Specialist Programme on Artificial Intelligence for IT & ITES Industry

Pattern Recognition and Machine Learning

By *Dr Zhu Fangming*
fangming@nus.edu.sg

Singapore e-Government Leadership Centre
National University of Singapore

Transform
Lead
Inspire

Patterns

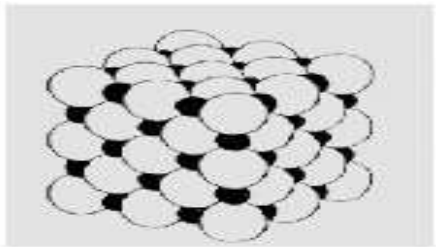
- Pattern is in everything around us in this digital world.

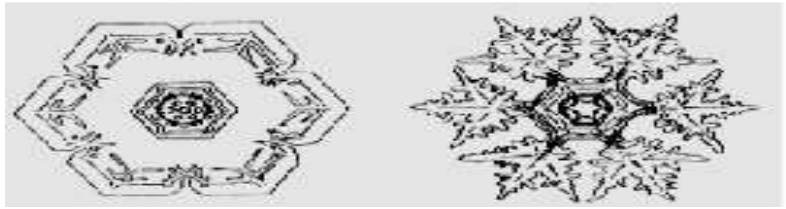
- Visual, audio, text, temporal…

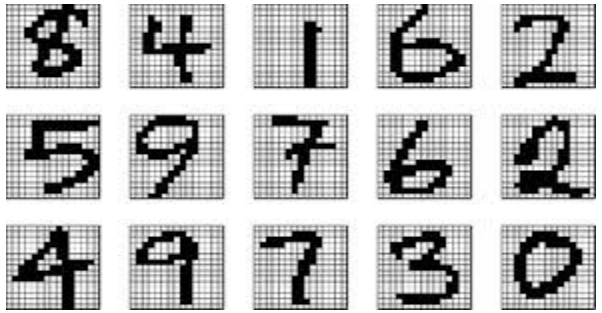
- A pattern can either be seen physically or it can be observed mathematically by applying algorithms.

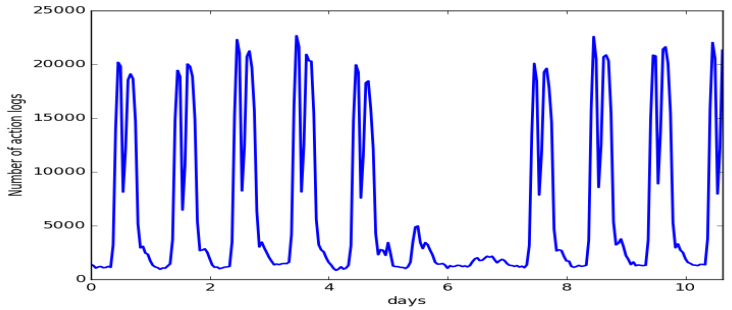
  e.g.: The colours on the clothes, speech pattern etc.

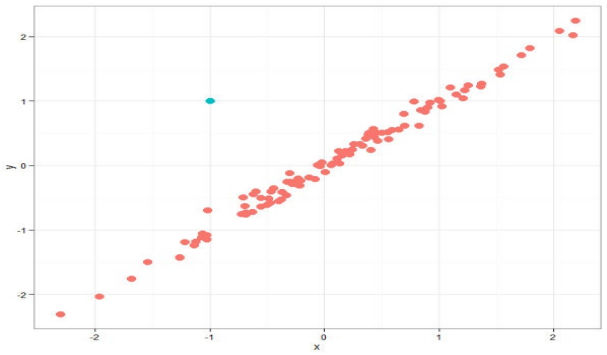
Patterns

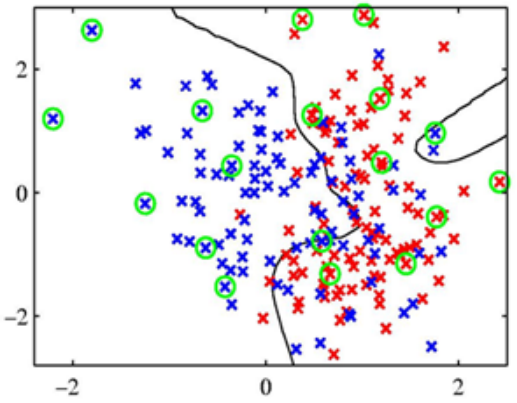


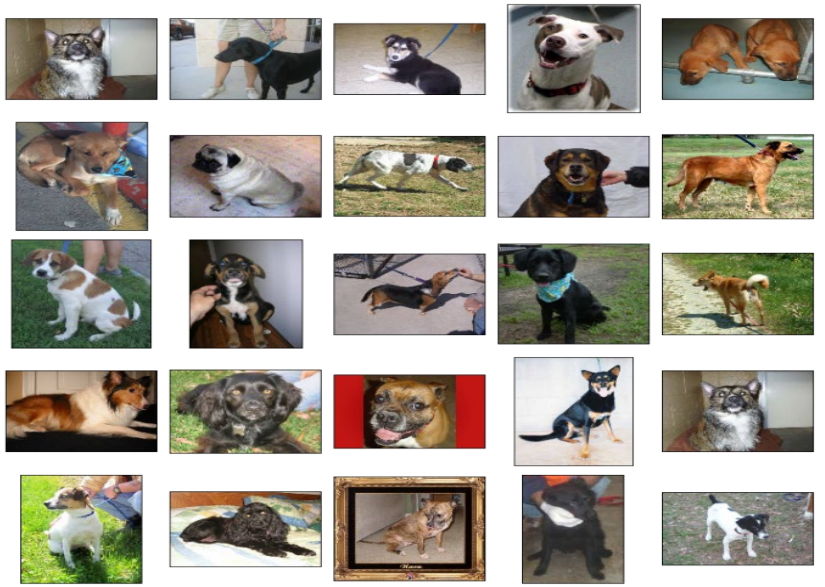










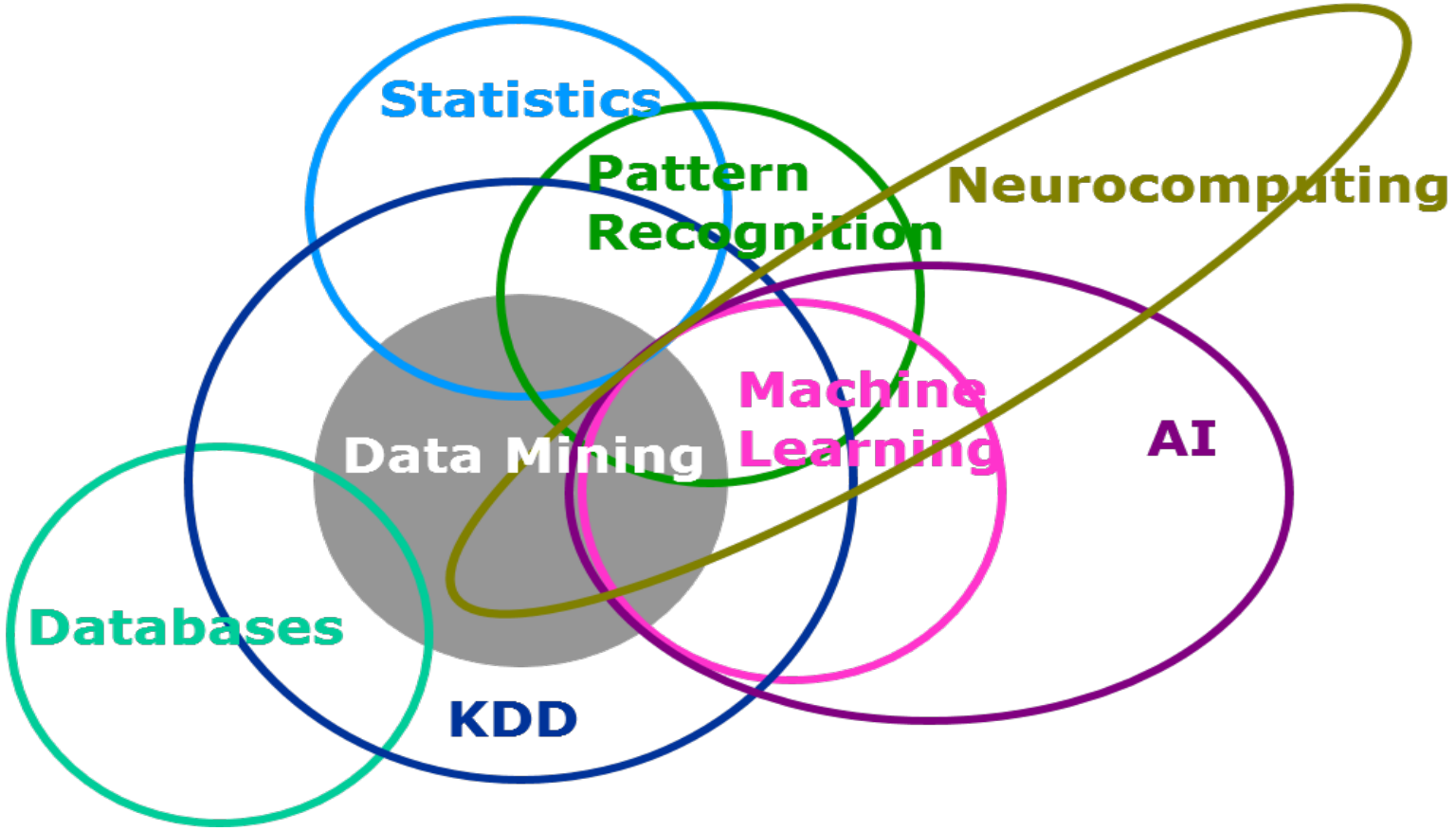


Pattern Recognition

- Pattern recognition is the automated recognition of patterns and regularities in data. Pattern recognition is closely related to artificial intelligence and machine learning, together with applications such as data mining and knowledge discovery in databases, and is often used interchangeably with these terms.

--- Wikipedia

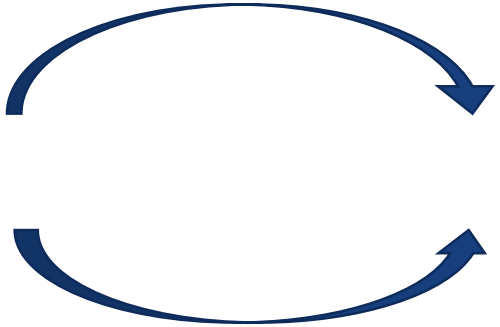
Pattern Recognition

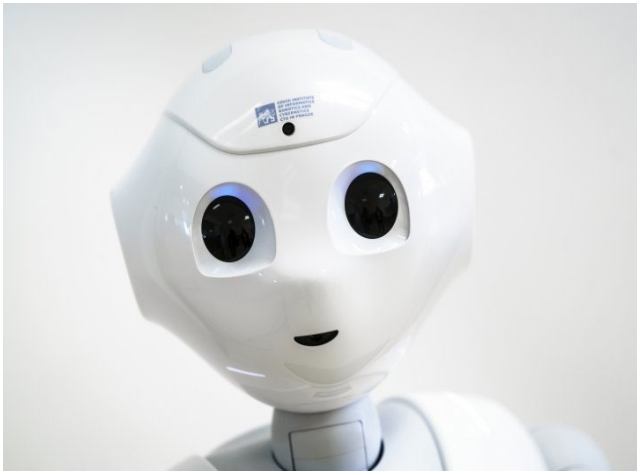


https://www.analyticsvidhya.com

Pattern Recognition

From Human Perception to Machine Perception





From Human Perception to Machine Perception

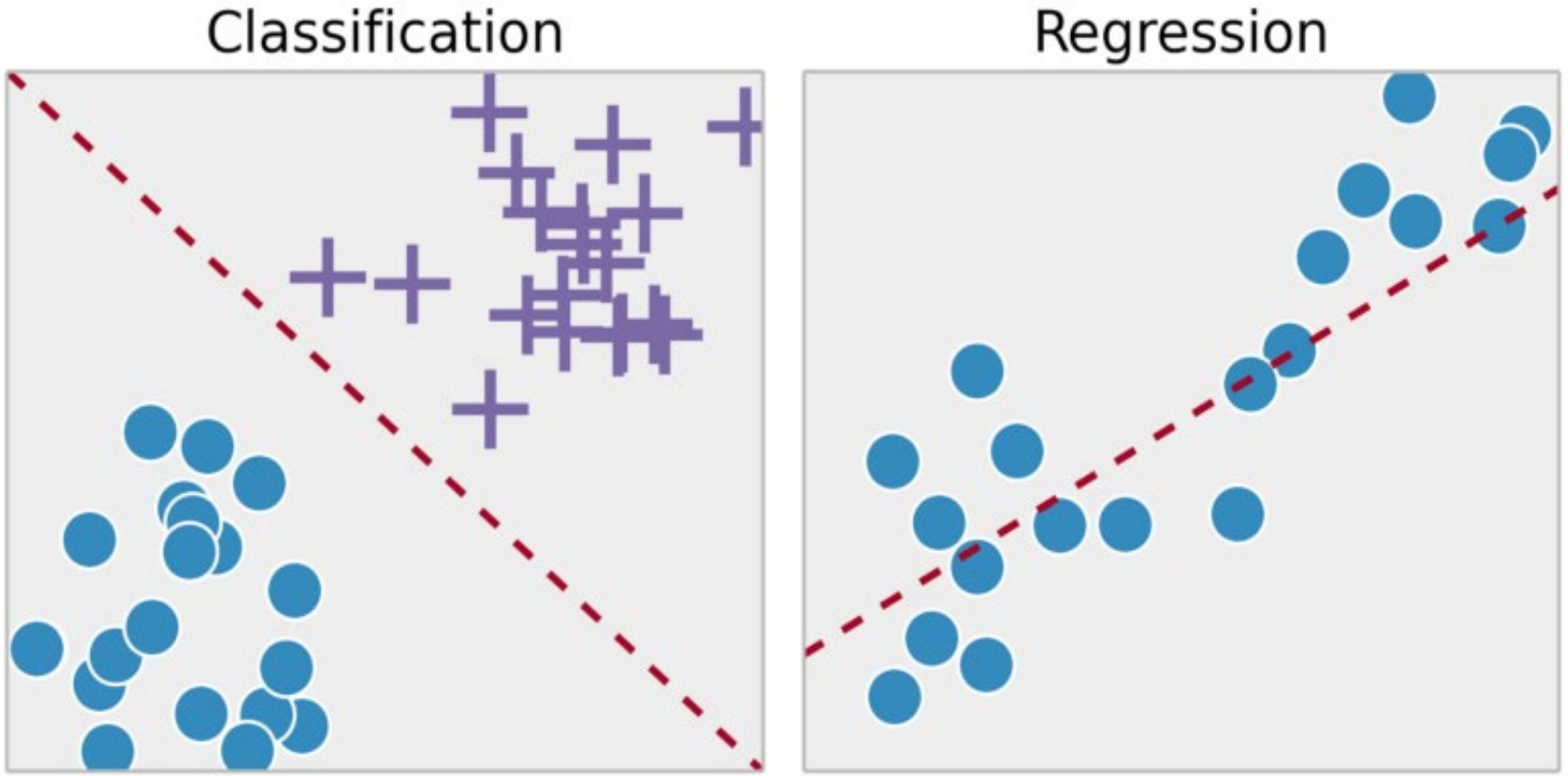
- **Humans have developed highly sophisticated skills for sensing their environment and taking actions according to what they observe, e.g.,**
  - Recognizing a face.
  - Understanding spoken words.
  - Reading handwriting.
  - Distinguishing fresh food from its smell.
- **We are often influenced by the knowledge of how patterns are modeled and recognized in nature when we develop pattern recognition algorithms.**
- **Research on machine perception also helps us gain deeper understanding and appreciation for pattern recognition systems in nature.**

Machine Leaning for Pattern Recognition

"Pattern Recognition is a type of problem while Machine Learning is a type of solution."

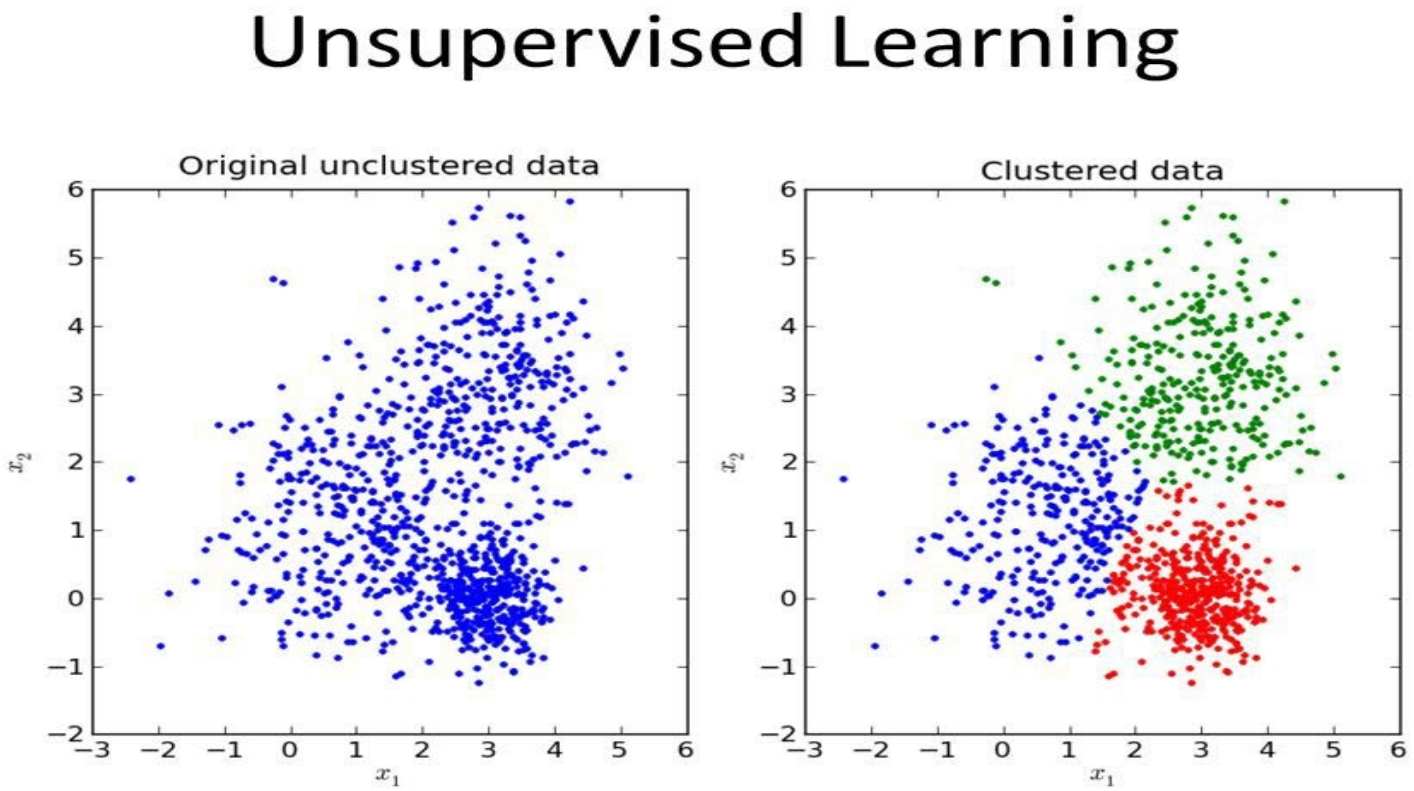
- **Supervised learning**
  - A teacher provides a category label or cost for each pattern in the training set.
- **Unsupervised learning**
  - The system forms clusters or natural groupings of the input patterns (based on some similarity criteria).
- **Reinforcement learning**
  - No desired category is given but the teacher provides feedback to the system such as the decision is right or wrong.

Supervised Learning

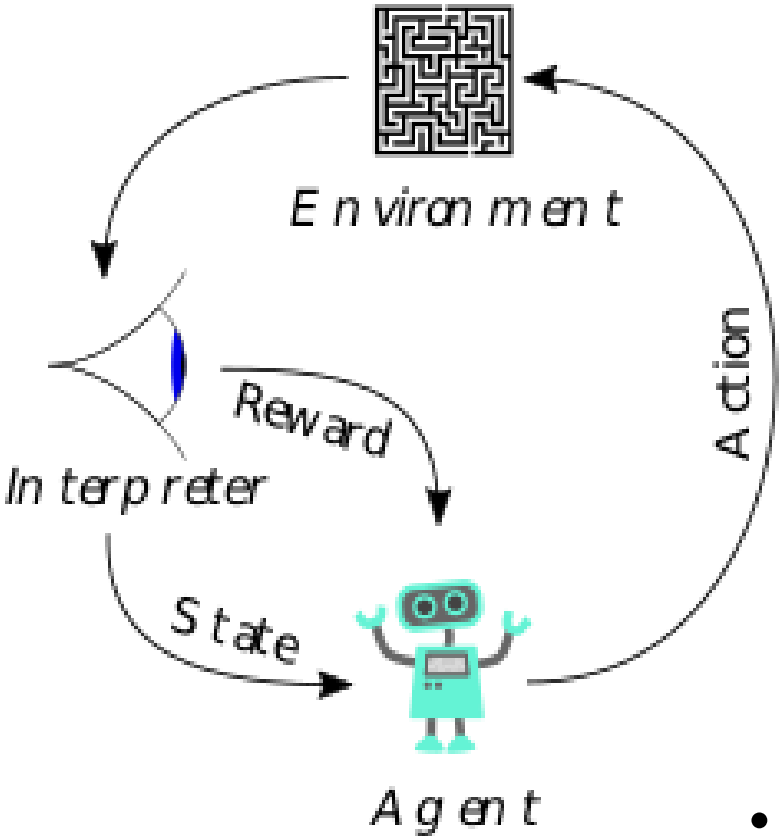


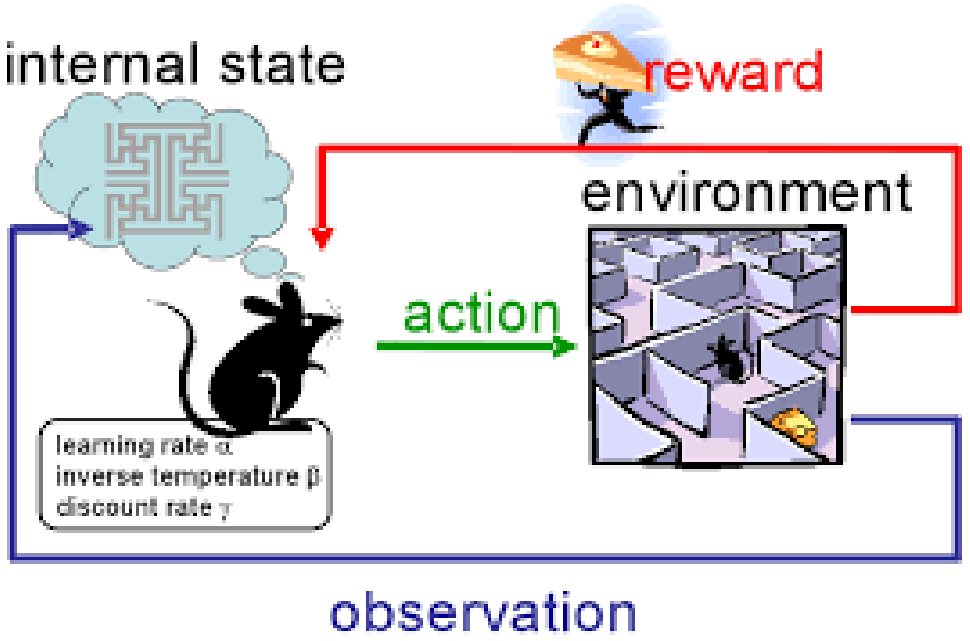
Source: KDnuggets

Unsupervised Learning



Reinforcement Learning



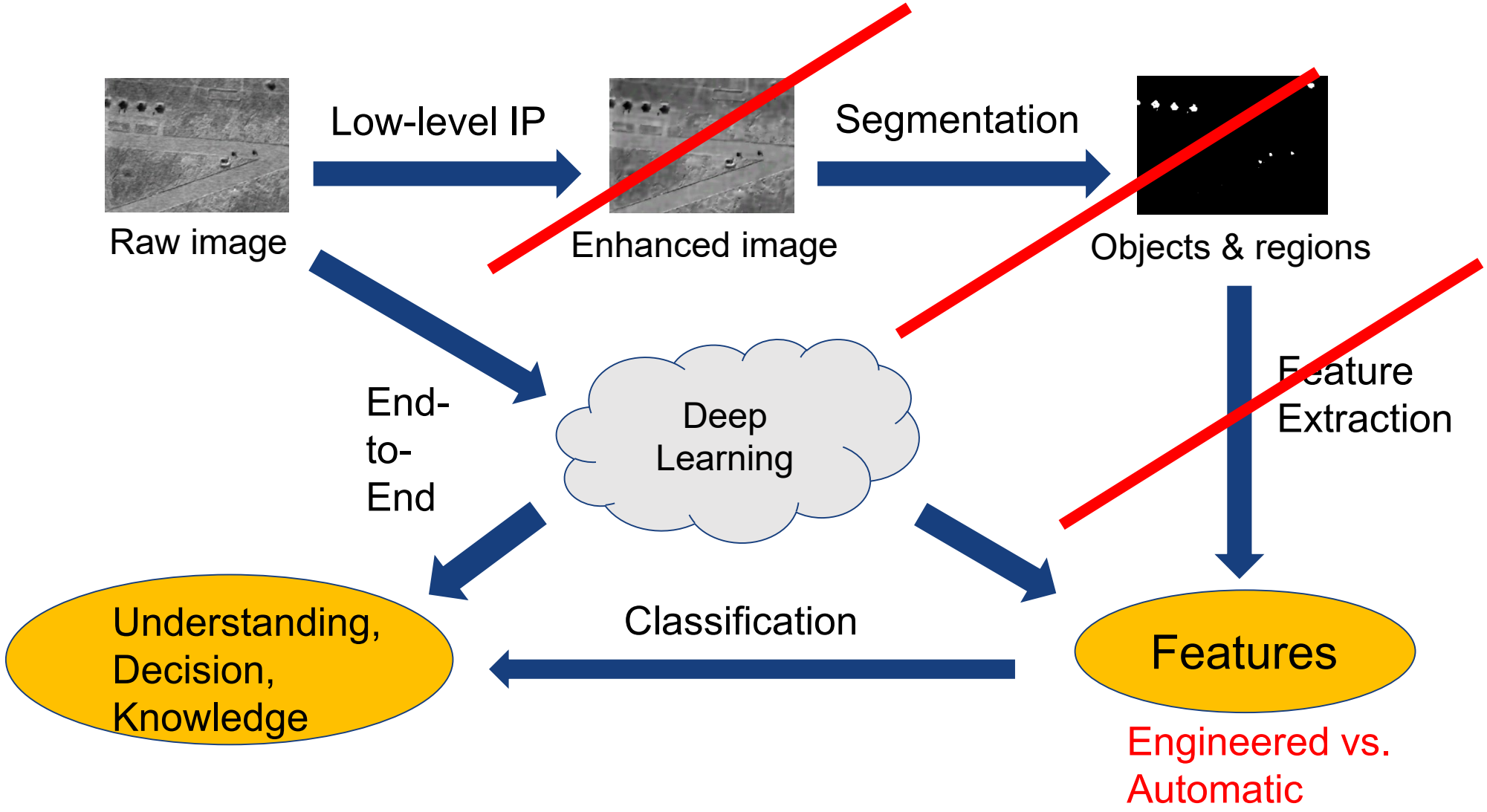


- A reinforcement learning agent interacts with its environment in discrete time steps.

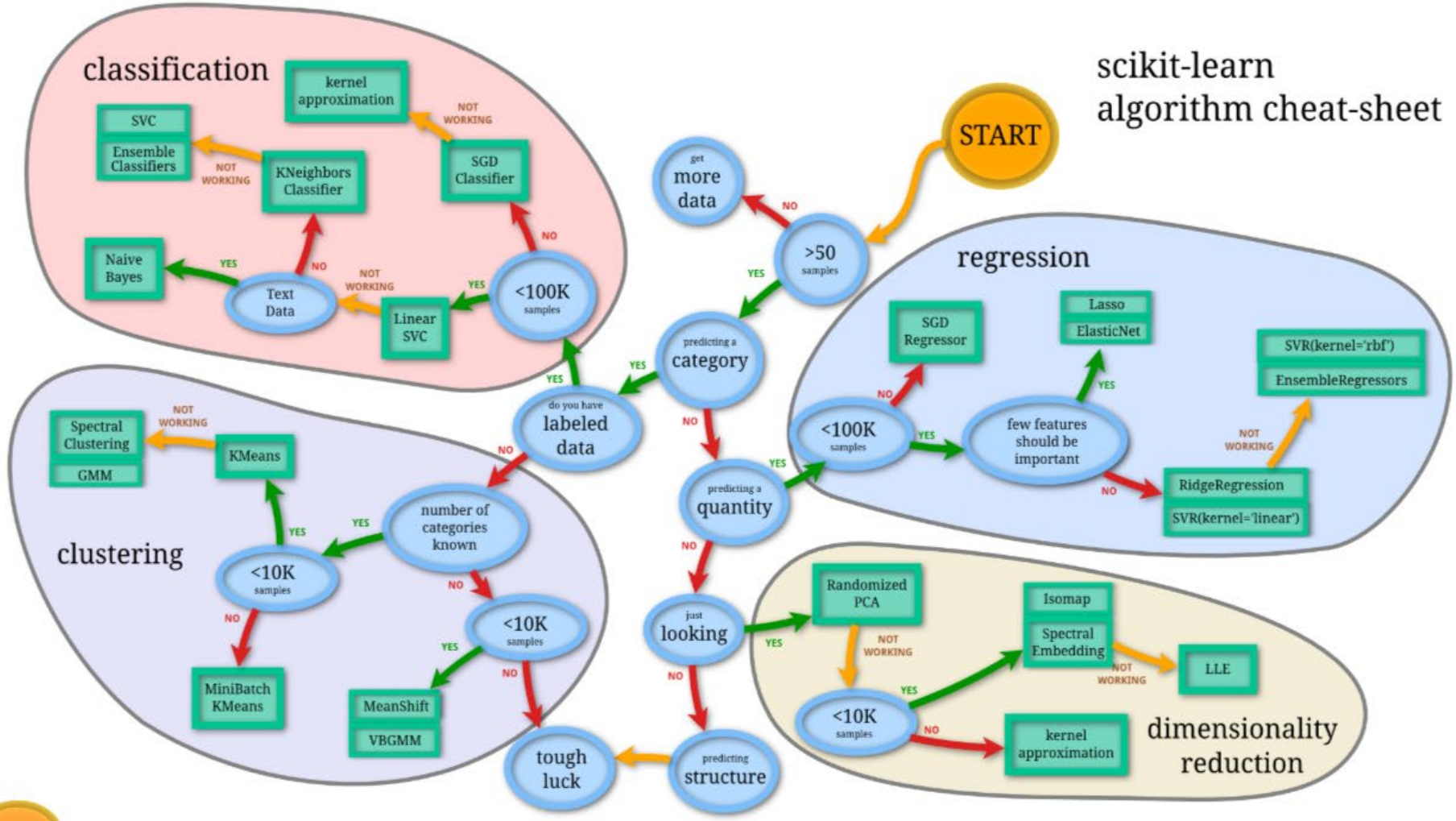
Machine Learning Techniques/Algorithms

- Linear regression / Logistic regression
- Decision tree (C5.0, CART, …)
- Naïve Bayes, Bayesian Network
- Neural network (MLP, Radial Basis, SOM, …)
- Deep Learning (CNN, LSTM, GAN, VAE…)
- Support Vector Machine
- Memory-based reasoning (K-NN)
- K-Means
- Hierarchical Clustering
- ……

Deep Learning Paradigm



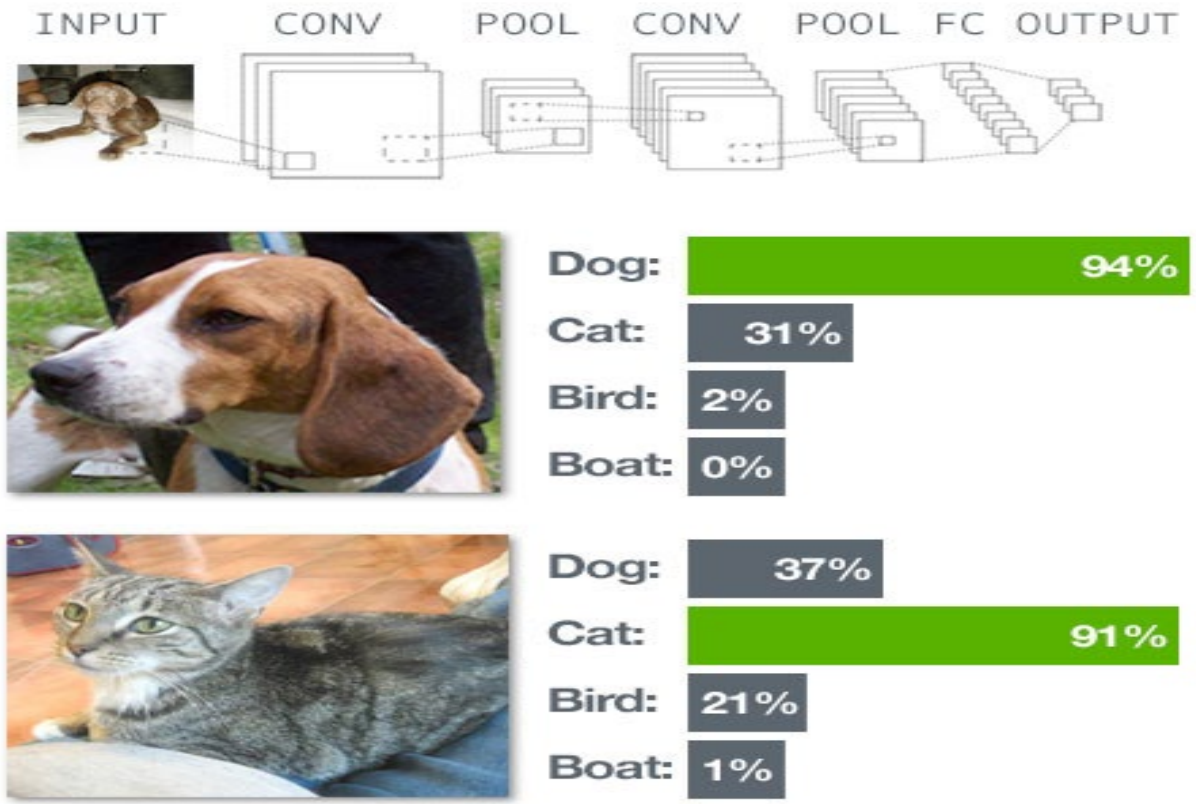
Scikit-learn's Algorithms

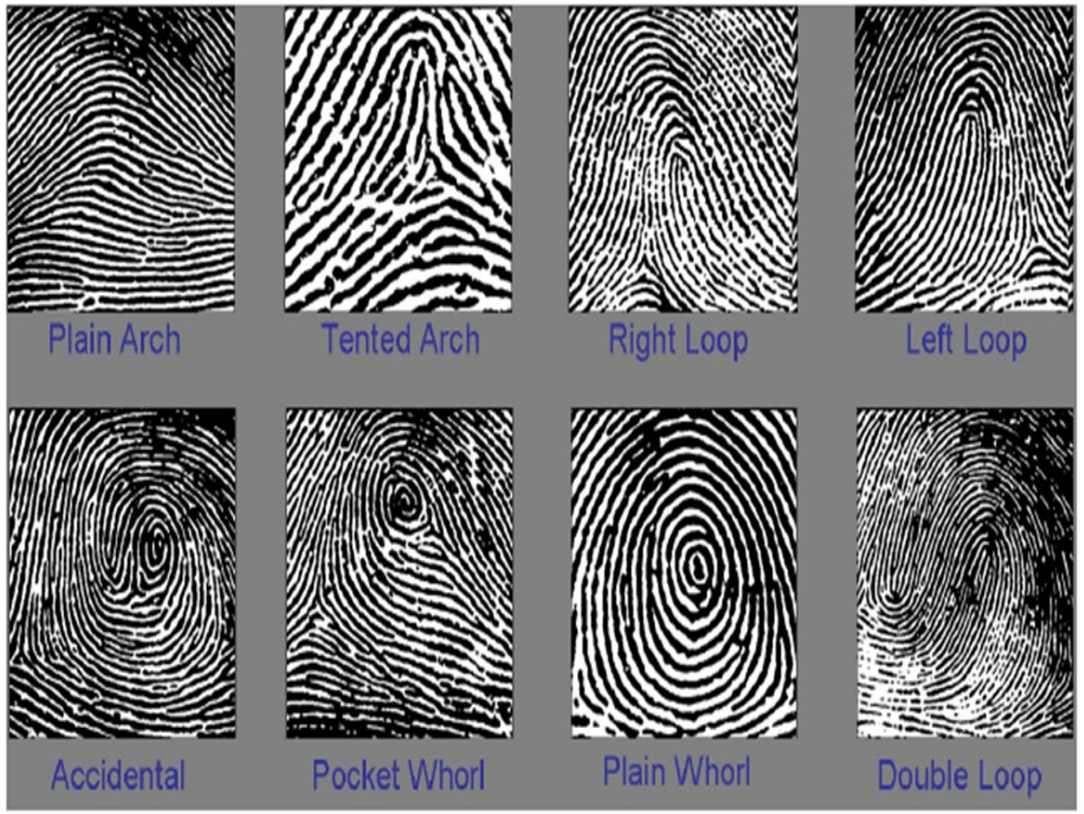


Applications of Pattern Recognition and Machine Learning

- Biomedical informatics
- Computer vision
- Customer relationship management
- Data mining
- Email filtering
- Natural language processing (NLP)
- Pattern recognition
  - Facial recognition system
  - Handwriting recognition
  - Image recognition
  - Optical character recognition
  - Speech recognition
- Recommendation system
- ……

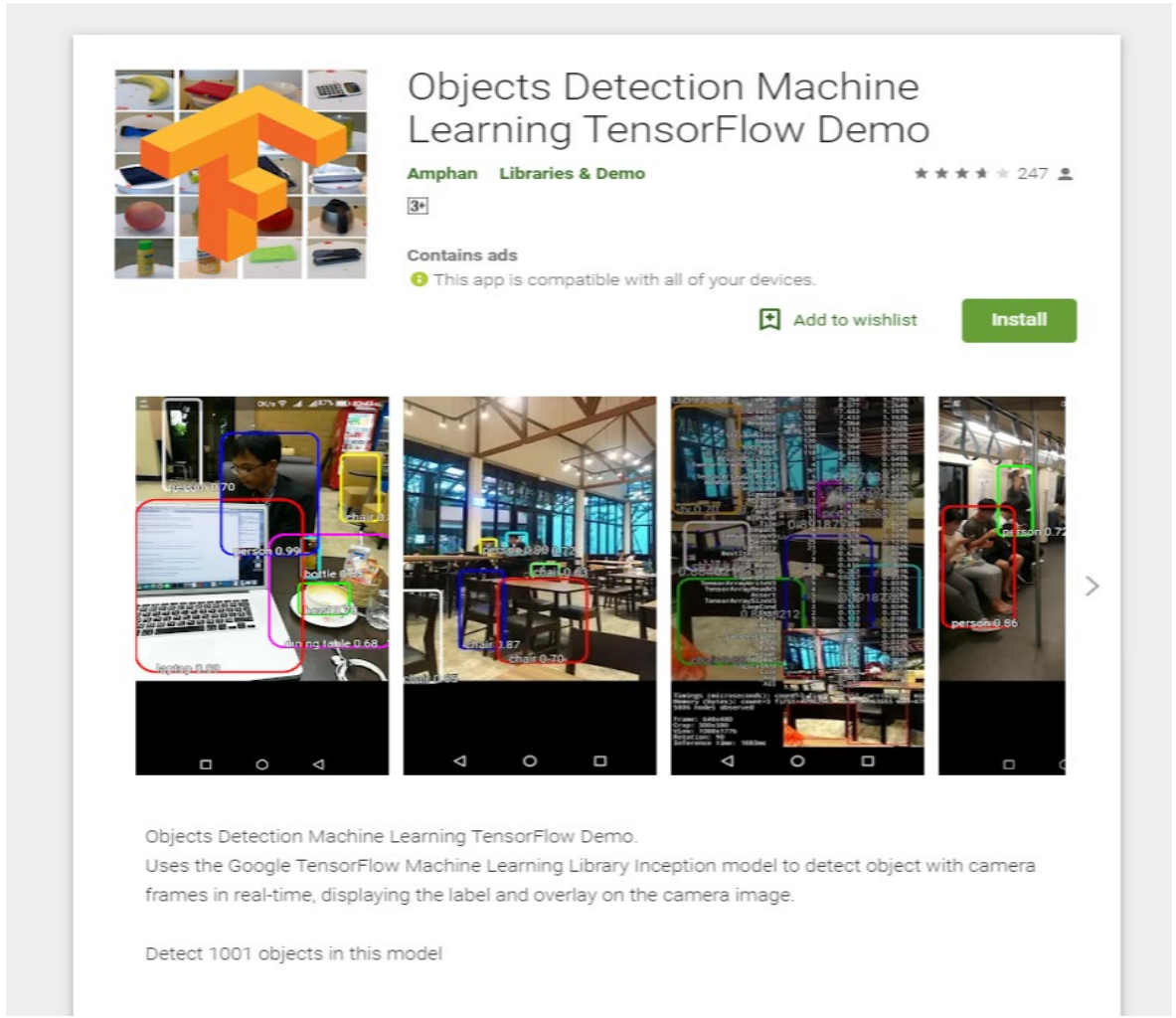
PR and ML Systems: Image Classification

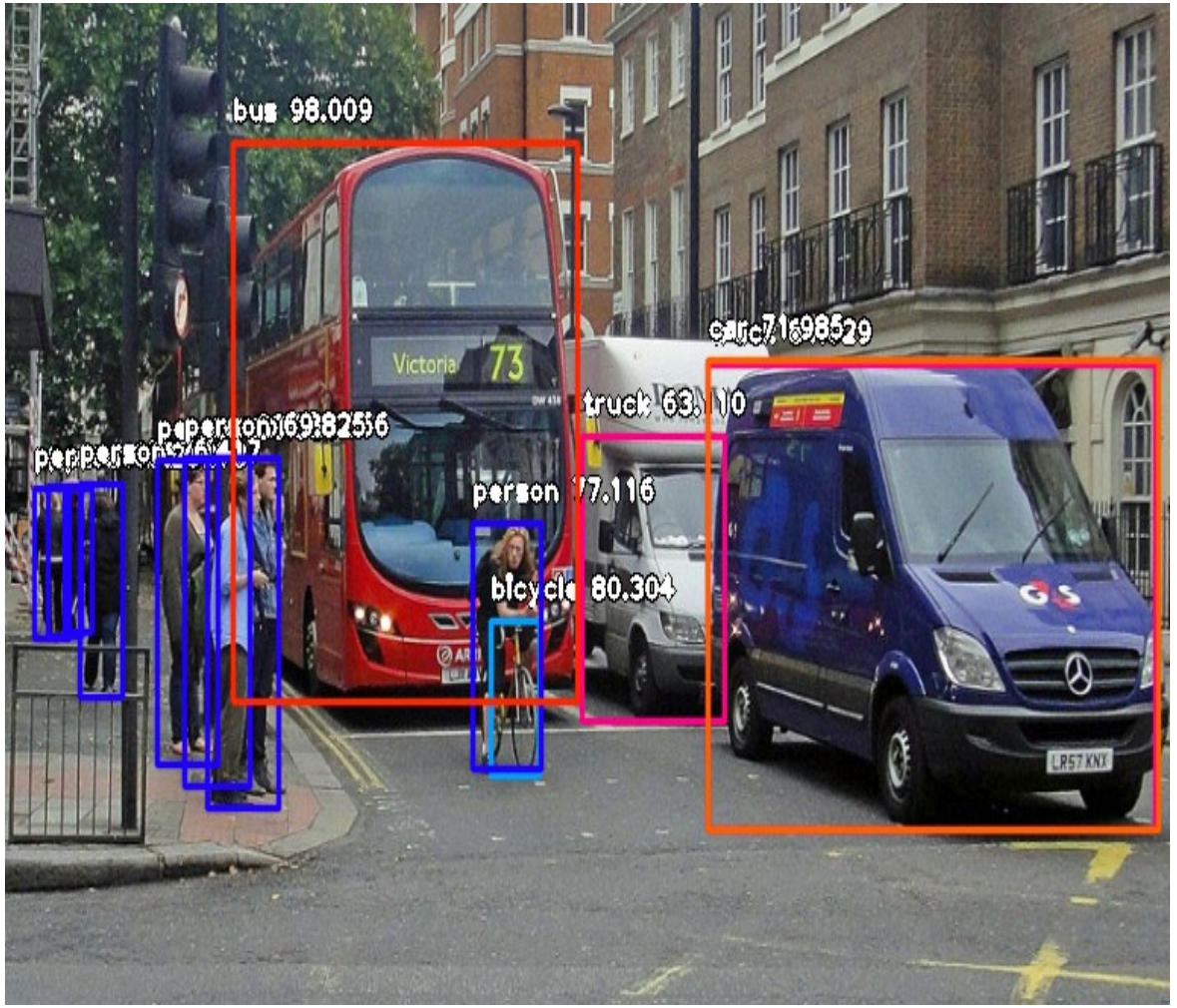




Source: pyimagesearch.com

PR and ML Systems: Object Detection

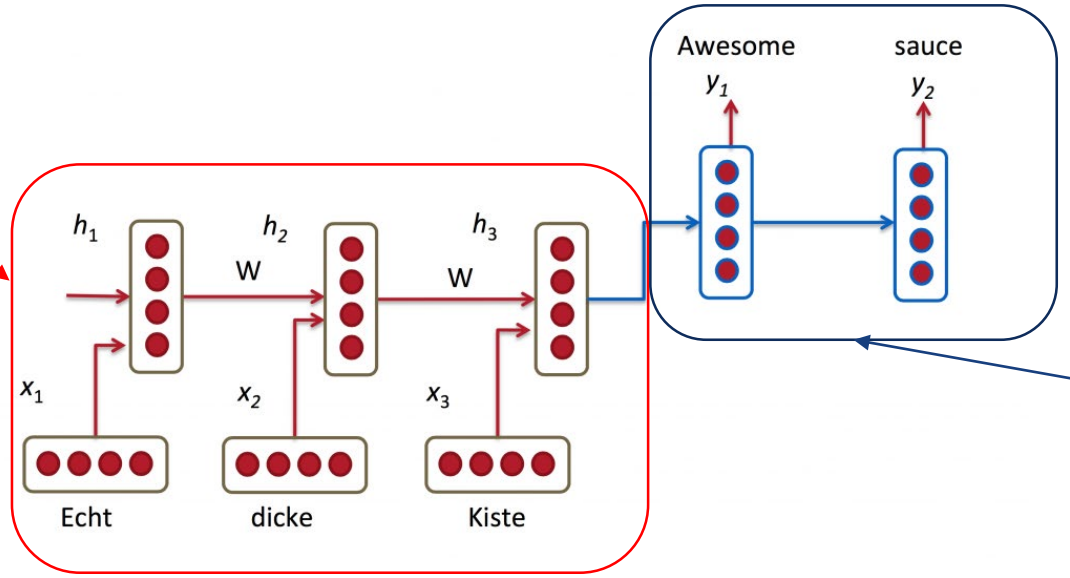




PR and ML Systems: Machine Translation

- **The input is a sequence of words in source language, and the output is a sequence of words in target language.**

Encoder: An RNN to encode the input sentence into a hidden state (feature)

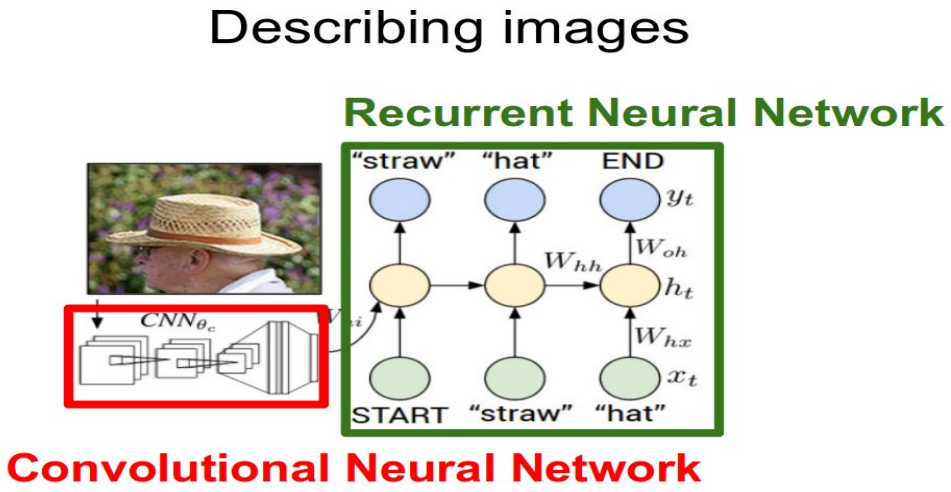


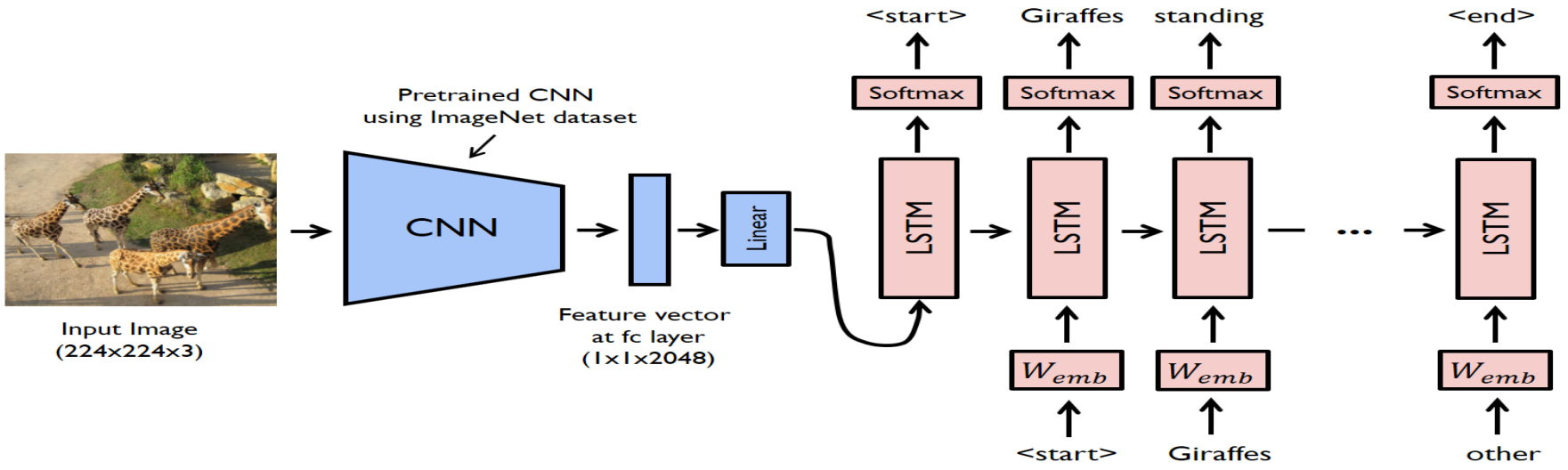
Decoder: An RNN with the hidden state of the sentence in source language as the input and output the translated sentence

Encoder-decoder architecture for machine translation

PR and ML Systems: Image Captioning

- **Image captioning: CNN+LSTM**





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Contact eGL

Singapore e-Government Leadership Centre
National University of Singapore
29 Heng Mui Keng Terrace
Block D & E
Singapore 119620

Tel	:	**(65) 6516 1156**
Fax	:	**(65) 6778 2571**
URL	:	**www.egl.sg**
Email	:	**egl-enquiries@nus.edu.sg**

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