

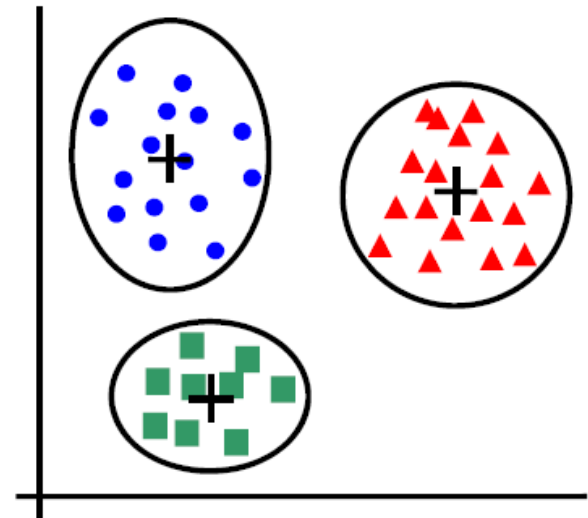
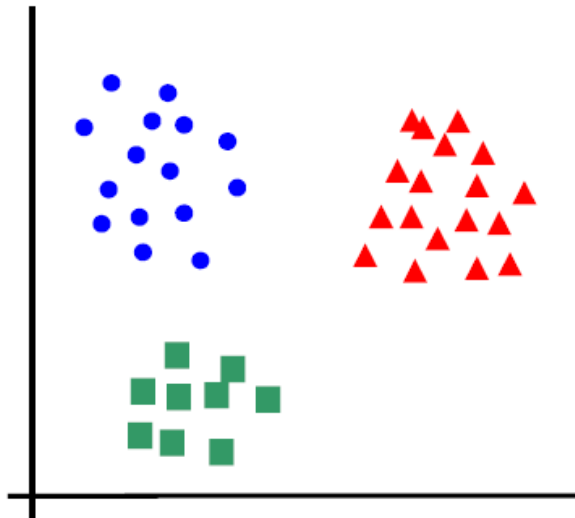
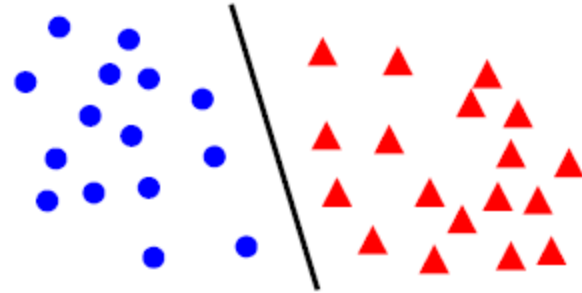
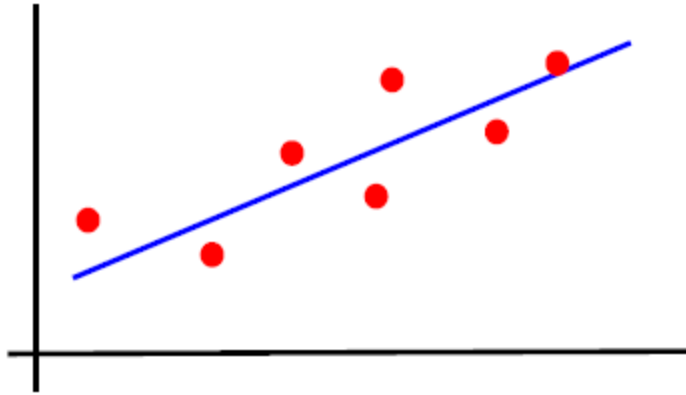
# Machine Learning

## Introduction

Indian Institute of Information Technology  
Sri City, Chittoor



# Welcome to Machine Learning Class



# Today's Agenda

- Course plan
  - Pre-requisite
  - Topics
  - Textbooks/References
  - Evaluation components
  - Honor code
- Introduction to machine learning
  - What is ML?
  - When do we use ML?
  - Applications
  - Relation with AI and DL
  - Relation with other fields
  - Different machine learning paradigms

# Pre-requisite

- Probability
  - Distribution, random variable, expectation, conditional probability, variance, density
- Linear algebra
  - Matrix multiplication
  - Eigen vector
- Basic programming
  - Python (First Priority)
  - Matlab/C/C++ (Second Priority)

# Topics

- Supervised Learning
  - Classification
  - Regression
- Unsupervised Learning
  - Clustering
- Reinforcement Learning
- Semi-supervised Learning

# Textbooks/References

1. “Pattern Classification” by R. O. Duda, P. E. Hart and D. G. Stork.
2. “An Introduction to Statistical Learning” by Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani.
3. “Pattern Recognition and Machine Learning” by Christopher M. Bishop.
4. “Introduction to Machine Learning” by Ethem Alpaydin.
5. “Pattern Recognition: An Algorithmic Approach” by M. Narasimha Murty, V. Susheela Devi.
6. “Machine learning” by Tom Mitchell.

# Evaluation Components

- Mid-Exam: 20%
- End-Exam: 30%
- Assignments: 30%
- Scheduled Quiz: 10%
- Class Participation: 10%

# Honor Code

## Do's

- Write down the code independently
- Submit the assignment within the deadline
- Read the books/references for detail description of the topics

## Don'ts

- copy, refer to, or look at any **official or unofficial** previous years' solutions in **preparing** the answers



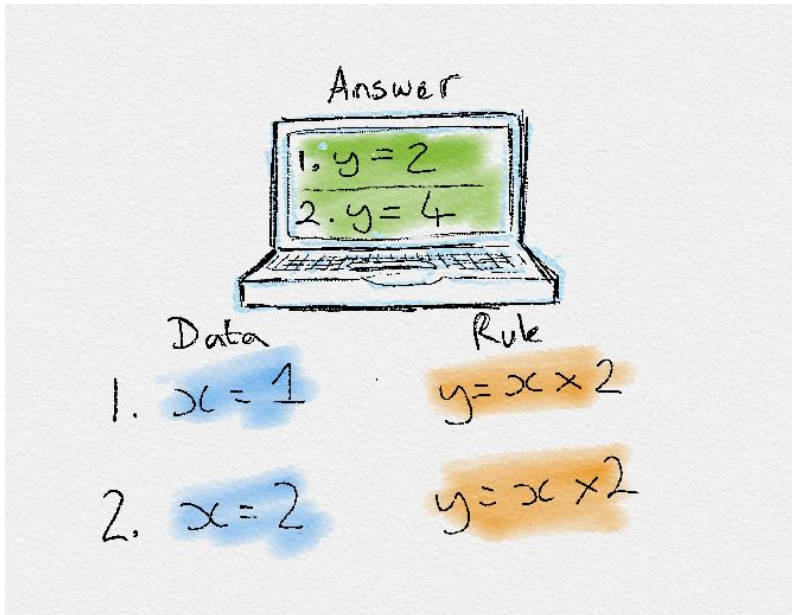
# Introduction to ML

- What is ML?
- Terminologies used in ML
- When do we use ML?
- Applications
- Relation with AI and DL
- Relation with other fields
- Different machine learning paradigms

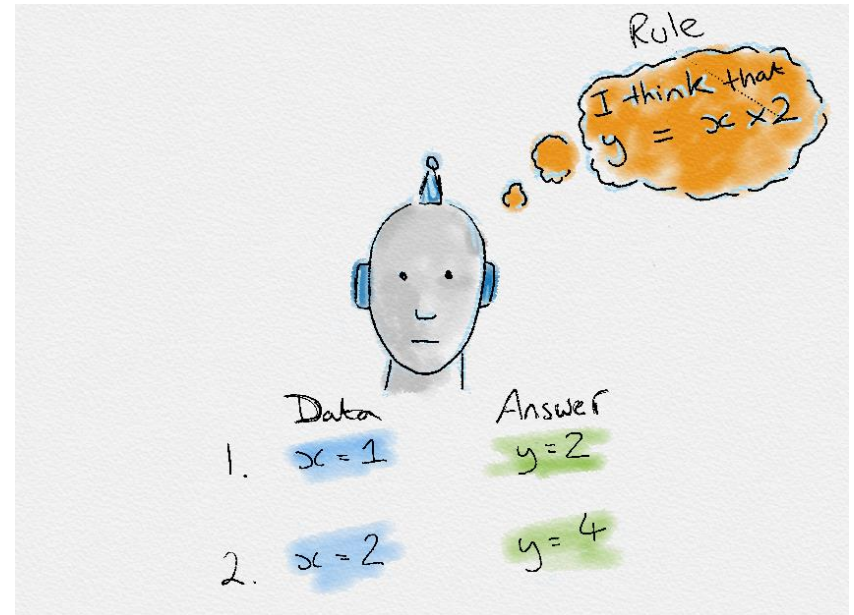
# What is ML?

- Machine learning (ML) is the study of computer algorithms that improve automatically through experience.
- Machine-learning algorithms use statistics to find patterns in massive amounts of data.
- Traditionally, software engineering combined human created rules with data to create answers to a problem. Instead, machine learning uses data and answers to discover the rules behind a problem – **F. Chollet, Deep Learning with Python**

# What is ML?



Traditional Programming



Machine Learning

# Terminologies used in ML

- ML systems learn how to make inference from the input data samples to produce useful predictions on un-seen (test) data.
- Input data:
  - labelled examples: A labelled example includes feature(s) and the label. {features, label}: (x, y)

- For e.g.:

Features:	Label
Normal RBC, Normal HgB	Healthy
Low RBC, Low HgB	Anaemic

- unlabelled examples: An unlabelled example contains features but not the label. {features, ?}: (x, ?)

- For e.g.:

Features:
Housing type: 4BHK, Price: 40,000
Housing type: 4BHK, Price: 15,000
Housing type: 2BHK, Price: 25,000
Housing type: 2BHK, Price: 8,000

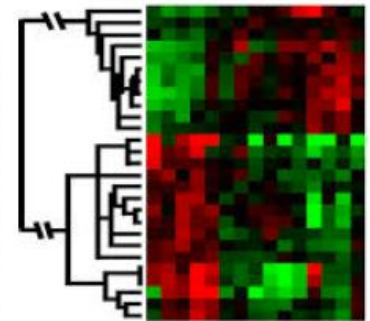
# Terminologies used in ML

- Machine Learning Model:
  - A ML model defines the relationship between the features and label.
    - For e.g.: An anaemia diagnostic model might associate certain features strongly with “anaemic” or “healthy”, and predict the labels based on the association rules it inferred.
  - Two Phases of ML model development
    - **Training** means creating or **learning** the model.
    - **Testing/Inference** means applying the trained model to unlabelled examples.

# When do we use ML?

ML is used when:

- Human expertise does not exist (navigating on Mars)
- Humans can't explain their expertise (speech recognition)
- Models must be customized (personalized medicine)
- Models are based on huge amounts of data (genomics)



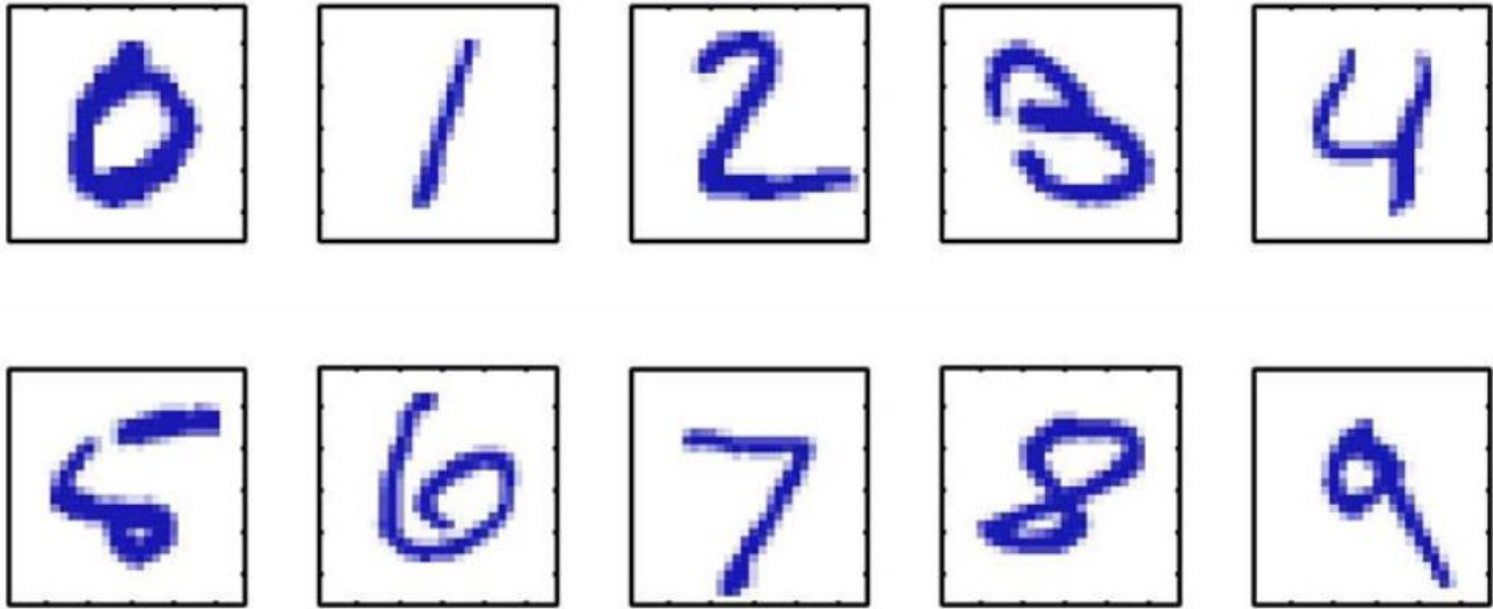
Learning isn't always useful:

- There is no need to “learn” to calculate payroll

# Applications

- Hand-written digit recognition
- Speech recognition
- Face detection
- Object classification
- Email spam detection
- Computational biology
- Autonomous cars
- Computer-aided diagnosis

# Hand-written Digit Recognition



Images are 28 x 28 pixels

Represent input image as a vector  $\mathbf{x} \in \mathbb{R}^{784}$

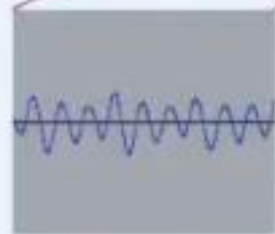
Learn a classifier  $f(\mathbf{x})$  such that,

$$f : \mathbf{x} \rightarrow \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$$

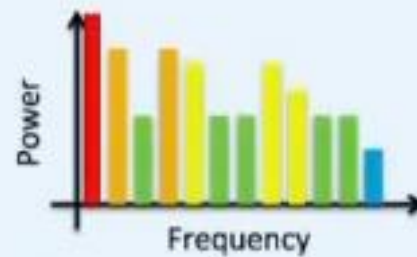


# Speech Recognition

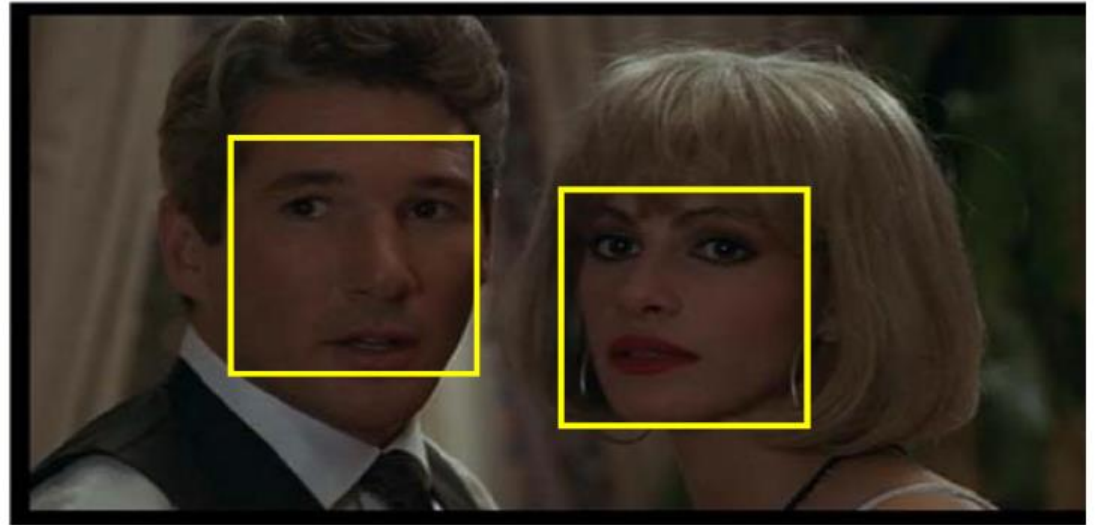
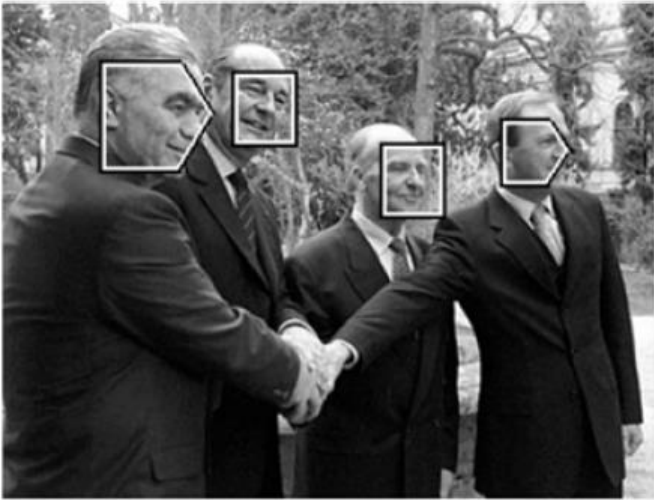
Spectrogram



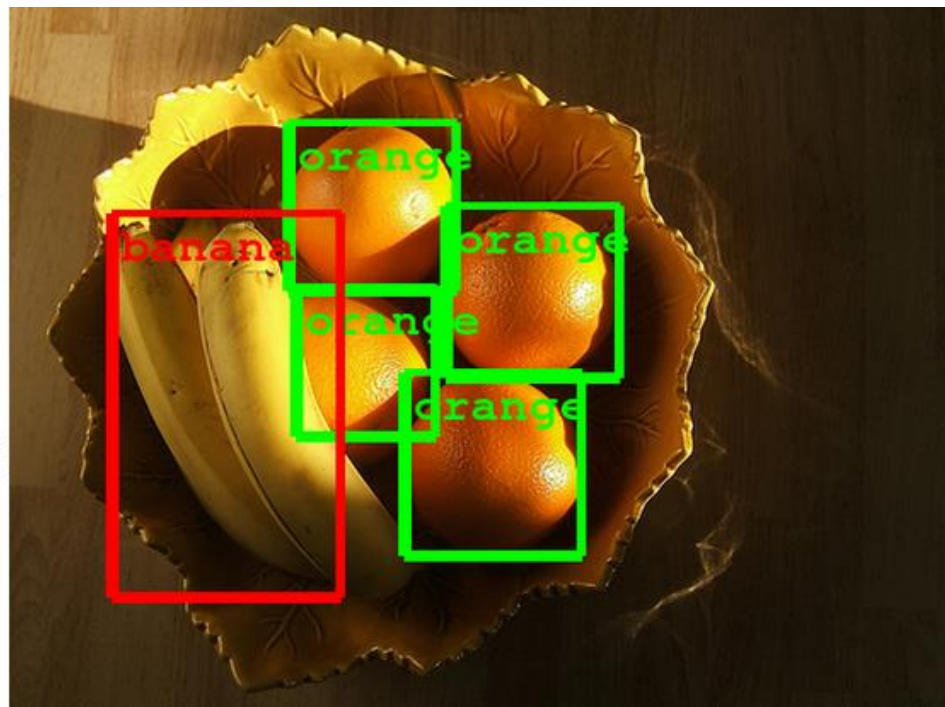
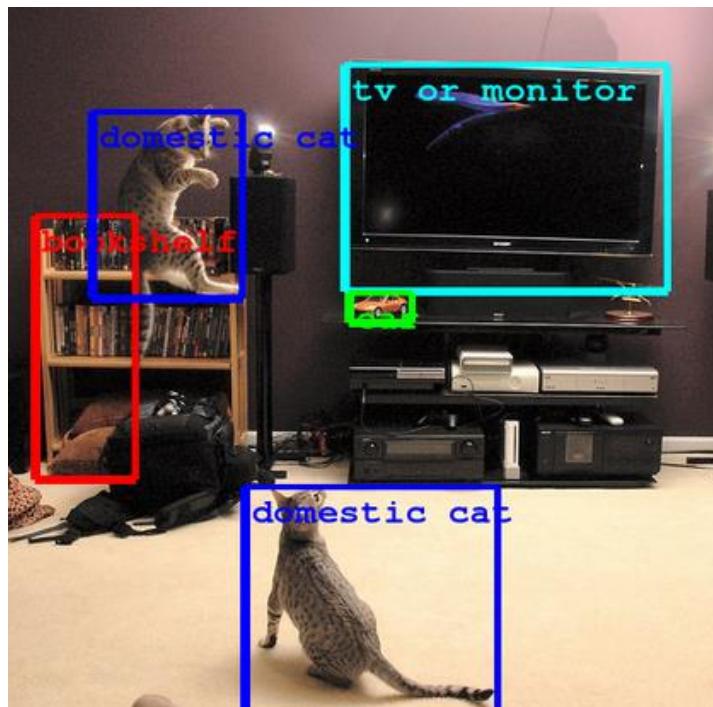
$\log |\text{FFT}(X)|^2$



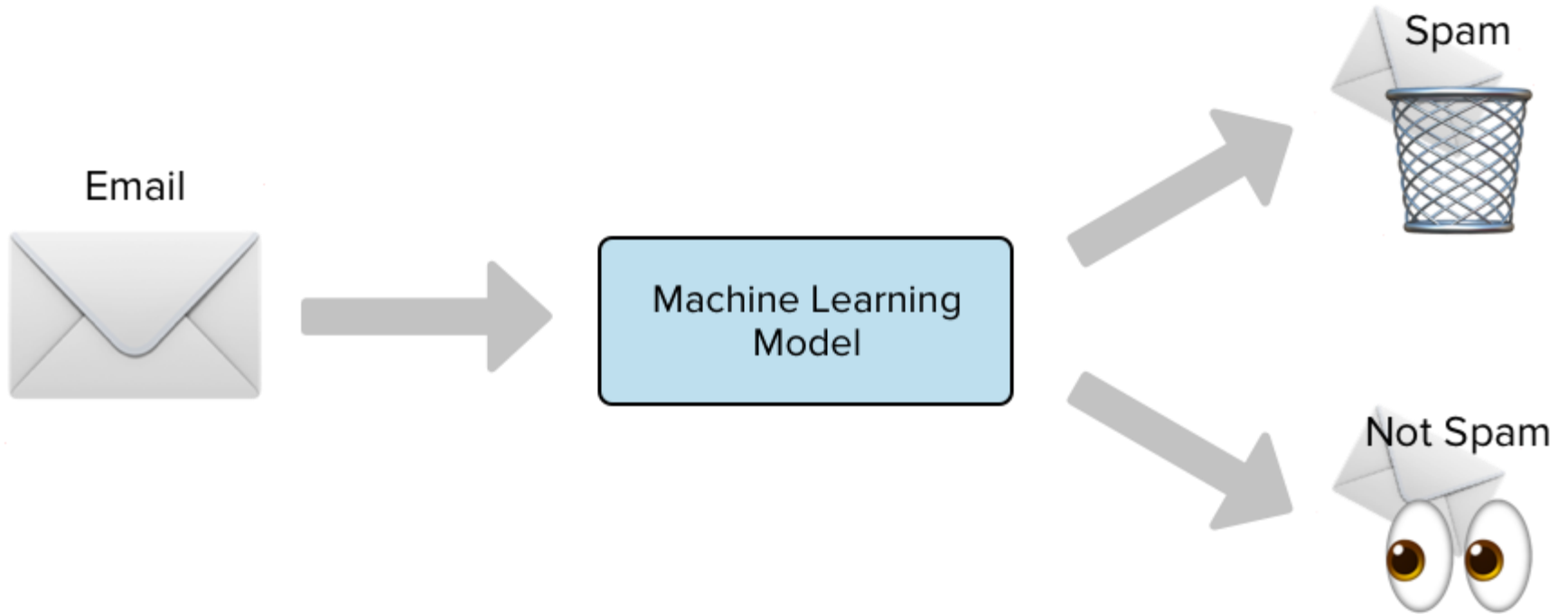
# Face Detection



# Object Classification



# Email Spam Detection



# Computational Biology

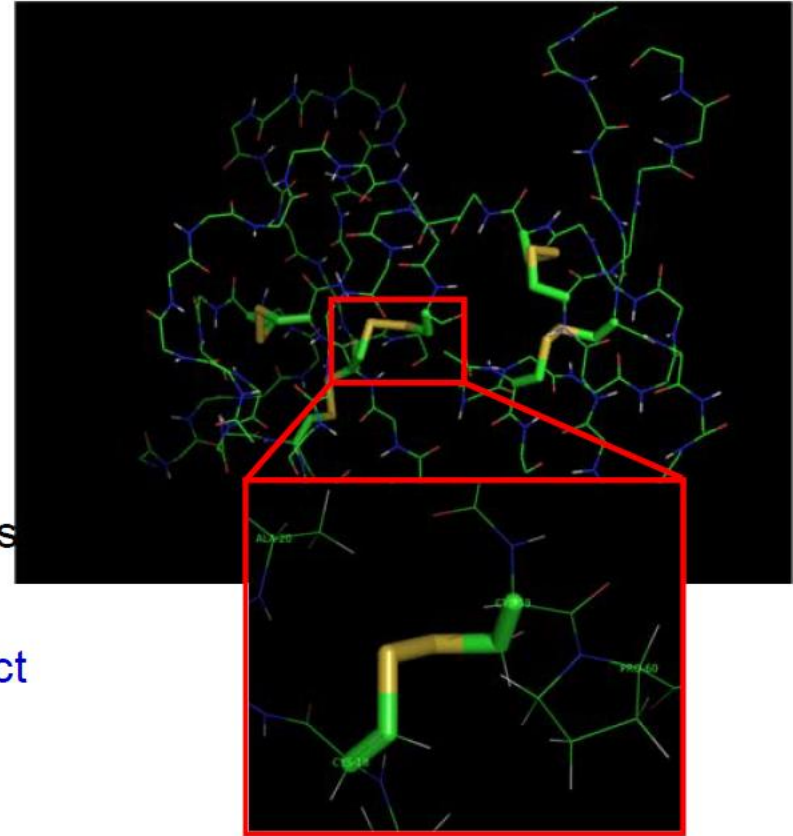
x

y

AVITGACERDLQCG  
KGTCCA VSLWIKSV  
RVCTPVGTSGEDCH  
PASHKIPFSGQRMH  
HTCPCAPNLACVQT  
SPKKFKCLSK



Protein Structure and Disulfide Bridges

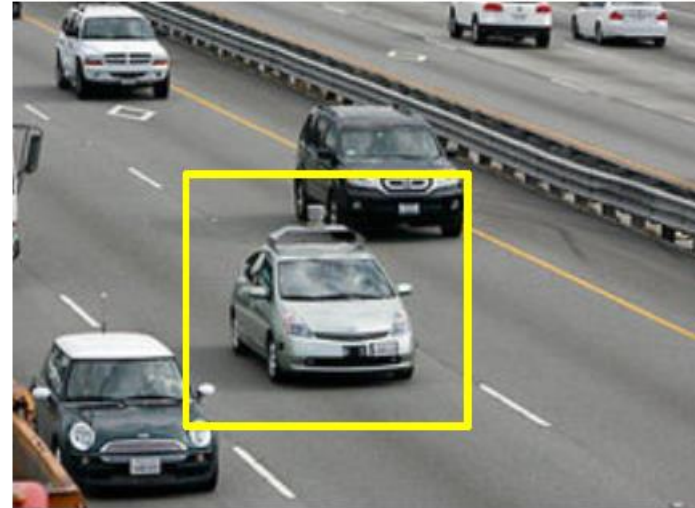


Regression task: given sequence predict  
3D structure

Protein: 1IMT



# Autonomous Cars

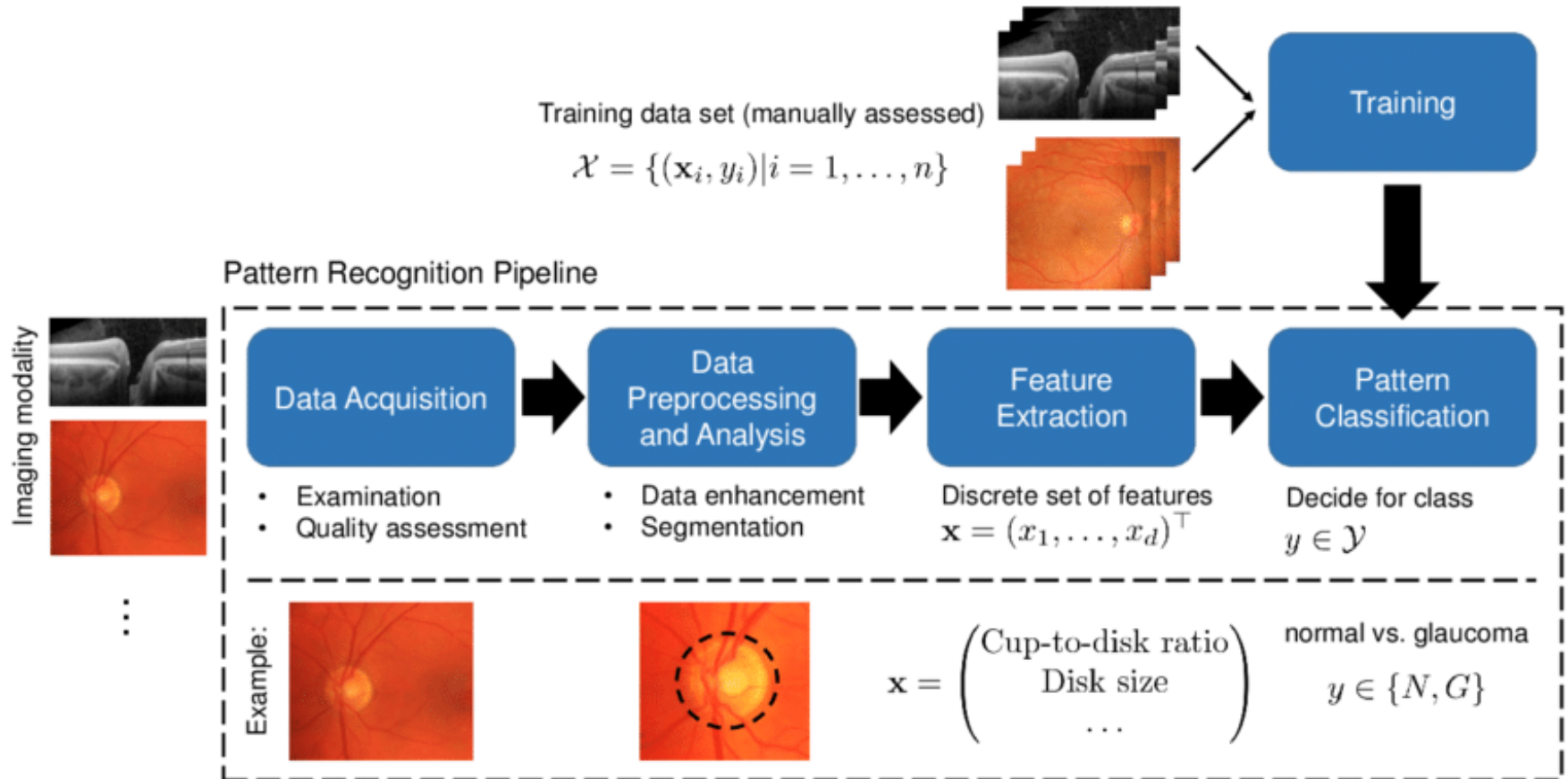


- Nevada made it legal for autonomous cars to drive on roads in June 2011
- As of 2013, four states (Nevada, Florida, California, and Michigan) have legalized autonomous cars

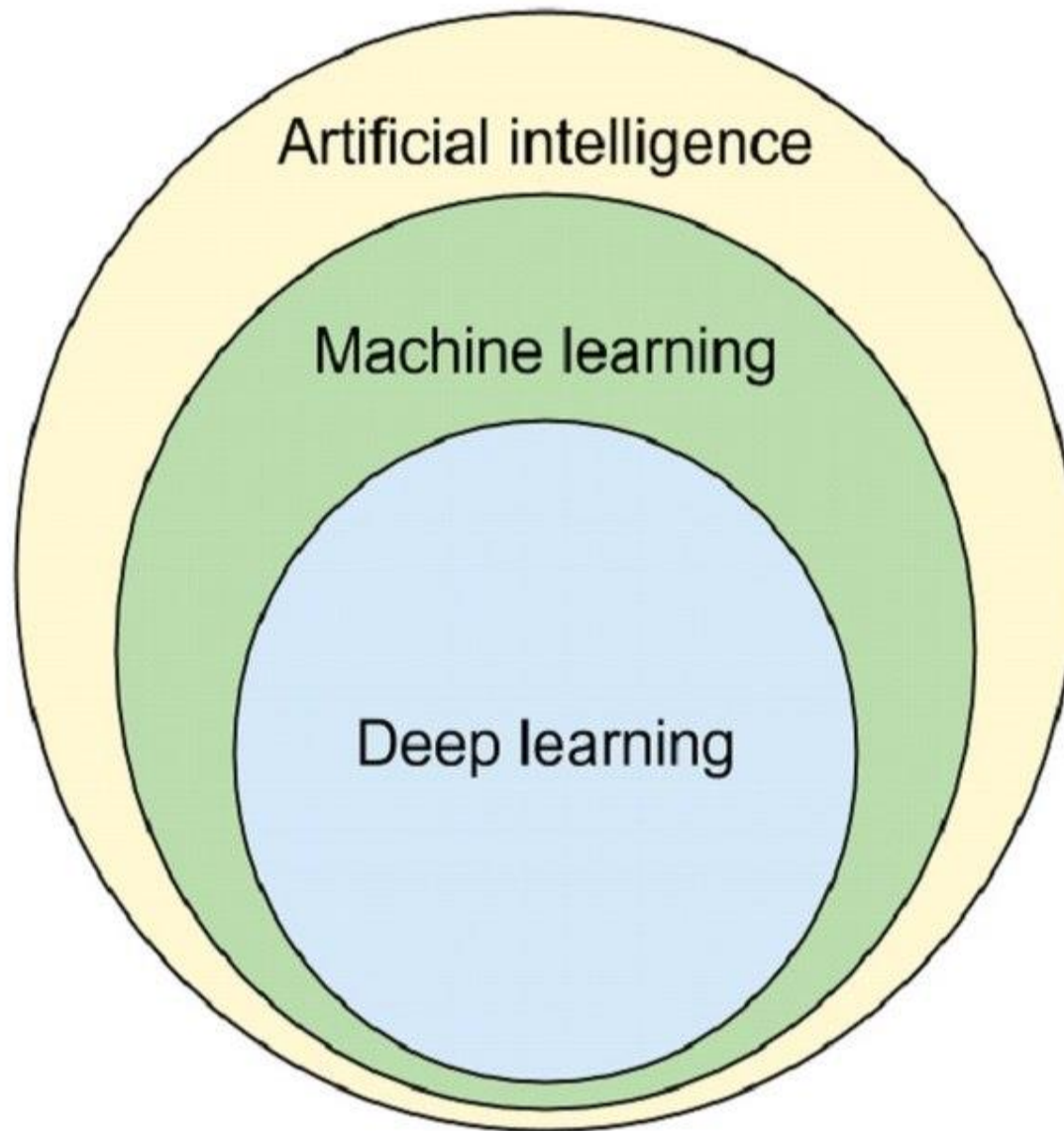
Penn's Autonomous Car →  
(Ben Franklin Racing Team)



# Computer-aided Diagnosis

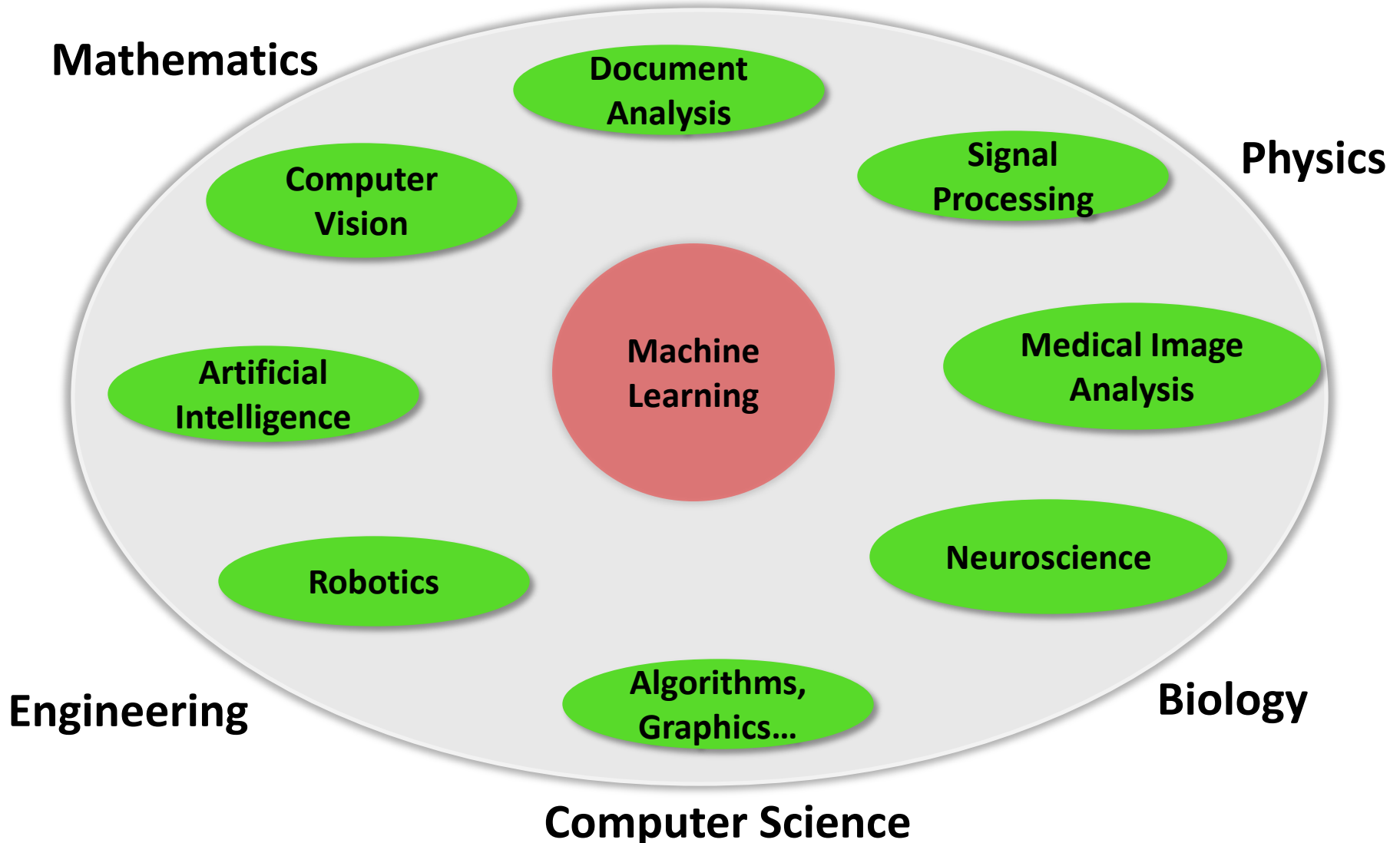


# Relation with AI and DL

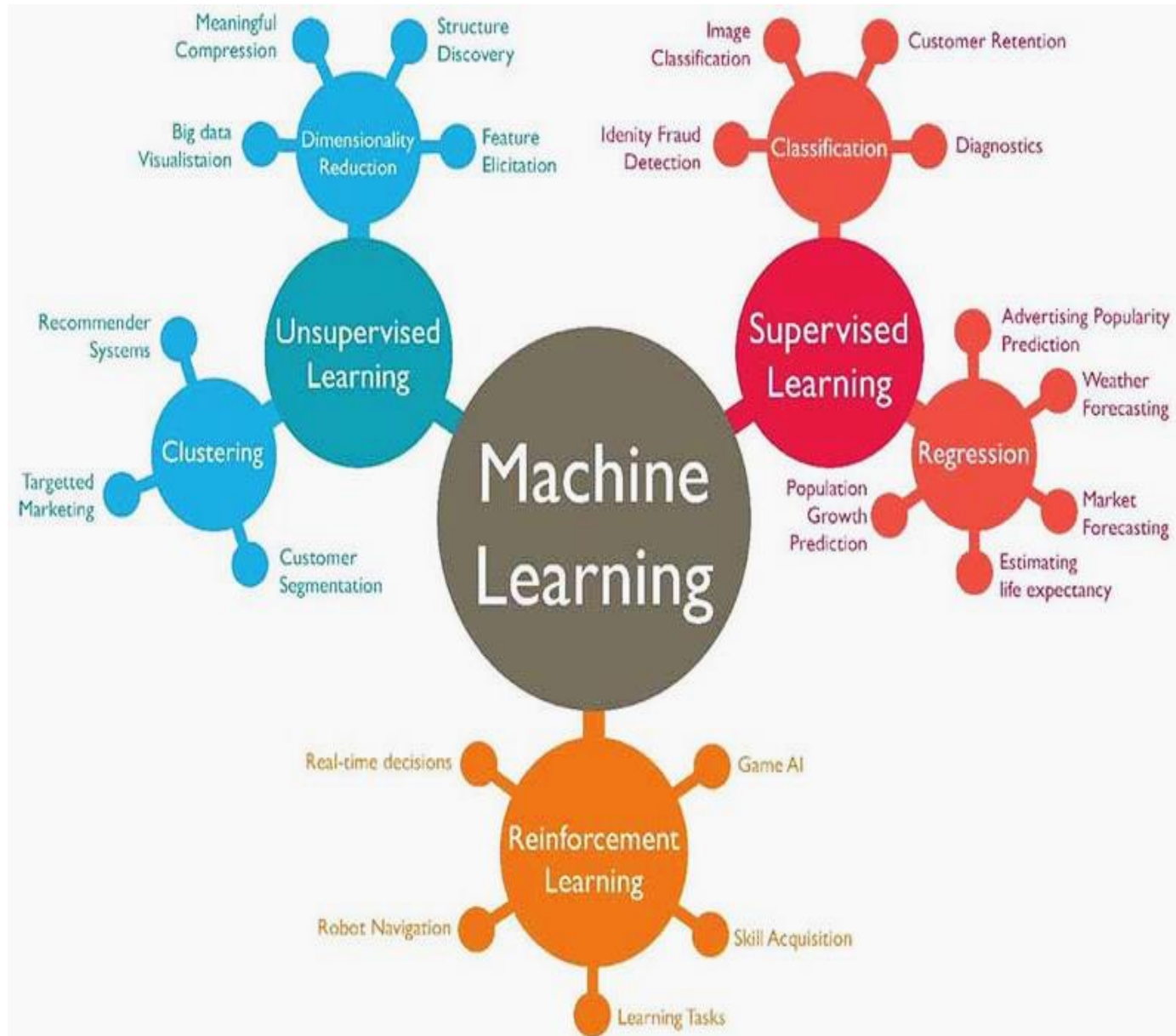




# Relation with Other Fields



# Different Machine Learning Paradigms



**Thank You: Question?**