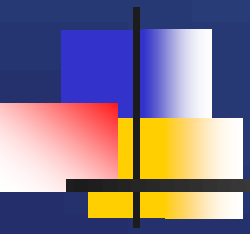


# Machine Learning

# Objectives

1) What is Learning?

2) What is Machine Learning?

3) Steps in machine learning.

4) Types of machine Learning.

5) Applications of  Machine Learning.

# What is Learning?

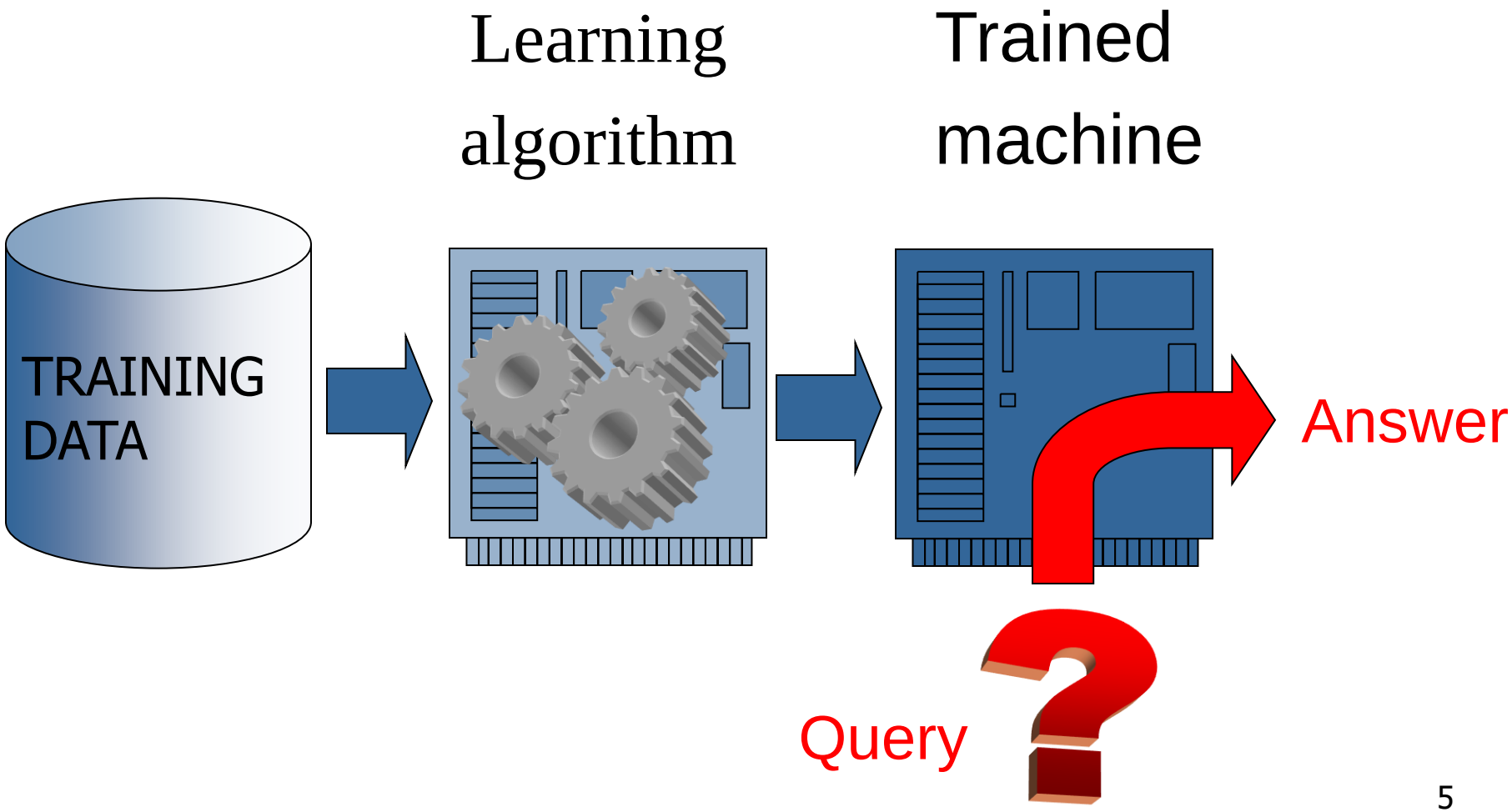
"To gain **knowledge** or **understanding** of, or **skill** in **by study**, **instruction** or **experience**"

- Learning a set of new facts.
- Learning HOW to do something .
- Improving ability of something already learned.

# What is Machine Learning?

- Machine Learning is the study of methods for programming computers to learn.
- Building machines that automatically learn from experience.
- Machine learning usually refers to the changes in systems that perform tasks associated with artificial intelligence AI Such tasks involve recognition, diagnosis, planning, robot control, prediction, etc.

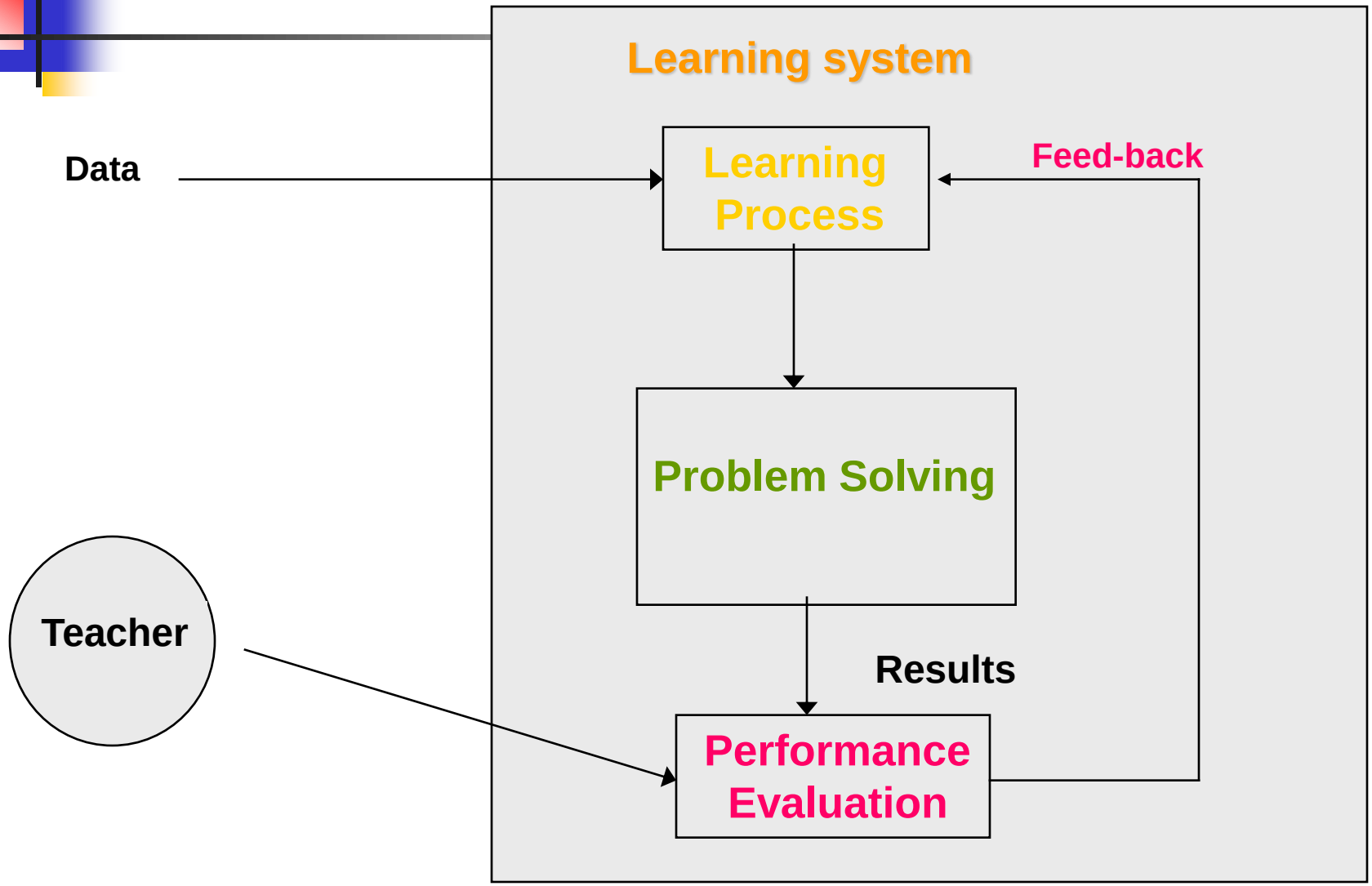
# What is Machine Learning?



# Steps in machine learning

1) **Data collection.**
2) **Representation.**
3) **Modeling.**
4) **Estimation.**
5) **Validation.**
6) **Apply learned model to new “test” data**

# General structure of a learning system

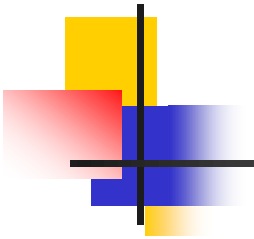


# Advantages of ML

1) Solving vision problems through statistical inference.

2) Intelligence from the common sense AI.

3) Reducing the constraints over time achieving complete autonomy.



# Disadvantages of ML

1) Application specific algorithms.

2) Real world problems have too many variables and sensors might be too noisy.

3) Computational complexity.

# Types of machine Learning

1) Unsupervised Learning .

2) Semi-Supervised (reinforcement).

3) Supervised Learning.

# Unsupervised Learning

- Studies how input patterns can be represented to reflect the statistical structure of the overall collection of input patterns
- No outputs are used (unlike supervised learning and reinforcement learning)
- Learner is provided only unlabeled data.
- No feedback is provided from the environment

# Unsupervised Learning

- **Advantage**
- Most of the laws of science were developed through unsupervised learning.

- **Disadvantage**
- The identification of the features itself is a complex problem in many situations.

# Semi-Supervised (reinforcement)

- it is in between Supervised and Unsupervised learning techniques the amount of labeled and unlabelled data required for training.
- With the goal of reducing the amount of supervision required compared to supervised learning.
- At the same time improving the results of unsupervised clustering to the expectations of the user.

# Semi-Supervised (reinforcement)

- Semi-supervised learning is an area of increasing importance in Machine Learning.
- Automatic methods of collecting data make it more important than ever to develop methods to make use of unlabeled data.

# Supervised Learning

**1) Analogical Learning.**

**2) Learning by Decision Tree.**

# Analogical Learning

instances of a problem and the learner has to form a concept that supports most of the positive and no negative instances. This demonstrates that a number of training instances are required to form a concept in inductive learning. Unlike this, analogical learning can be accomplished from a single example. For instance, given the following training instance, one has to determine the plural form of bacilus.

# Analogical Learning

Problem Instance

| Input (singular) | Output (plural) |
| --- | --- |
| fungus | fungi |

# The main steps in analogical learning are now formalized below.

1. Identifying Analogy: Identify the similarity between an experienced problem instance and a new problem.

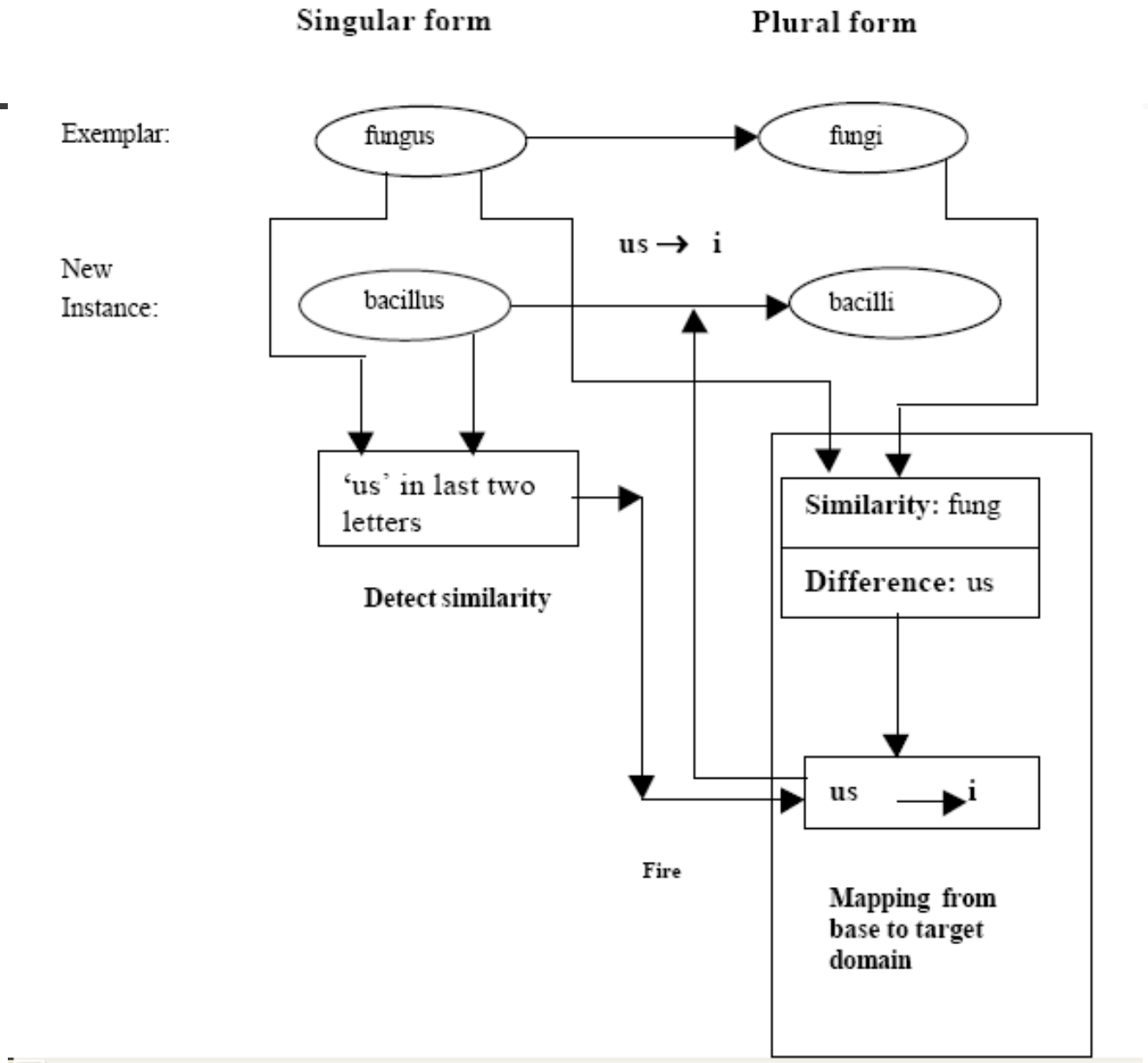
2. Determining the Mapping Function: Relevant parts of the experienced problem are selected and the mapping is determined.

3. Apply Mapping Function: Apply the mapping function to transform the new problem from the given domain to the target domain.

# The main steps in analogical learning are now formalized below.

4. Validation: The newly constructed solution is validated for its applicability through its trial processes like theorem or simulation .

5. Learning: If the validation is found to work well, the new knowledge is encoded and saved for future usage.


Singular form
Plural form
Exemplar:
fungus
fungi
us → i
New Instance:
bacillus
bacilli
'us' in last two letters
Detect similarity
Similarity: fung
Difference: us
us → i
Fire
Mapping from base to target domain

# Learning by Decision Tree

**A decision tree receives a set of attributes (or properties) of the objects as inputs and yields a binary decision of true or false values as output. Decision trees, thus, generally represent Boolean functions. Besides a range of {0,1} other non-binary ranges of outputs are also allowed. However, for the sake of simplicity, we presume the restriction to Boolean outputs. Each node in a decision tree represents 'a test of some attribute of the instance, and each branch descending from that node corresponds to one of the possible values for this attribute'**

# Learning by Decision Tree

To illustrate the contribution of a decision tree, we consider a set of instances, some of which result in a true value for the decision. Those instances are called **positive instances. On the other hand, when the resulting decision** is false, we call the instance '**a negative instance'. We now consider** the learning problem of a bird's flying. Suppose a child sees different instances of birds as tabulated below.

# Learning by Decision Tree

| Instances | No. of wings | Broken wings if any | Living status | Wing area/ weight of bird | Fly |
|---|---|---|---|---|---|
| 1. | 2 | 0 | alive | 2.5 | True |
| 2. | 2 | 1 | alive | 2.5 | False |
| 3. | 2 | 2 | alive | 2.6 | False |
| 4. | 2 | 0 | alive | 3.0 | True |
| 5. | 2 | 0 | dead | 3.2 | False |
| 6. | 0 | 0 | alive | 0 | False |
| 7. | 1 | 0 | alive | 0 | False |
| 8. | 2 | 0 | alive | 3.4 | True |
| 9. | 2 | 0 | alive | 2.0 | False |

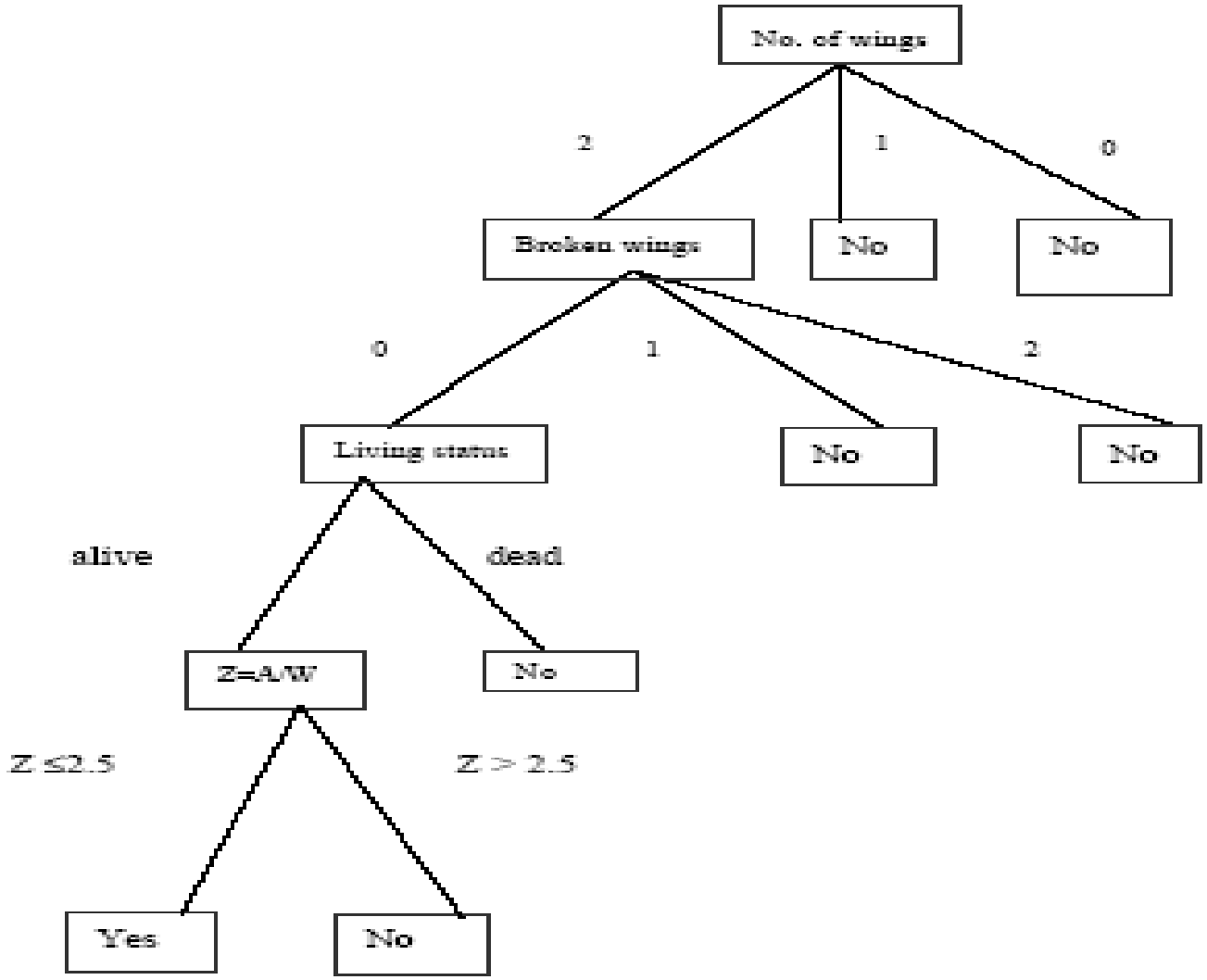
# Decision Tree example

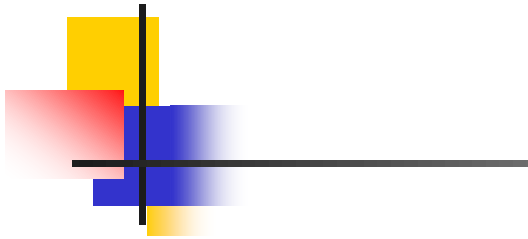
It is seen from the above table that Fly = true if (no. of wings=2)∧ (broken wings=0)∧(living status-alive)∧((wing area / weight) of the bird ≥2.5) is true.

Thus we can write:

Fly = (no. of wings = 2) ∧ (broken wings = 0 ) ∧ (living status = alive) ∧ (wing area / weight (A/W) ≥ 2.5)

# Decision Tree example

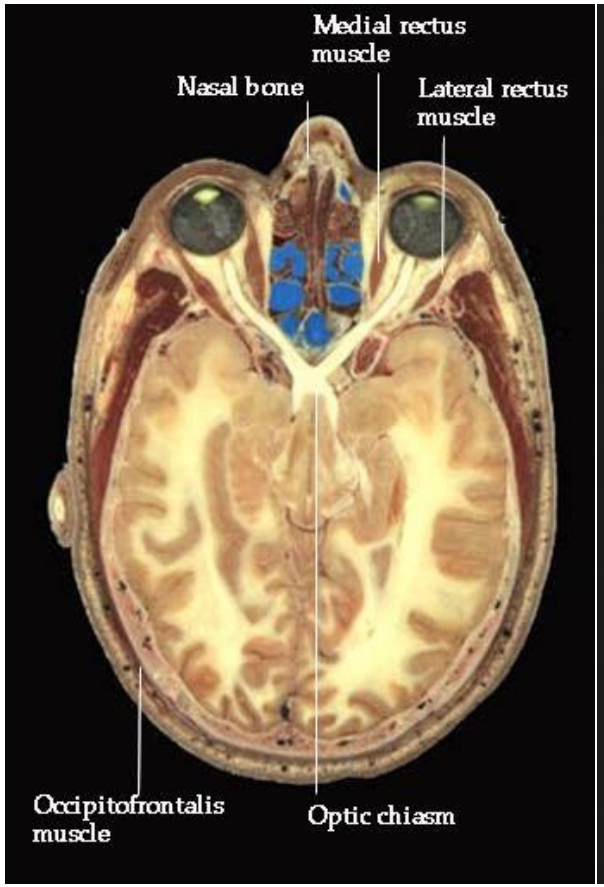


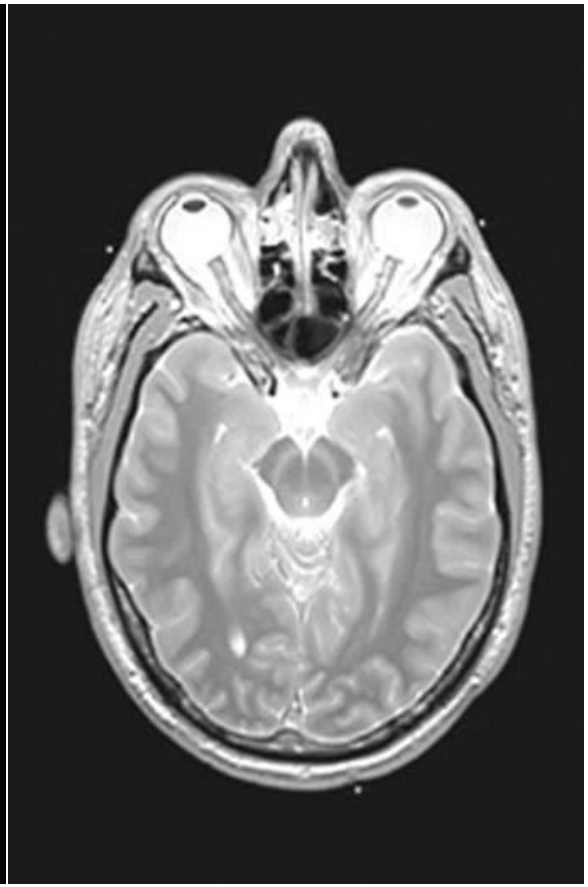


# Applications of Machine Learning

# Drug discovery

# Medical diagnosis



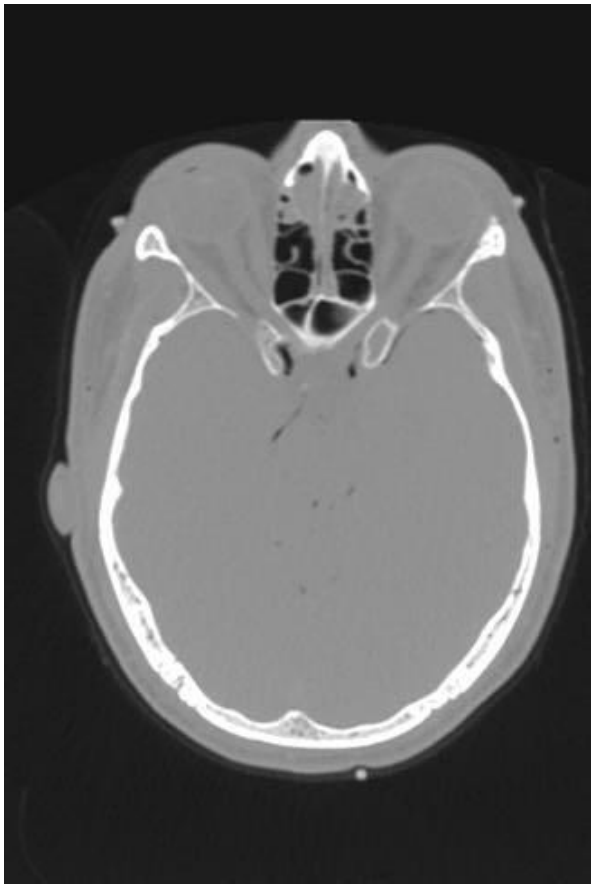
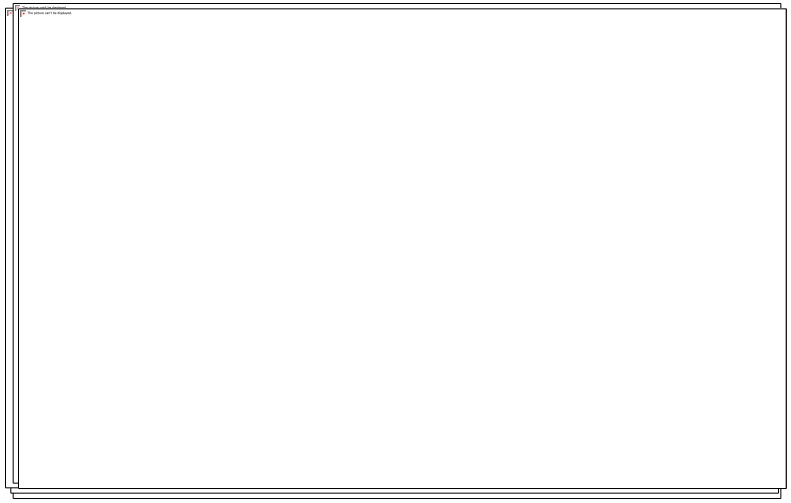
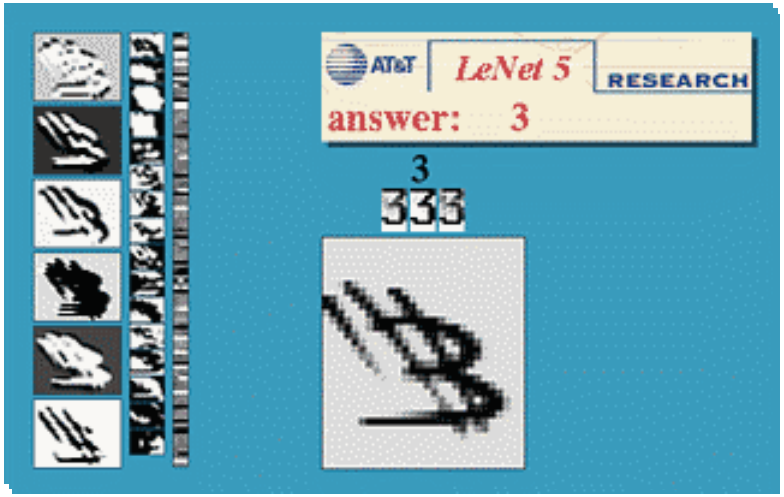


Photo MRI CT

# Iris verification

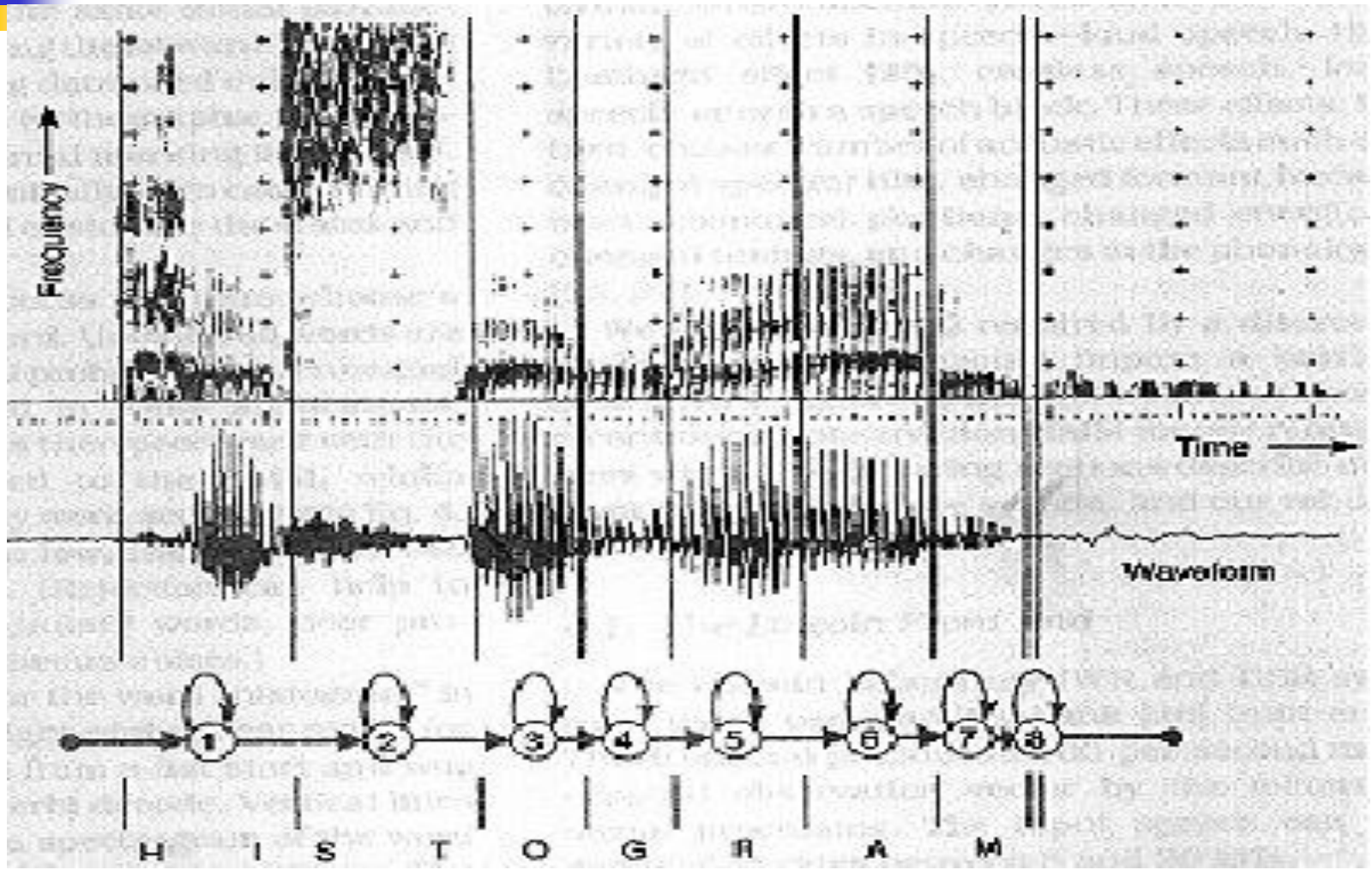
# Hand-written digits



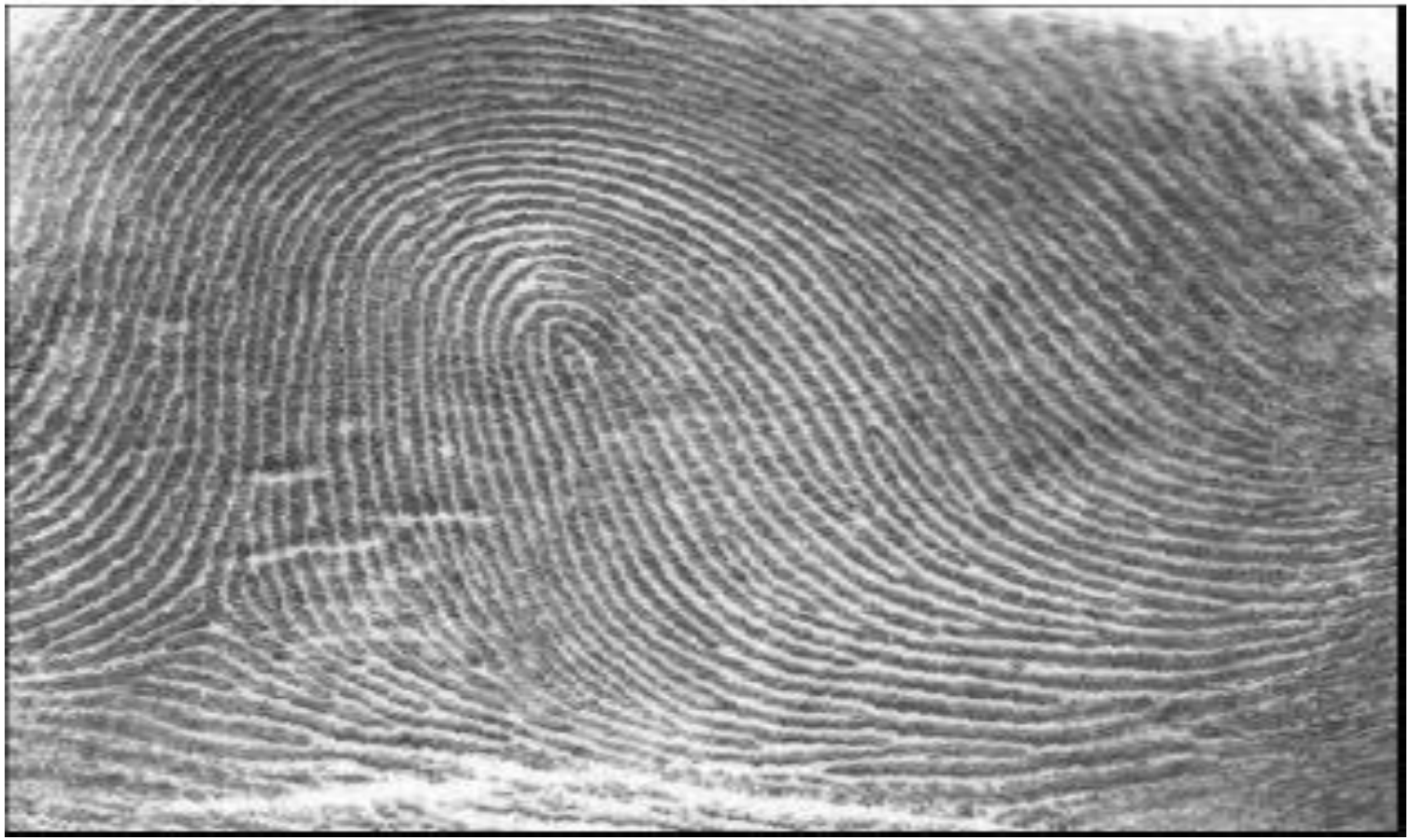



# Radar Imaging

# Speech Recognition



# Finger print

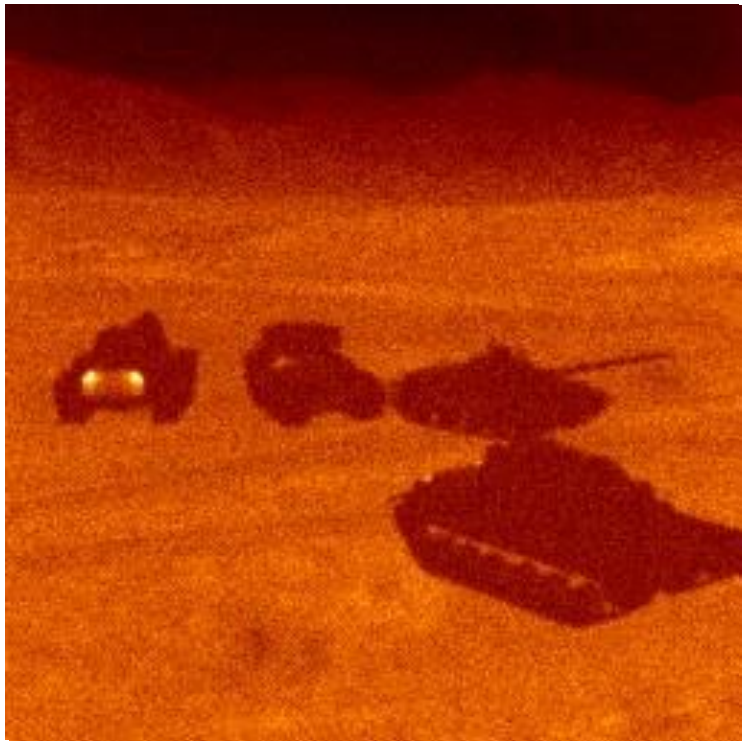


fingerprint image

# Signature Verification

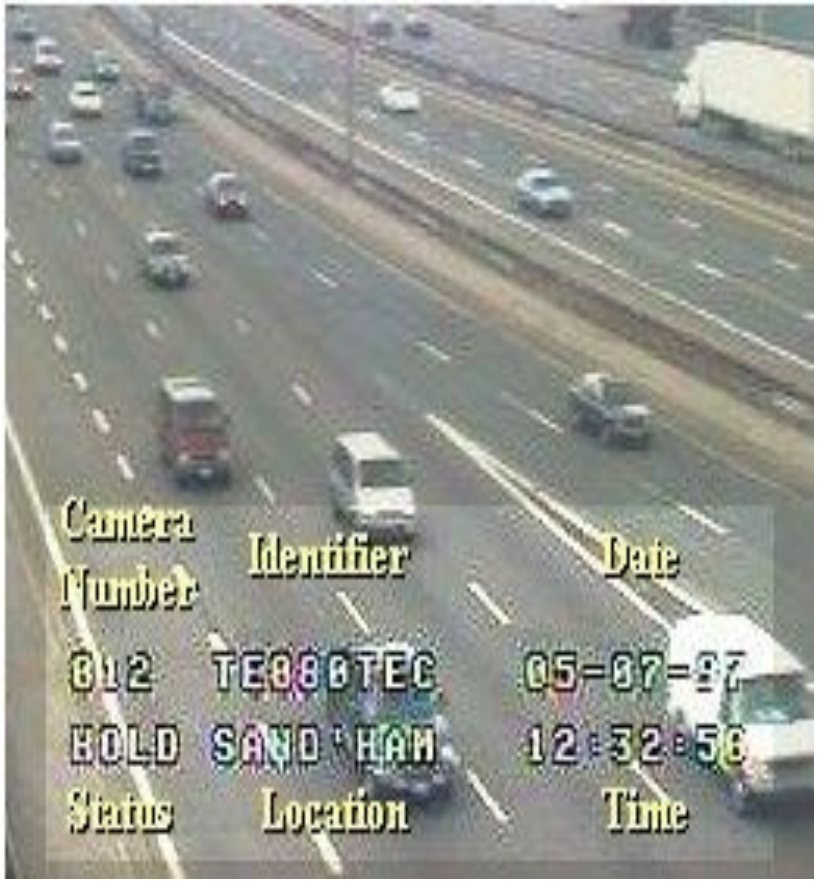
# Face Recognition

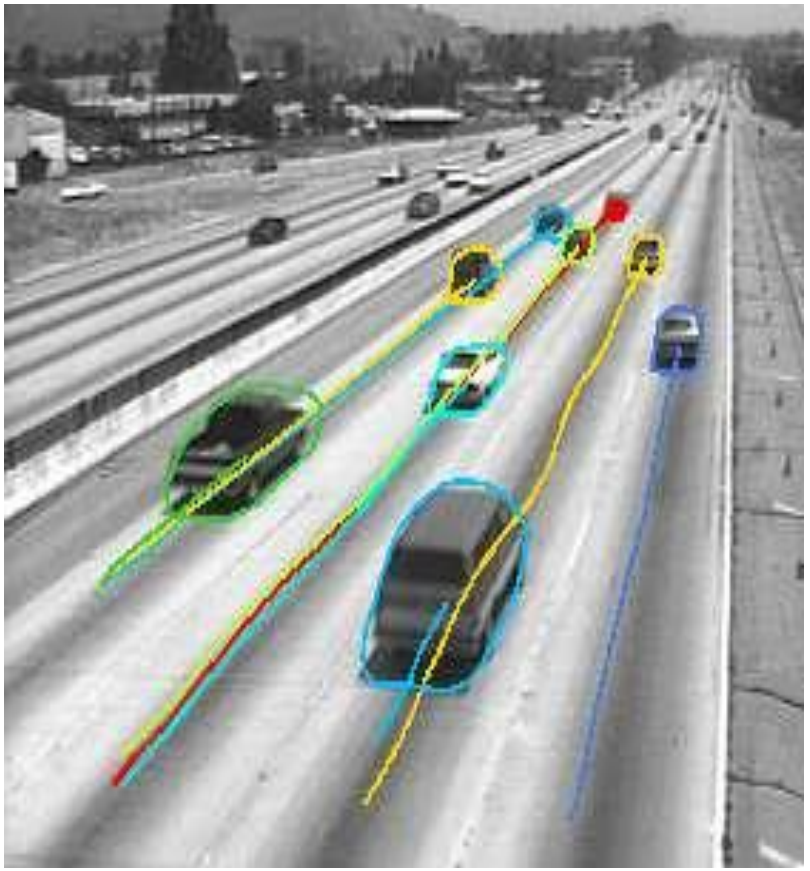
# Target Recognition



# Robotics vision

# Traffic Monitoring



# Thank you