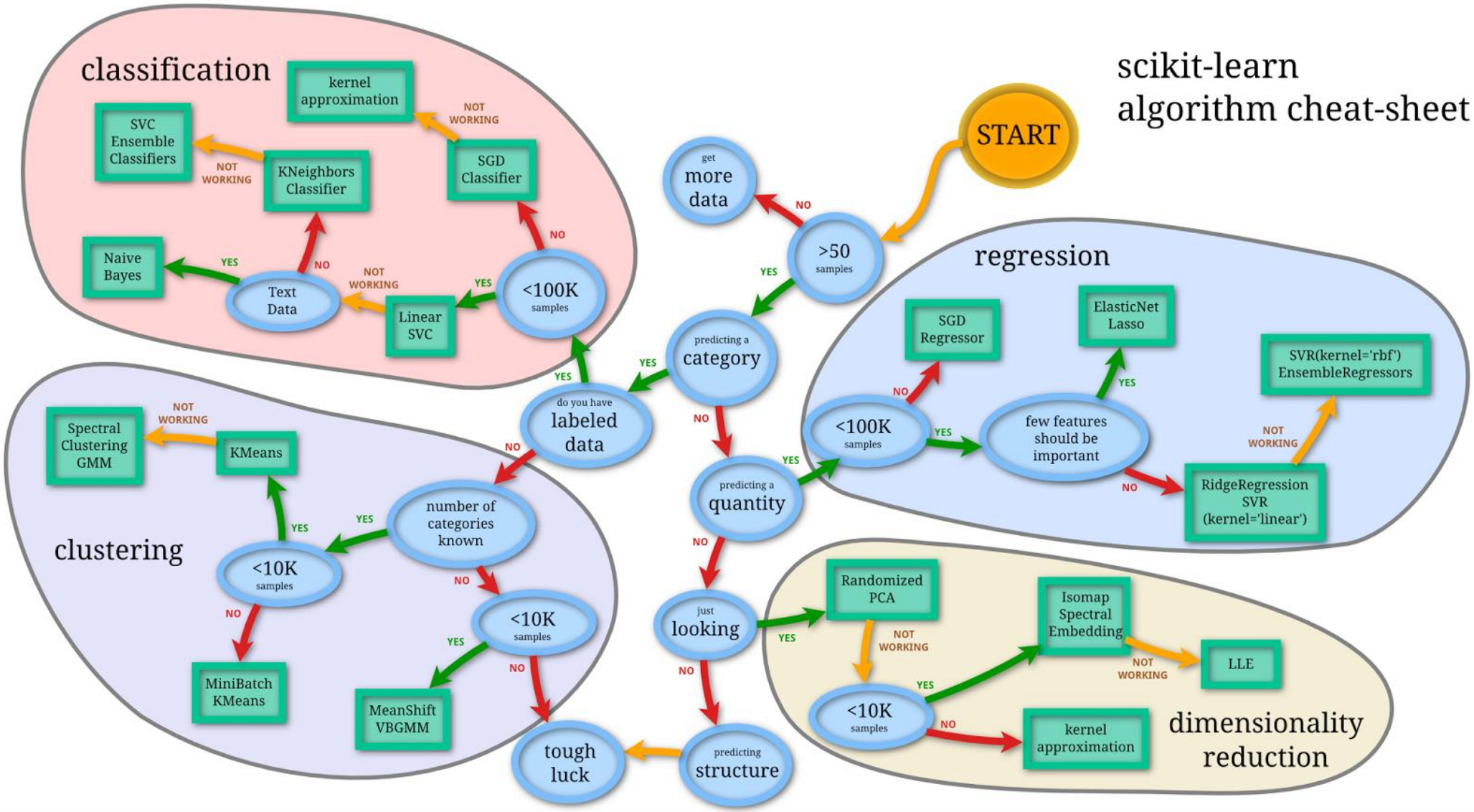


Rule-based system



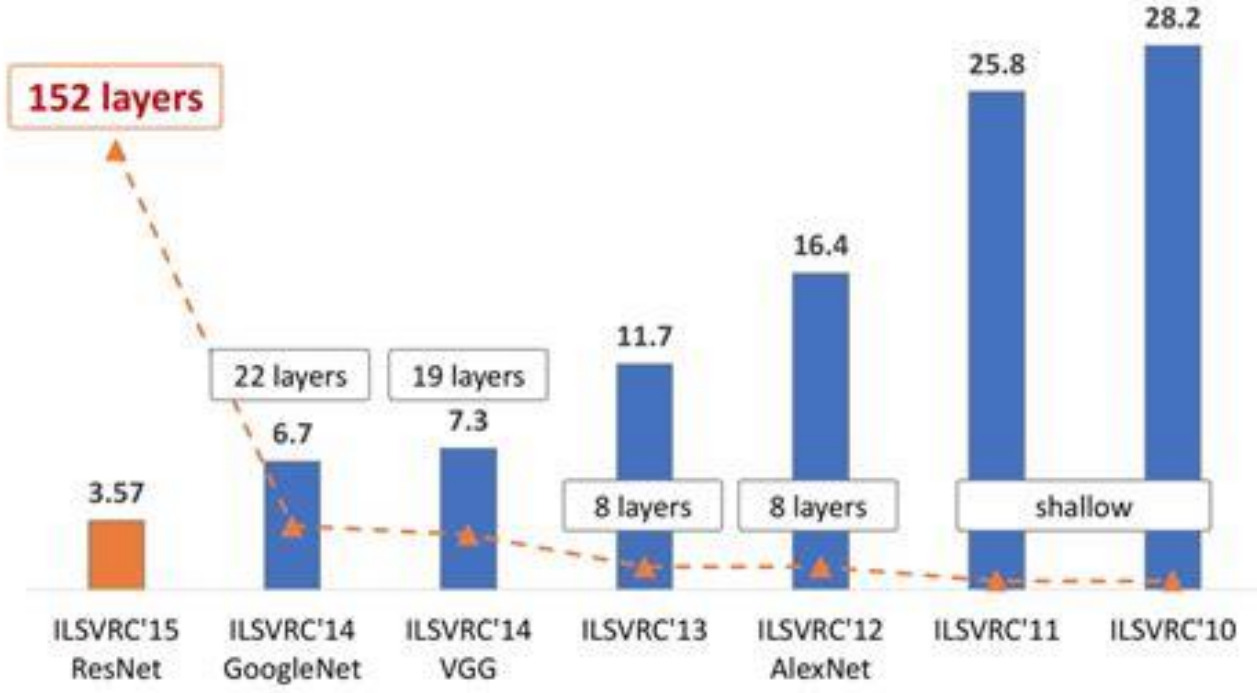
Training from data

Traditional machine learning strategy



New challenge

- Limit of hand-designed feature.
- SVM can not handle big data set well.
- More and more application need to handle unstructured data.



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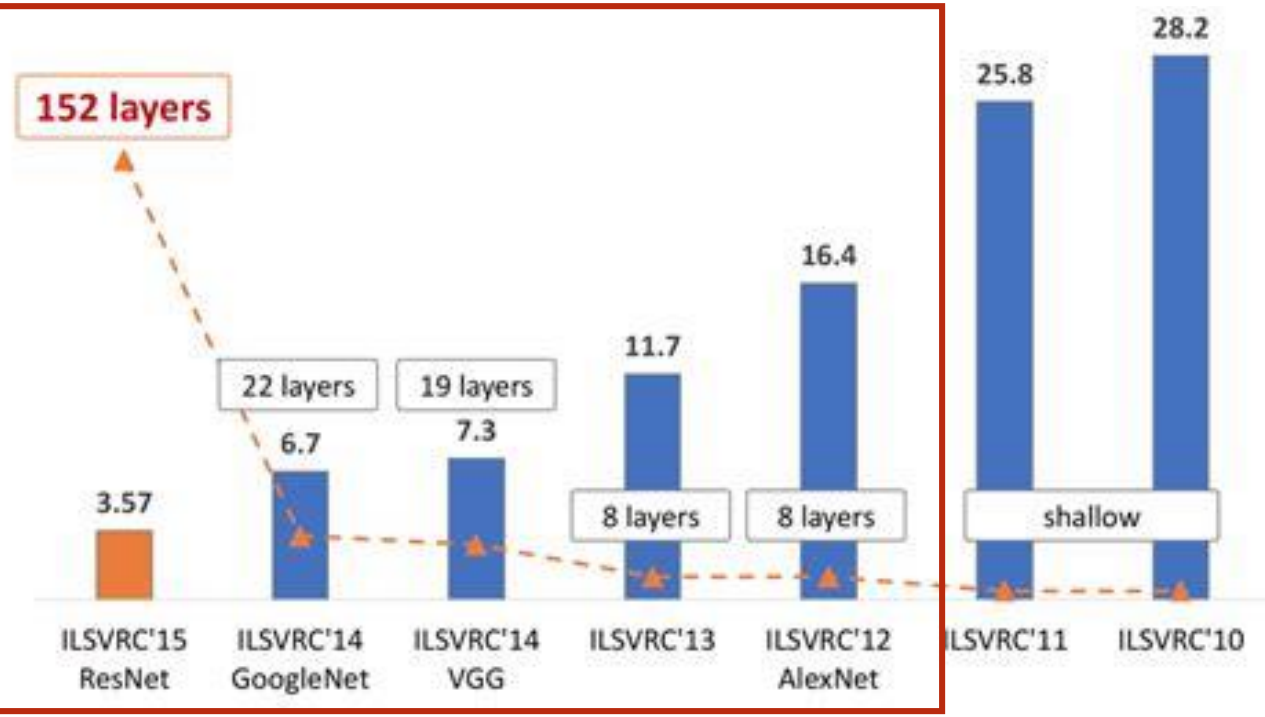
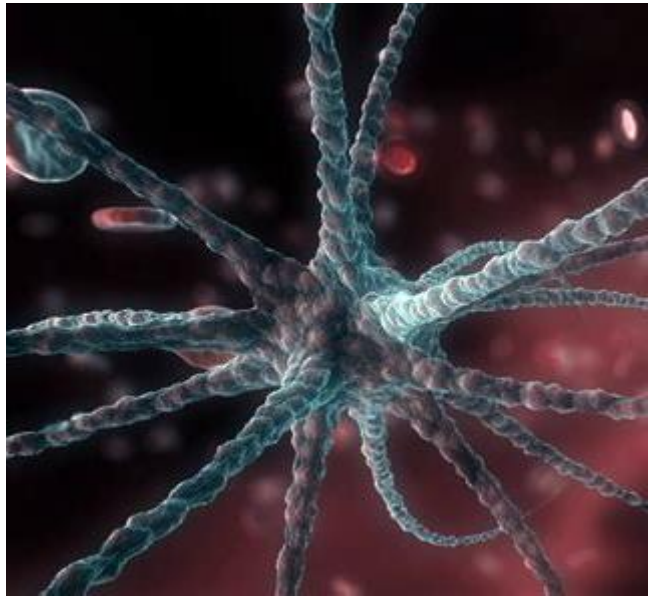
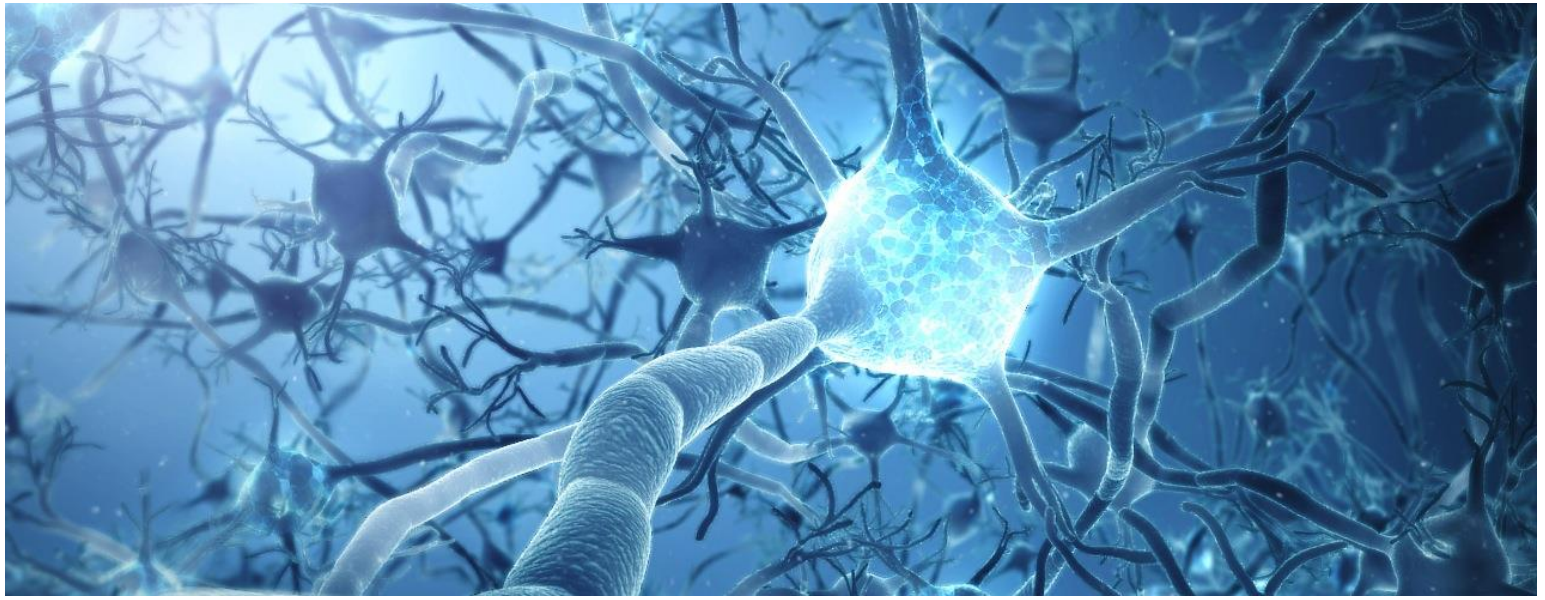
Deep Learning







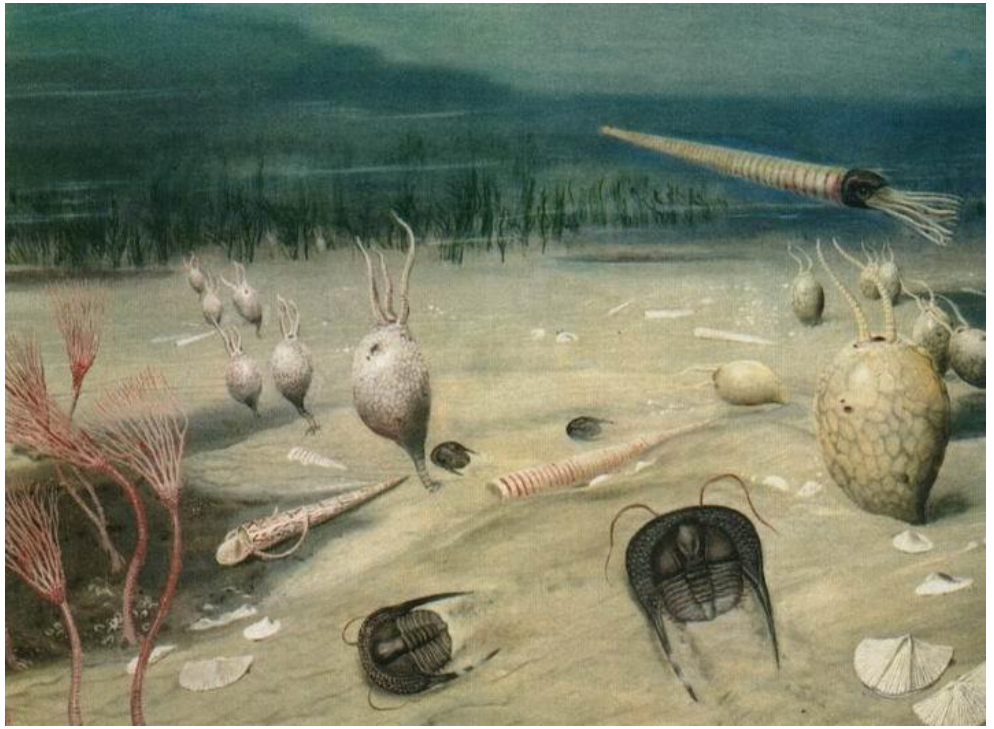
Brief history of neural networks

From neuroscience to mathematic & engineering

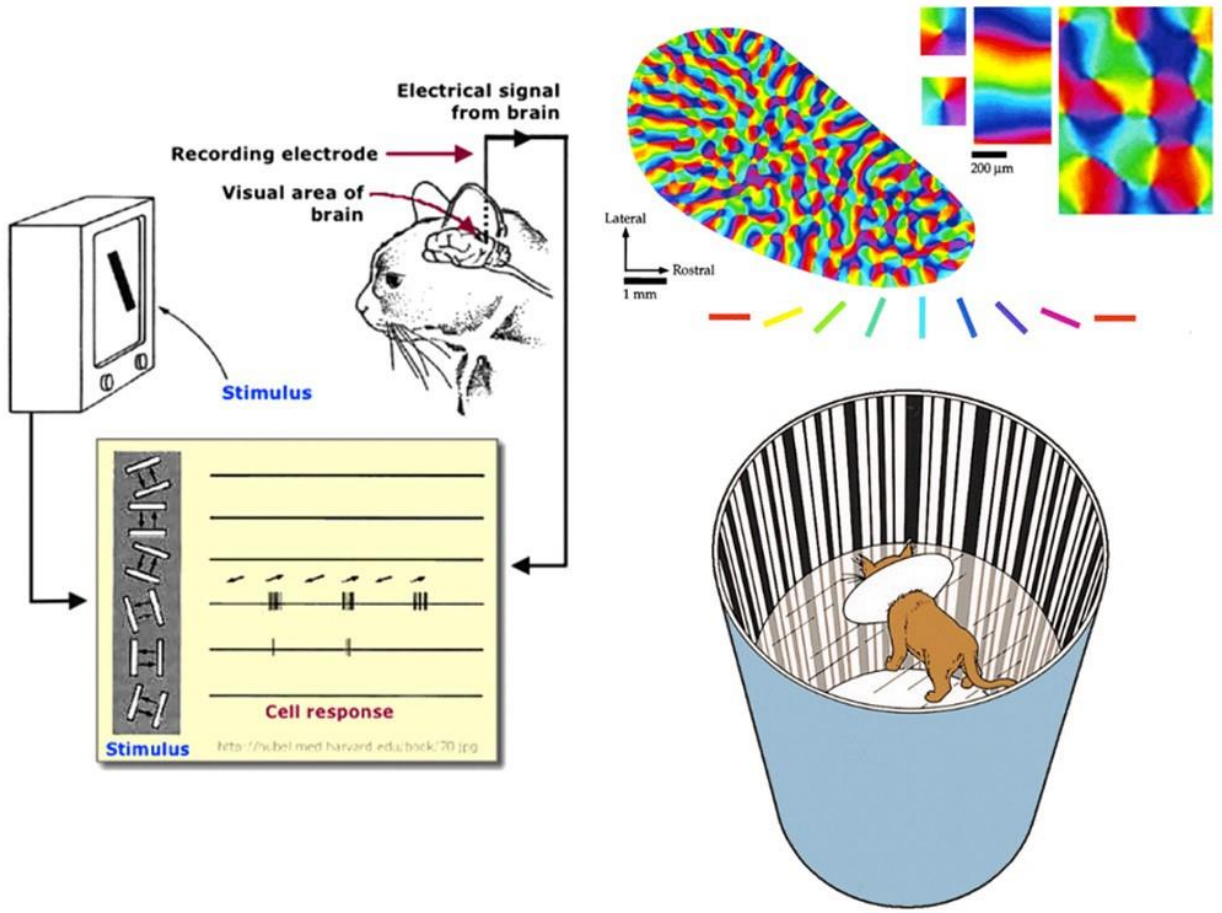
Brief history of neural networks

Cambrian Period

543 million years, B.C.

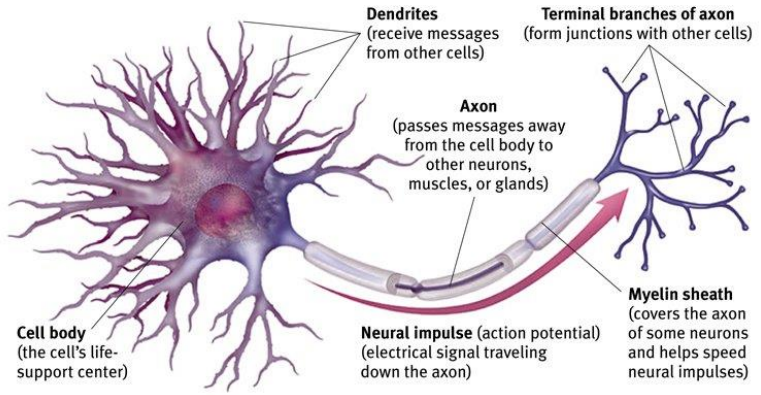


Brief history of neural networks

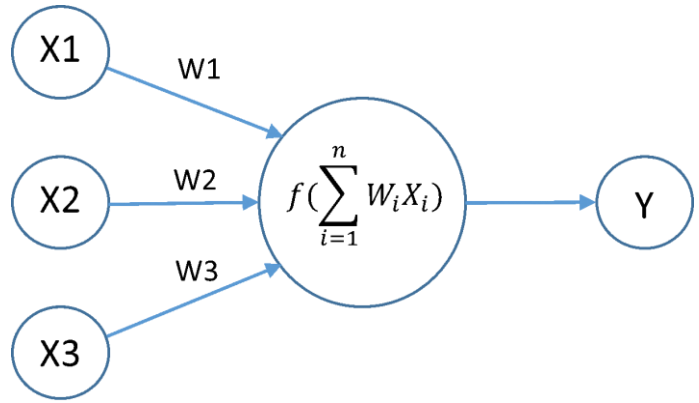


Hubel D H, Wiesel T N. Receptive fields of single neurones in the cat's striate cortex[J]. Journal of Physiology, 1959, 148(3):574.

Brief history of neural networks

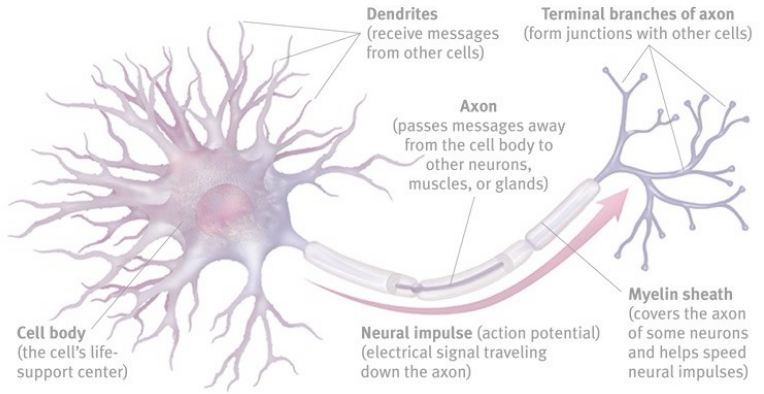


Single Neural Unit

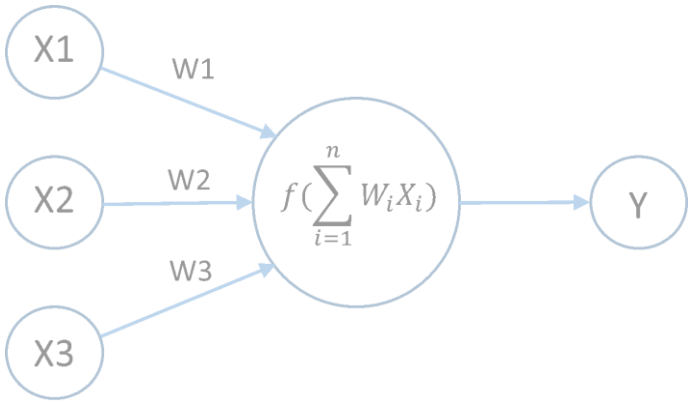


Perceptron

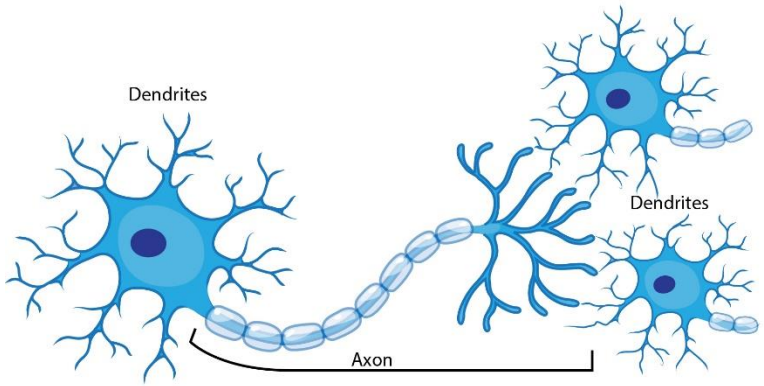
Brief history of neural networks



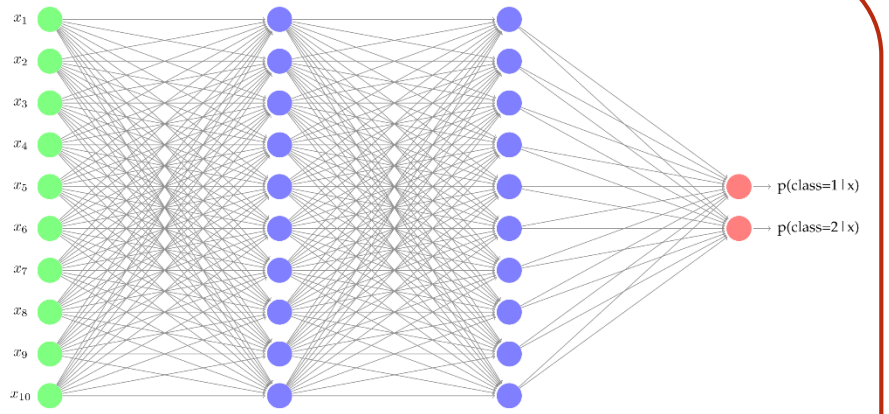
Single Neural Unit



Perceptron



Connected Neural Units

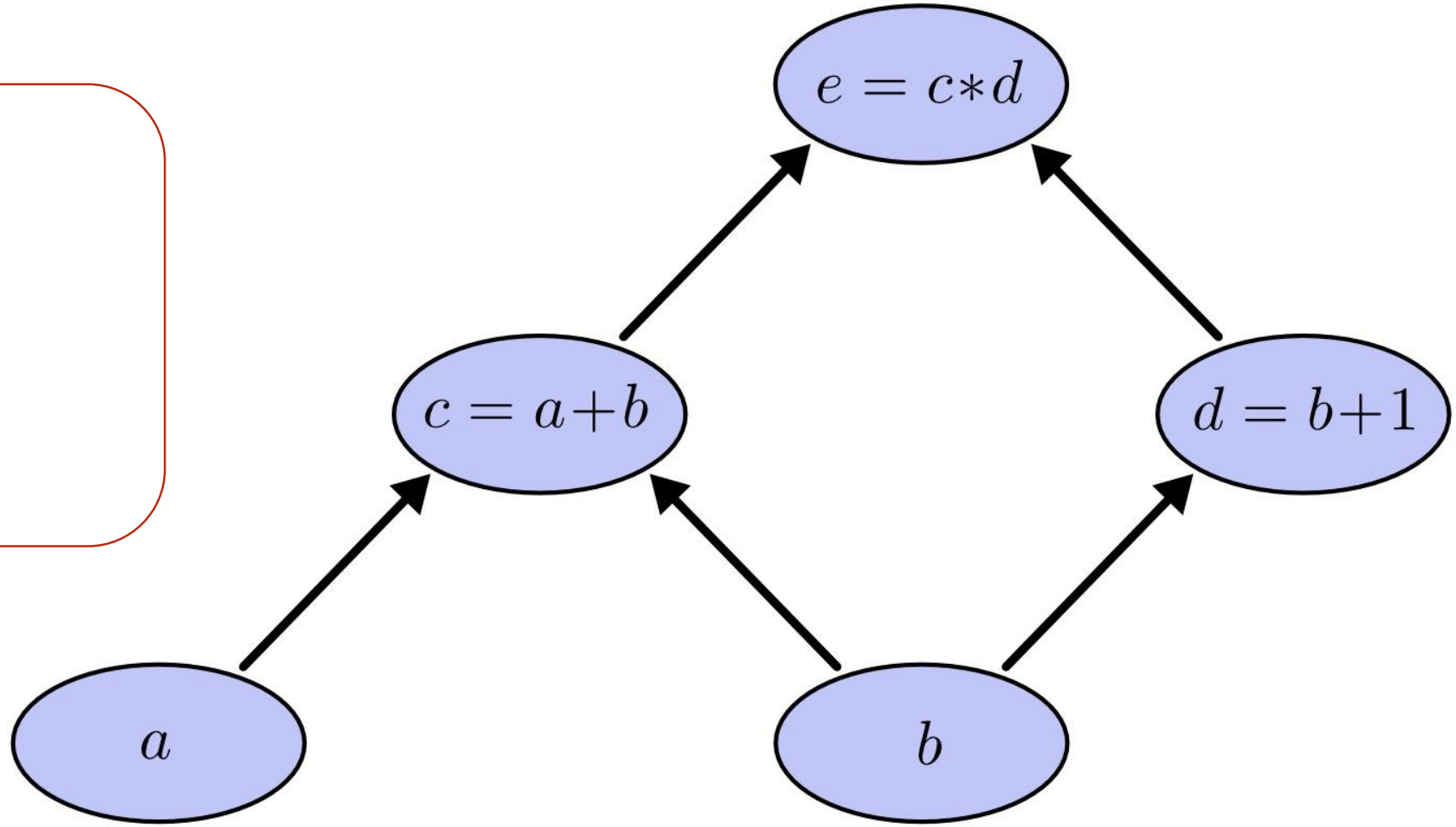


Artificial Neural Network

Back Propagation

$$\frac{\partial e}{\partial a} = ?$$

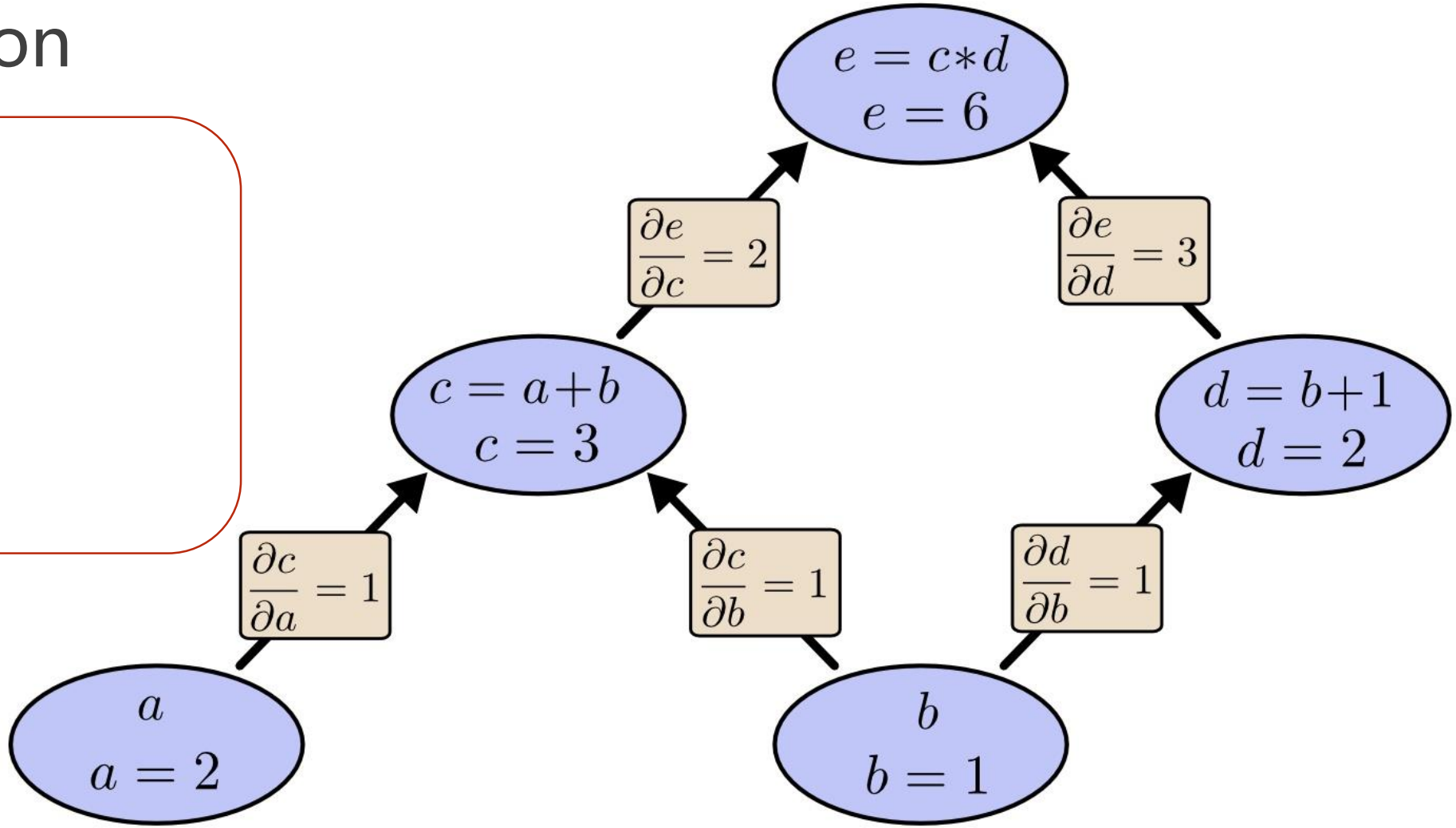
$$\frac{\partial e}{\partial b} = ?$$



Back Propagation

$$\frac{\partial e}{\partial a} = ?$$

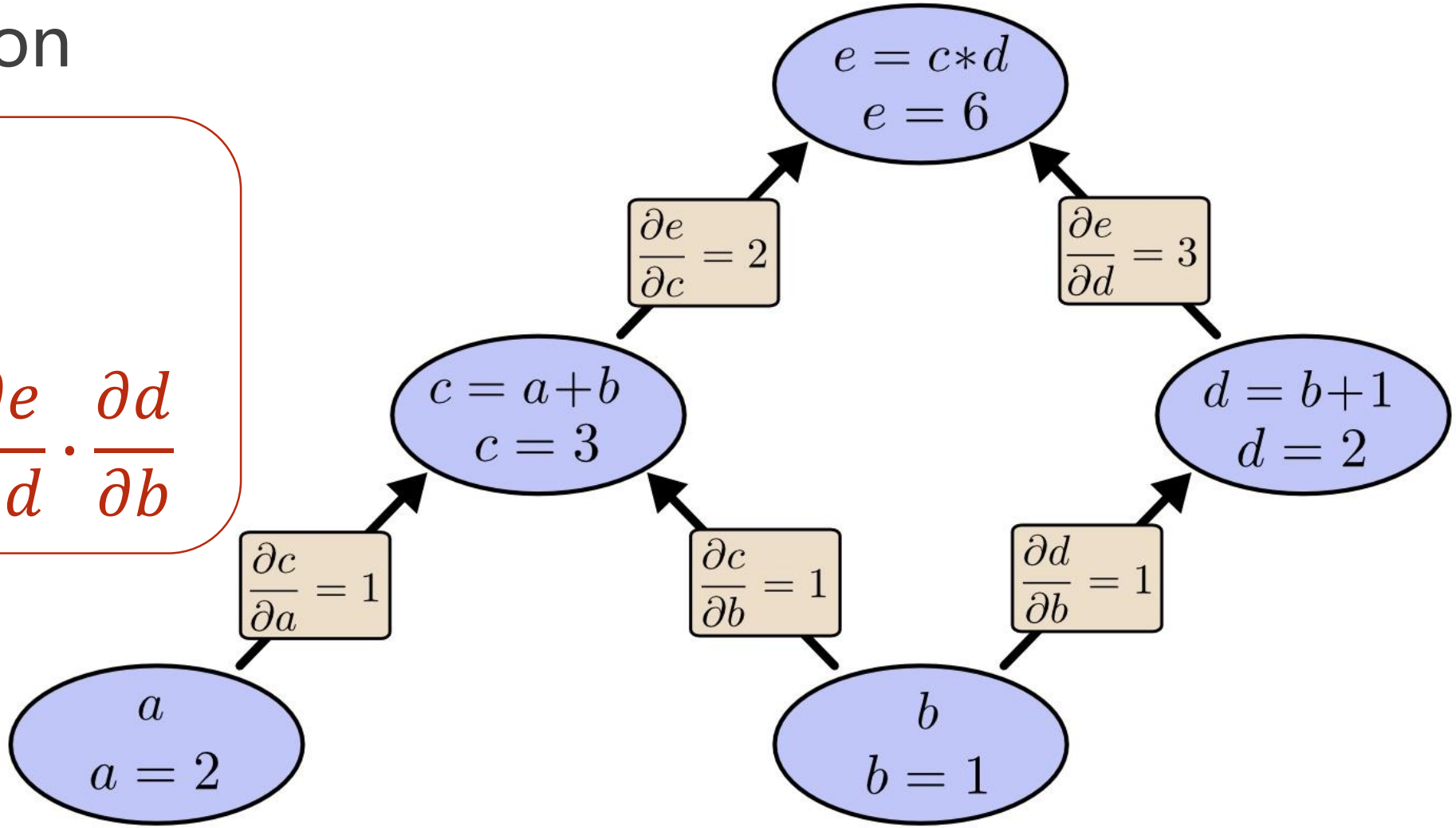
$$\frac{\partial e}{\partial b} = ?$$



Back Propagation

$$\frac{\partial e}{\partial a} = \frac{\partial e}{\partial c} \cdot \frac{\partial c}{\partial a}$$

$$\frac{\partial e}{\partial b} = \frac{\partial e}{\partial c} \cdot \frac{\partial c}{\partial b} + \frac{\partial e}{\partial d} \cdot \frac{\partial d}{\partial b}$$



LeNet-5 LeCun 1998

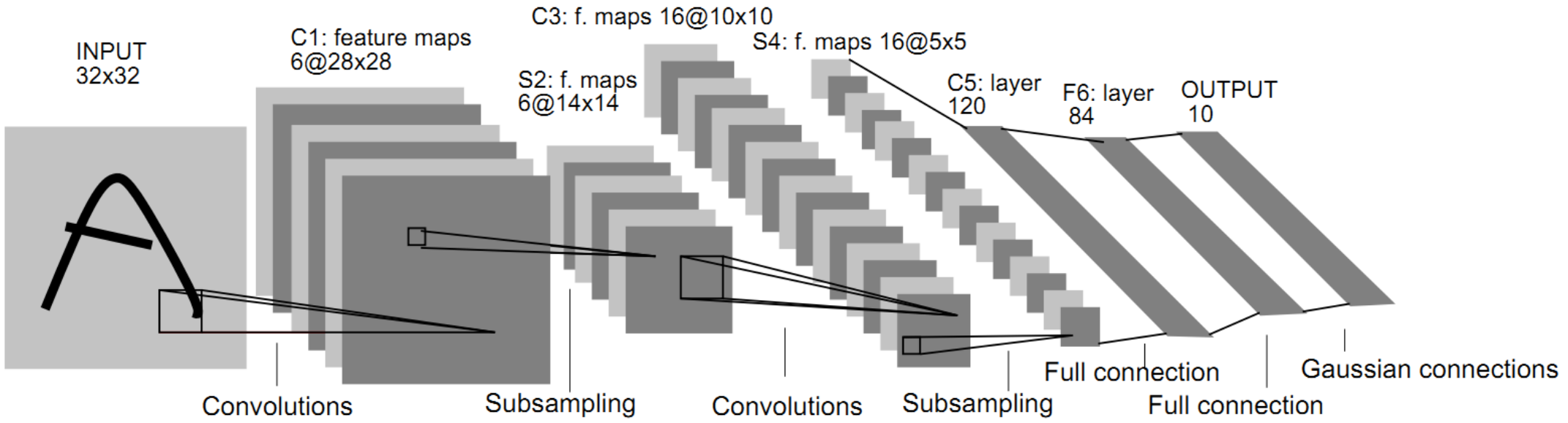
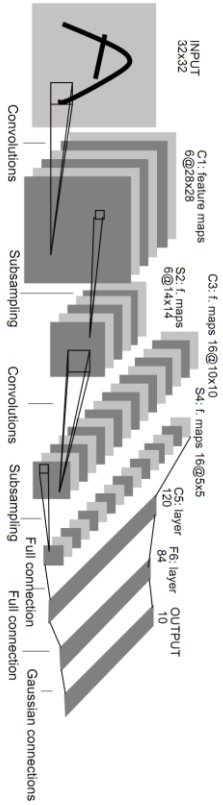


Fig. 2. Architecture of LeNet-5, a Convolutional Neural Network, here for digits recognition. Each plane is a feature map, i.e. a set of units whose weights are constrained to be identical.

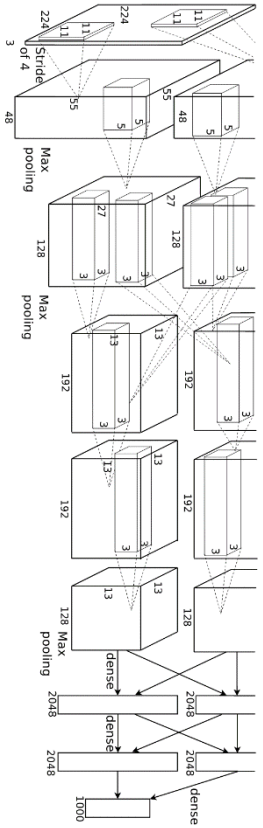
Y. LeCun, L. Bottou, Y. Bengio and P. Haffner: Gradient-Based Learning Applied to Document Recognition, Proceedings of the IEEE, 86(11):2278-2324, November 1998,

Brief history of neural networks

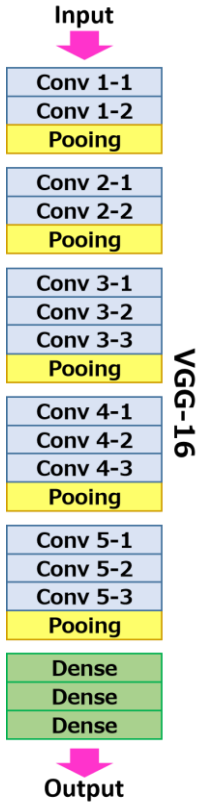
[1998]
LeNet-5



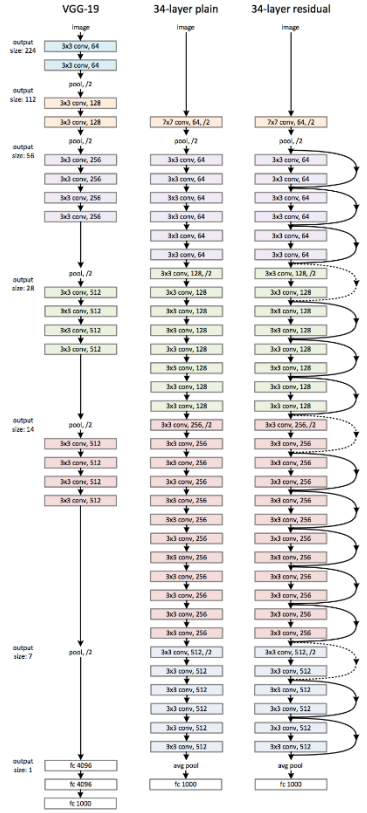
[2012]
AlexNet



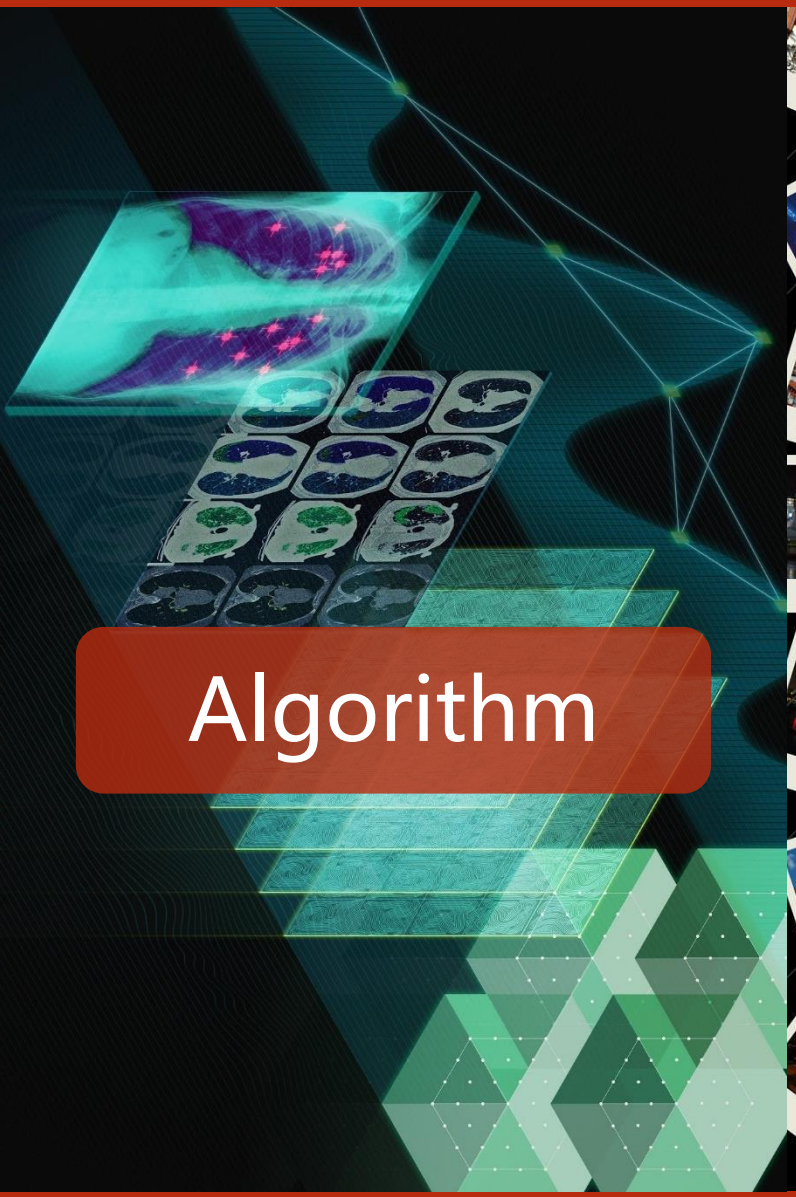
[2014]
GoogLeNet & VGG



[2015]
ResNet



Brief history of neural networks



Algorithm

Data

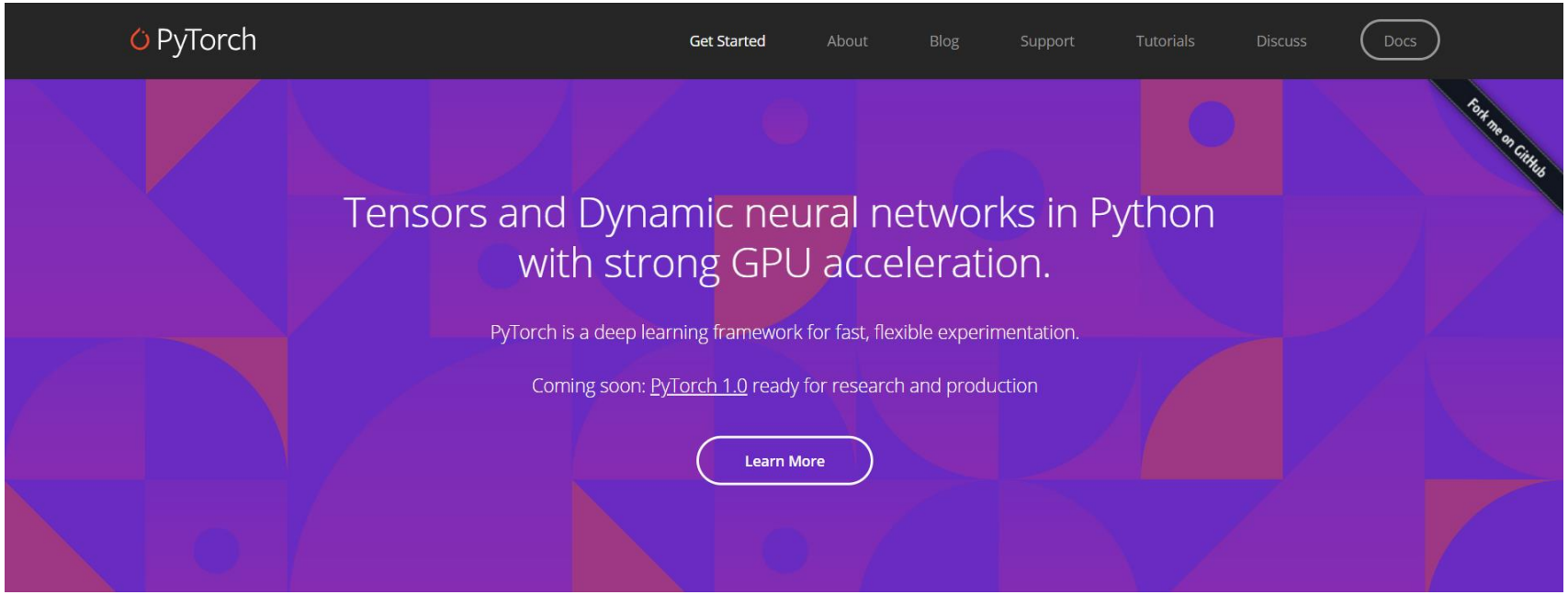
Computation

Good news

- Deep learning is not too difficult
  - Basic algebra + probability + python
  - Less than one year study
- There are lots of deep learning framework
  - Starting from scratch do not be required
  - Enabled efficient and convenient use of GPU
  - Lots of components of neural networks provided by framework
- Popular deep learning frameworks
  - Theano (University of Montreal) / TensorFlow (Google)
  - Caffe (UC Berkeley) / Caffe 2 (Facebook)
  - Torch (NYU & Facebook) / **PyTorch** (Facebook)

What is PyTorch

- PyTorch is a python package that provides two high-level features:
  - Tensor computation (like numpy) with strong GPU acceleration
  - Deep Neural Networks built on a tape-based autodiff system



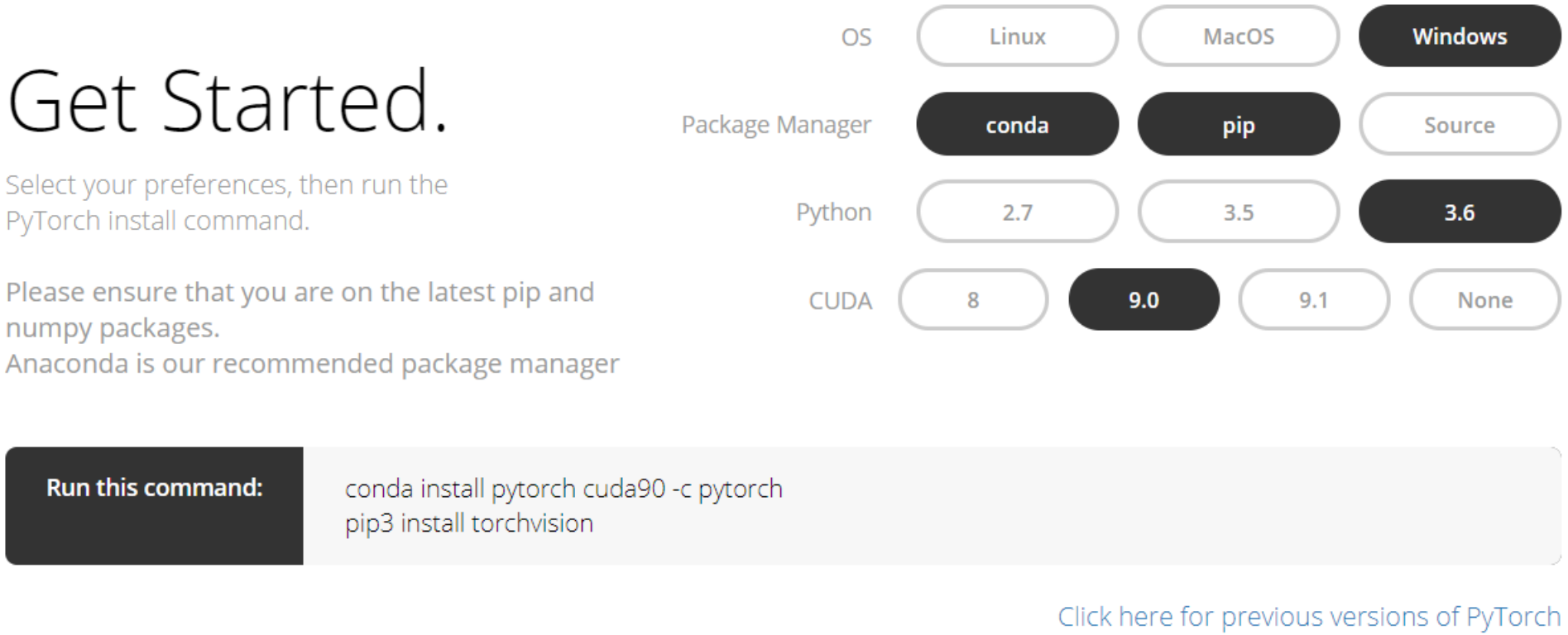
Why PyTorch

- Dynamical graph
  - More flexible
  - Easy to debug
  - Intuitive and cleaner code
- More neural networkic
  - Write code as network works
  - AutoGrad for forward / backward

A graph is created on the fly


```
x = torch.randn(1, 10)
prev_h = torch.randn(1, 20)
W_h = torch.randn(20, 20)
W_x = torch.randn(20, 10)
```

Install PyTorch



https://pytorch.org

After install PyTorch on your computer

```
PS C:\Users\liuii> python
Python 3.6.5 |Anaconda, Inc.| (default, Mar 29 2018, 13:32:41) [MSC v.1900 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> import torch
>>> print(torch.__version__)
0.4.0
>>> # Perfect!
```

PyTorch Tutorial

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