

PROBLEM SOLVING USING PATTERN RECOGNITION DAY 1A

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DAY 1 AGENDA

1.1 Introduction to Problem Solving Using Pattern Recognition

1.2 How to analyse, model and solve pattern recognition problems

1.3 Solving Pattern Recognition Problems Using Supervised Learning
Techniques (I)

1.4 Pattern Recognition Workshop 1

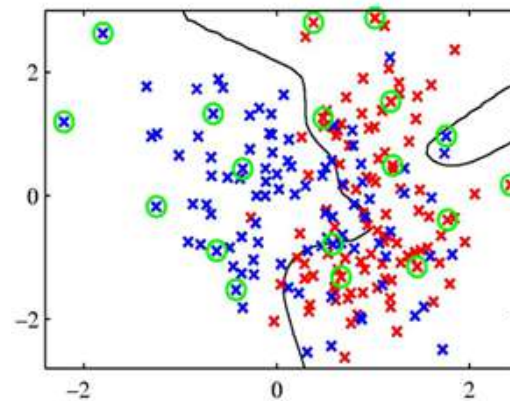
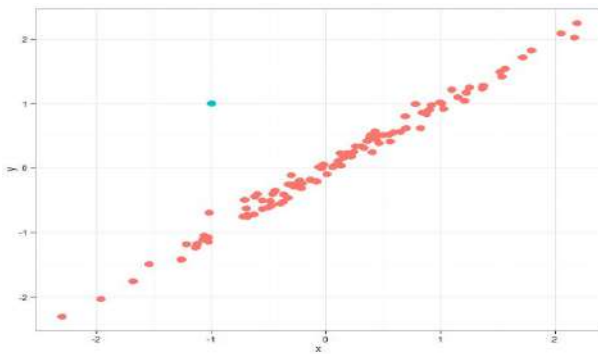
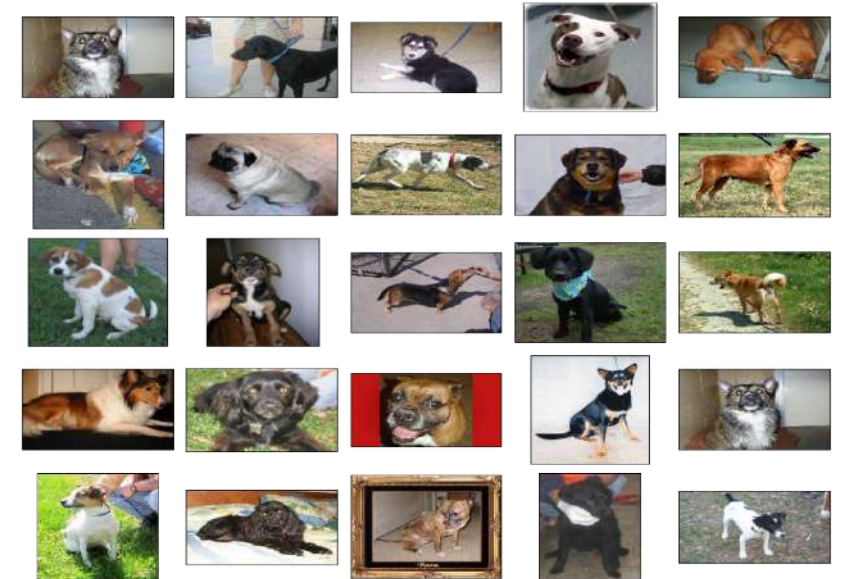
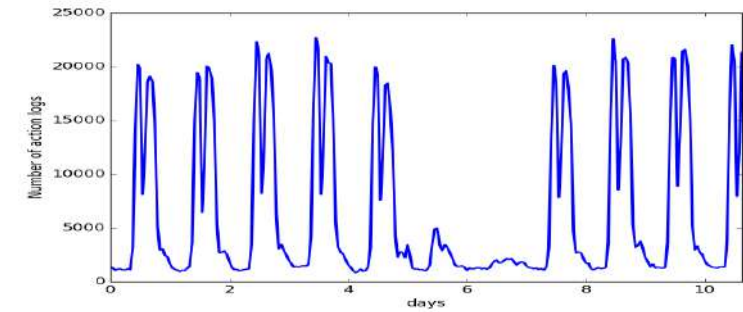
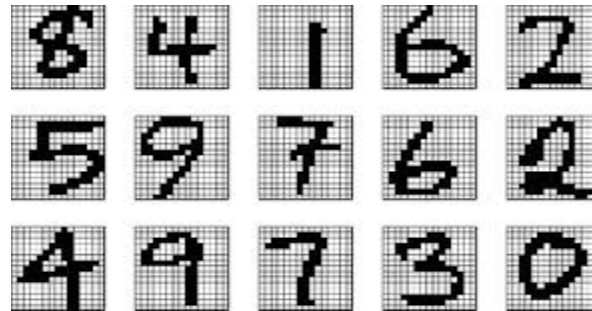
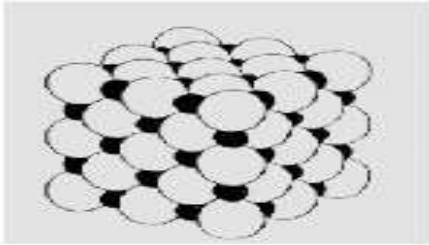
1.1

Introduction to Problem Solving Using Pattern Recognition

- **What is Pattern?**
- **What is Pattern Recognition?**
- **Examples of Pattern Recognition**
- **Applications of Pattern Recognition**

- 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.

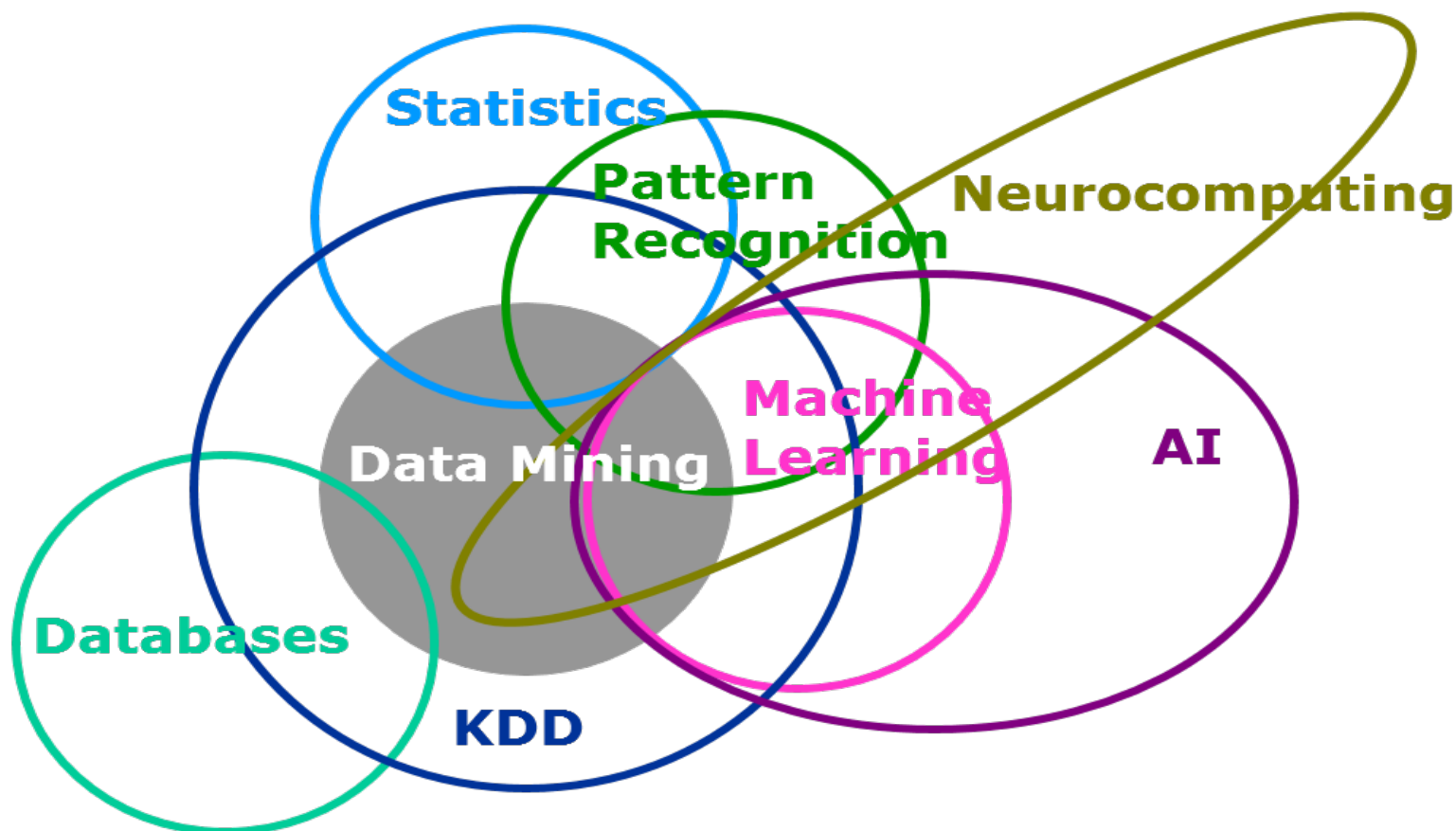
Patterns



- Pattern recognition 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.

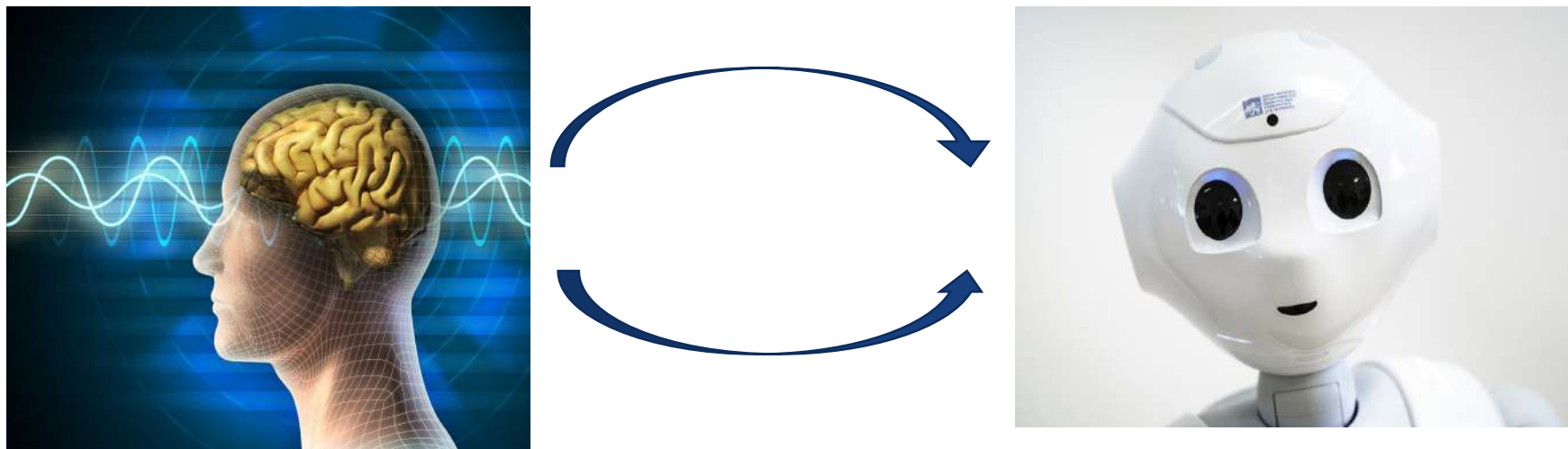
--- [Wikipedia](#)

Pattern Recognition



<https://www.analyticsvidhya.com>

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.**

“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.

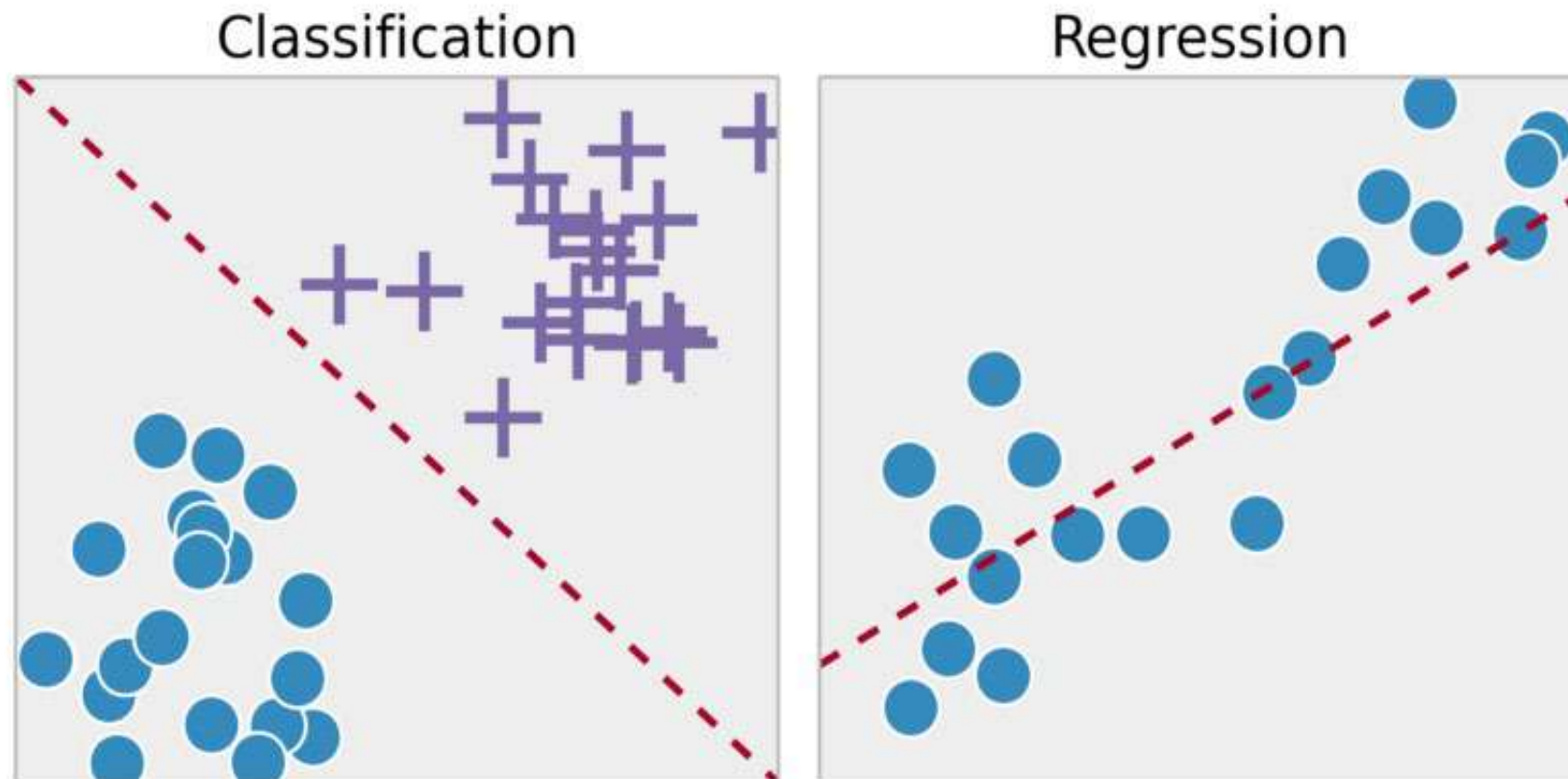
- **Unsupervised learning**

- The system forms clusters or natural groupings of the input patterns (based on some similarity criteria).

- **Reinforcement learning**

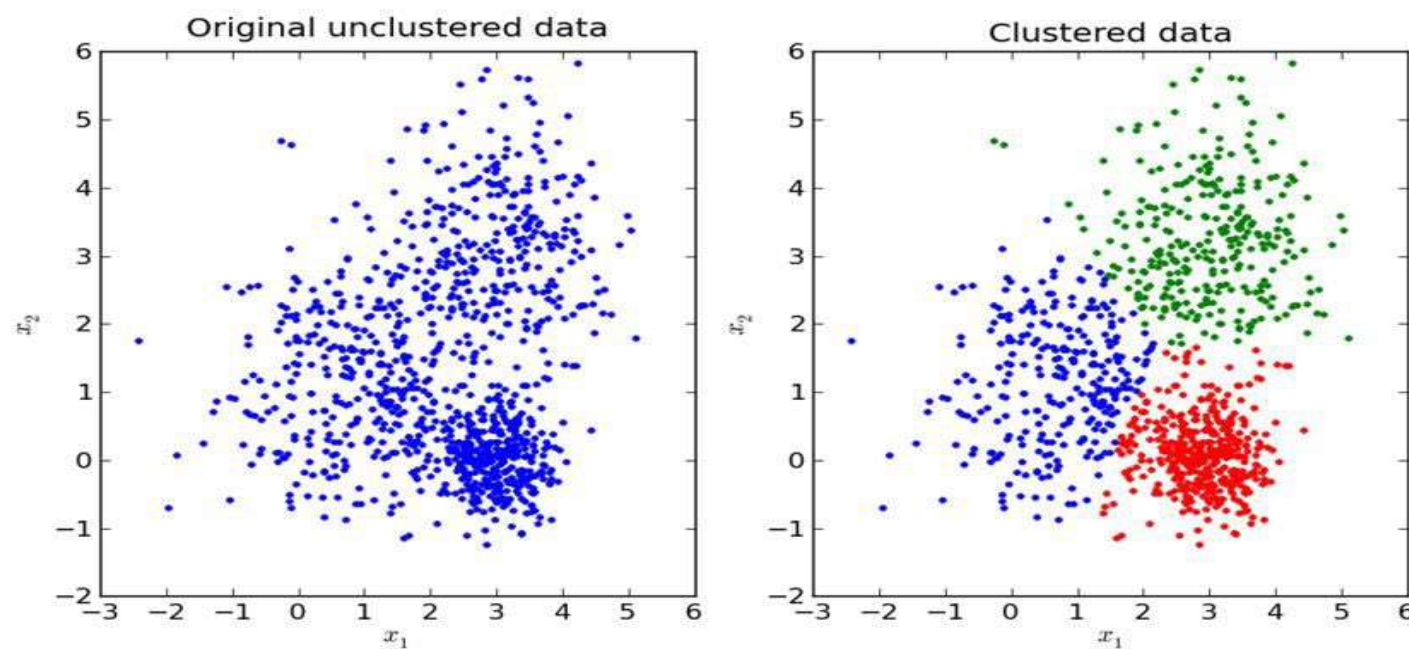
- No desired category is given but the teacher provides feedback to the system such as the decision is right or wrong.

Supervised Learning

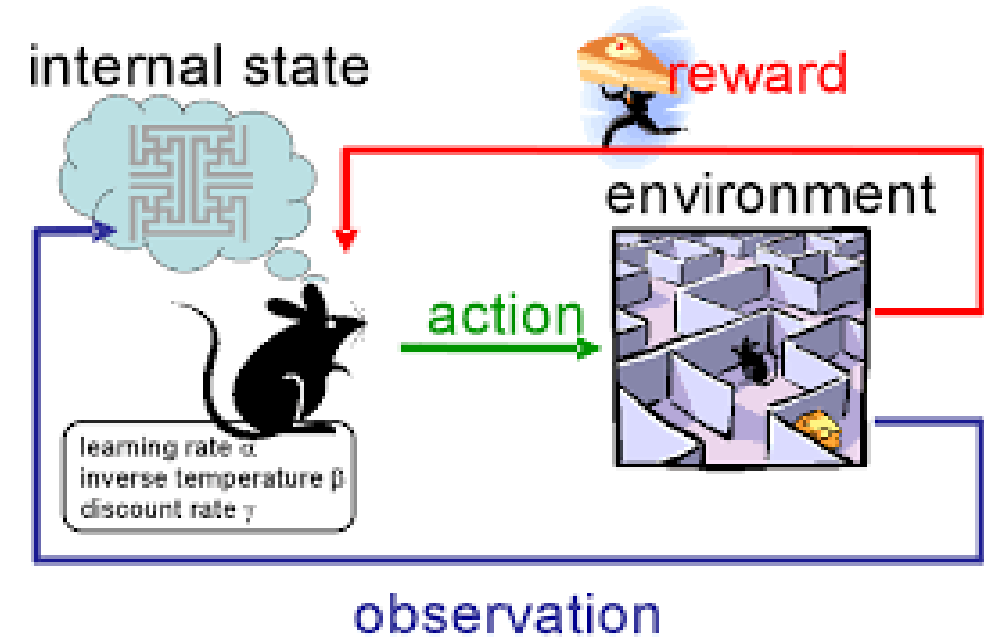
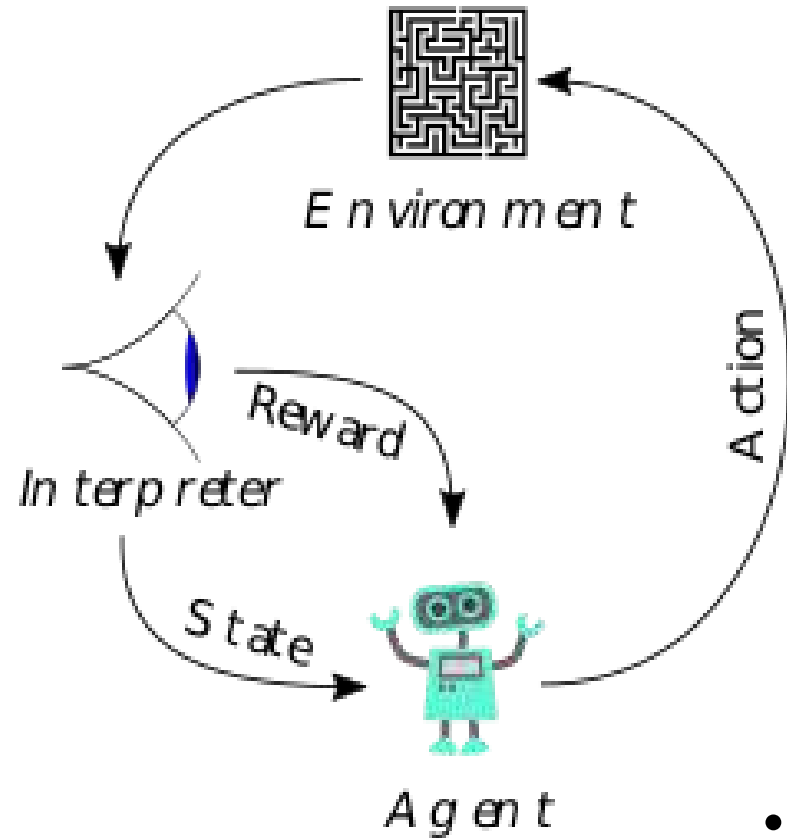


Source: KDnuggets

Unsupervised Learning



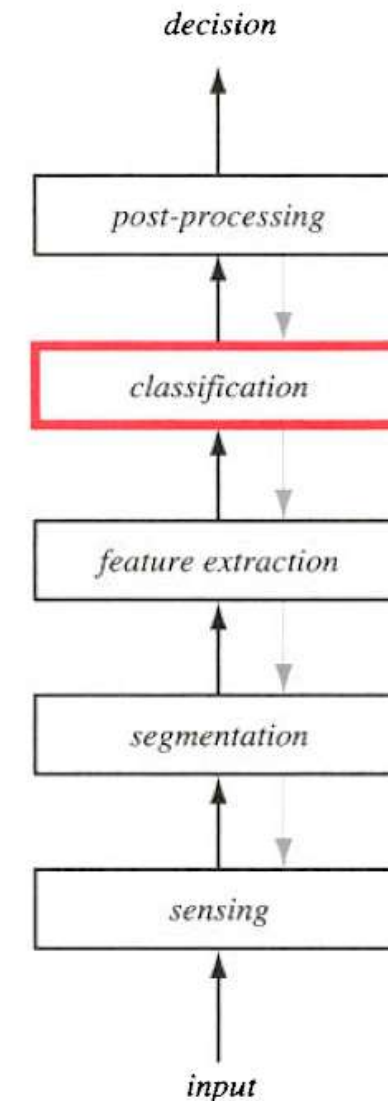
Reinforcement Learning



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

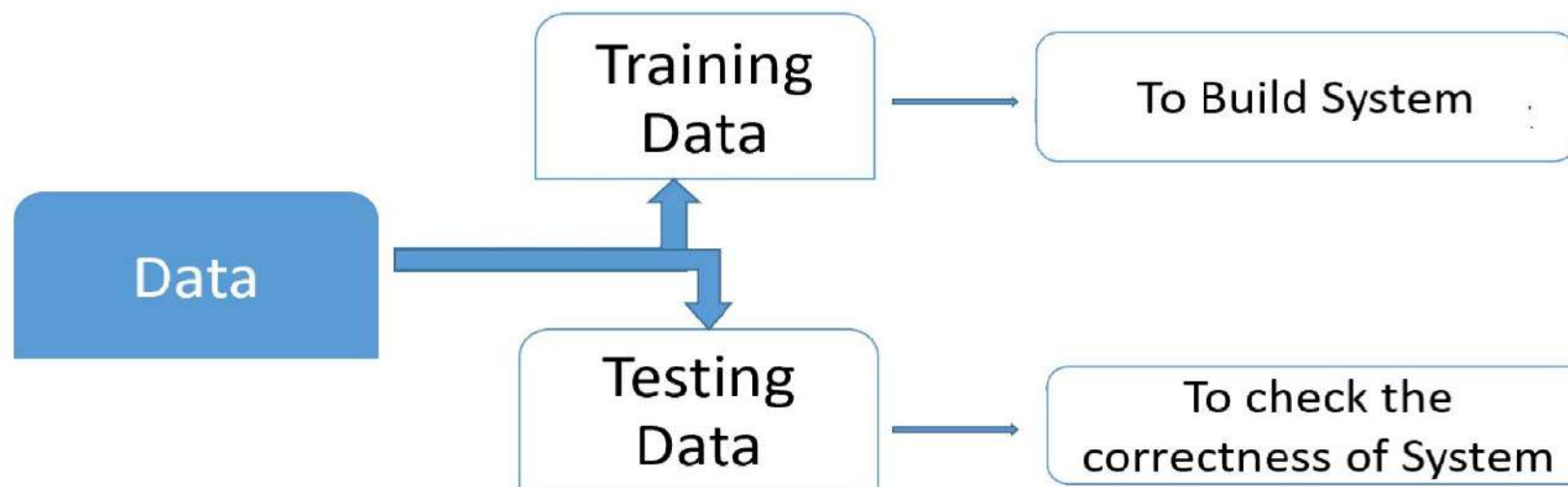
Pattern Recognition Process

- **Data acquisition and sensing:**
 - Measurements of physical variables.
 - Important issues: bandwidth, resolution , etc.
- **Pre-processing:**
 - Removal of noise in data.
 - Isolation of patterns of interest from the background.
- **Feature extraction:**
 - Finding a new representation in terms of features.
- **Classification/Clustering**
 - Using features to learn models for different tasks.
- **Post-processing**
 - Evaluation of confidence in decisions.



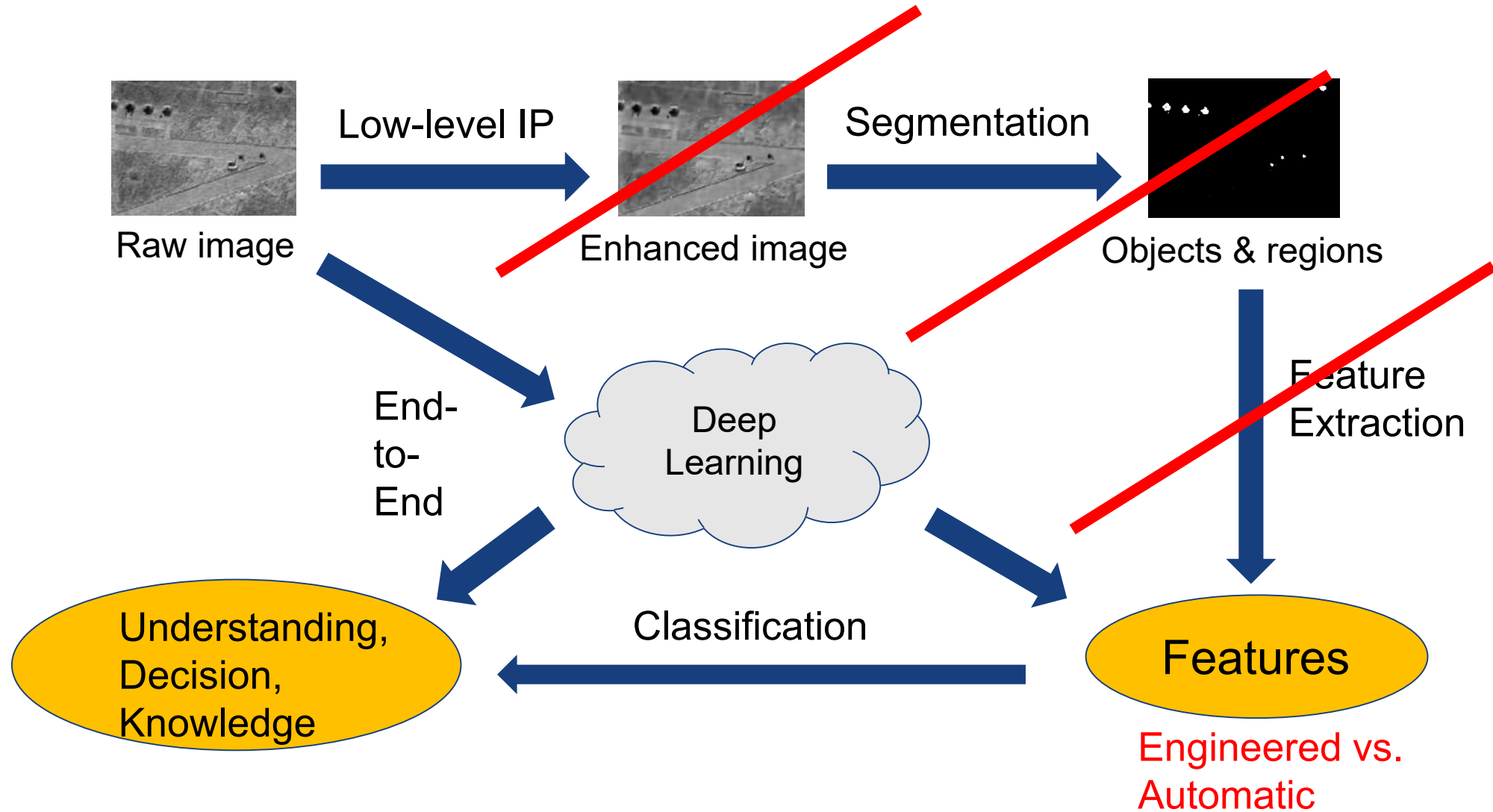
Training and Testing Models in PR

- **Learning (training):** Learn a model using the training data
- **Testing:** Test the model using unseen test data to assess the model accuracy

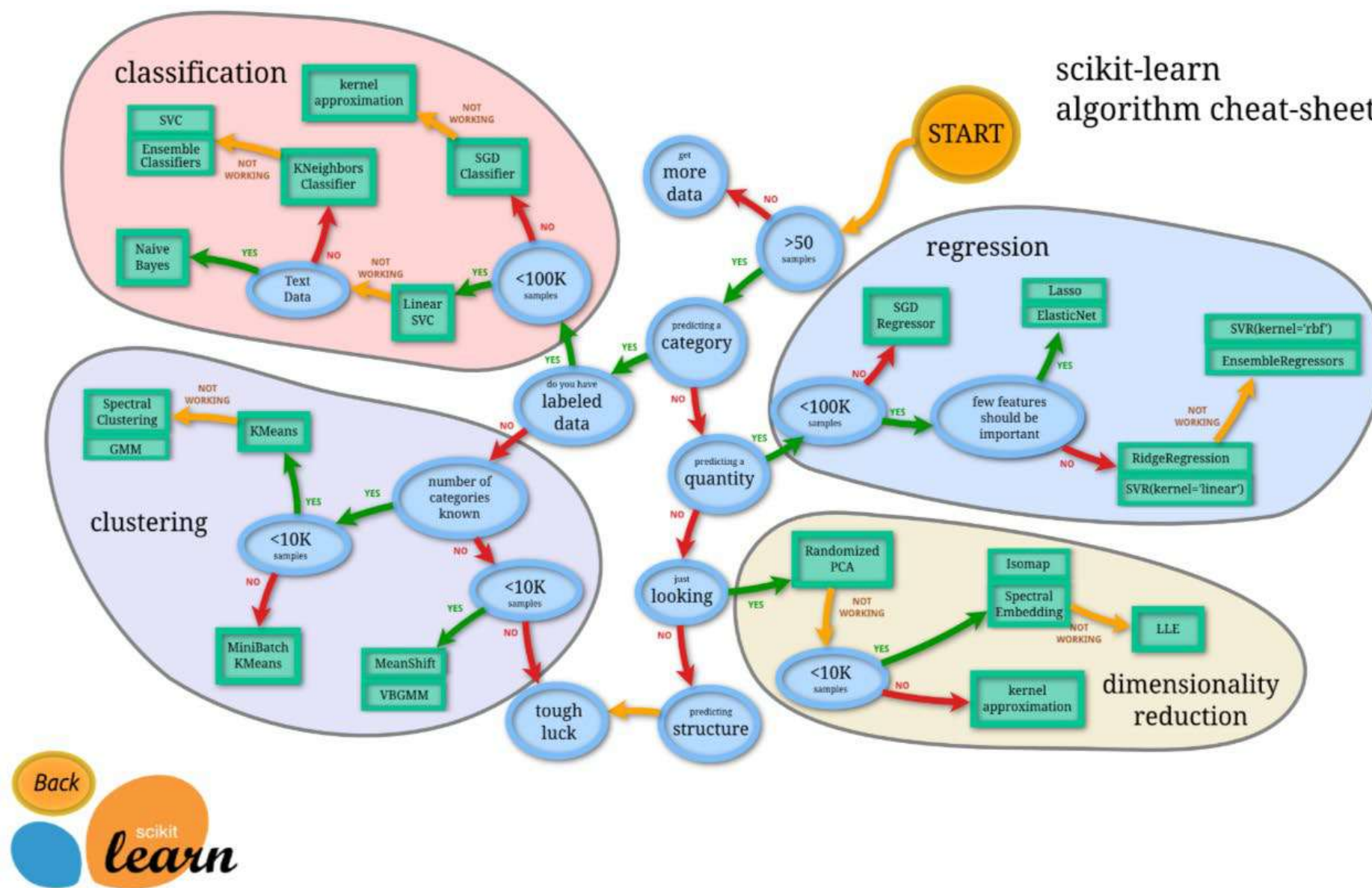


- Linear regression / Logistic regression
- Decision tree (C5.0, CART, ...)
- Naïve Bayes, Bayesian Network
- Neural network (MLP, Radial Basis, SOM, ...)
- Deep Learning (CNN, LSTM, GAN, VAE...)
- Support Vector Machine
- Memory-based reasoning (K-NN)
- K-Means
- Hierarchical Clustering
-

Deep Learning Paradigm



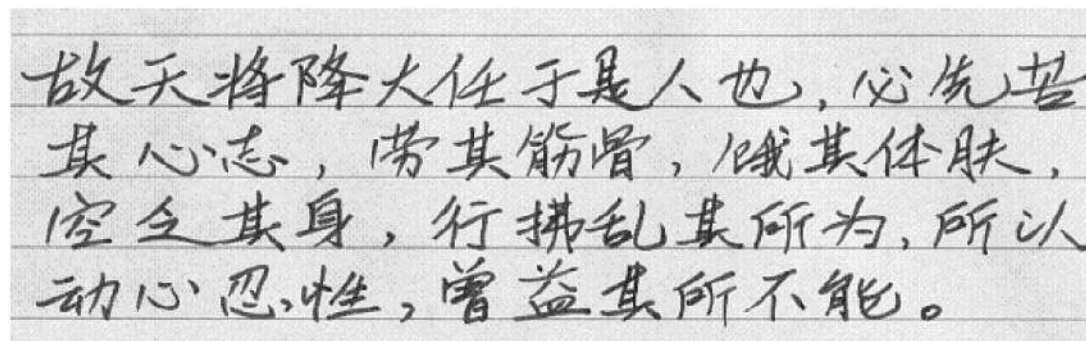
Scikit-learn's Algorithms



Applications of Pattern Recognition

- Handwritten digit/letter recognition
- Biometrics: voice, iris, fingerprint, face, and gait recognition
- Speech recognition
- Smell recognition (e-nose, sensor networks)
- Defect detection in chip manufacturing
- Interpreting DNA sequences
- Medical diagnosis
- Terrorist Detection
- Credit Fraud Detection
- Credit Applications
-

- Hand-Written Character Recognition



(a) Handwriting

故天将降大任于是人也，必先苦
其心志，劳其筋骨，饿其体肤，
空乏其身，行拂乱其所为，所以
动心忍性，曾益其所不能。

(b) Corresponding Machine Print

Applications of Pattern Recognition (cont.)

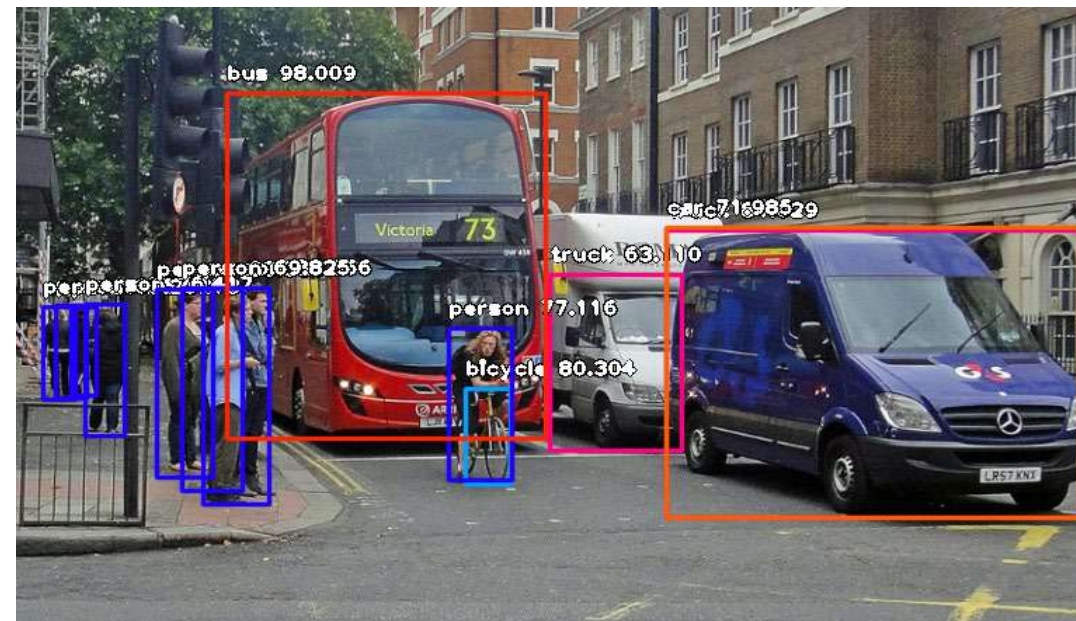
- **Fingerprint Classification**



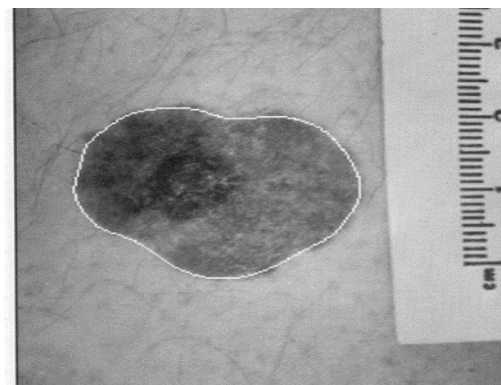
Applications of Pattern Recognition (cont.)



Autonomous Systems



Object Detection



Medical Applications - Skin cancer detection

References

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