Welcome to BT5153

More like “Web Information Analytics” or “Text Information Analytics”
than “Topics in Business Analytics”

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Agenda

- Introduction to Machine Learning
- Introduction to Deep Learning
- K-Nearest Neighbour Classifier
- Hands-On

Terms

- Computer Science: Theory, experiments to inform computer design/use
- Artificial Intelligence: Intelligence exhibited by machines to mimic a human mind
- Machine Learning: Computers being able to learn without hand-coding each step
- Deep Learning: Multi-layered algorithms for learning from data
- Data Science: Methods, processes, and systems to extract insights from data
- Analytics: Discovery of meaningful patterns in data

more of predictive analytics

What is what

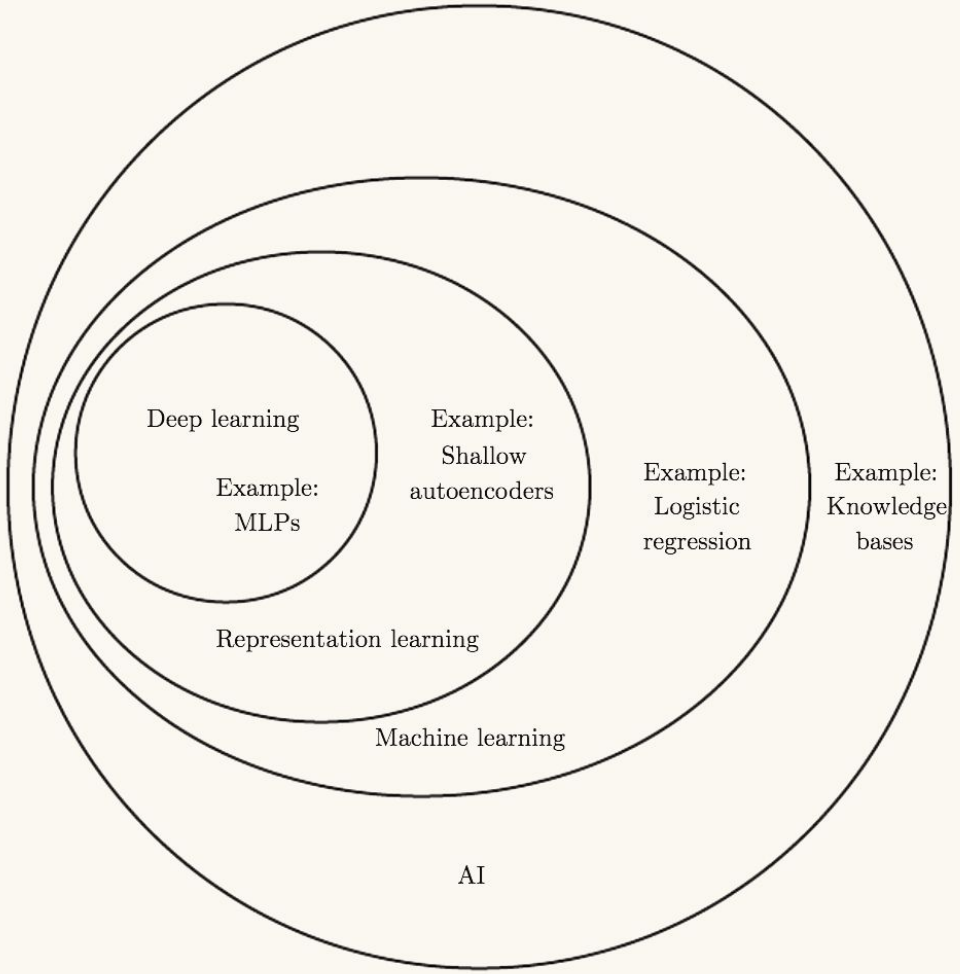


Figure 1.4: A Venn diagram showing how deep learning is a kind of representation learning, which is in turn a kind of machine learning, which is used for many but not all approaches to AI. Each section of the Venn diagram includes an example of an AI technology.

Now machine learning can only do specific tasks not general tasks like humans

Goodfellow, Ian, et al. *Deep learning*. Vol. 1. Cambridge: MIT press, 2016.

Machine Learning

Definition of ML

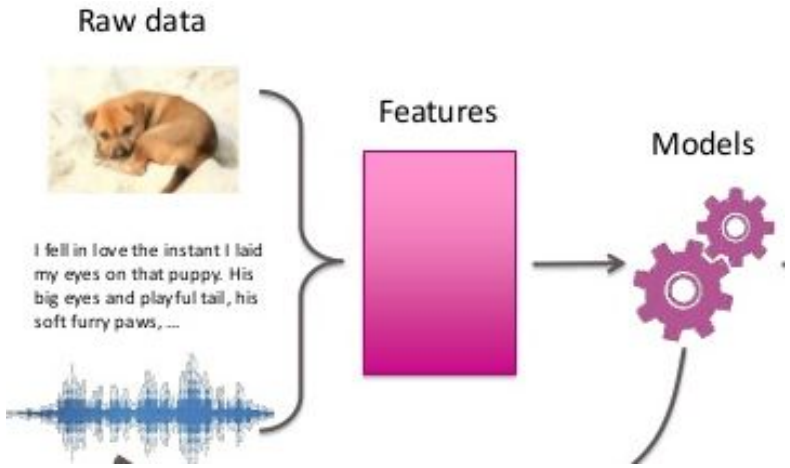
- From Wiki: ML is the scientific study of algorithms and statistical models that computer systems use to progressively improve their performance on a specific task.
- From Tom Mitchell, a computer program is said to learn from experience E with respect to some class of tasks T and performances P, if its performance at tasks in T, as measured by P, improves with experience E. E = training data

Machine Learning

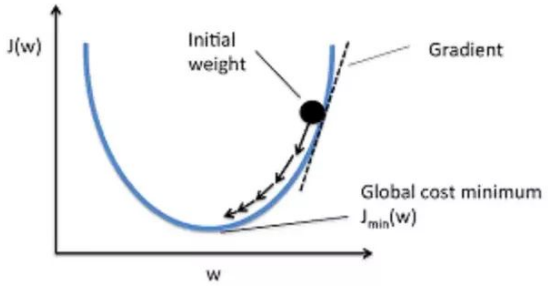
Machine Learning can be decomposed into three components:

- **Representation** (Model and Data Level)
- **Evaluation** (Loss Function/ Target Function)

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2$$

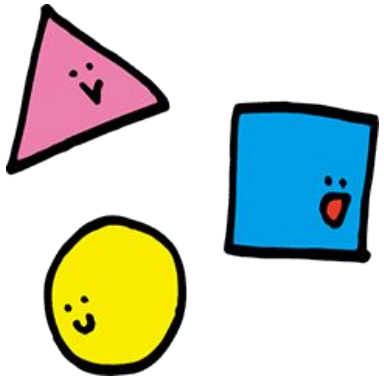


- **Optimization**: How to search model parameters to obtain better evaluation



Representation Learning

- Given a task: how to classify these following shapes:



- Our system should work as:
  - Input: Image
  - Representation: Number of corners.
  - Model: Fed with representation and based on mathematical models or rules to make prediction
- Designing features is a complex process, which require a deep domain expertise.
- Deep learning is the method which tries to learn features by the model itself.

Deep Learning

Deep Learning

- Deep learning is a subfield of machine learning
- Most machine learning methods work well because of high-quality feature engineering.
  - SIFT or HOG features for images
  - MFCC or LPC features for speech
  - Features about words parts (suffix, capitalized)

.

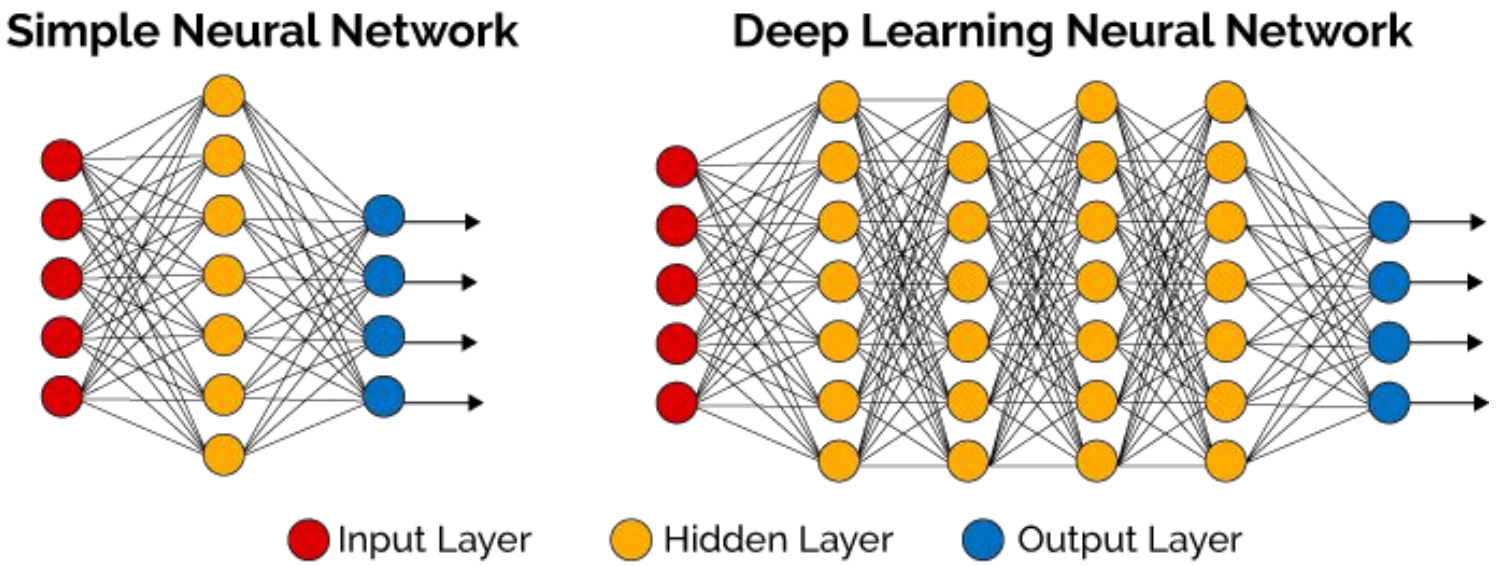
But deep learning no need to do that, it depends on representation learning

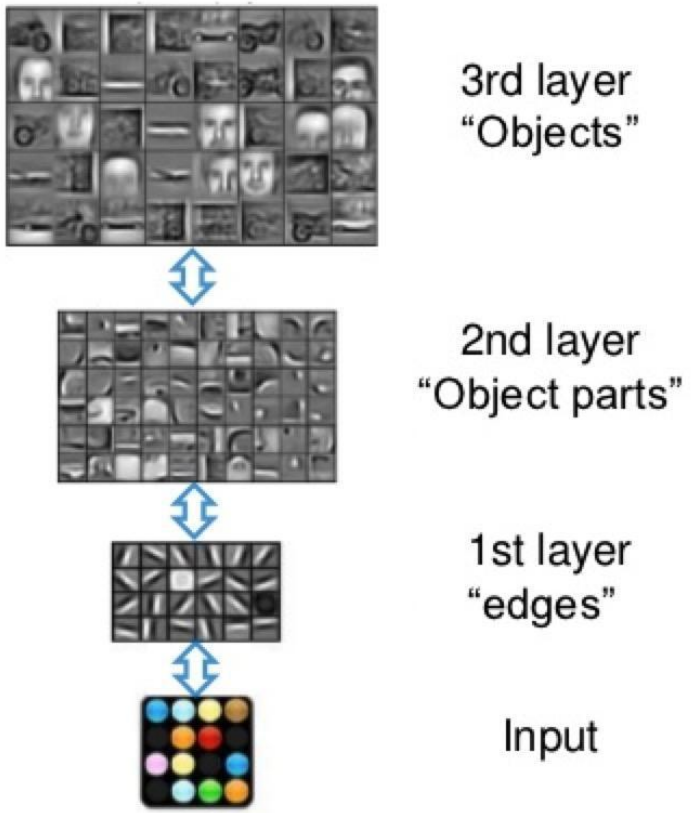
Deep Learning

DL focus on representation learning instead of feature engineering

- Representation learning attempts to automatically learn good features or representation
- It will learn multiple levels of representation
- From “raw” inputs x

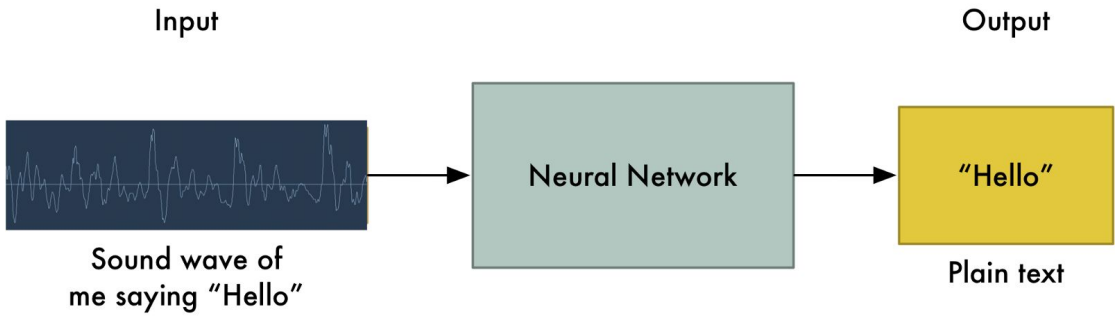
Learn more details (higher level) along the way

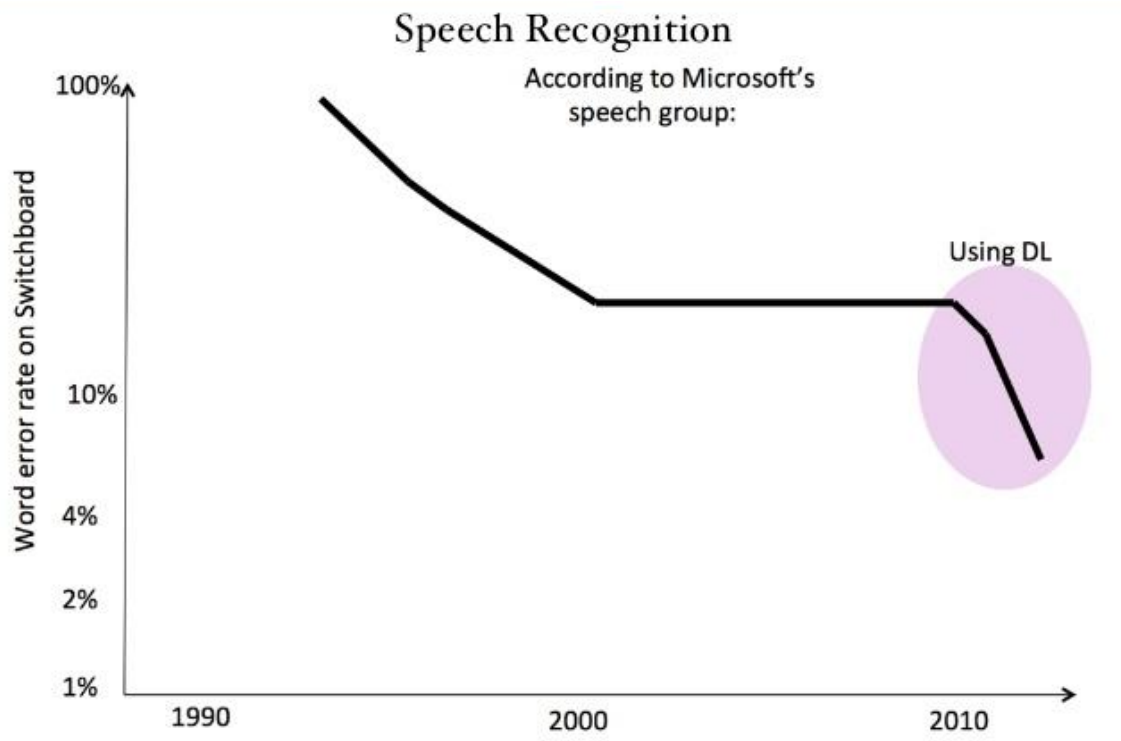




Deep Learning for Speech

The first real-world tasks addressed by deep learning is speech recognition

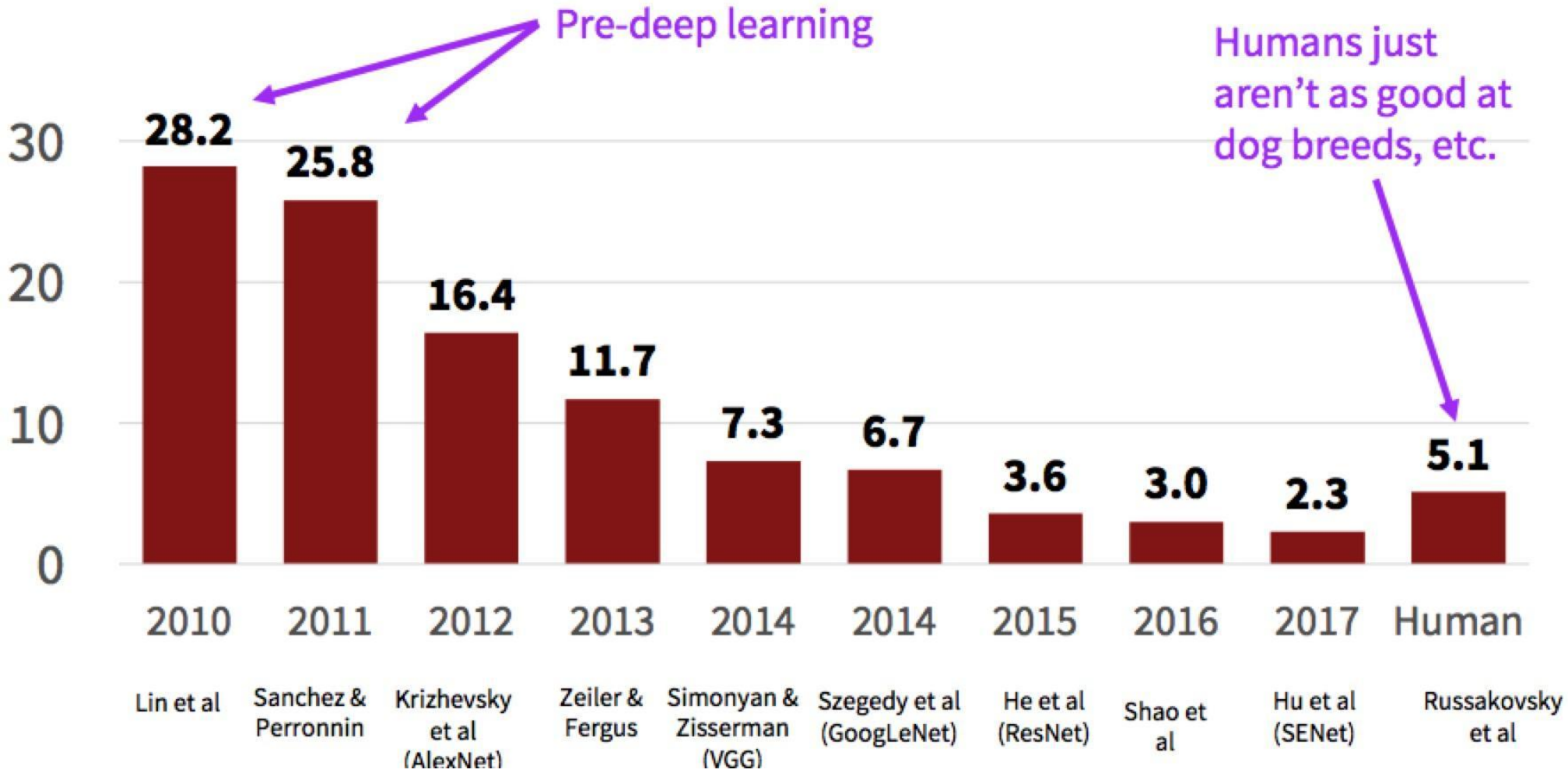




Deep Learning for Computer Vision

- Computer vision may be the most well-known breakthrough of DL.
- ImageNet Classification with Deep Convolutional Neural Networks.

ImageNet Scoreboard



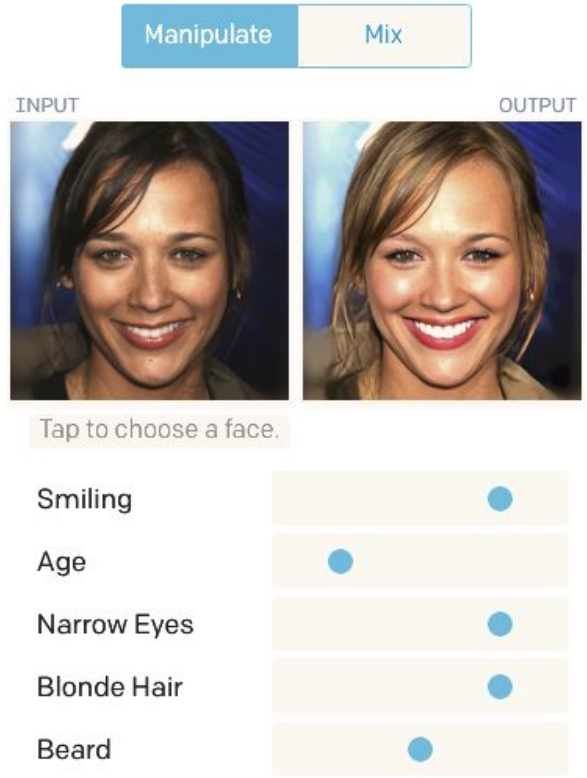
Deep Learning For Arts

Style transfer based on Deep Learning: use one image to stylize another.

The now iconic examples from Figure 2 of Gatys et al (2015).

Deep Learning For Data Generation

Glow, a reversible generative model using invertible 1*1 convolutions, learns a latent space where certain directions capture attributes like age, hair color, and so on. (Kingma & Dhariwal 2018)



Why is Deep Learning Powerful Now?

- Feature engineering require high-level expert knowledge, which are easily over-specified and incomplete.
- Large amounts of training data
- Modern multi-core CPUs/GPUs/TPUs

TPUs r specialised for matrix multiplications

- Better deep learning ‘tricks’ such as regularization, optimization, transfer etc.
- Better context-modeling due to less independence assumptions
- Effective method for end-to-end system optimization.

Can reduce a lot of human labour

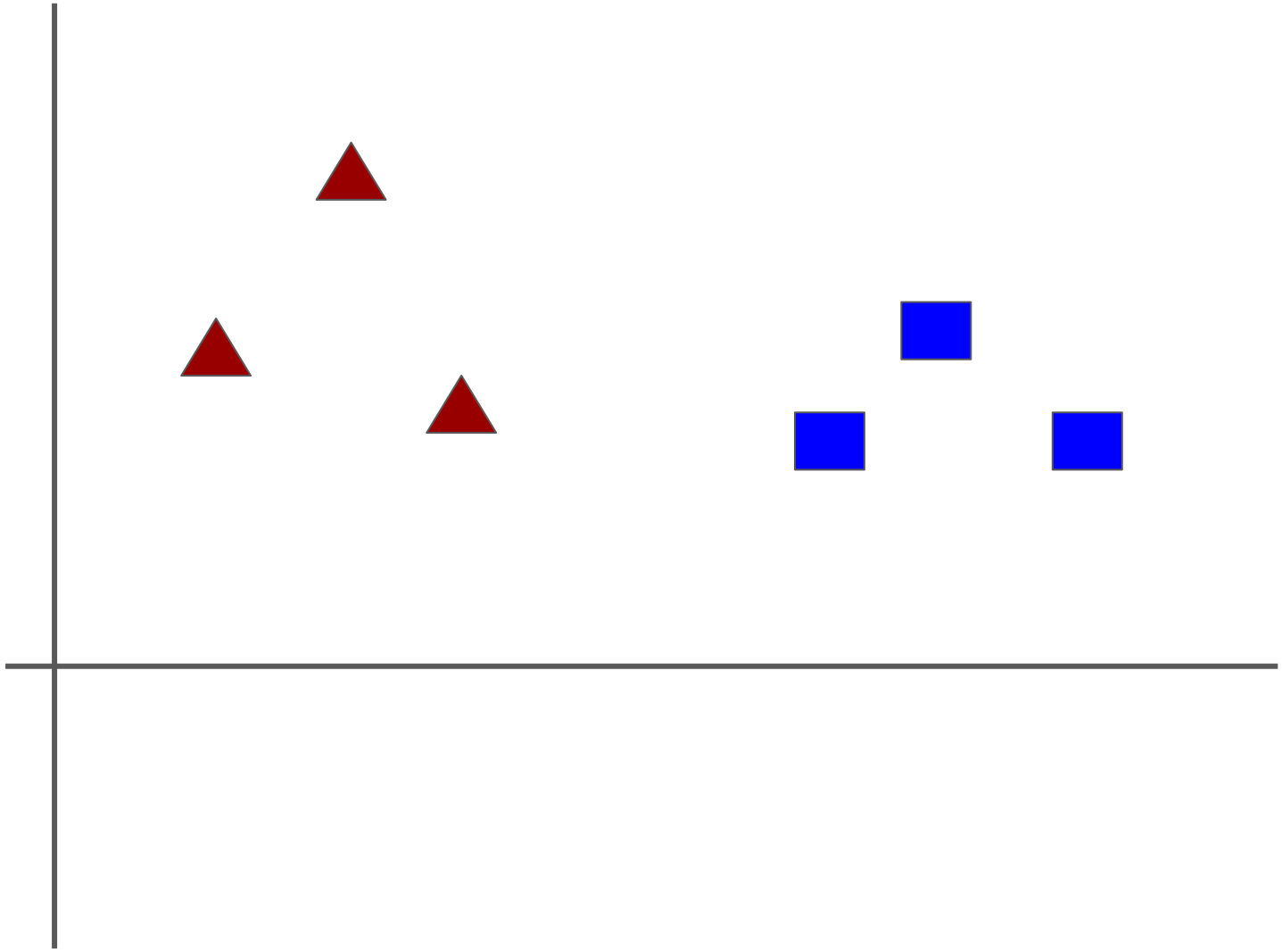
KNN Classifier

Different Learning Methods

- Eager Learning
  - Explicit description of target function on the whole training set

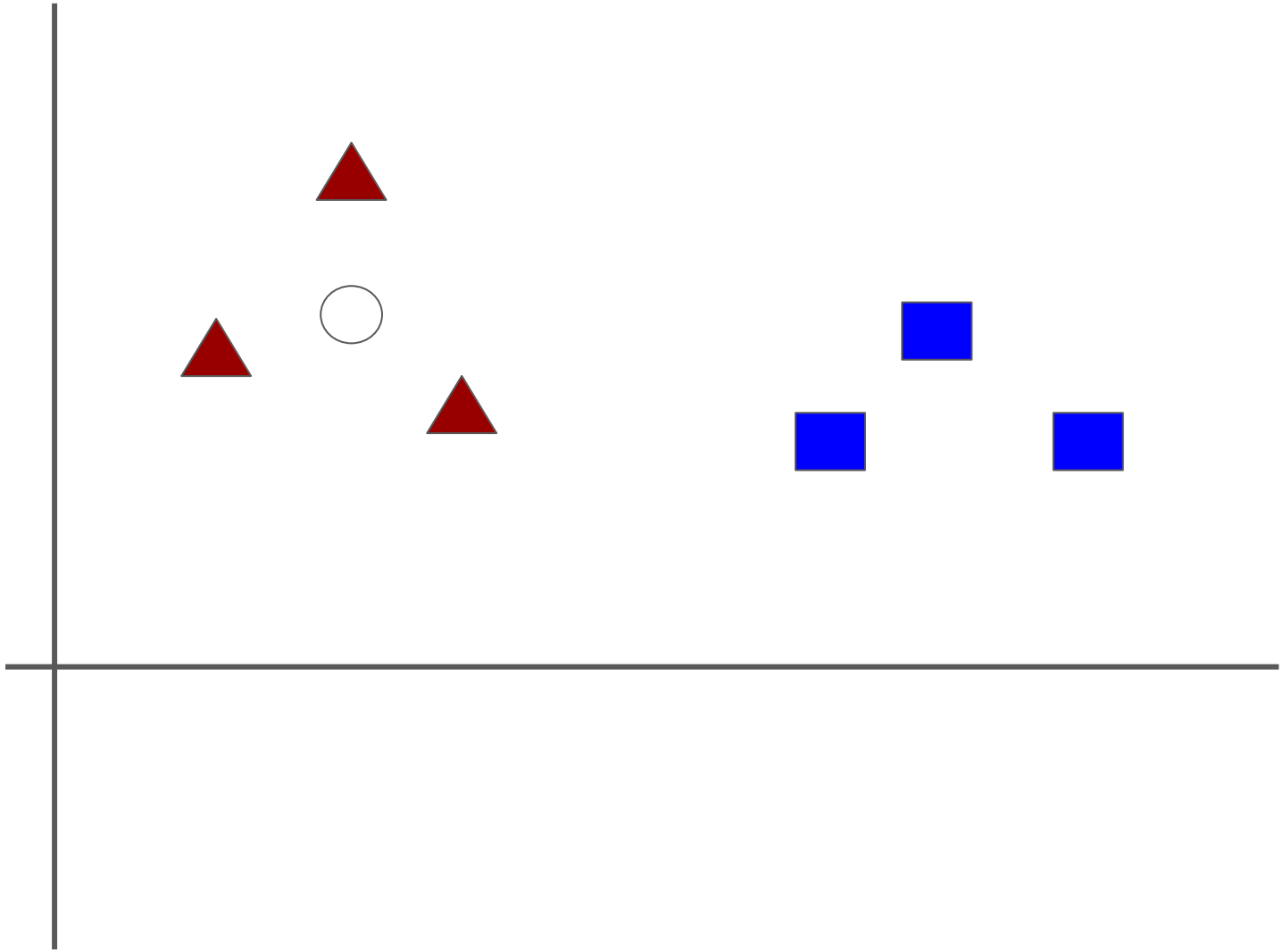
- Instance-based Learning
  - Learning=storing all training instances
  - Classification=assigning target function to a new instance
  - Referred to as “Lazy” learning

K Nearest Neighbour Classifier



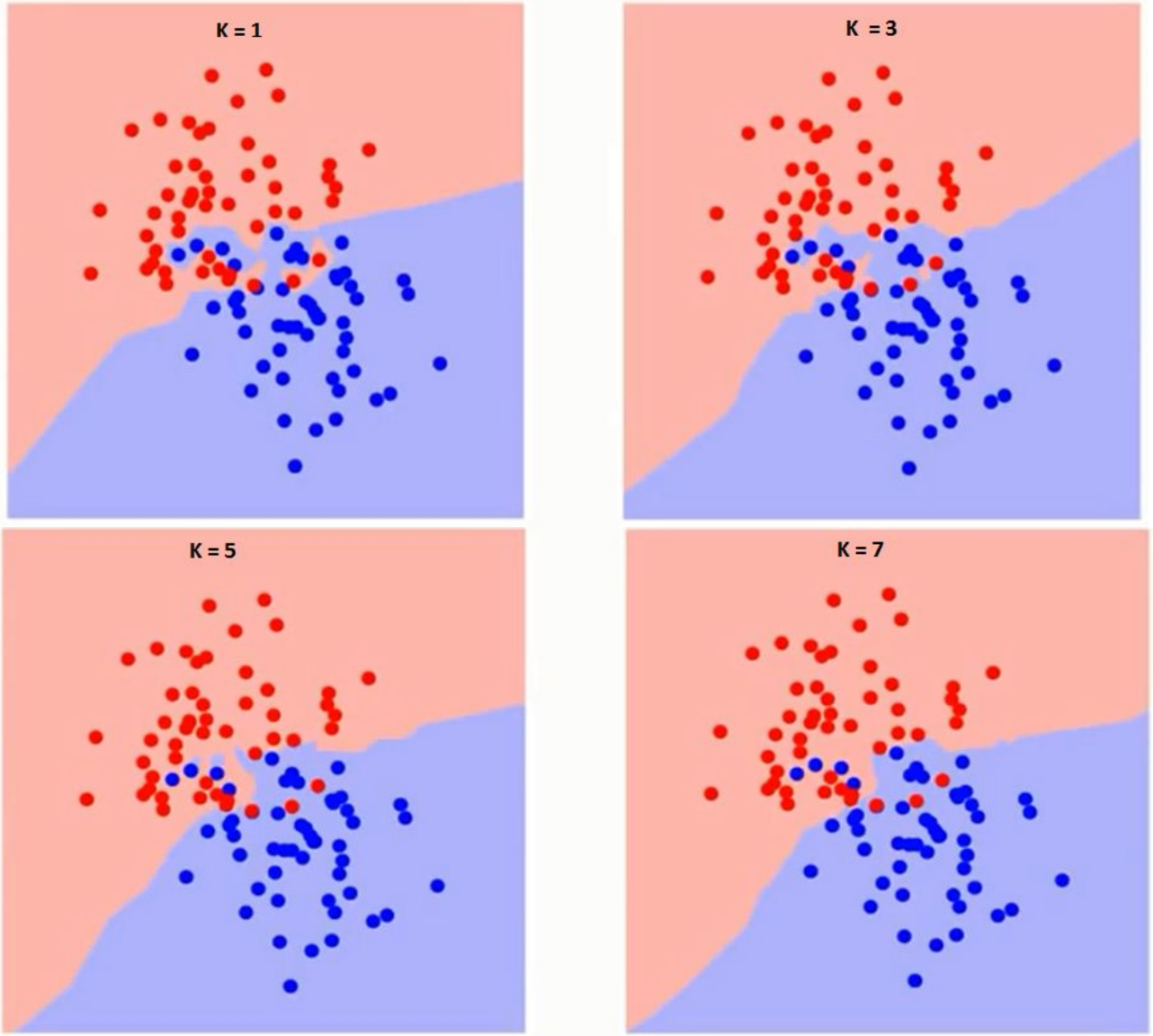
- We have two class data points: Red-Triangle and Blue-Square
- It is the spread of RT and BS.

K Nearest Neighbour Classifier



- The task is defined to identify the class of the white circle.

How to select K



K Nearest Neighbour Classifier

- All instances correspond to points in an n-dimensional Euclidean space
- Classification is delayed till a new instance arrives
- Classification done by comparing feature vectors of the different points
- Target function may be discrete or real-valued

Summary

- ML = Representation + Loss/Target + Optimization;
- Deep Learning is promising these days given large data and faster computation resources
- KNN is a simple instance-based learning approach