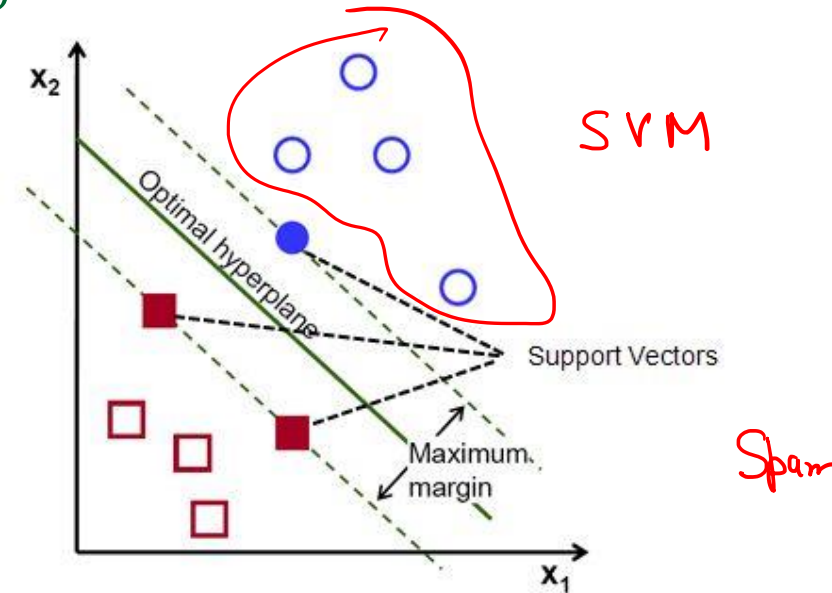
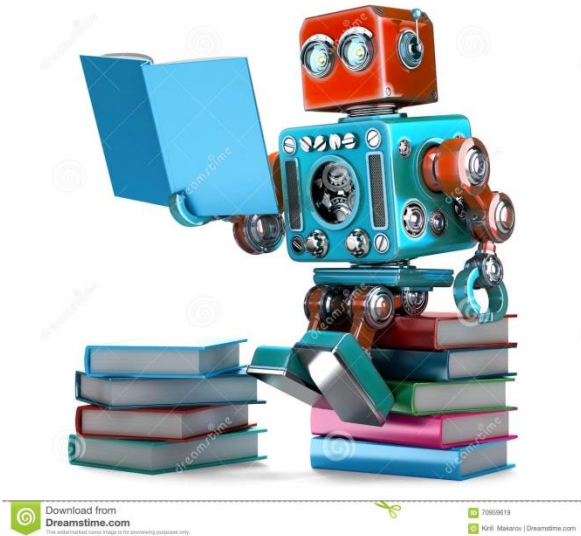


The background of the slide features a circular diagram with four blue rectangular boxes connected by a circular arrow, representing the machine learning process. The boxes are labeled 'Train model' (top), 'Apply model' (right), 'Capture feedback' (bottom), and 'Prepare data' (left). The entire diagram is set against a light blue background with a faint circuit board pattern. The title 'Mathematics for Machine Learning' is centered over the diagram in a green serif font, flanked by two horizontal gold lines.

Mathematics for Machine Learning

Overview of the Machine Learning Process

What is Machine Learning?



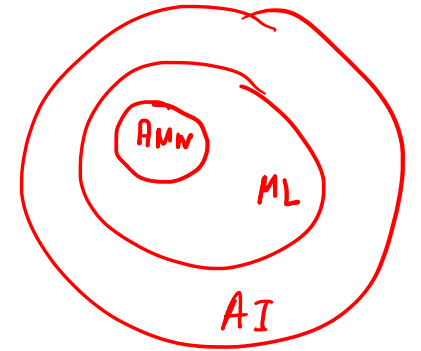
- Simple Definition -- Using Data to answer questions
- Study of computer algorithms
 - that improve automatically
 - through experience.
- Formally, A computer program is said to learn from experience \checkmark \downarrow \downarrow \bar{E} with respect to some class of tasks \bar{T} and performance measure \bar{P} if its performance at tasks in T , as measured by P , improves with experience E .

When is Machine Learning useful?

- When experts are unable to explain their expertise
 - Image recognition
 - Speech recognition
 - Driving a car
- When Human expertise does not exist
 - Hazardous environments -- Navigating on Mars
- Solution changes in time
 - Routing on a computer network
 - Financial markets prediction
- Solution needs to be adapted to particular cases
 - User biometrics

Some common terms

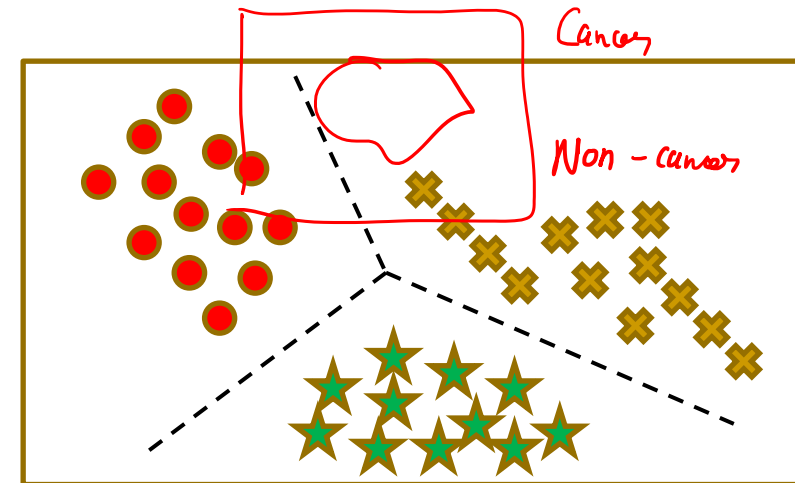
- Artificial Intelligence – Any method that tries to replicate some aspect of human cognition
- **Machine Learning** – Programs that perform better with experience.
- Big Data – Using data to find unobvious patterns
- **Artificial Neural Networks** (ANN) – A Machine Learning algorithm
- **Deep Learning** – A type of ANN



Types of learning approaches

■ Supervised Learning

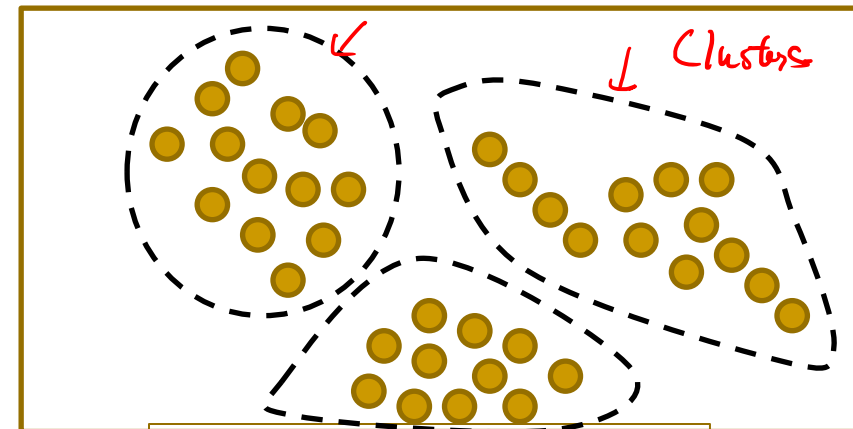
- Data labeled by human experts
- Labeling images
- Speech recognition
- OCR



Supervised learning

■ Unsupervised Learning

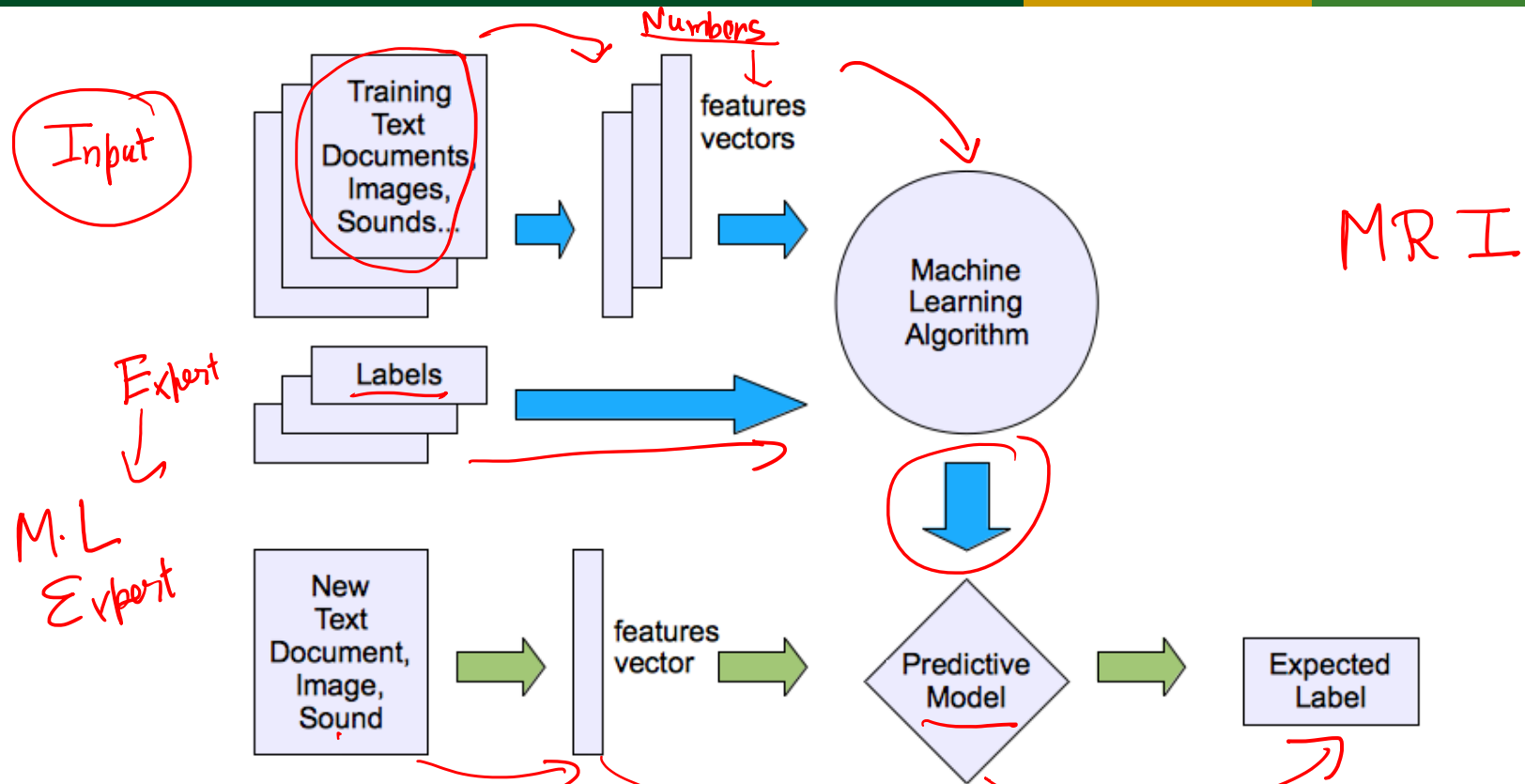
- Unlabeled data
- Grouping customers
- Detecting new diseases



Unsupervised learning

A third, very powerful approach is Reinforcement Learning. Combines with both

General structure of ML process



Which is this -- Unsupervised or supervised learning?

Philosophical underpinning of NN: All problems are data, all solutions are functions *Map*

Seven Steps in Machine Learning

1. Gathering Data

- Deciding what “data” means is part of the problem

2. Preparing Data

- Ensuring that there is no bias

3. Choosing a Model/Algorithm

- Examples – Random Forest, ANNs, Hidden Markov Models, etc

4. Training

- Using data to determine model parameters

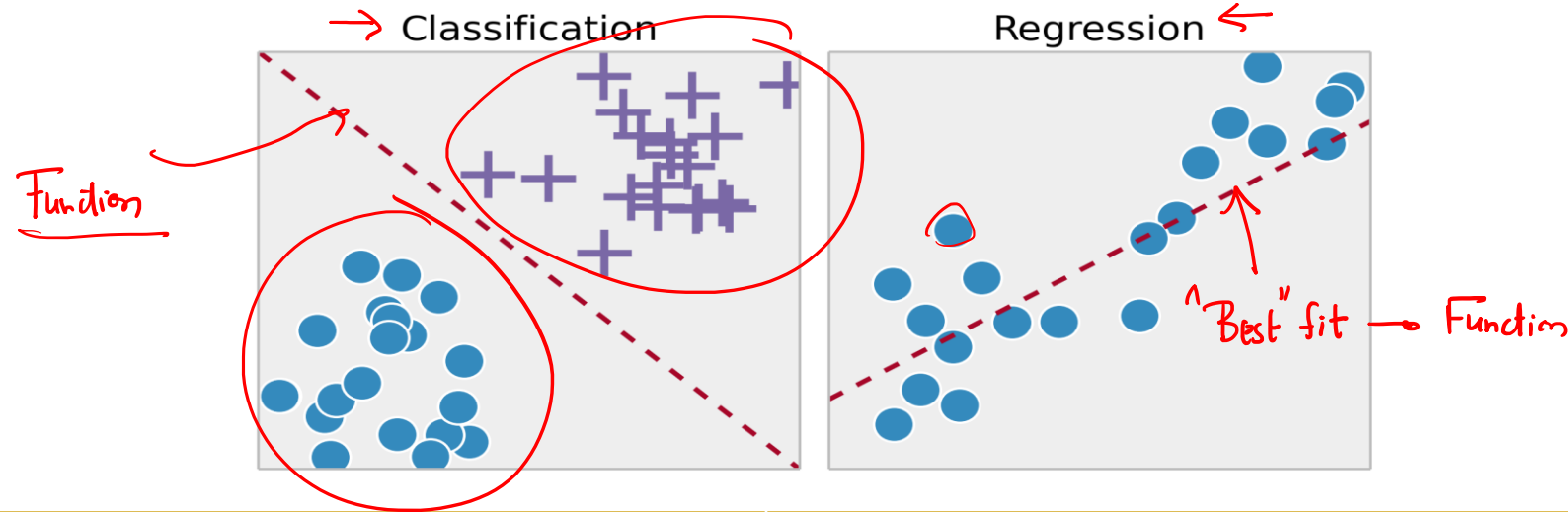
5. Evaluation – How well did we do? → TEST

6. Hyperparameter Tuning

7. Prediction → Real case

Input → Map → Output

Two problems in Supervised Learning



Classification	Regression
(Split it) ←	Fit it
<u>Discrete</u> or Categorical data.	<u>Real number data</u>
Has category associated	Has associated <u>number</u>
Example : <u>Tumour classification</u>	Example : Prediction of stock market

Philosophical underpinning of NN: All problems are data, all solutions are functions