Welcome to BT5153

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Ice Breaker

- Tell us about your background

- Tell us what you would like to get out of the course

Some Expectations

- Knowledge sharing instead of teaching
  - Interactive
  - Initiative
  - Innovative

Some Expectations

- Knowledge sharing instead of teaching
  - Interactive
  - Initiative
  - Innovative
- Tuned towards more industry-oriented learning
  - try to be less academic
  - focus on project/report/presentation

Agenda

- IVLE
- Introduction to Machine Learning
- Introduction to Deep Learning
- Introduction to NLP
- 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

What is what

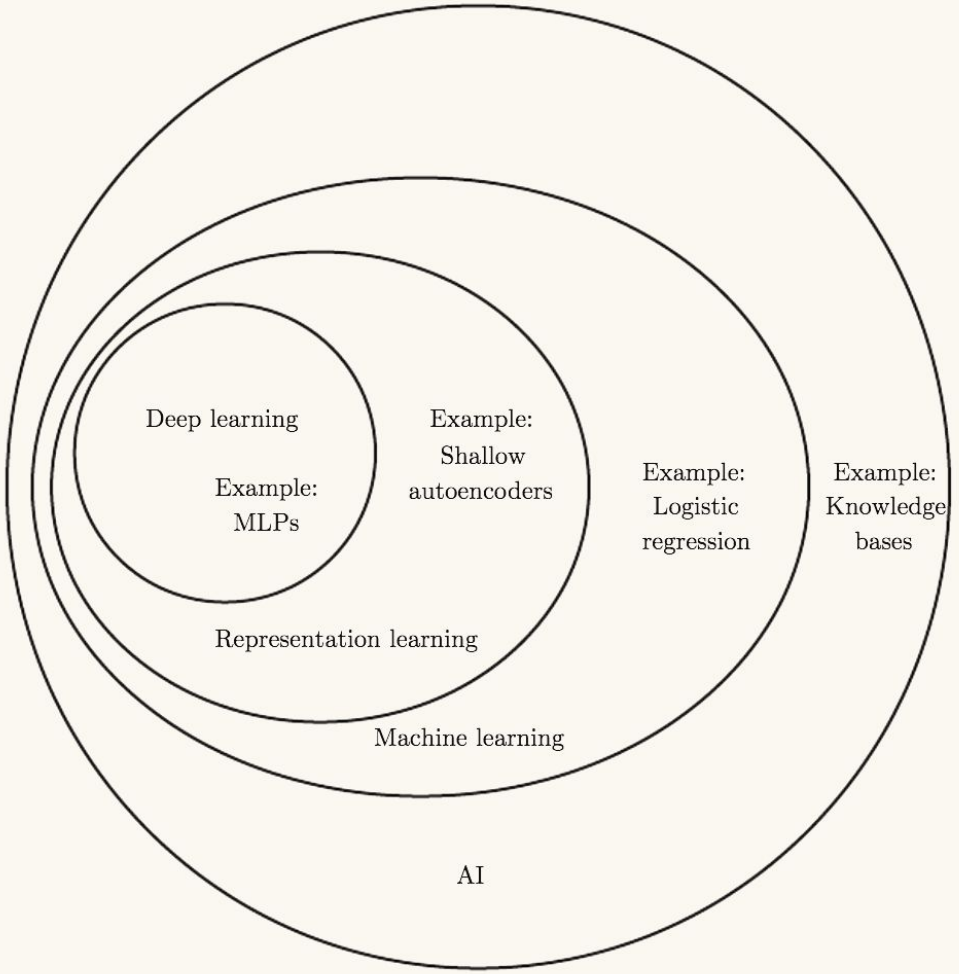

Figure 1.4: A Venn diagram showing how deep learning is a kind of representation learning, which is in turn a kind of machine learning, which is used for many but not all approaches to AI. Each section of the Venn diagram includes an example of an AI technology.

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

Just a Joke

Andrew Chen Retweeted

Mat Velloso @matvelloso · Nov 22

Difference between machine learning and **AI**:

If it is written in Python, it's probably machine learning

If it is written in **PowerPoint**, it's probably **AI**

166 6.6K 19K

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Machine Learning

Definition of ML

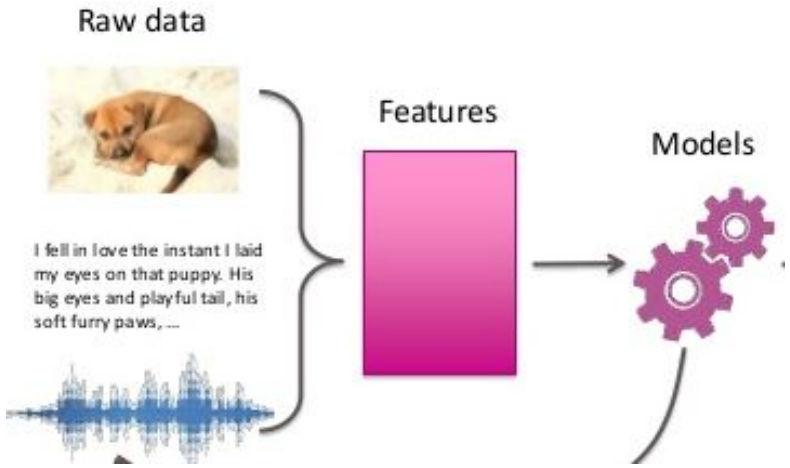
- From Wiki: ML is the scientific study of algorithms and statistical models that computer systems use to progressively improve their performance on a specific task.
- From Tom Mitchell, a computer program is said to learn from experience E with respect to some class of tasks T and performances P, if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

Machine Learning

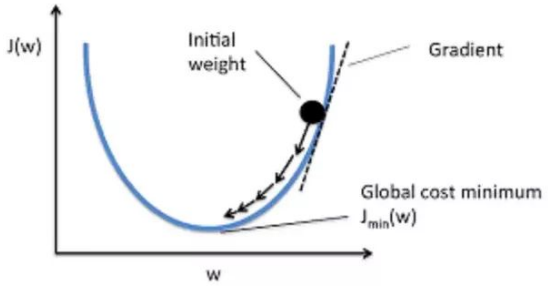
Machine Learning can be decomposed into three components:

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

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

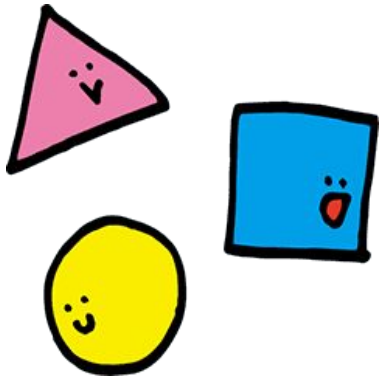


- **Optimization**: How to search model parameters to obtain better evaluation



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

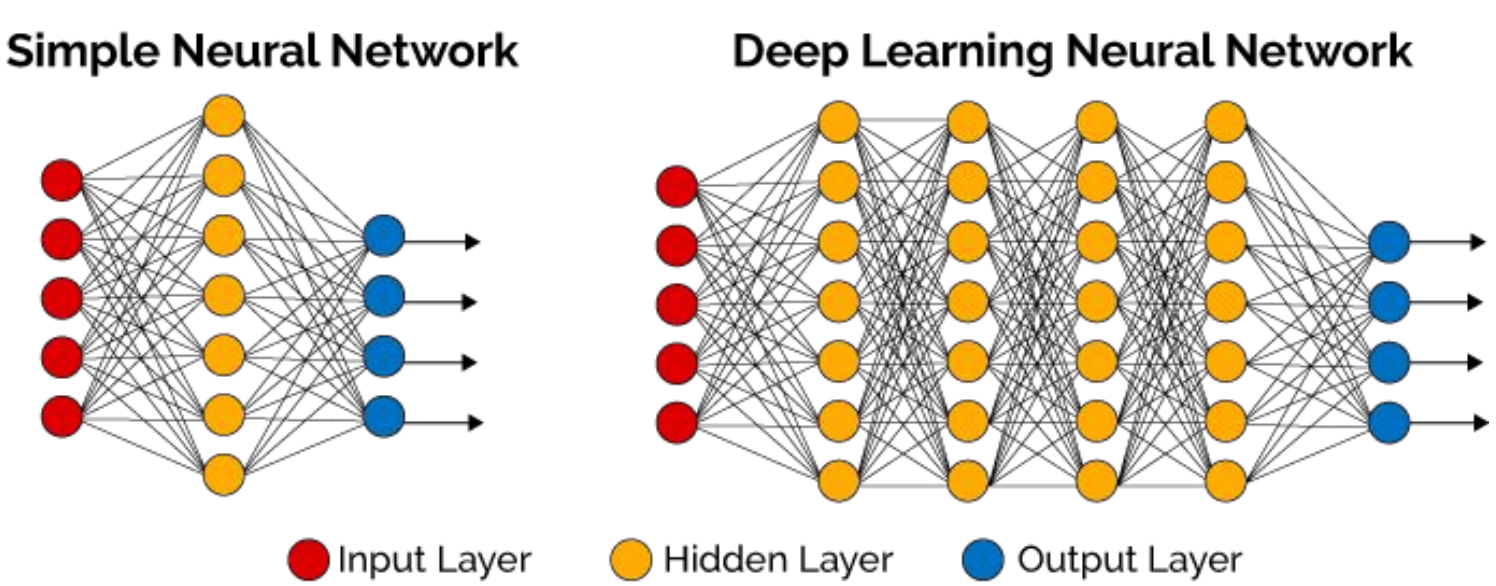
Deep Learning

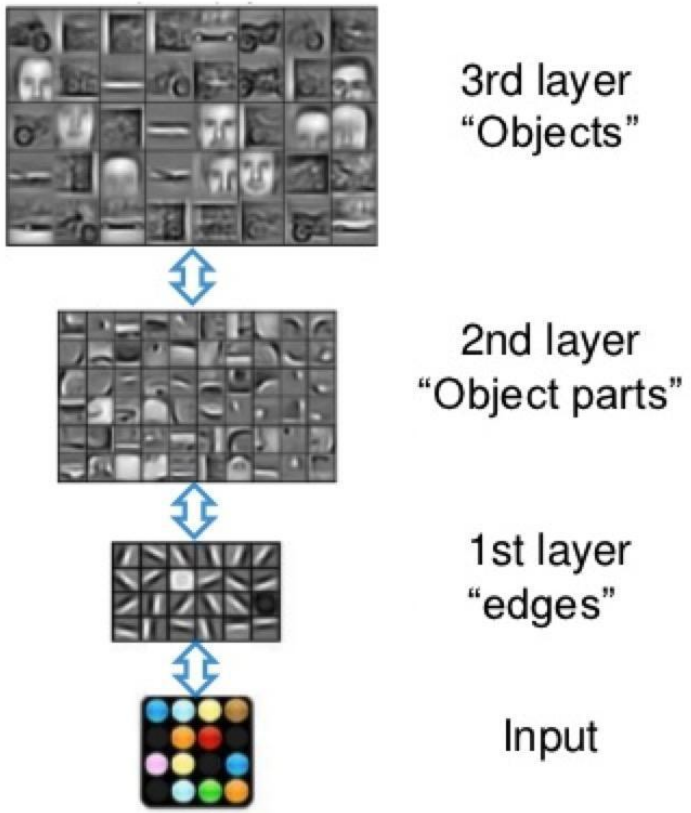
- Deep learning is a subfield of machine learning
- Most machine learning methods work well because of high-quality feature engineering/representation learning.

Deep Learning

DL focus on representation learning instead of feature engineering

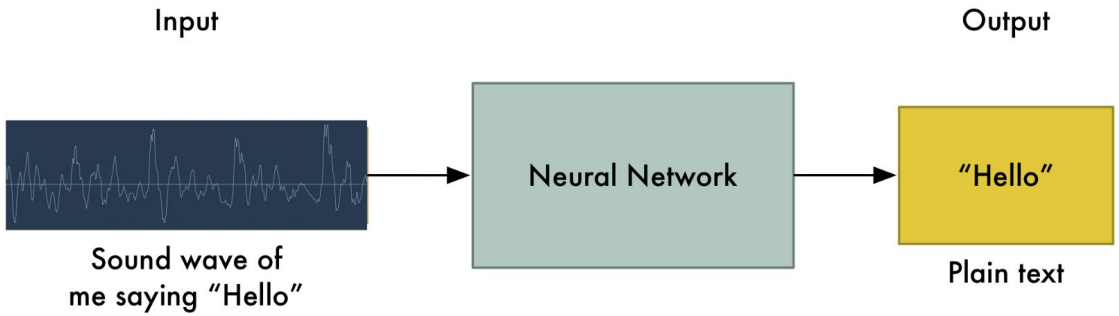
- Representation learning attempts to automatically learn good features or representation
- It will learn multiple levels of representation
- From “raw” inputs x

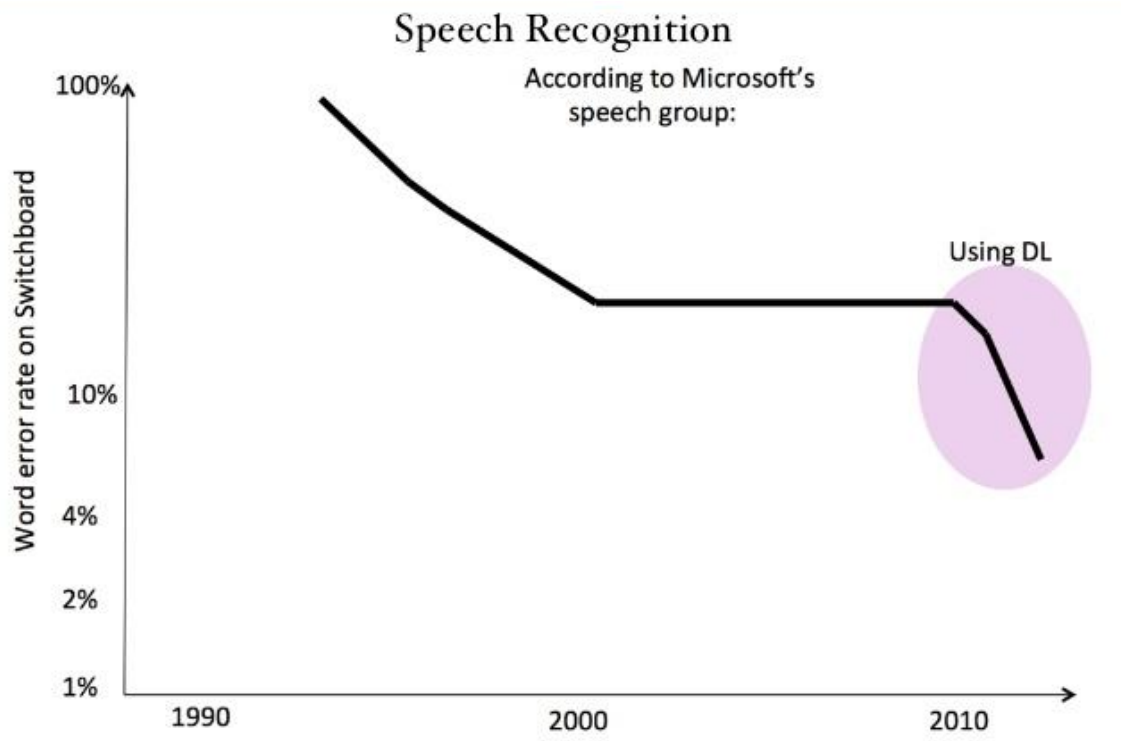




Deep Learning for Speech

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

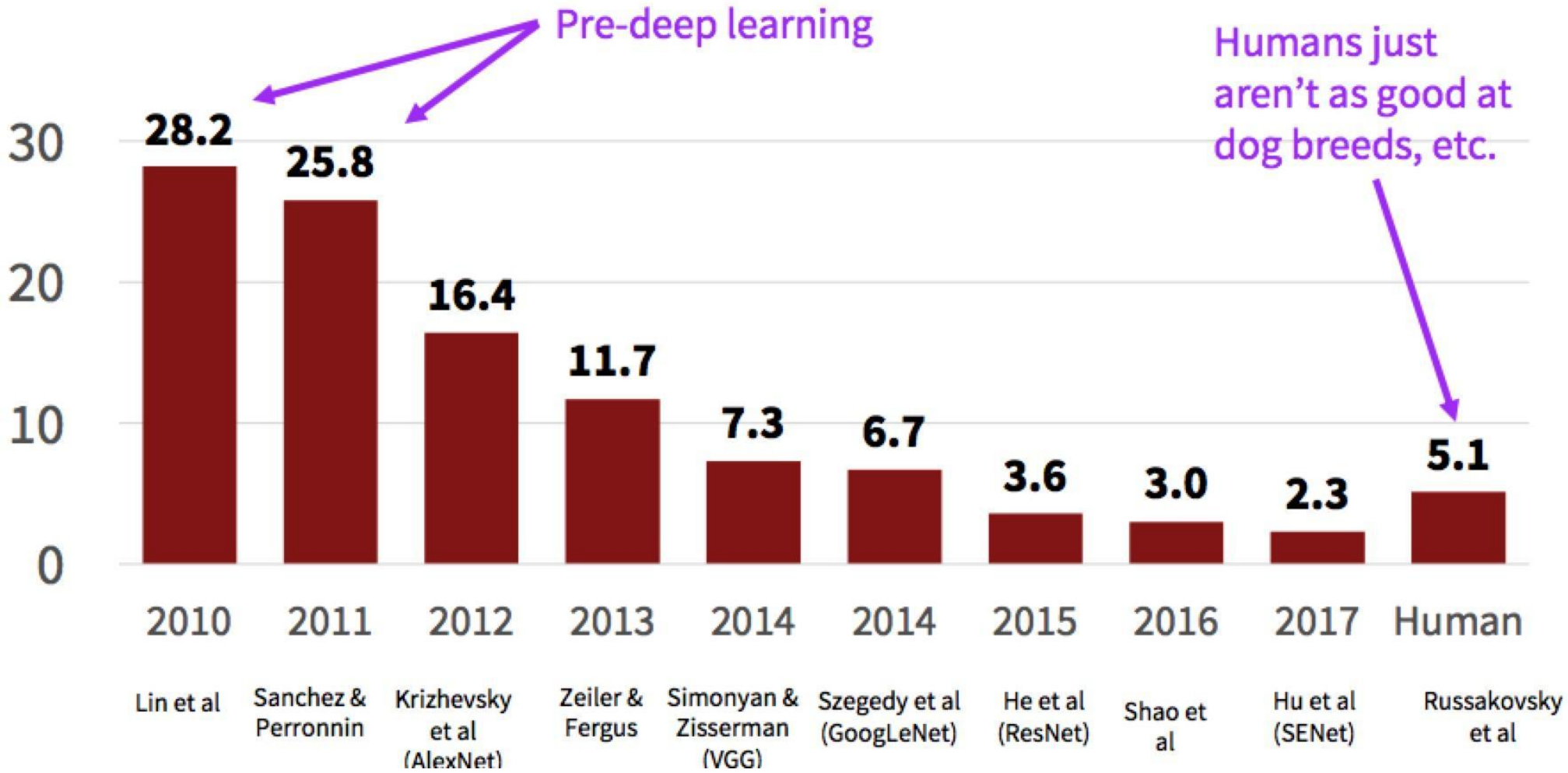




Deep Learning for Computer Vision

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

ImageNet Scoreboard



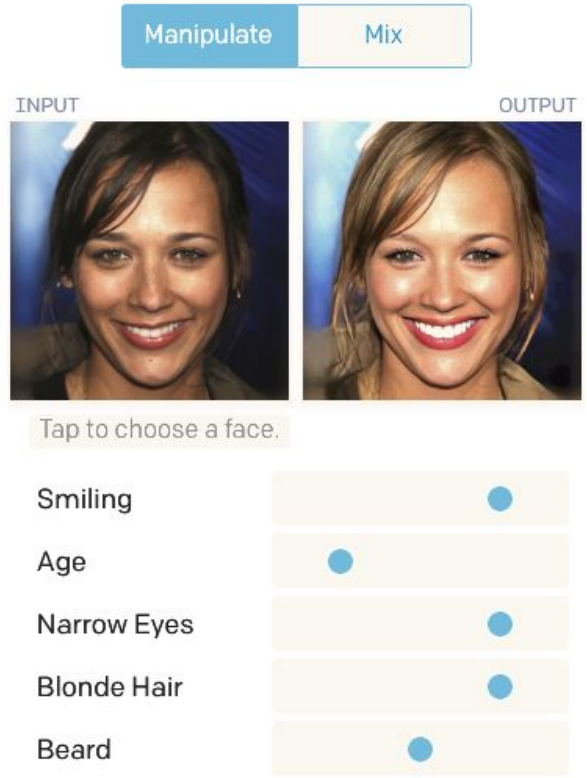
Deep Learning For Arts

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
- 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.

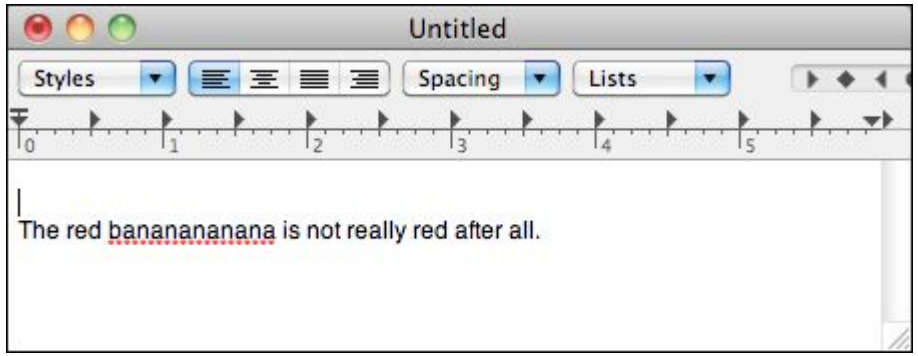
NLP

What is Natural Language Processing (NLP)?

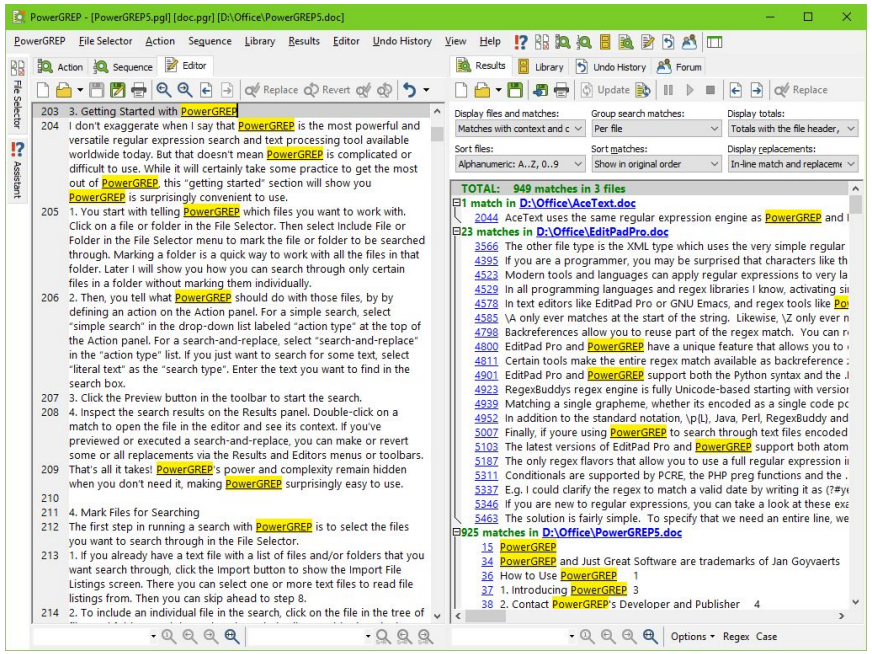
- Natural Language Processing: a field with three sub-topics:
  - Computer Science
  - Artificial intelligence
  - Linguistics
- NLP enables computers to understand and process human languages.
- One definition of AI-complete is perfect language understanding.

Easy NLP Tasks

- Spell Checking



- Keyword Search



Medium-Level NLP Tasks

- Name Entity Recognition

Figure 1: An example of NER application on an example text

- Convert unstructured text into a well structured document

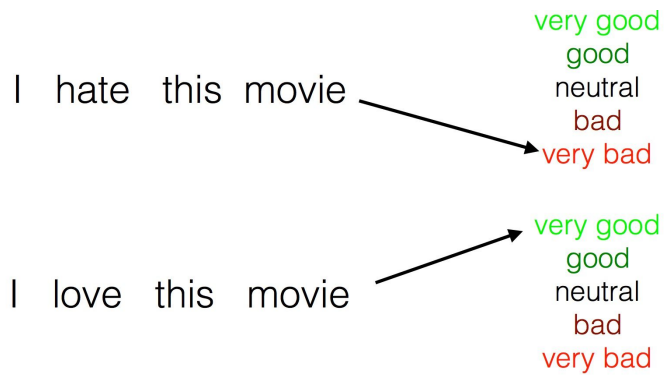
Medium-Level NLP Tasks

- Topic Classification

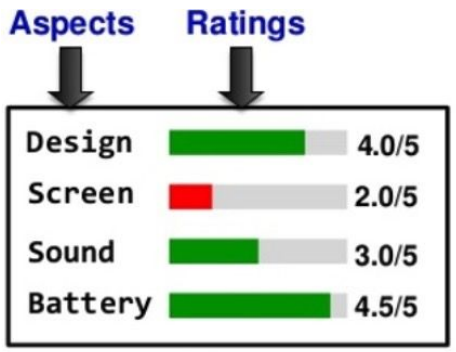
- Assign topic into each document/piece of text

Hard NLP Tasks

- Sentiment Analysis



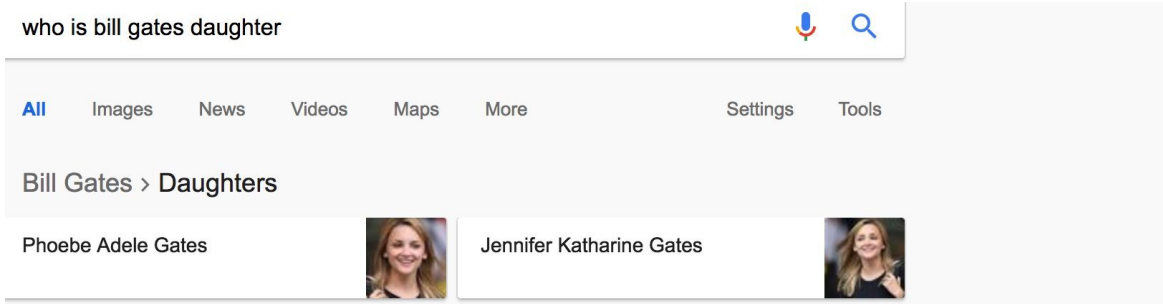
- Aspect-based sentiment Analysis



- Analyze opinions/sentiment behind text

Hard NLP Tasks

- Machine Translation
- Question Answering



- Visual Question Answering

NLP is very challenging

- AI-complete
- Ambiguity of Language
  - Lexical Ambiguity: bank
  - Syntactic Ambiguity: I heard his cell phone in my office
  - Semantic Ambiguity
- Data Variation
  - We have ImageNet, while we do not have such huge labelled volume text data
- Complexity in representation, learning and using linguistic/situational/word/visual knowledge

Some Machine Translation Examples

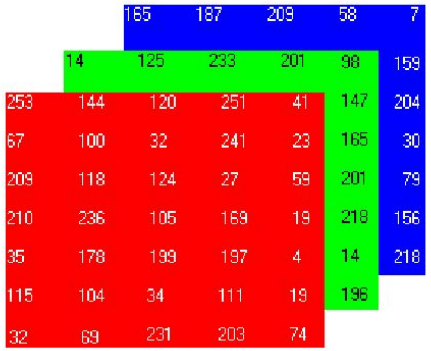
NLP and Machine Learning

- Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.

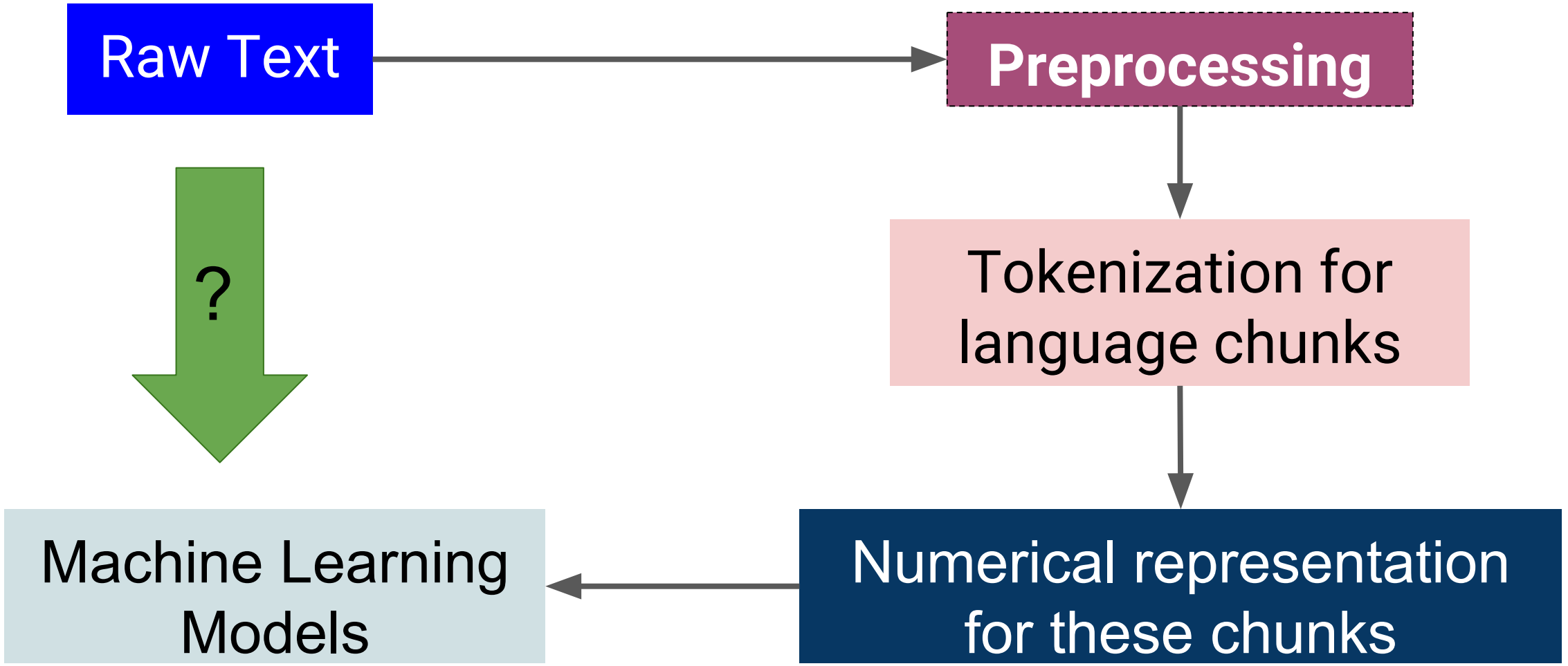
- Machine learning techniques can be applied to solve NLP problems.
  - Key challenge: How to convert the unstructured text into a structured format
  - Representation for text matters
  - Representation learning is a set of techniques that learn a feature,i.e., transform the raw data input to a representation that can be effectively exploited in machine learning tasks

Representation Matters

- Computer programs does not understand text
- Numeric representation are required for text
- Different from images (RGB matrix), there are not direct transformation.



NLP pipeline



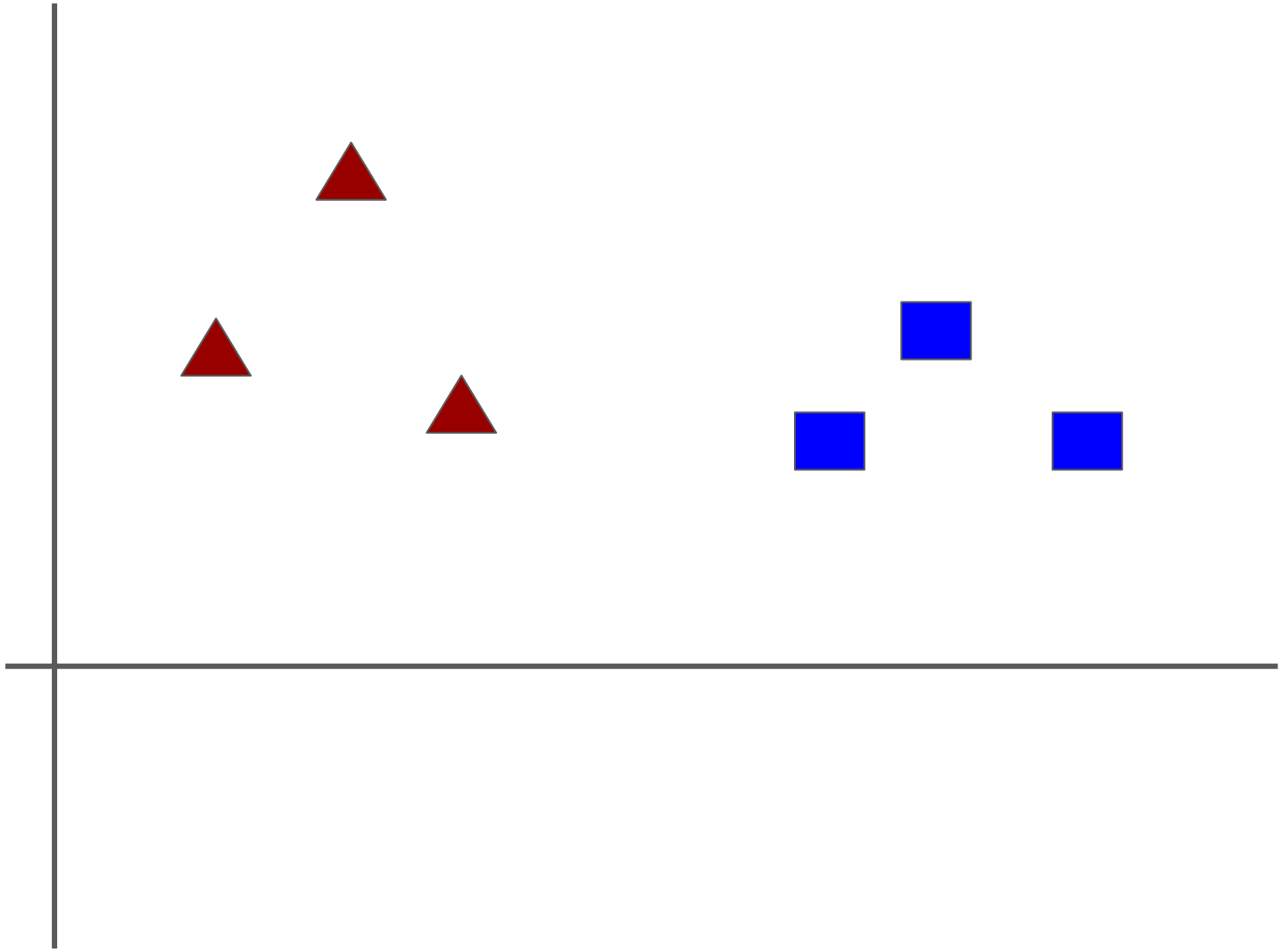
KNN Classifier

Different Learning Methods

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

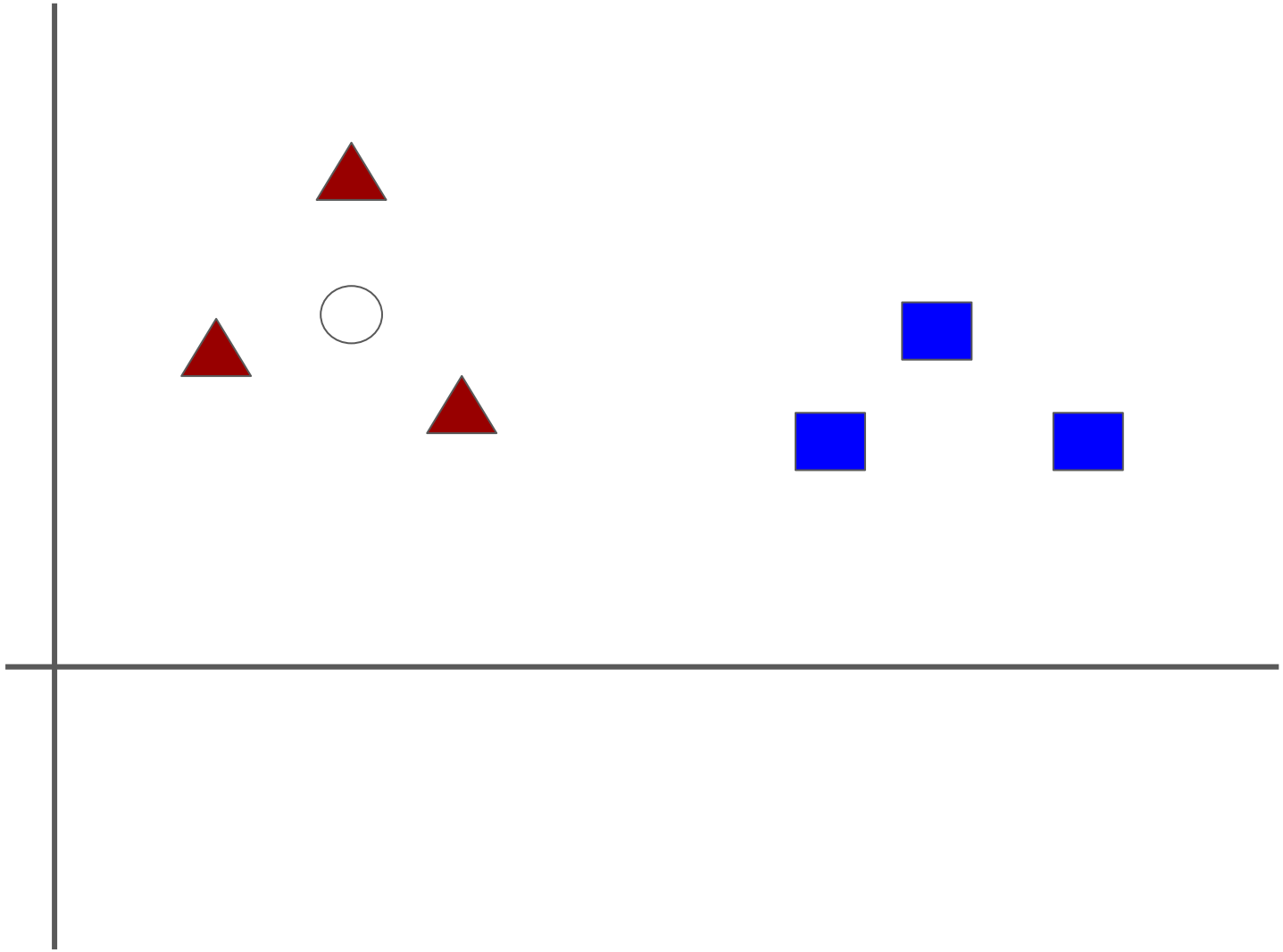
- Instance-based Learning
  - Learning=storing all training instances
  - Classification=assigning target function to a new instance
  - Referred to as “Lazy” learning

K Nearest Neighbour Classifier



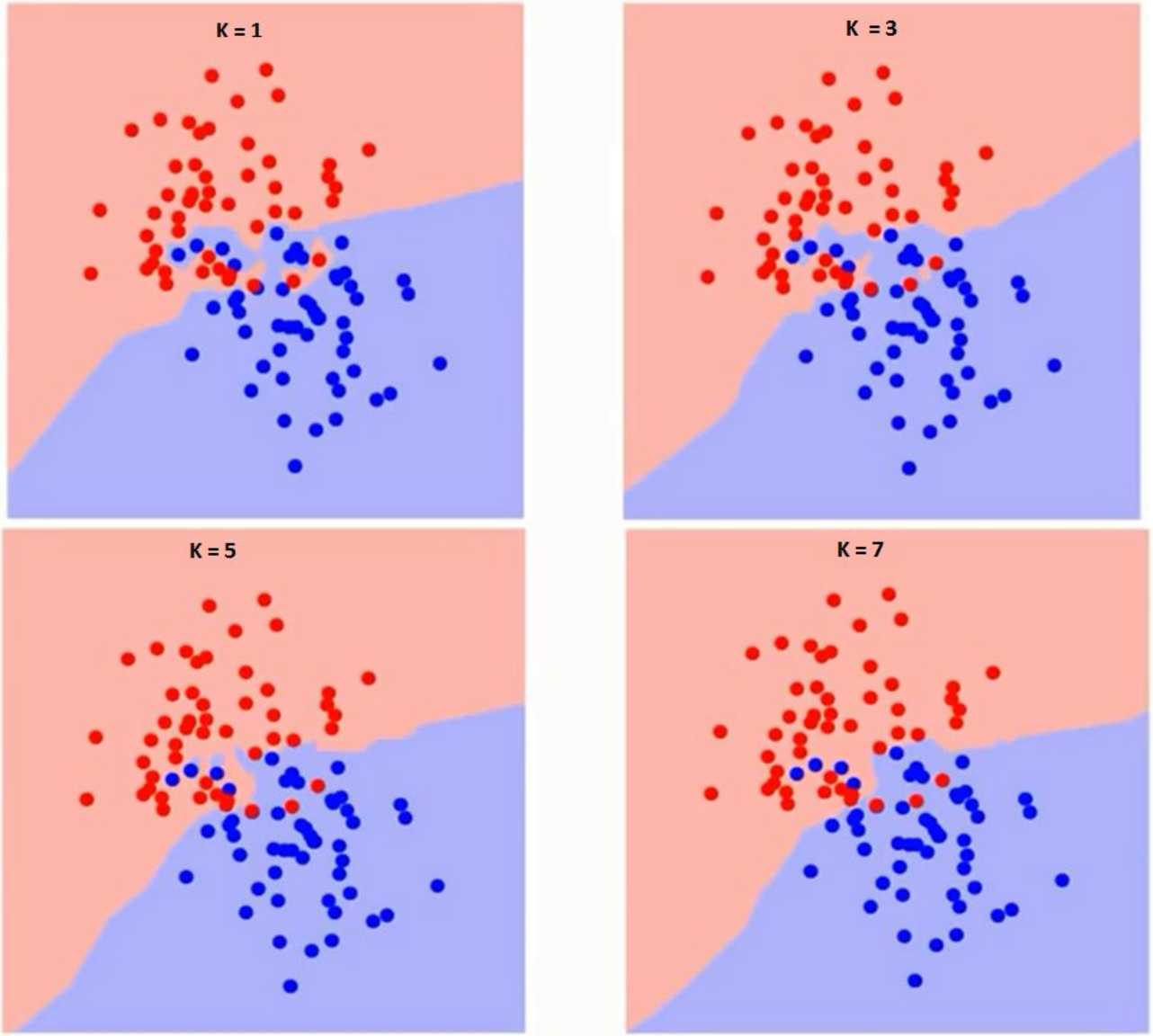
- We have two class data points: Red-Triangle and Blue-Square
- It is the spread of RT and BS.

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 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