Objectives

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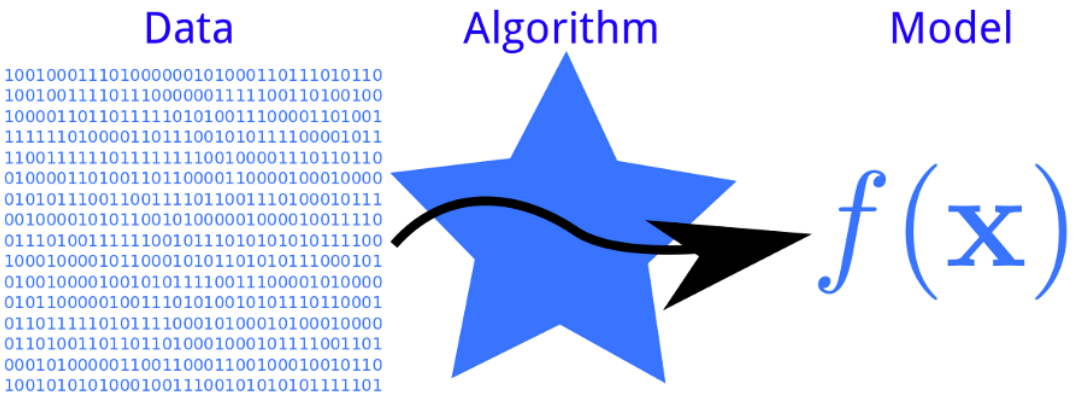
- **What Machine Learning is**
- **When to Leverage Machine learning**
- **Machine Learning algorithms**
- **Machine Learning methodology**

But Seriously, What is Machine Learning?

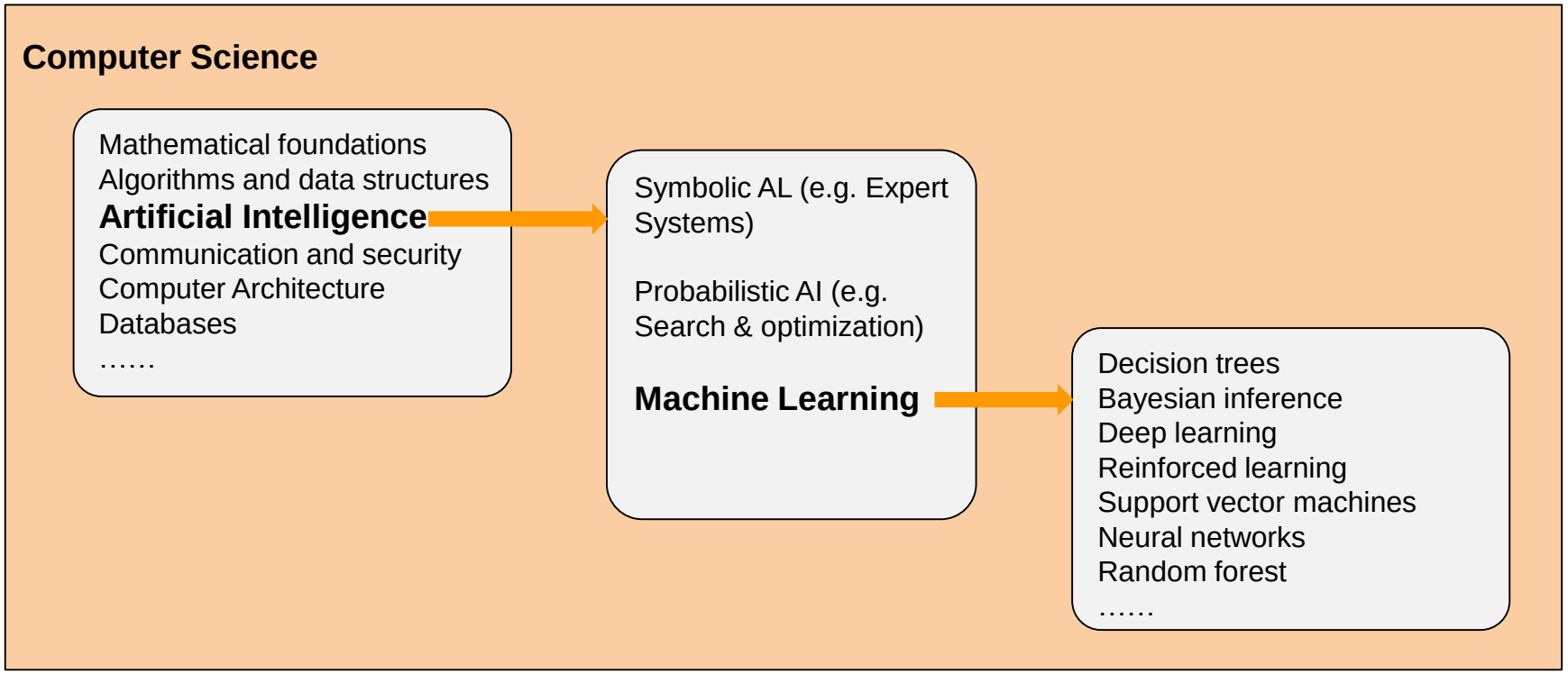


"Machine Learning is the science of getting computers to act without being explicitly programmed." – Andrew Ng (Coursera)

"A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at task in T, as measured by P, improves with experience E." – Tom M. Mitchell (1997)

What are AI and ML?

- Artificial Intelligence (AI) is a branch or Computer Science that uses algorithms and techniques to mimic human intelligence
- Machine Learning (ML) is one of several AI techniques for sophisticated cognitive tasks



Machine Learning

- Machine Learning is a particularly interesting technique because it represents a paradigm shift within AI

Traditional AI techniques

- **Static** – hard-coded set of steps and scenarios
- **Rule Based** – expert knowledge
- **No generalization** – handling special cases is difficult

Machine Learning

- **Dynamic** – evolves with data, finds new patterns
- **Data driven** – discovers knowledge
- **Generalization** – adapts to new situations and special cases

Machine Learning - Example

- Example - Excelling at playing the game of chess

Symbolic AI	Mathematical/Statistical AI	Machine Learning Approach
"Let us sit down with the world's best chess player, Ekpe Okorafor, and put his knowledge into a computer program"	"Let us simulate all the different possible moves and the associated outcomes at each single step and go with the most likely to win"	**"Let us show millions of examples or real life and simulated games (won and lost) to the program, and let it learn from experience"**

Machine Learning – When to use

- Machine learning is particularly good at solving **2 types of problems** where other AI techniques fail

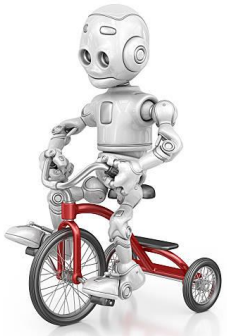
Tasks programmers can't describe

Complex multidimensional problems that can't be solved by numerical reasoning

Hand writing

Weather Forecasting

Health Care Outcomes



Cognitive Reasoning

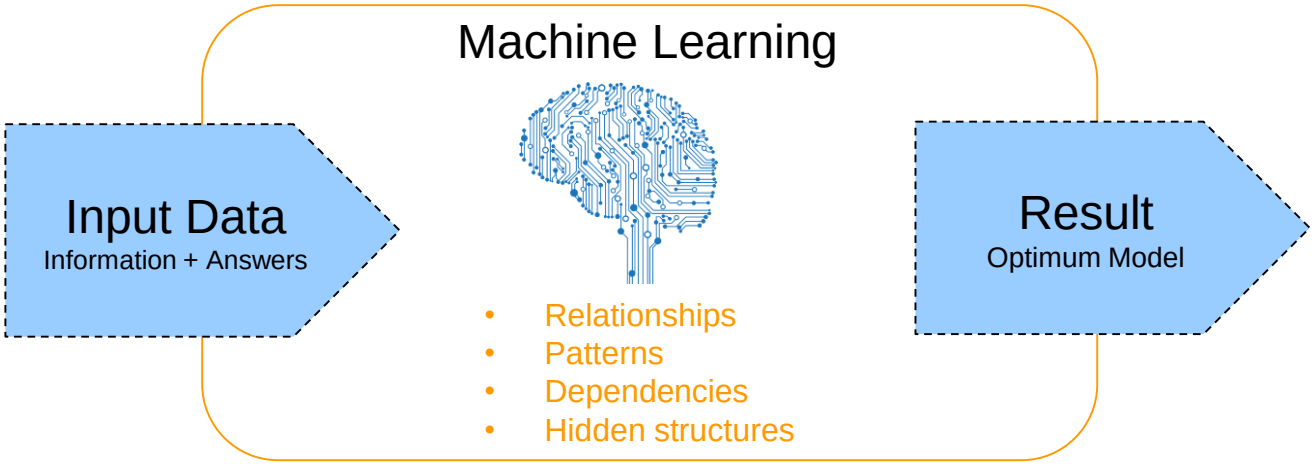
Network Intrusion

Movie Recommendation

Machine Learning – Breaking it down

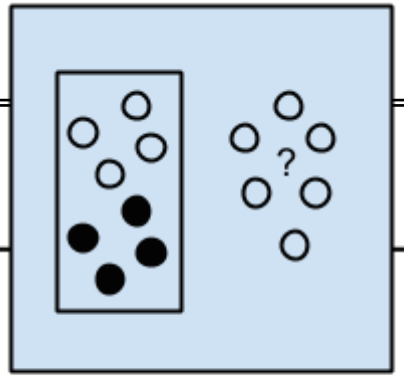
Supervised and Unsupervised Learning

- **Supervised learning** - we already know the answers we want (found in past or completed data).



- **Unsupervised learning** - we want to find unknown structures or trends.

Supervised Learning



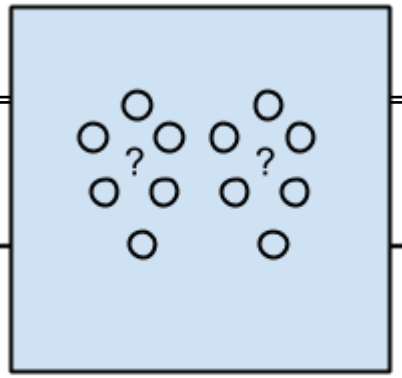
Supervised Learning Algorithms

Math Quiz #1 - Teacher's Answer Key

1) 2 4 5 = 3
2) 5 2 8 = 2
3) 2 2 1 = 3
4) 4 2 2 = 6

5) 6 2 2 = 10
6) 3 1 1 = 2
7) 5 3 4 = 11
8) 1 8 1 = 7

Unsupervised Learning



Unsupervised Learning Algorithms

Math Quiz #1 - Teacher's Answer Key

1) 2 4 5 =
2) 5 2 8 =
3) 2 2 1 =
4) 4 2 2 =
5) 6 2 2 =
6) 3 1 1 =
7) 5 3 4 =
8) 1 8 1 =

Supervised and Unsupervised Learning

Supervised Learning:

Predicting values. **Known** targets.
User inputs correct answers to learn from. Machine uses the information to guess new answers.

REGRESSION:
Estimate continuous values
(Real-valued output)

CLASSIFICATION:
Identify a unique class
(Discrete values, Boolean, Categories)

Unsupervised Learning:

Search for structure in data. Unknown targets.
User inputs data with undefined answers. Machine finds useful information hidden in data

CLUSTER ANALYSIS:
Group into sets

DENSITY ESTIMATION:
Approximate distribution

DENSITY REDUCTION:
Select relevant variables

Supervised and Unsupervised Learning

Supervised Learning:

Regression
- Linear Regression
- Ordinary Least Squares Regression
- LOESS (Local Regression)
- Neural Networks

Classification
- Decision Trees
- K-Nearest Neighbors
- Support Vector Machine
- Logistic Regression
- Naïve Bayes
- Random Forests

Unsupervised Learning:

Cluster Analysis
- K-Means Clustering
- Hierarchical Clustering

Dimension Reduction
- Principal Component Analysis (PCA)
- Linear Discriminant Analysis (LDA)

What About Reinforcement Learning?

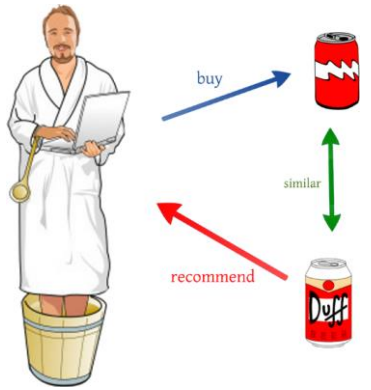
Class Discussion

10 Mins

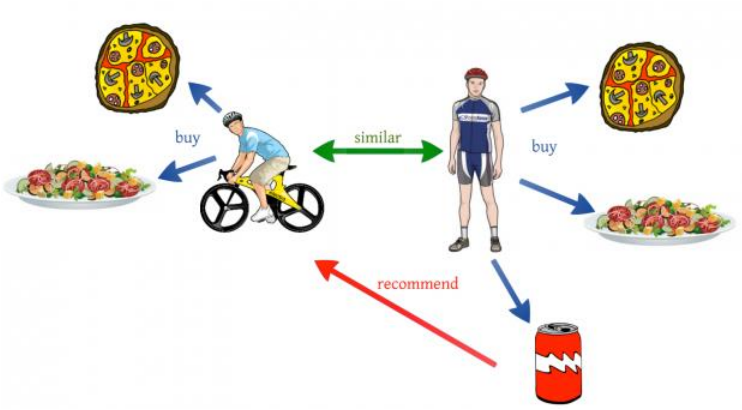
Machine Learning Application – Recommender Systems

- Recommender systems deal with making recommendations based upon previously collected data and leveraging ML techniques.

Content Based (Features)
Modified Linear Regression



Non-content Based (No Features)
Collaborative Filtering
Matrix Factorization

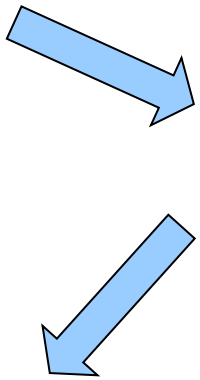


Train & Test Methodology

- ML techniques use a train + test system (commonly known as cross-validation) before using findings in real situations.

TRAINING:
Learn data properties

1. The machine makes conclusions by learning from the data
2. It improves its model until optimal Performance is reached
3. Using a Cost / Loss Function to measure Accuracy. It repeats iterations until a minimum Is reached.



TESTING:
Test the properties

1. Apply the conclusions to new data and compare results to know answers
2. The model does not change. It us just tested to measure how good the machine did after training
3. Useful to detect overfitting. If good enough, it is ready to be used

APPLICATION:
Use the properties

- In a real situation, the answers are not known
- Apply the model conclusions to predict the answers from the inputs. Use the answers in whatever necessary