清華大學
Tsinghua University

大数据机器学习

第一讲 概述

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清华大学深圳研究生院
2017/5/26

- **提纲：**
  - 大数据机器学习的背景知识
  - 机器学习与相关学科的关系
  - 机器学习发展历程
  - 大数据机器学习的主要特征
  - 课程参考书

Question: What's the classification the images belong to?

ladles

ImageNet Challenge 2012

Task 1: Classification

Car

- Predict a class label
- 5 predictions / image
- 1000 classes
- 1,200 images per class for training
- Bounding boxes for 50% of training.

Task 2: Detection (Classification + Localization)

classification Car

- Predict a class label and a bounding box
- 5 predictions / image
- 1000 classes
- 1,200 images per class for training
- Bounding boxes for 40% of training.

Task 3: Fine-grained classification

classification Walker hound

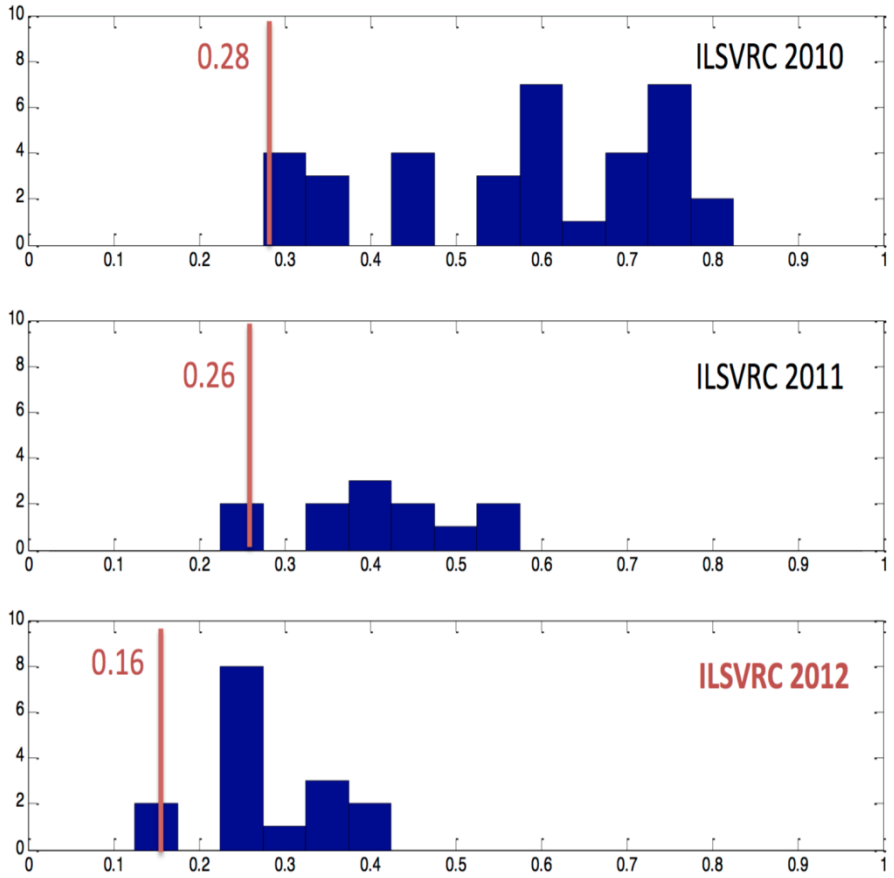
- Predict a class label given a bounding box in test
- 1 prediction / image
- 120 dog classes (subset)
- ~200 images per class for training (subset)
- Bounding boxes for 100% of training

Convolutional Neural Network

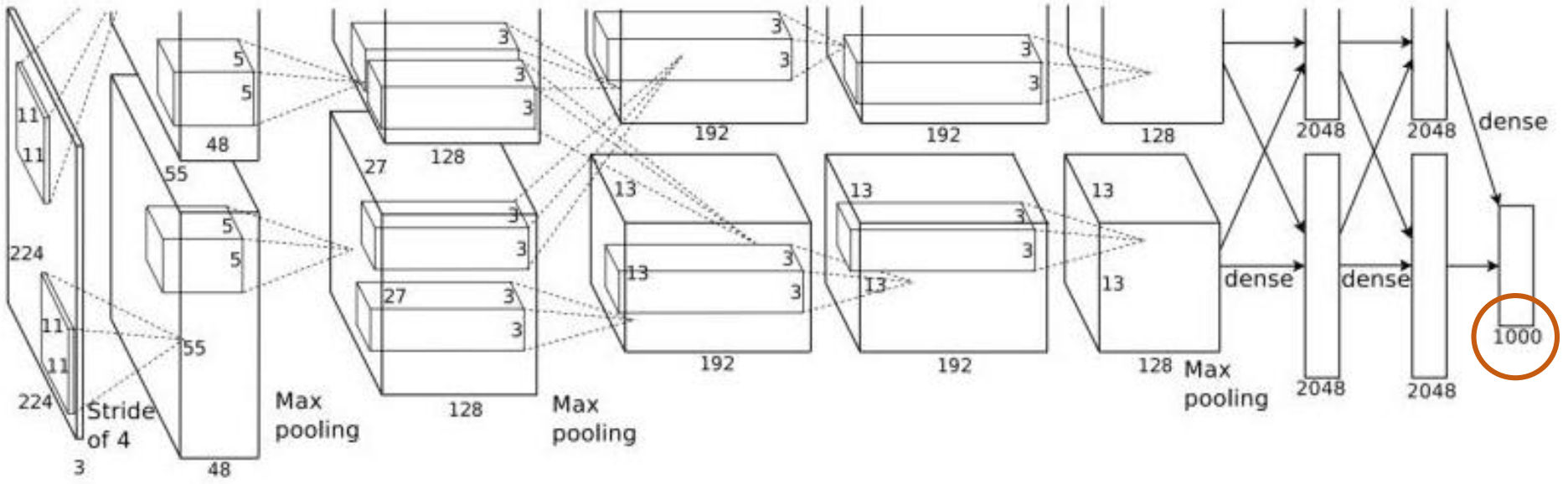
Promising techniques

Method	Year
Locality-constrained Linear Coding	ILSVRC 2010
Improved Fisher Vectors	ILSVRC 2011
Convolutional Neural Networks	ILSVRC 2012

Alex Krizhevsky, Ilya Sutskever, Geoffrey Hinton, University of Toronto 2012



Convolutional Neural Network



Alex Krizhevsky, Ilya Sutskever, Geoffrey Hinton, University of Toronto 2012

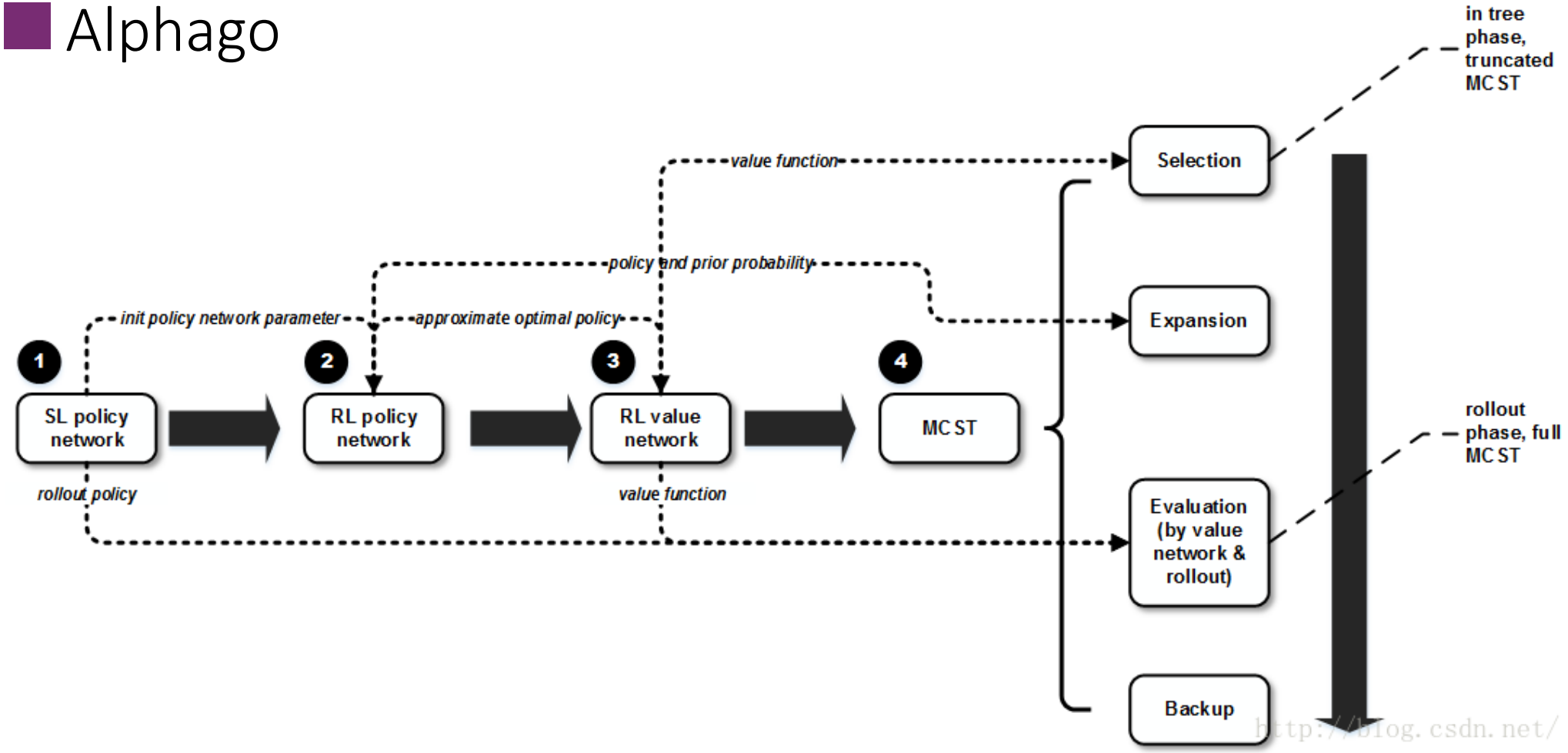
ImageNet Progress:

- 2015年：微软的神经网络系统错误率为4.94%，低于人类测试者的5.1%。

	layers	error(top 5)	
AlexNet	8	15%	2012
VGGNet	19	7.32%	2014
GooleNet	22	6.66%	2014
MSRA	152	3.57%	2016

Alphago

Alphago



- 机器学习进入了新的时代!

机器学习

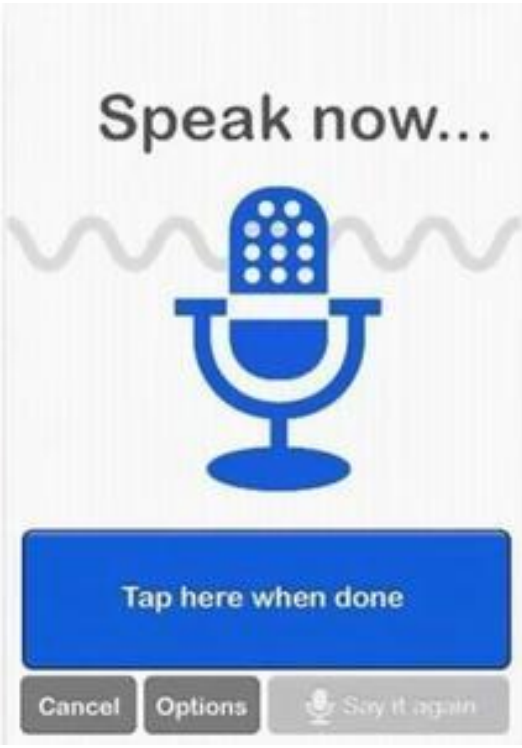
- 维基百科：
- 机器学习是近20多年兴起的一门多领域交叉学科，涉及概率论、统计学、逼近论、凸分析、算法复杂度理论等多门学科。机器学习理论主要是设计和分析一些让计算机可以自动“学习”的算法。机器学习算法是一类从数据中自动分析获得规律，并利用规律对未知数据进行预测的算法。因为学习算法中涉及了大量的统计学理论，机器学习与统计推断学联系尤为密切，也被称为统计学习理论。

Game


大侠，能告诉我们您到底是谁吗？别让我们瞎猜了，想急死谁啊？？
PK
海龙 0312
比赛结果揭晓了，奖金归属揭晓了，大侠们的身份啥时候揭晓呢？


IBM

Text to speech and speech recognition



3D 体感游戏

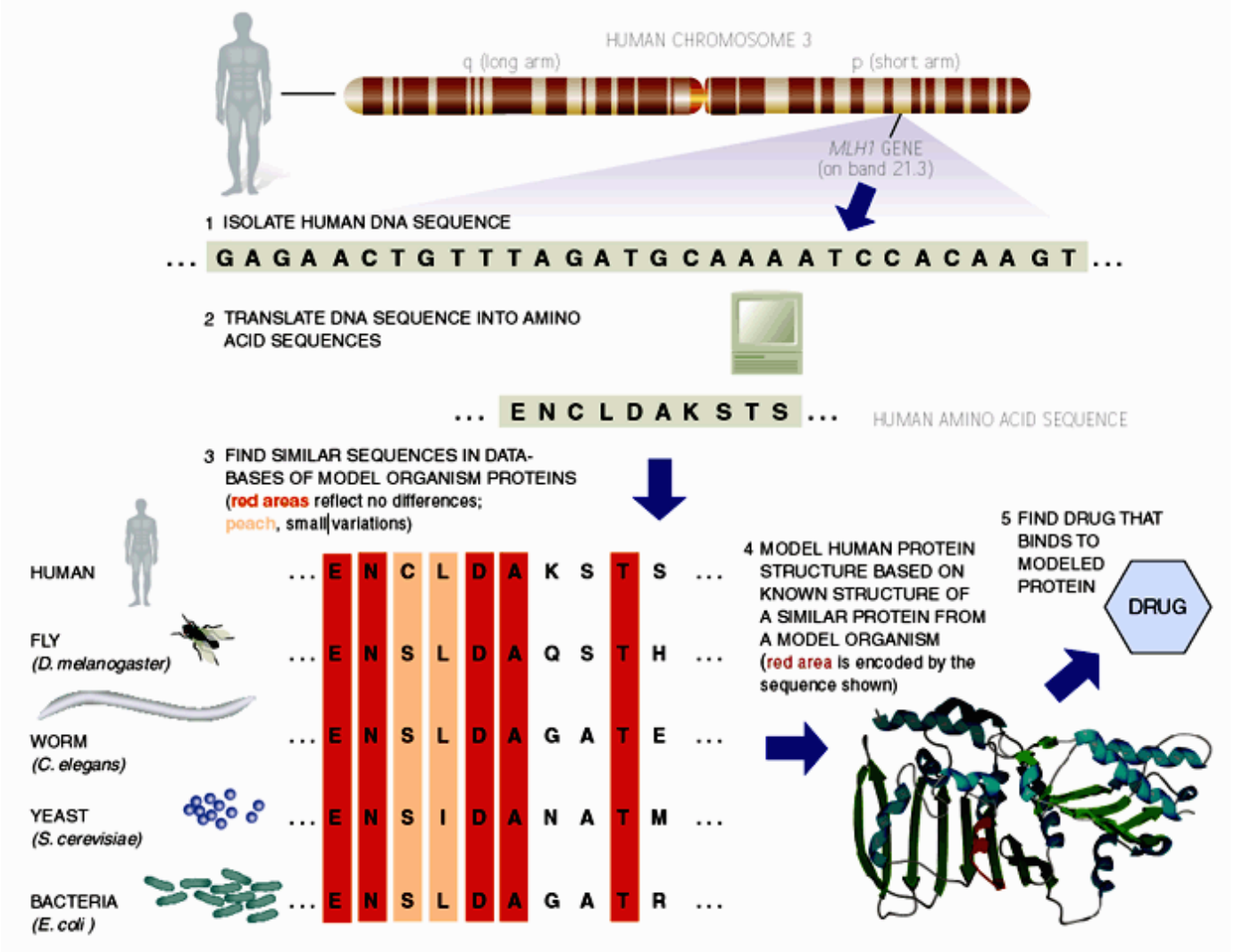
清華大學
Tsinghua University

Bioinformatics

Gene

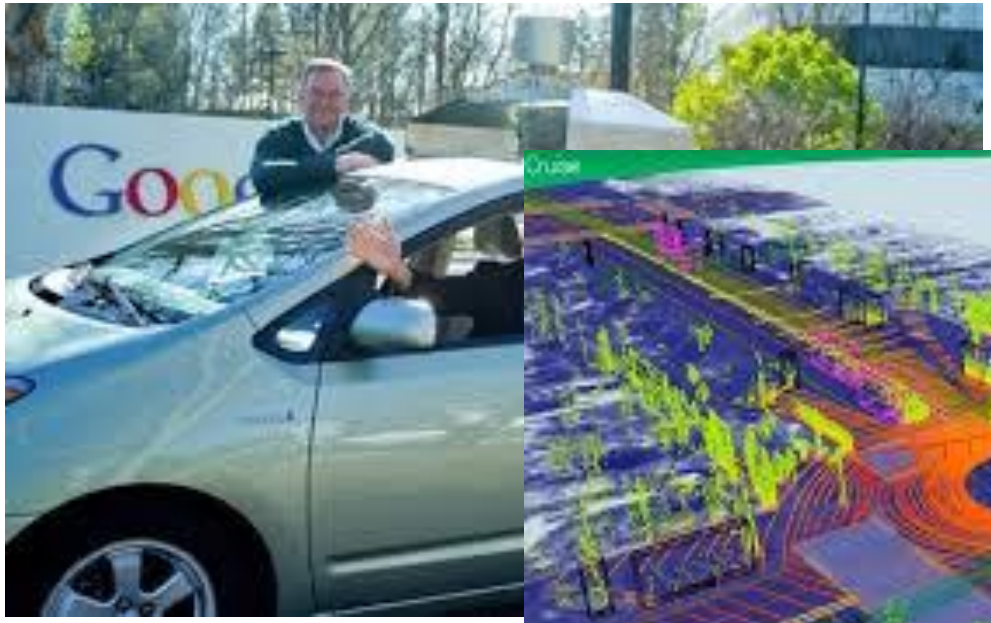
Bioinformatics

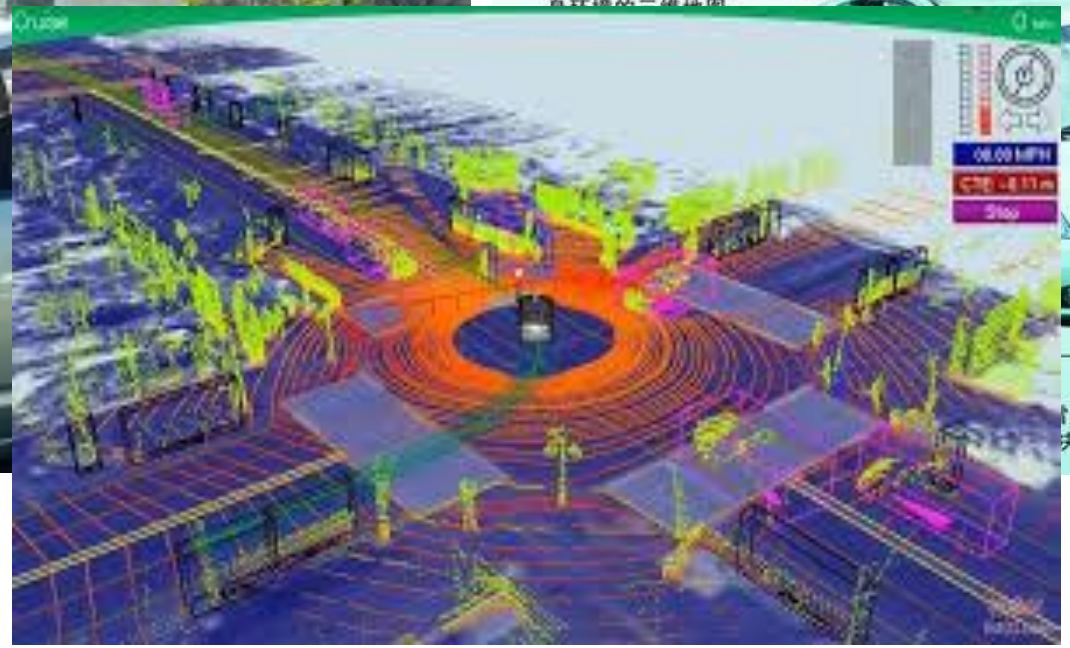
Gene



Quantitative trading

Robotic Control





再现古代陶瓷工艺

机器学习相关概念

人工智能

机器学习

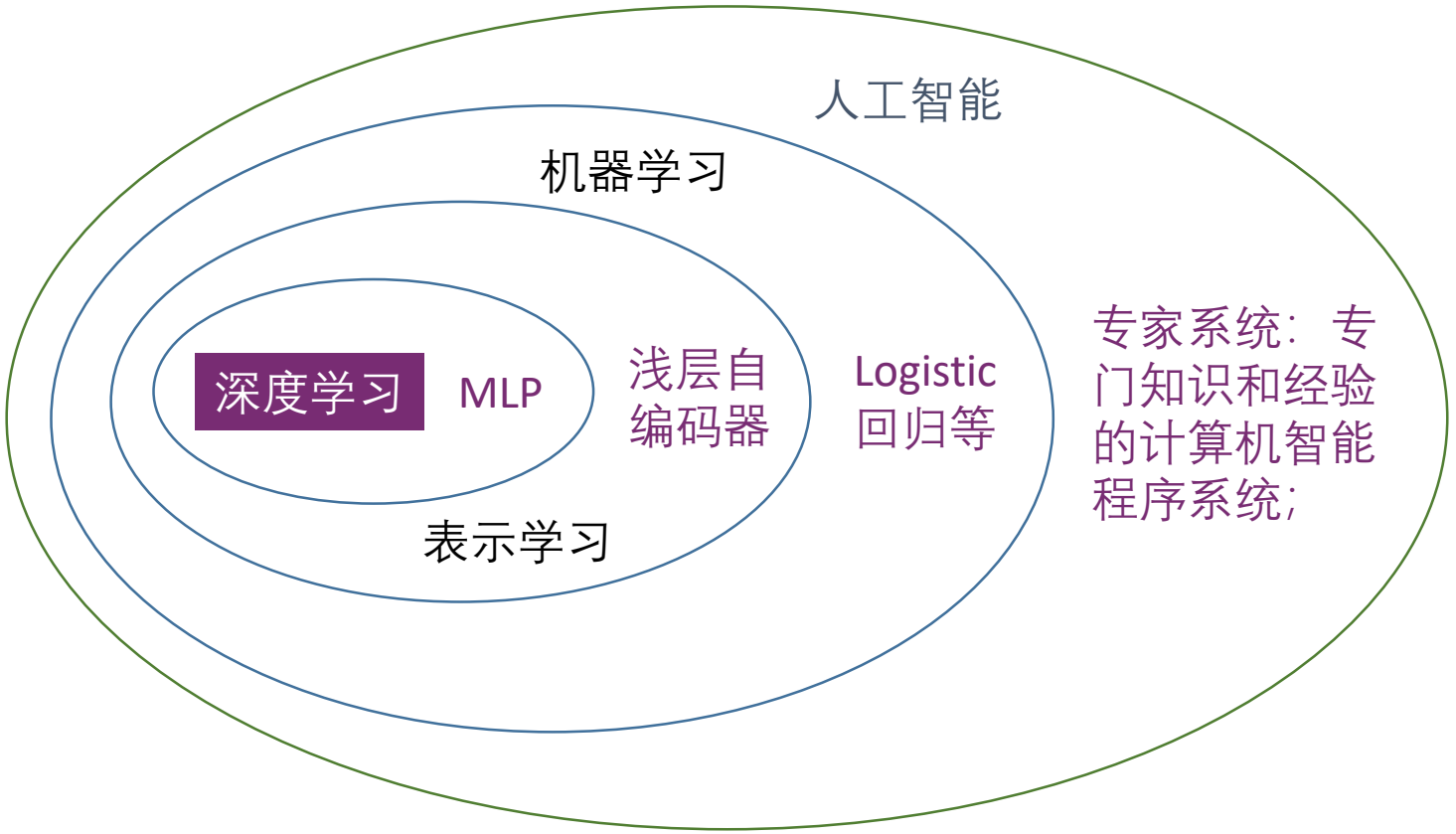
深度学习

数据挖掘

计算机视觉

统计学习

人工智能/机器学习/深度学习

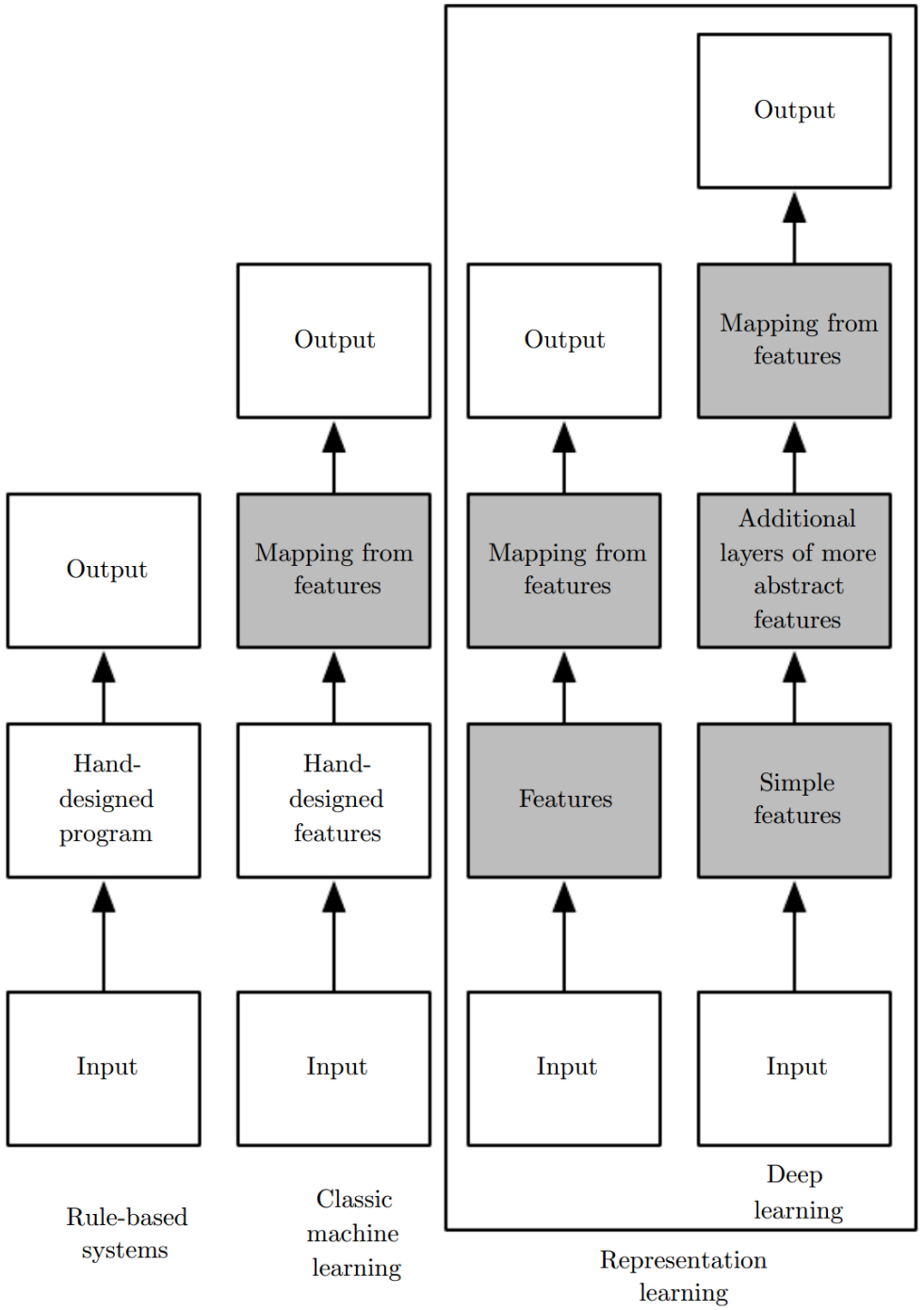


人工智能：是科学，为机器赋予视觉/听觉/触觉/推理等智能。

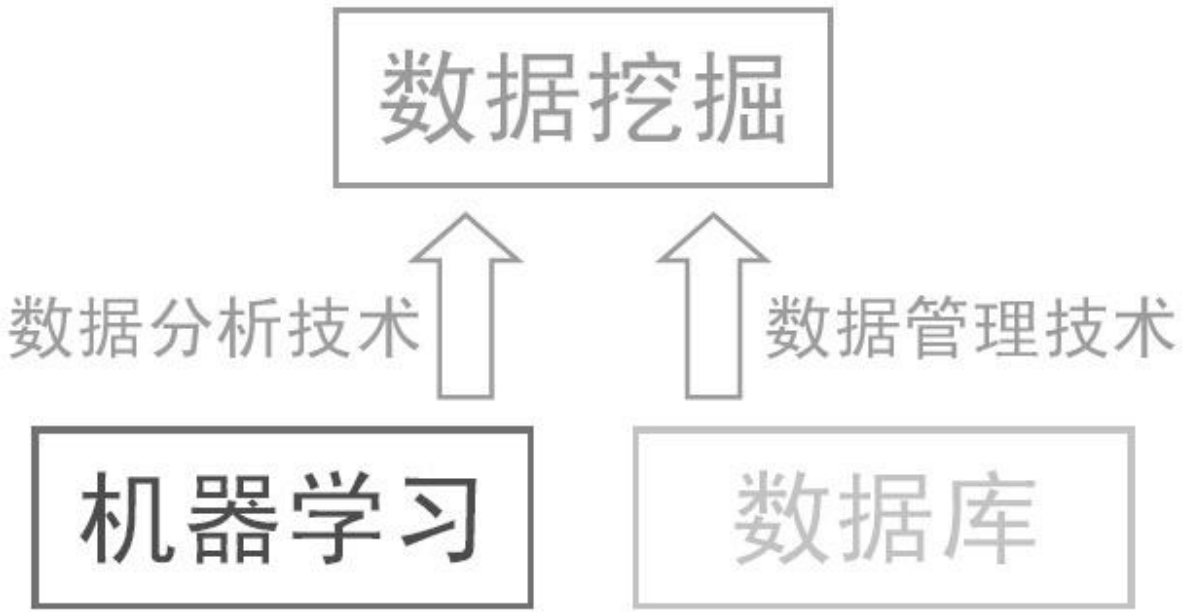
机器学习：人工智能的计算方法。

深度学习和人工智能其它方法

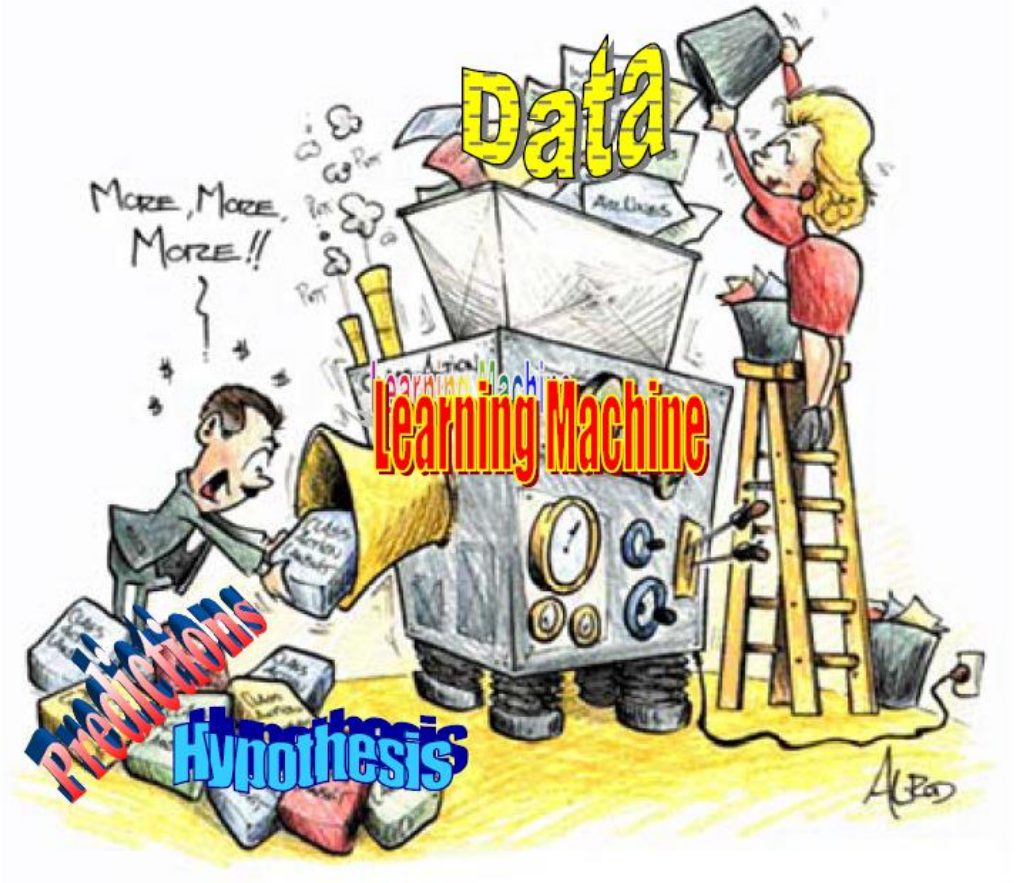
阴影：可学习的部分



机器学习和数据挖掘



机器学习的一个形象描述



机器学习和计算机视觉

播放视频

播放视频

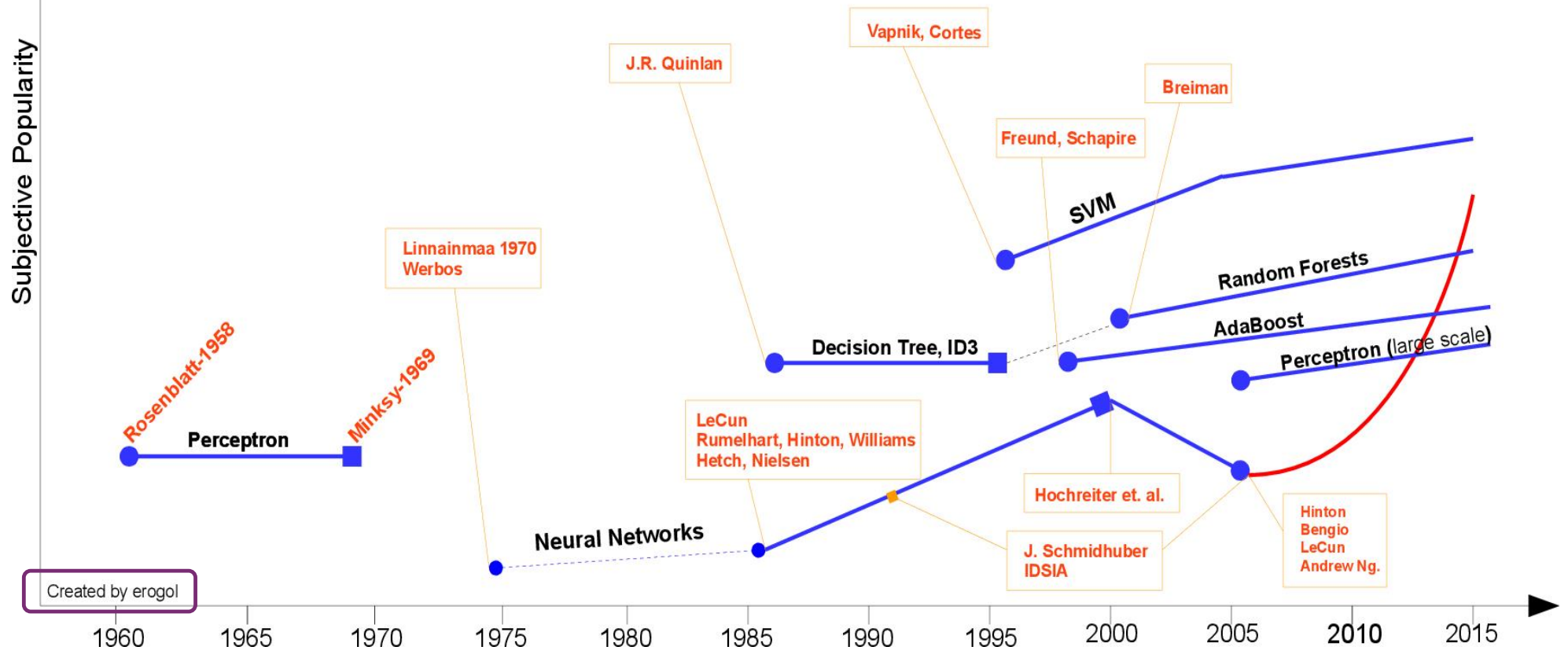
计算机视觉是机器学习最重要的应用

机器学习和统计学习

- ---Simon Blomberg:
  - From R’ s fortunes package: To paraphrase provocatively, ‘machine learning is statistics minus any checking of models and assumptions’ .
- ---Andrew Gelman:
  - In that case, maybe we should get rid of checking of models and assumptions more often. Then maybe we’ d be able to solve some of the problems that the machine learning people can solve but we can’ t!

机器学习=统计— 模型和假设的检验

机器学习的发展历程


Subjective Popularity
Vapnik, Cortes
J.R. Quinlan
Breiman
Freund, Schapire
SVM
Linnainmaa 1970
Werbos
Random Forests
AdaBoost
Perceptron (large scale)
Rosenblatt-1958
Minksy-1969
Perceptron
Decision Tree, ID3
LeCun
Rumelhart, Hinton, Williams
Hetch, Nielsen
Hochreiter et. al.
Neural Networks
J. Schmidhuber
IDSIA
Hinton
Bengio
LeCun
Andrew Ng.
Created by erogol
1960
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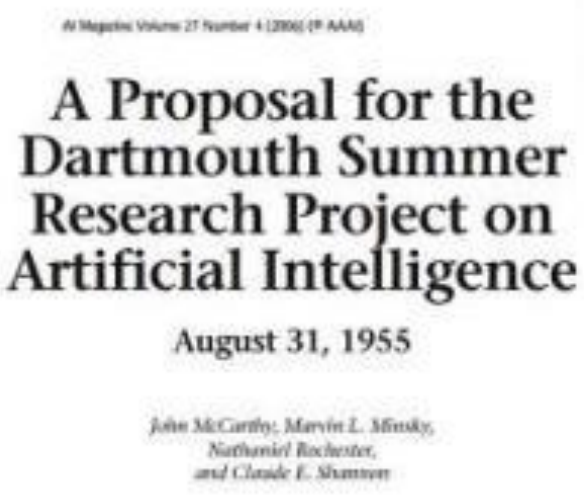
2015

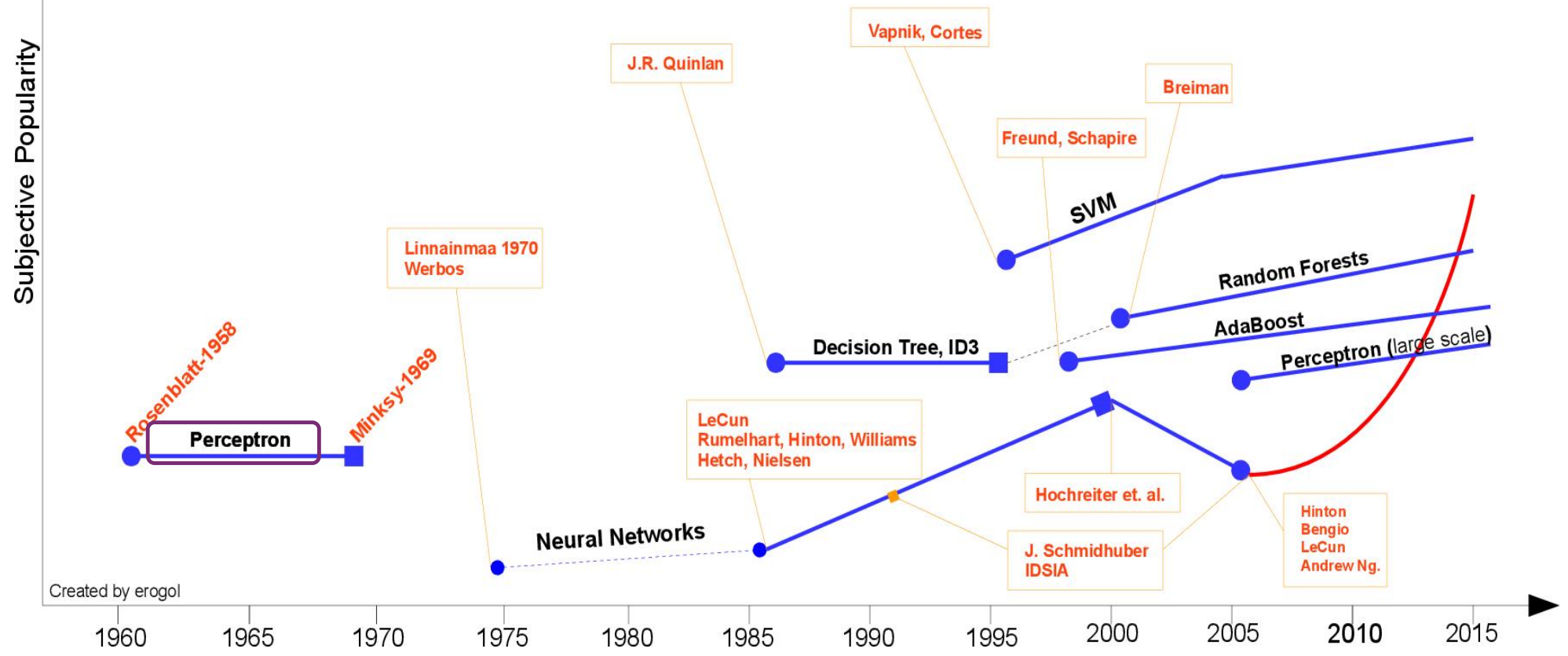
机器学习的发展历程



在人工智能50年大会上，5位1956年Dartmouth人工智能夏季研究会的与会者再相聚

照片从左至右：Trenchard More, John McCarthy, Marvin Minsky, Oliver Selfridge, 以及 Ray Solomonoff (Photo by Joseph Mehling, '59)

机器学习的发展历程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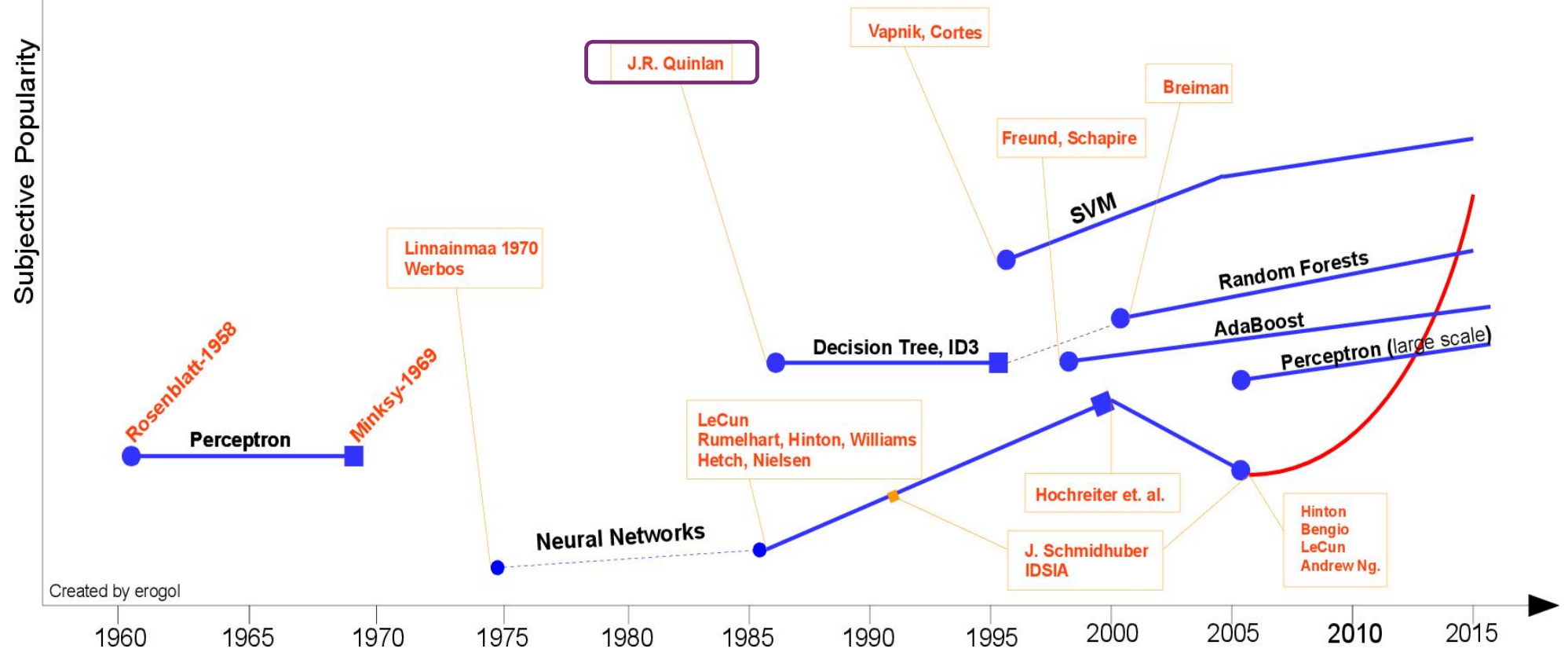
机器学习的发展历程

Figure 4.8 Illustration of the Mark 1 perceptron hardware. The photograph on the left shows how the inputs were obtained using a simple camera system in which an input scene, in this case a printed character, was illuminated by powerful lights, and an image focussed onto a 20×20 array of cadmium sulphide photocells, giving a primitive 400 pixel image. The perceptron also had a patch board, shown in the middle photograph, which allowed different configurations of input features to be tried. Often these were wired up at random to demonstrate the ability of the perceptron to learn without the need for precise wiring, in contrast to a modern digital computer. The photograph on the right shows one of the racks of adaptive weights. Each weight was implemented using a rotary variable resistor, also called a potentiometer, driven by an electric motor thereby allowing the value of the weight to be adjusted automatically by the learning algorithm.

Image and caption from PRML pp.196

机器学习的发展历程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机器学习的发展历程

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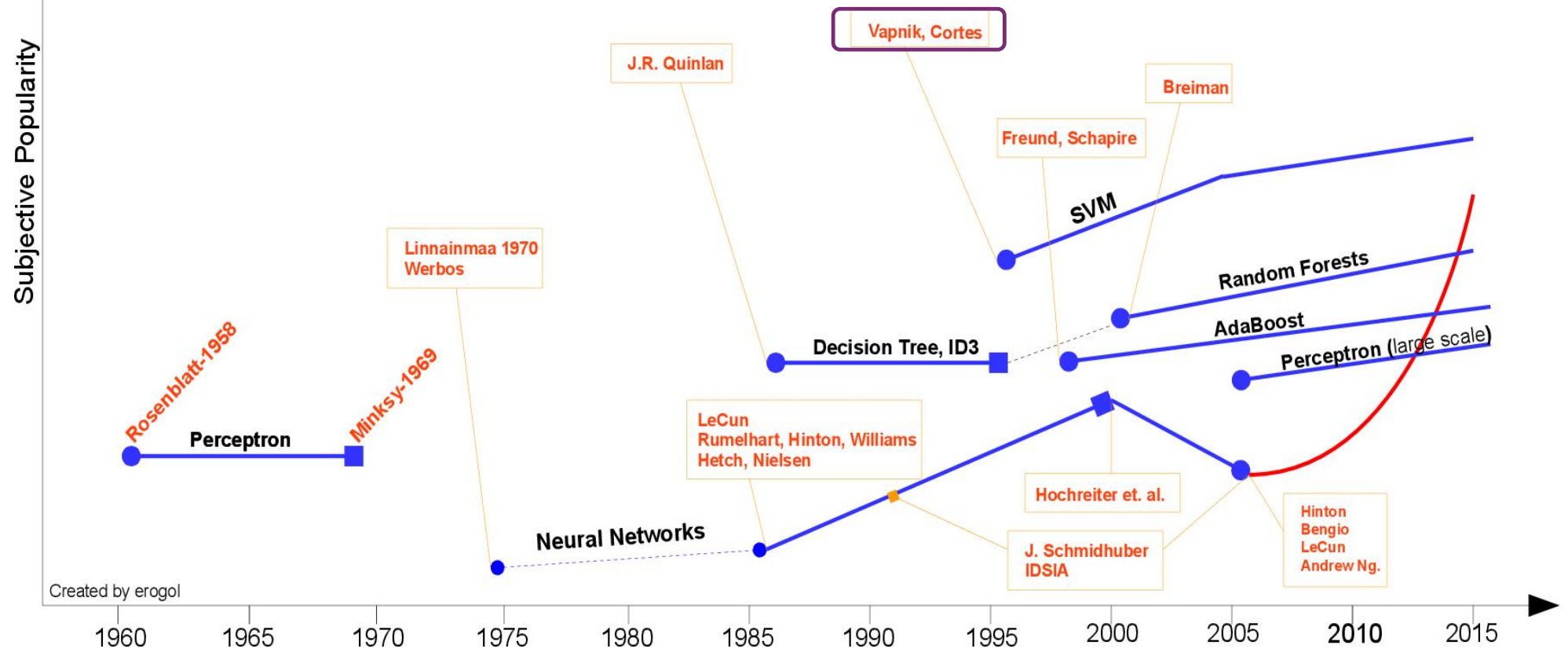
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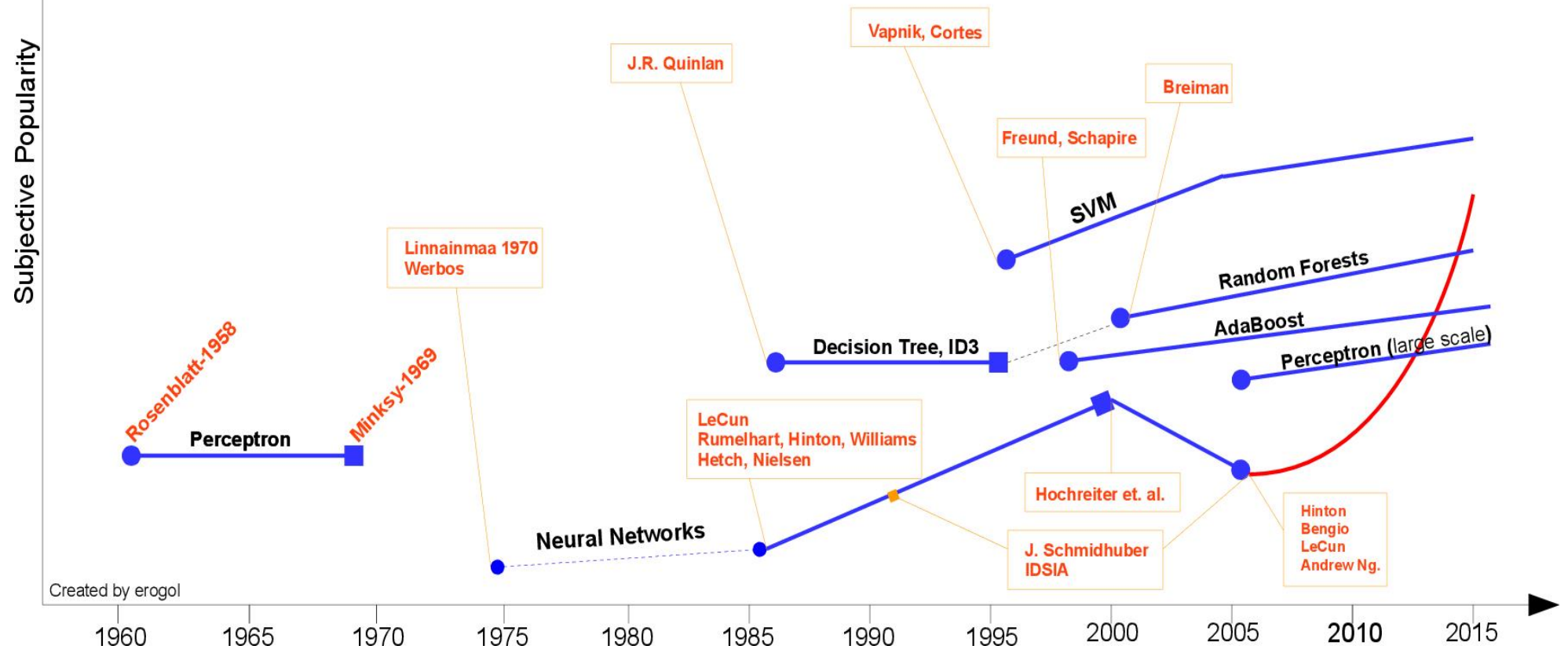
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机器学习的发展历程

大数据机器学习的主要特征

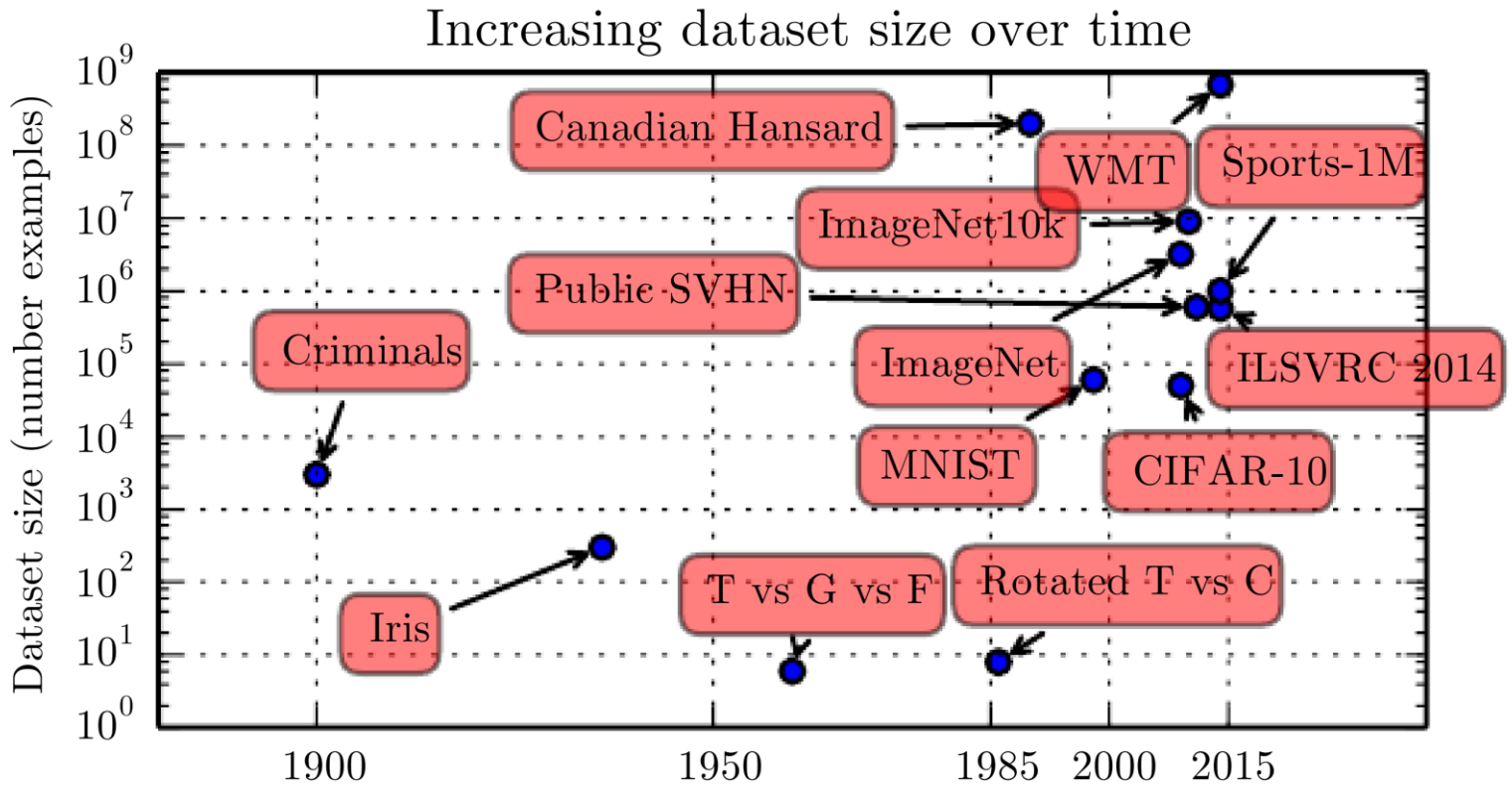
与日俱增的数据量：Facebook

- facebook月活跃用户接近8.5亿
- 每天上传的照片总量为2.5亿张
- 4.25亿移动用户
- 1000亿个connections
- Zygna游戏为facebook总收入贡献了12%
- 57%的用户为女性用户

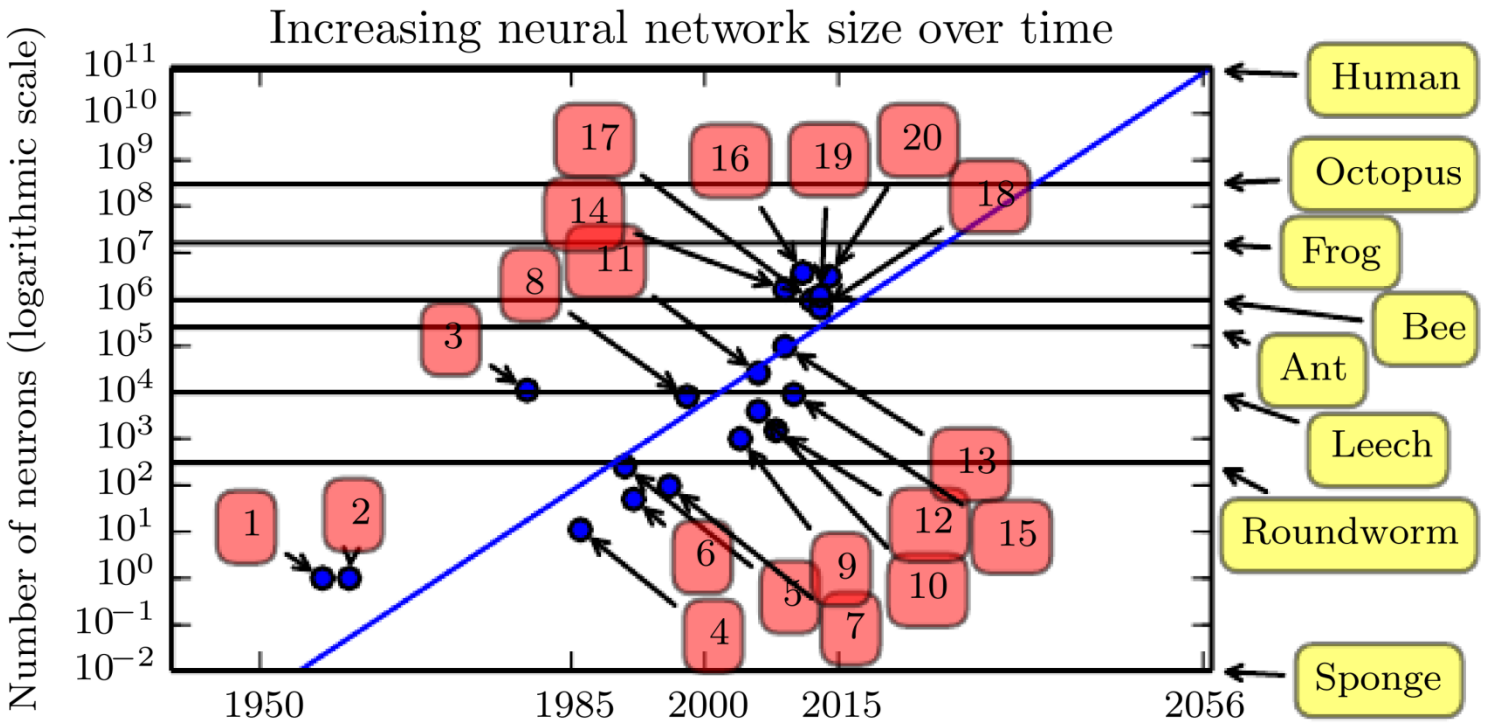
与日俱增的数据量： Tencent

- QQ：月活跃用户超 8 亿，最高同时在线1.9亿;在线人际关系链超1000亿;
- 微信：月活跃用户超3.5亿;日均消息量超50亿;
- 空间：月活跃用户超6亿;日均相册上传超过4亿;
- 游戏：腾讯游戏月活跃用户4.5亿；手机游戏月活跃用户近2亿;
- 网站：日均浏览量PC侧超17亿；手机侧近13亿;最高日接入消息条数8000亿；日接入数据量200TB； 并发分拣业务接口10000个。

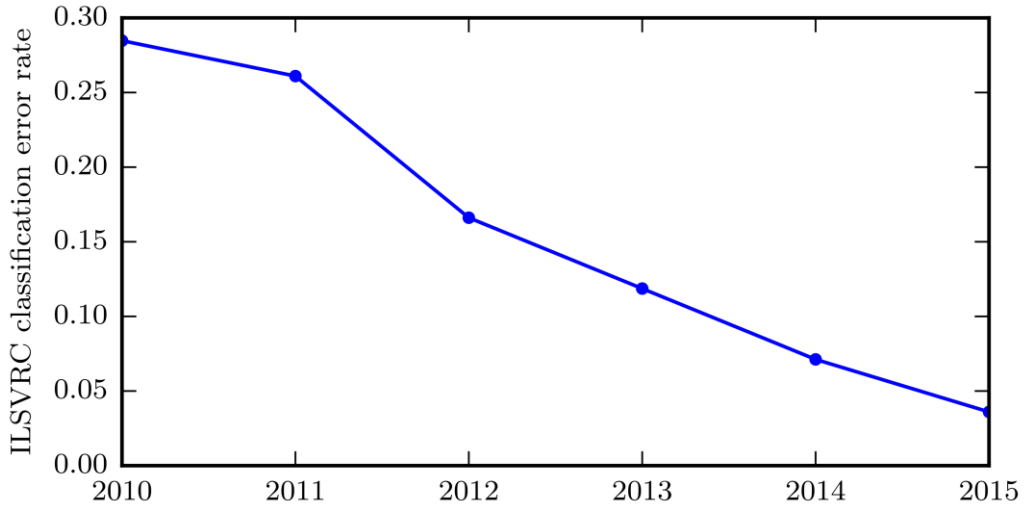
实验数据量的增加

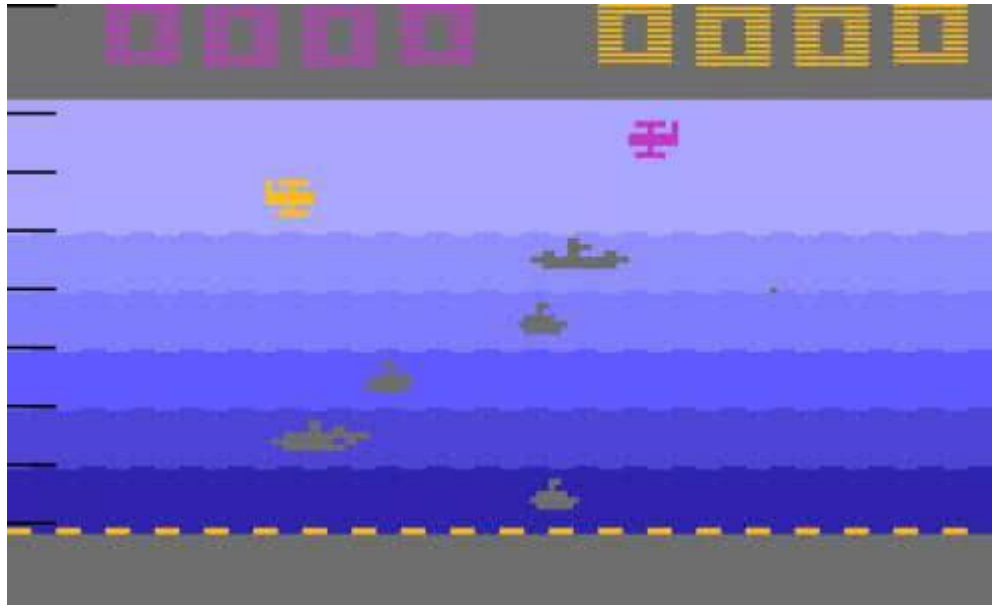

Increasing dataset size over time
Dataset size (number examples)
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
1900
1950
1985
2000
2015
Canadian Hansard
WMT
Sports-1M
ImageNet10k
Public SVHN
Criminals
ImageNet
ILSVRC 2014
MNIST
CIFAR-10
Iris
T vs G vs F
Rotated T vs C

与日俱增的神经网络模型规模

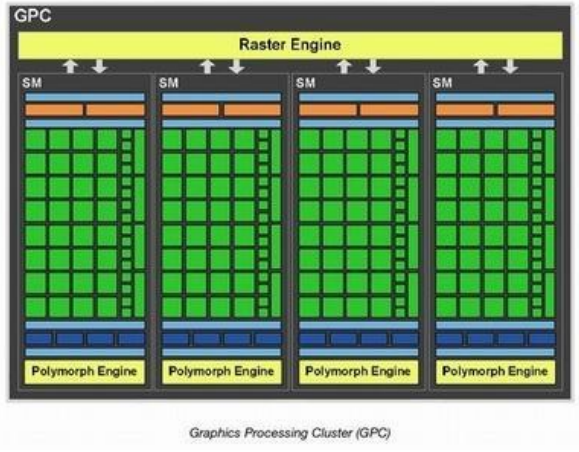


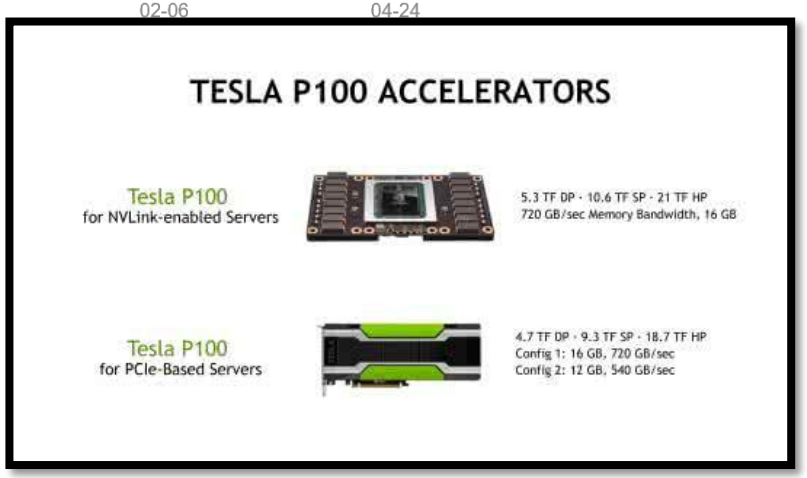
与日俱增的精度、复杂度和对现实世界的冲击



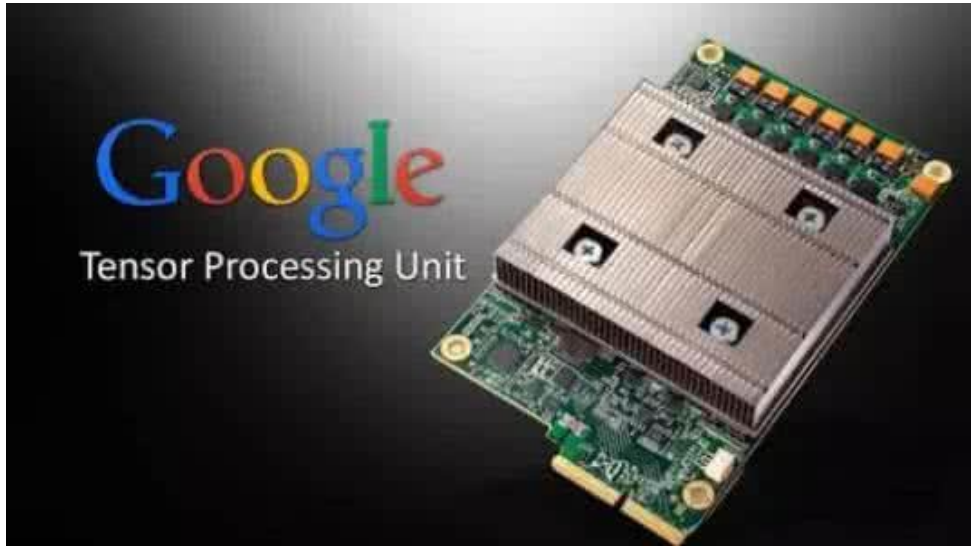


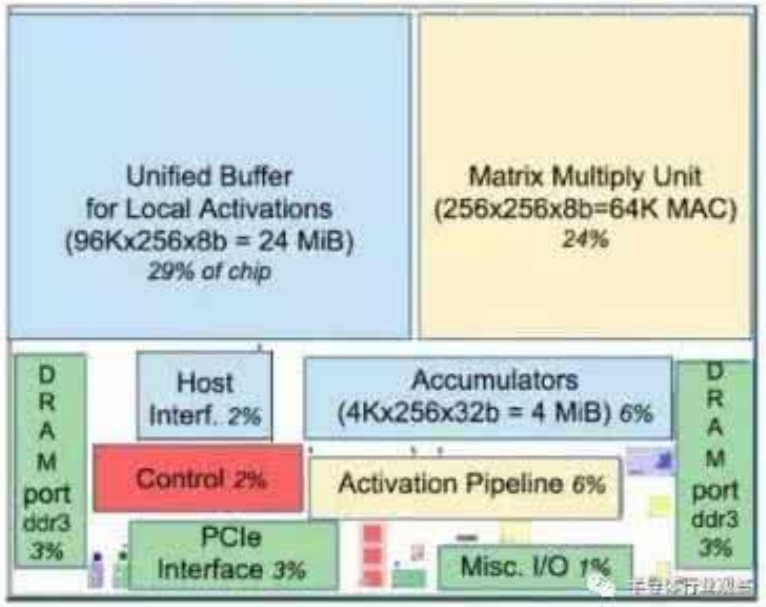
GPU （Graphic Processing Unit）





TPU Tensor Processing Unit





深度学习框架

TensorFlow

Pytorch

Caffe

CNTK

Keras

MXNet

Theano

Scikit-learning

Spark MLlib

课程特点

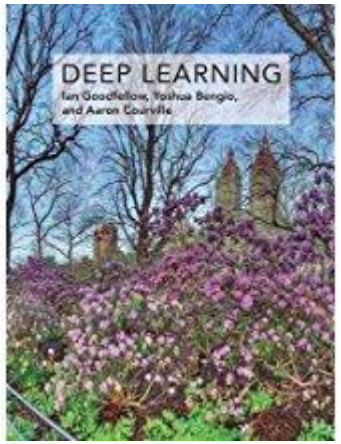
- 以机器学习方法为主干
- 以深度学习模型为重点
- 实现大数据机器学习的应用为目标

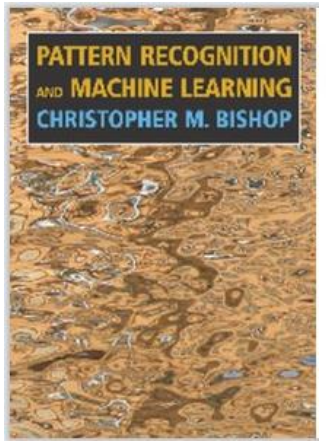
课程内容

- 参考教材


统计学习方法


Machine Learning
in Action
机器学习
实战


DEEP LEARNING
Ian Goodfellow, Yoshua Bengio,
and Aaron Courville


PATTERN RECOGNITION
AND MACHINE LEARNING
CHRISTOPHER M. BISHOP

Q&A?