TON DUC THANG UNIVERSITY
Faculty of Information Technology
Computer Science

Introduction to Machine Learning

LÊ ANH CƯỜNG

Outline

1. What are AI systems?
2. A general paradigm for AI systems and the ML component
3. Examples of ML models
4. The tasks of Machine Learning
5. History of ML
6. Topics of this course

What are AI Systems?

- Why AI?
- Domains of AI Applications

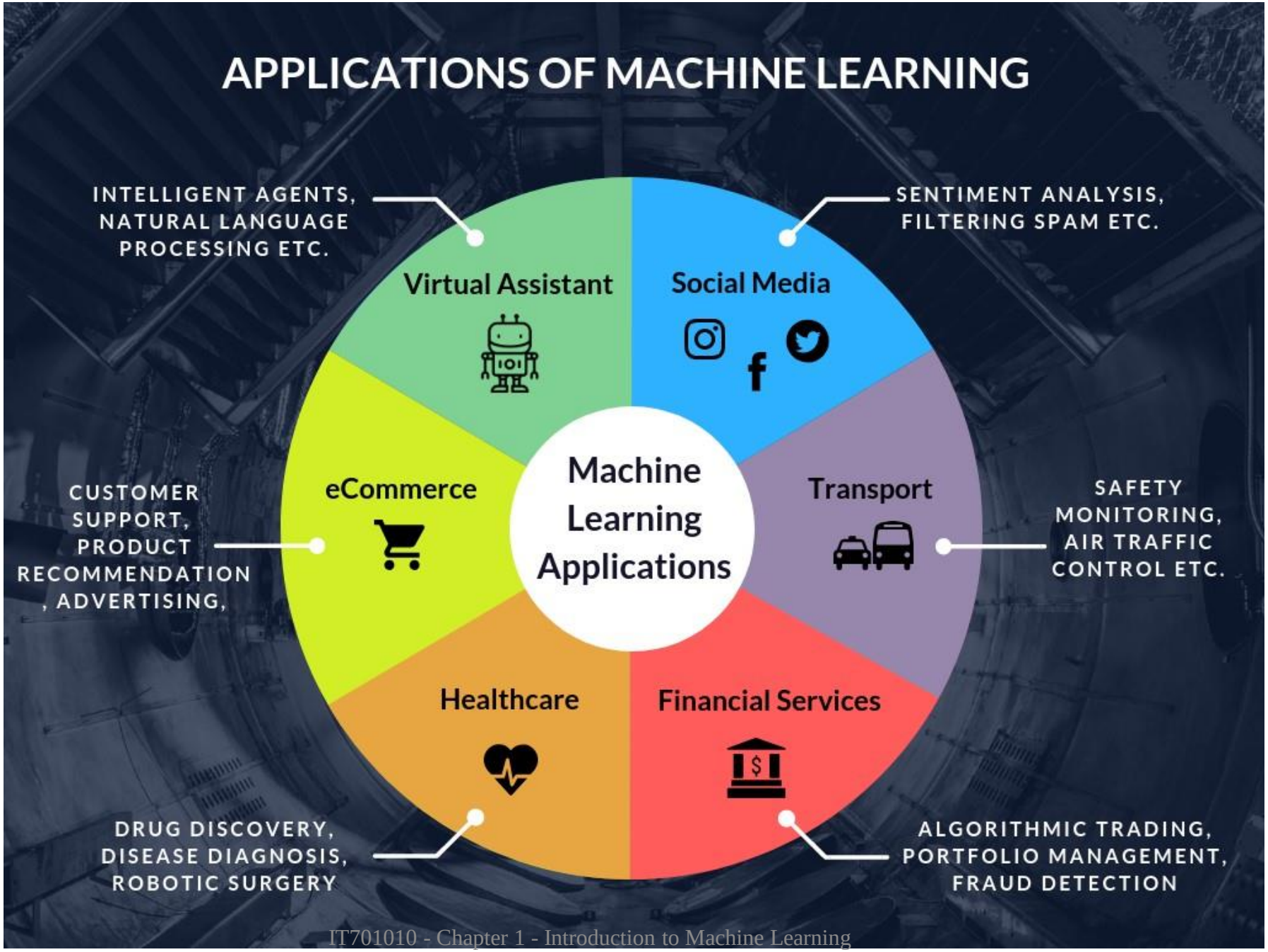
Why AI?

- AI is as capable as an expert
- AI acts as smart as humans
- AI solves difficult and complex problems
- AI offers optimal solutions to problems

Why AI?
AI capabilities

- AI adds intelligence to existing products.
- AI achieves incredible accuracy
- AI analyzes more and deeper data -> new knowledge

https://www.sas.com/en_us/insights/analytics/what-is-artificial-intelligence.html


APPLICATIONS OF MACHINE LEARNING
INTELLIGENT AGENTS, NATURAL LANGUAGE PROCESSING ETC.
Virtual Assistant
SENTIMENT ANALYSIS, FILTERING SPAM ETC.
Social Media
CUSTOMER SUPPORT, PRODUCT RECOMMENDATION , ADVERTISING,
eCommerce
Machine Learning Applications
Transport
SAFETY MONITORING, AIR TRAFFIC CONTROL ETC.
Healthcare
Financial Services
DRUG DISCOVERY, DISEASE DIAGNOSIS, ROBOTIC SURGERY
ALGORITHMIC TRADING, PORTFOLIO MANAGEMENT, FRAUD DETECTION

Domains of applying AI

- Retail
  - AI provides virtual shopping capabilities that offer personalized recommendations and discuss purchase options with the consumer.
- Banking
  - Artificial Intelligence enhances the speed, precision and effectiveness of human efforts. In financial institutions, AI techniques can be used to identify which transactions are likely to be fraudulent, adopt fast and accurate credit scoring, as well as automate manually intense data management tasks.
- Games
  - AI in games is about planning. The artificial agent must decide on the next best action(s) to perform depending on the state of the game.

Domains of applying AI

- Transportation
  - autonomous cars; navigation system; monitoring traffic lights;
- Logistics and Warehouse Management
  - Logistics and warehouses management are two very complex problems. They depends on many parameters difficult to model, some of them even time-dependent.
- Machine Translation
- Virtual Assistant
- Computer Vision
- Healthcare
- …

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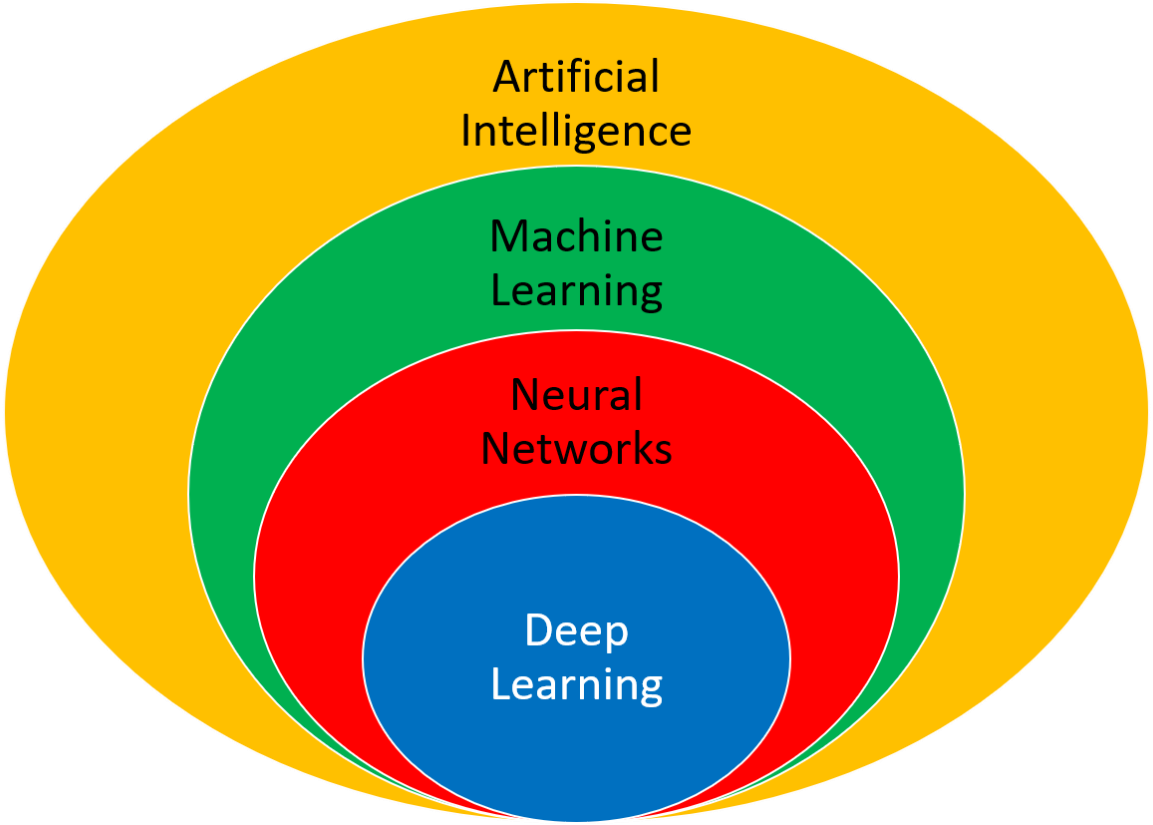
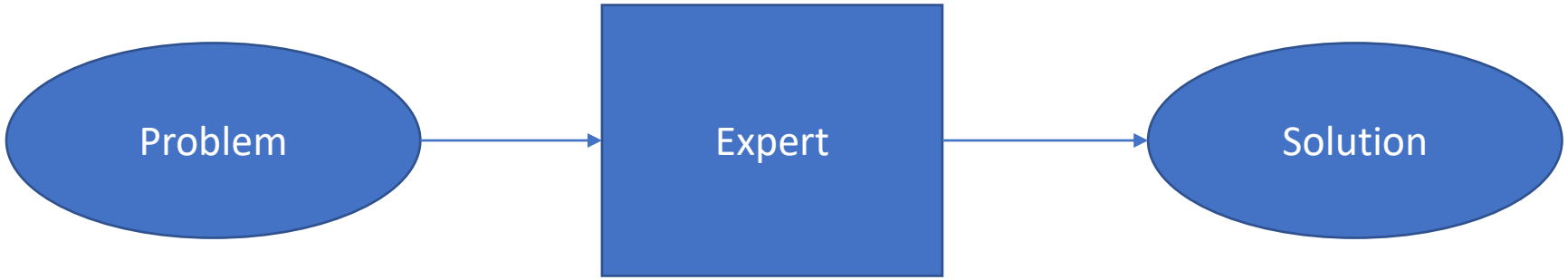
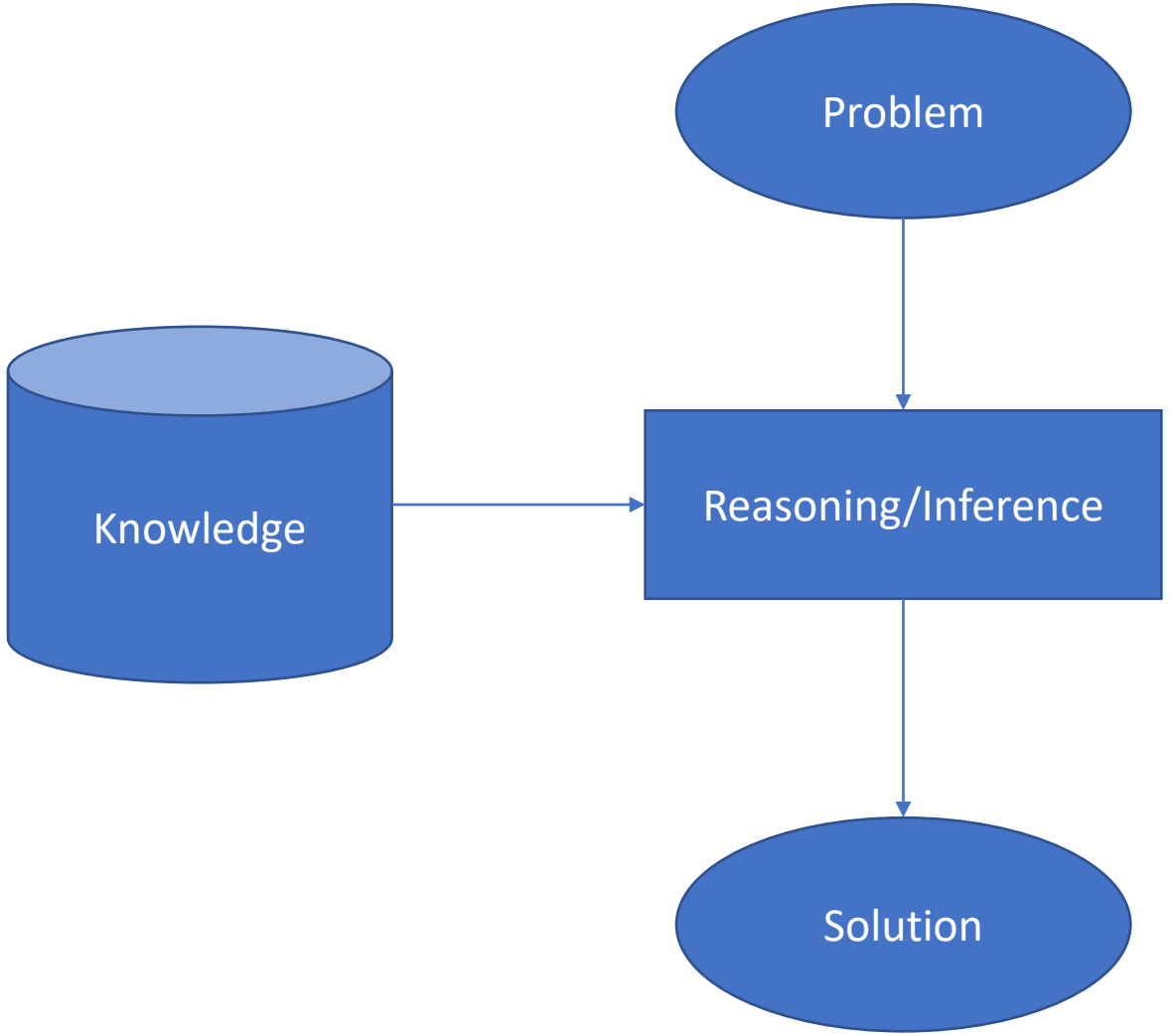
AI, Machine Learning, and Deep Learning



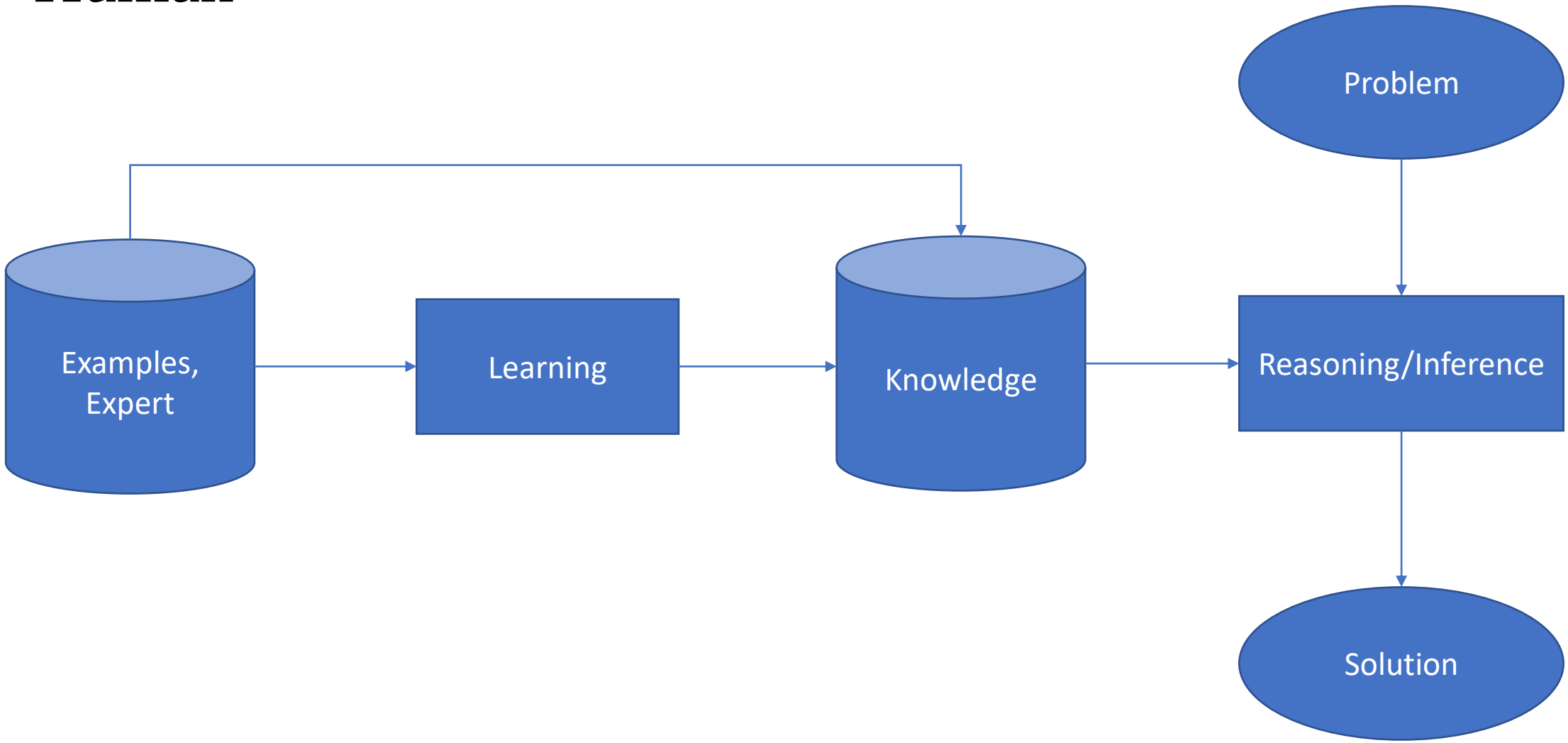
How does a person solve problems?



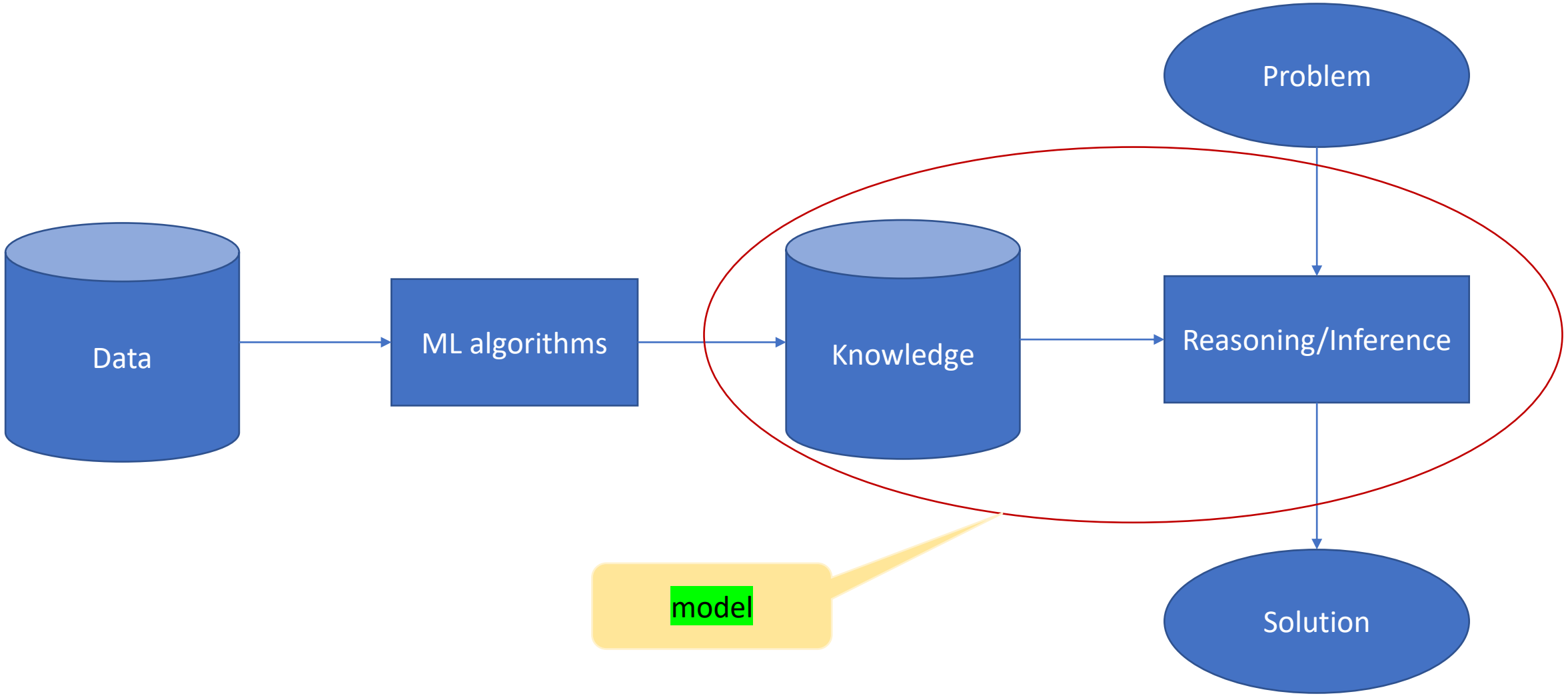
Human



Human


Problem
Examples, Expert
Learning
Knowledge
Reasoning/Inference
Solution

A General Paradigm of AI Systems



What are ML components in AI systems?

- Model
- Learning algorithms/methods

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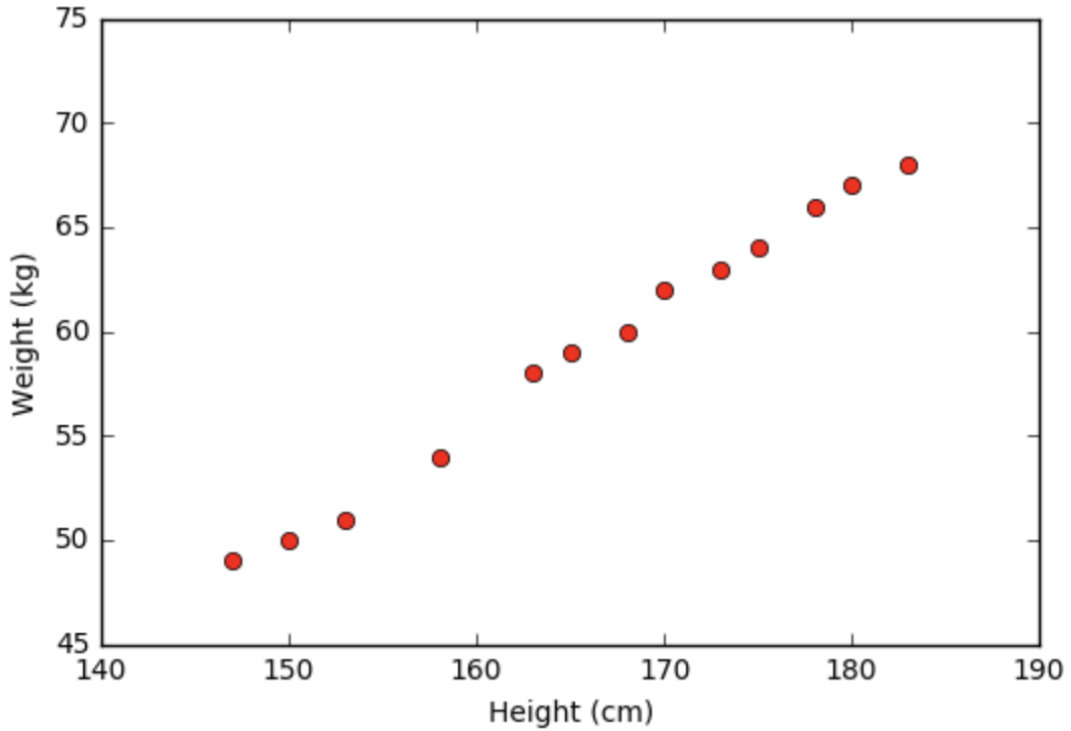
ML model: example 1

Chiều cao (cm)	Cân nặng (kg)	Chiều cao (cm)	Cân nặng (kg)
147	49	168	60
150	50	170	72
153	51	173	63
155	52	175	64
158	54	178	66
160	56	180	67
163	58	183	68
165	59		



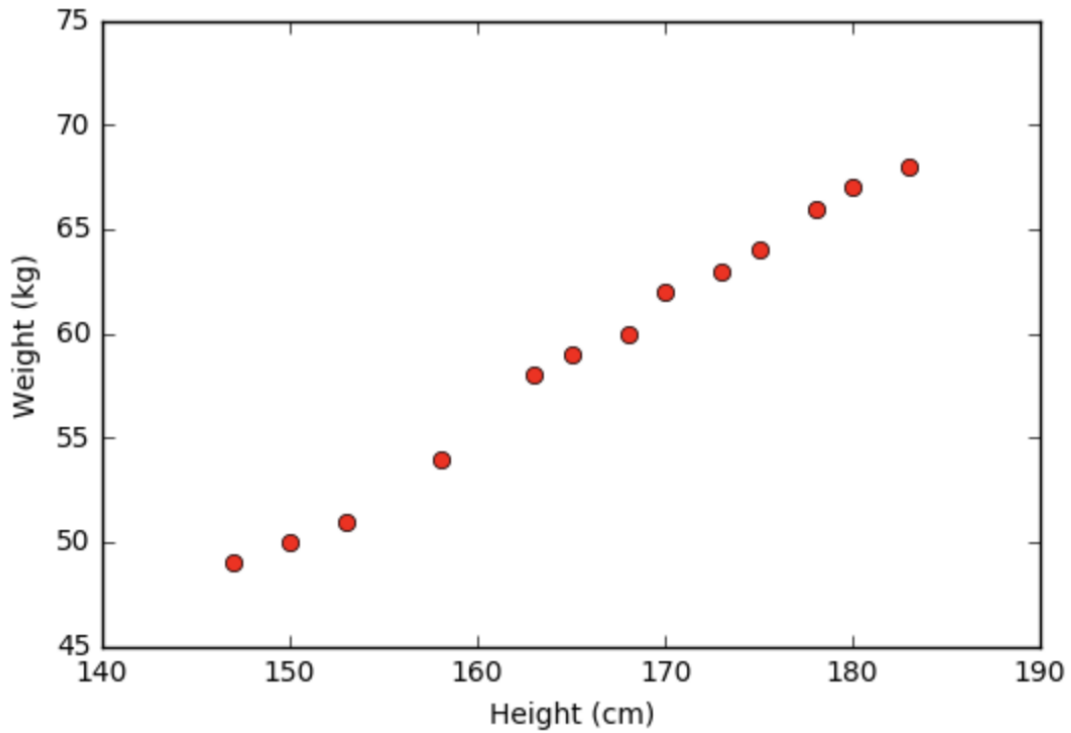
(cân nặng) = w_1*(chiều cao) + w_0

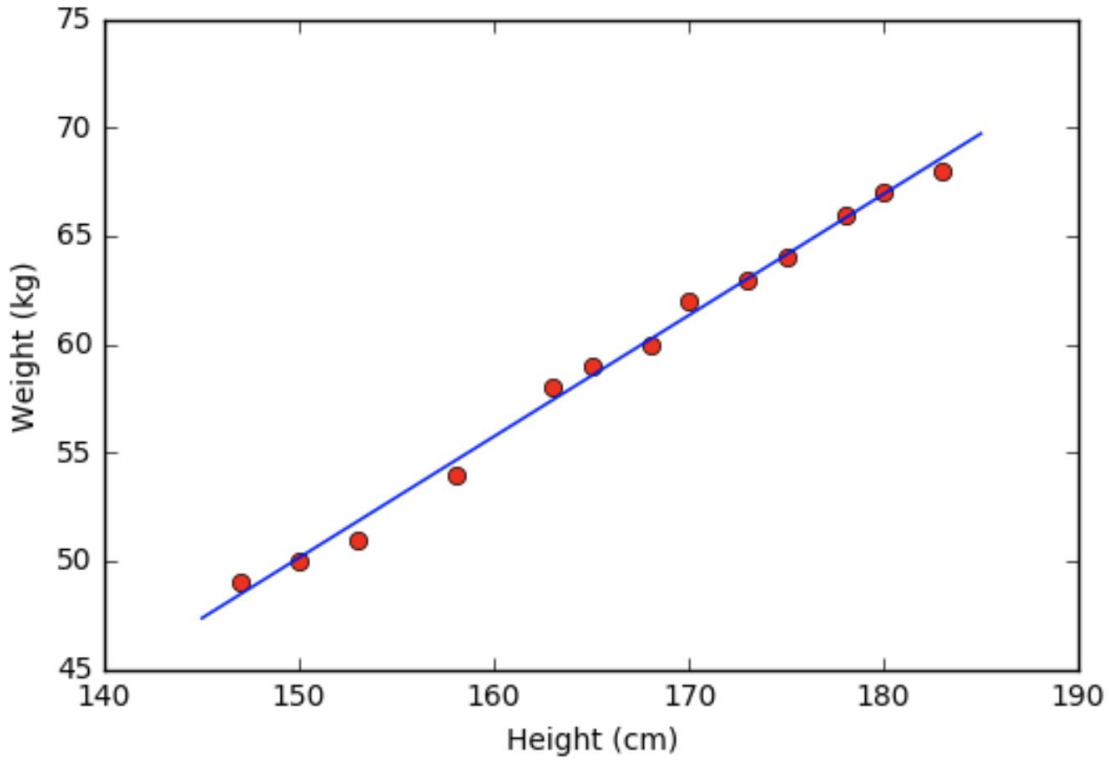
$$y = ax + b$$

(cân nặng) = w_1*(chiều cao) + w_0

```
w =  [[-33.73541021]
 [  0.55920496]]
```

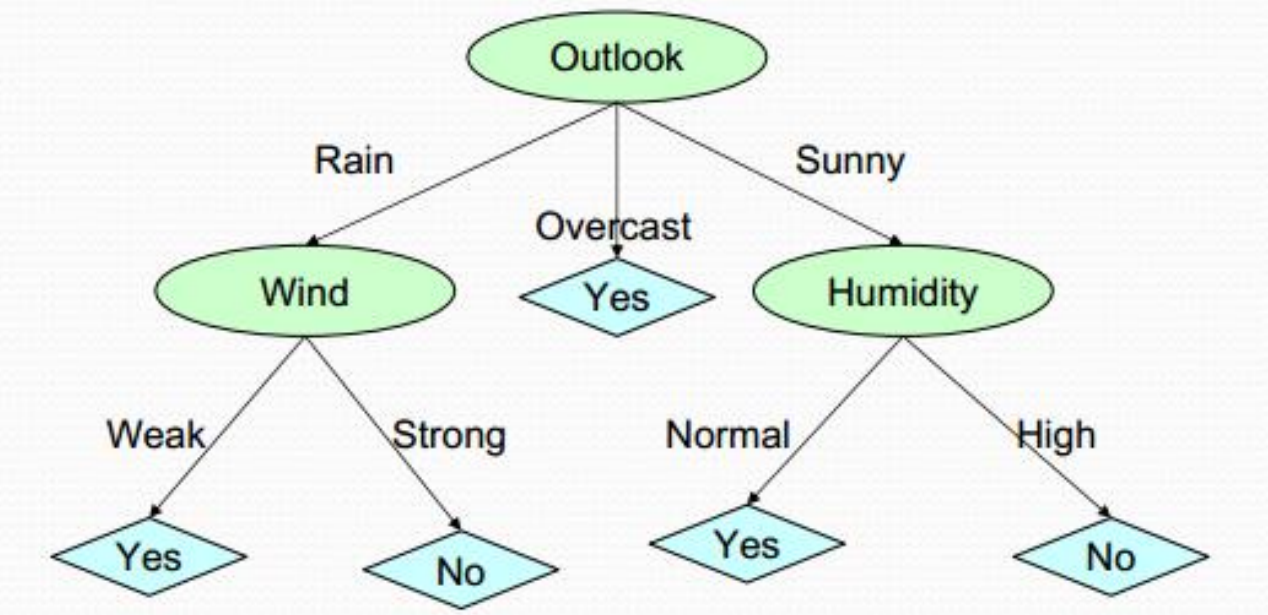
$$y = ax + b$$



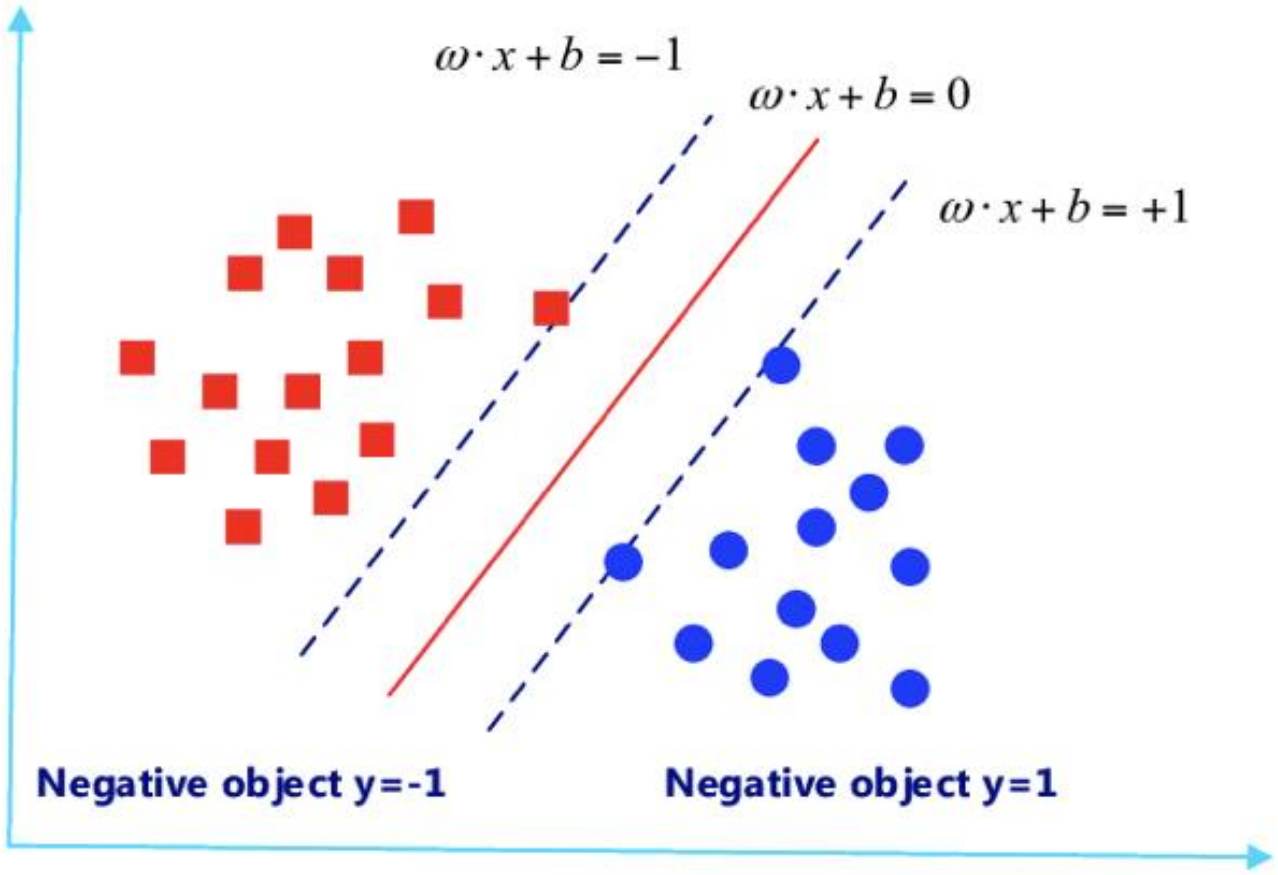


ML model: example 2

Outlook	Tempreature	Humidity	Windy	Class
sunny	hot	high	false	N
sunny	hot	high	true	N
overcast	hot	high	false	P
rain	mild	high	false	P
rain	cool	normal	false	P
rain	cool	normal	true	N
overcast	cool	normal	true	P
sunny	mild	high	false	N
sunny	cool	normal	false	P
rain	mild	normal	false	P
sunny	mild	normal	true	P
overcast	mild	high	true	P
overcast	hot	normal	false	P
rain	mild	high	true	N



ML model: example 3



How to understand Learning?

=> learn values for model's parameters by inferencing from given examples

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What should be learnt in Machine Learning?

- Understanding ML models
  - Architecture, Structure, or form of the models
  - Computation, inference/reasoning
- Methods/Algorithms for learning models' parameters
- Model evaluation
- ML problems: overfitting, sparse data, regularization, normalization

The Task of Machine Learning

- Developing efficient models
- Learning with big data
- Learning with high dimension data
- Developing efficient learning methods
- Related tasks:
  - Feature extraction, feature selection
  - Data representation
  - Dimensional reduction of data
  - Missing data
  - Mixed data (multiple types of data)

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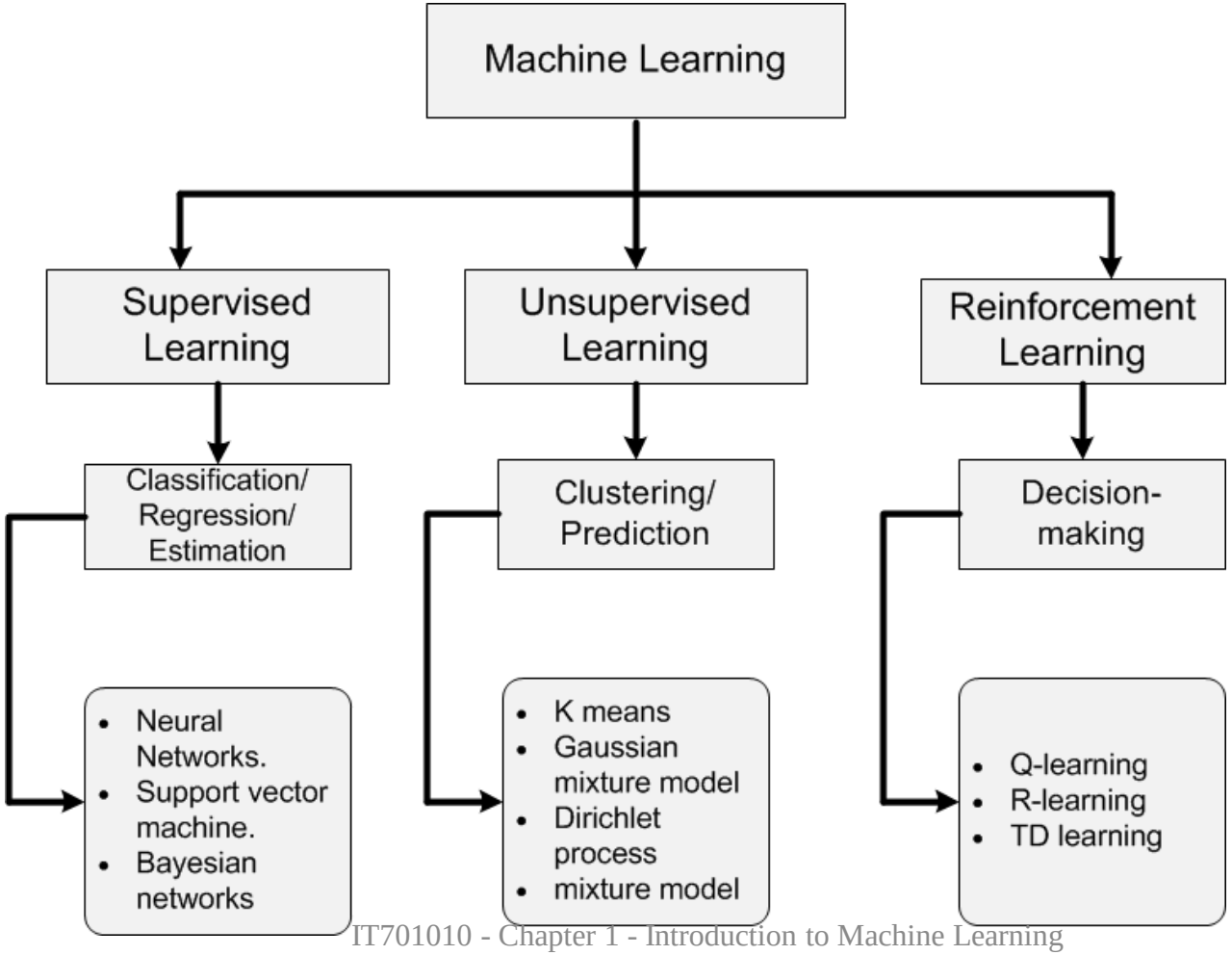
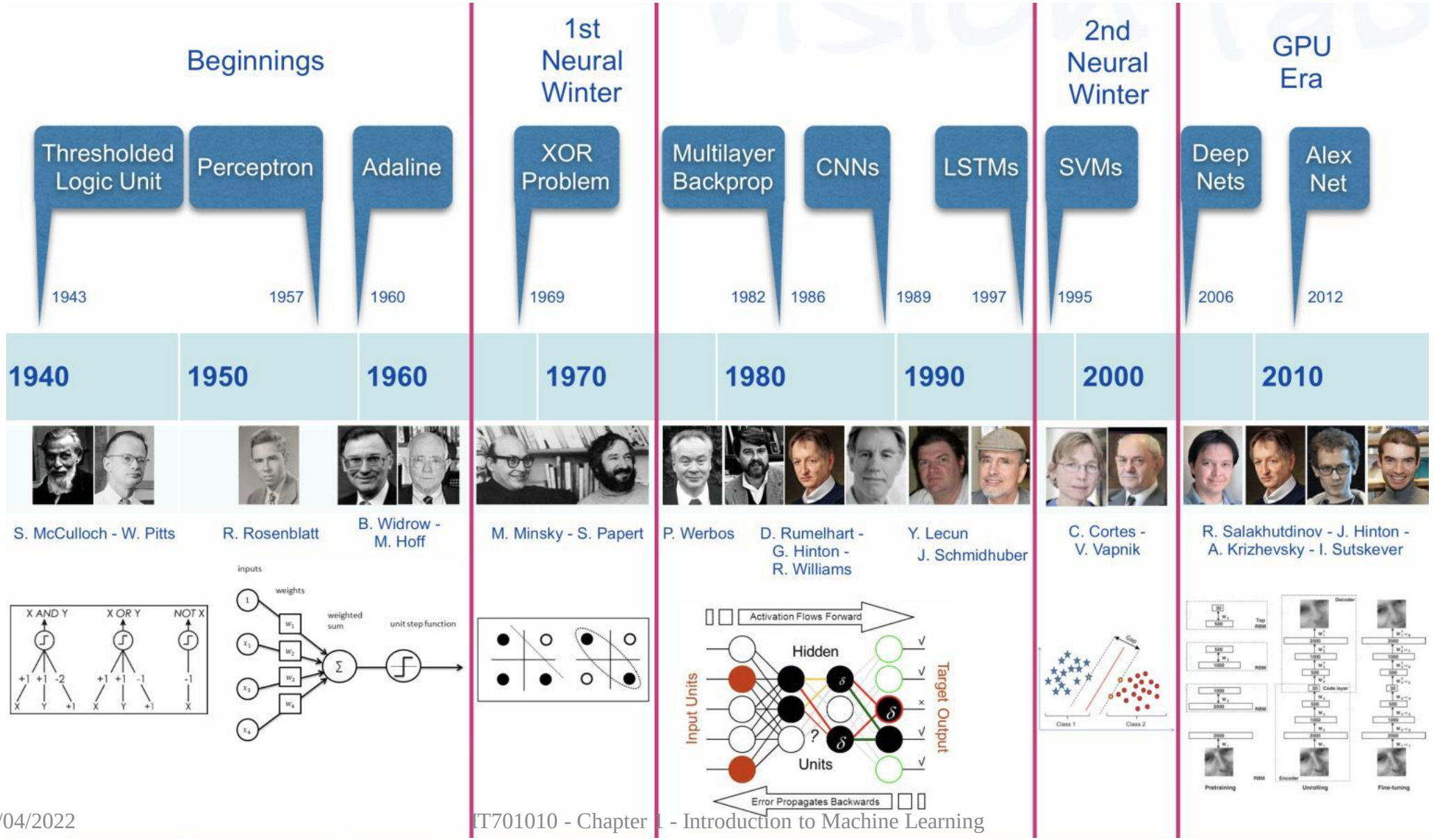
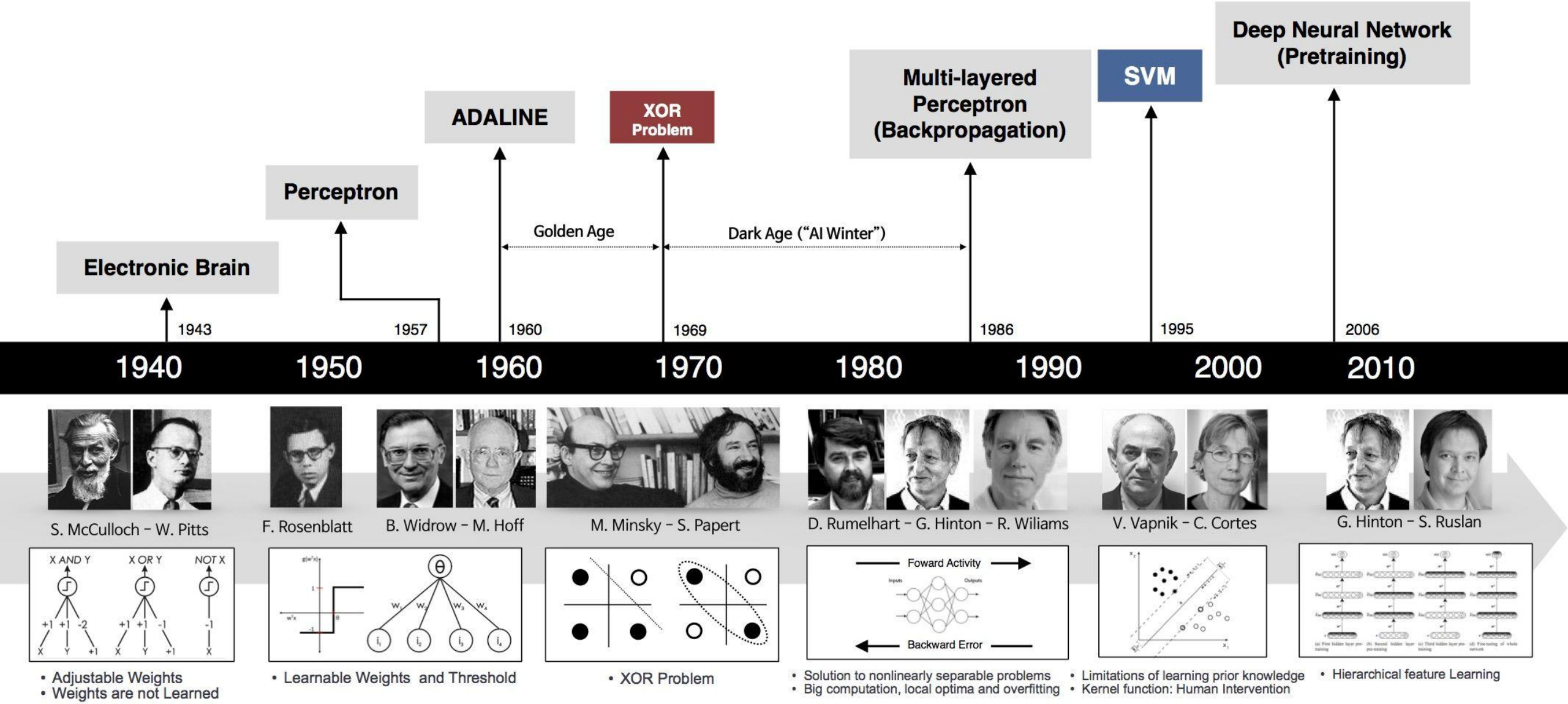
Types of Machine Learning



History of ML




Deep Neural Network (Pretraining)
SVM
Multi-layered Perceptron (Backpropagation)
XOR Problem
ADALINE
Perceptron
Electronic Brain
Golden Age
Dark Age ("AI Winter")
1943
1957
1960
1969
1986
1995
2006
1940
1950
1960
1970
1980
1990
2000
2010
S. McCulloch - W. Pitts
F. Rosenblatt
B. Widrow - M. Hoff
M. Minsky - S. Papert
D. Rumelhart - G. Hinton - R. Wiliams
V. Vapnik - C. Cortes
G. Hinton - S. Ruslan
X AND Y
X OR Y
NOT X
Foward Activity
Backward Error
• Adjustable Weights
• Weights are not Learned
• Learnable Weights and Threshold
• XOR Problem
• Solution to nonlinearly separable problems
• Big computation, local optima and overfitting
• Limitations of learning prior knowledge
• Kernel function: Human Intervention
• Hierarchical feature Learning

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Topics of this course

1. Machine Learning: Introduction and Overview
2. Conventional ML Methods (review)
    1. K-Nearest Neighbors
    2. Decision Tree
    3. Naïve Bayes Classifiers
    4. Support Vector Machines
    5. Unsupervised Learning and Clustering Methods
3. Neural Networks
    1. Linear Regression and Gradient Descent Algorithm
    2. Perceptron and Logistic Regression
    3. Multi-layer Perceptron (MLP)
    4. Recurrent Neural Networks (RNN)
4. Deep Learning Models
    1. Introduction to Deep Learning
    2. Long Short Term Memory (LSTM)
    3. Convolutional Neural Network
5. Ensemble Learning
6. Reinforcement Learning
7. Seminar of Advanced Models
    1. Generative Adversarial Networks
    2. Deep Reinforcement Learning
    3. Random Forest
    4. Transformers
    5. (others …)

Schedule

STT	Topic	Hours
1	Machine Learning: Introduction and Overview	3
2	Conventional ML Methods	6
3	Neural Networks	9
4	Middle Term Project Presentation	3
5	Deep Learning: LSTM and CNN	9
6	Ensemble Learning	3
7	Reinforcement Leanring	3
8	Advanced Topics	6
9	Final Project Presentation	3
		45

Summary

- AI and AI applications
- A general paradigm of AI systems
- ML role and its components
- Tasks in ML
- ML types
- History of ML/AI development