

TOCI: DEEP LEARNING

LECTURE 1

FARZEEN ASHFAQ

What is artificial intelligence?

Artificial intelligence is the ability of a computer to perform tasks commonly associated with intelligent beings.

What is machine learning?

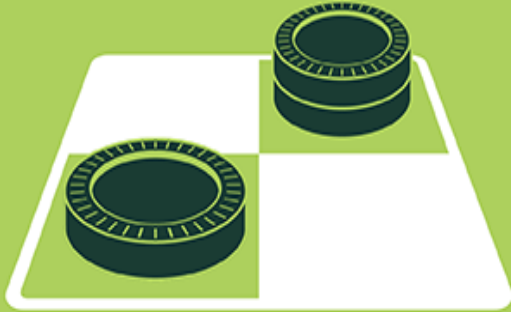
Machine learning is the study of algorithms that learn from examples and experience instead of relying on hard-coded rules and make predictions on new data.

What is deep learning?

Deep learning is a subfield of machine learning focusing on learning data representations as successive layers of increasingly meaningful representations.

ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



MACHINE LEARNING

Machine learning begins to flourish.



DEEP LEARNING

Deep learning breakthroughs drive AI boom.



1950's

1960's

1970's

1980's

1990's

2000's

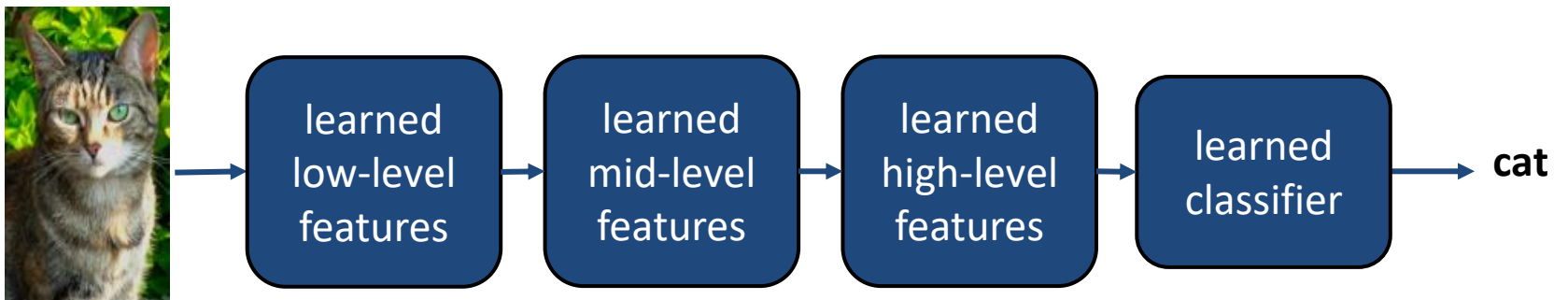
2010's

Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

“Traditional” machine learning:



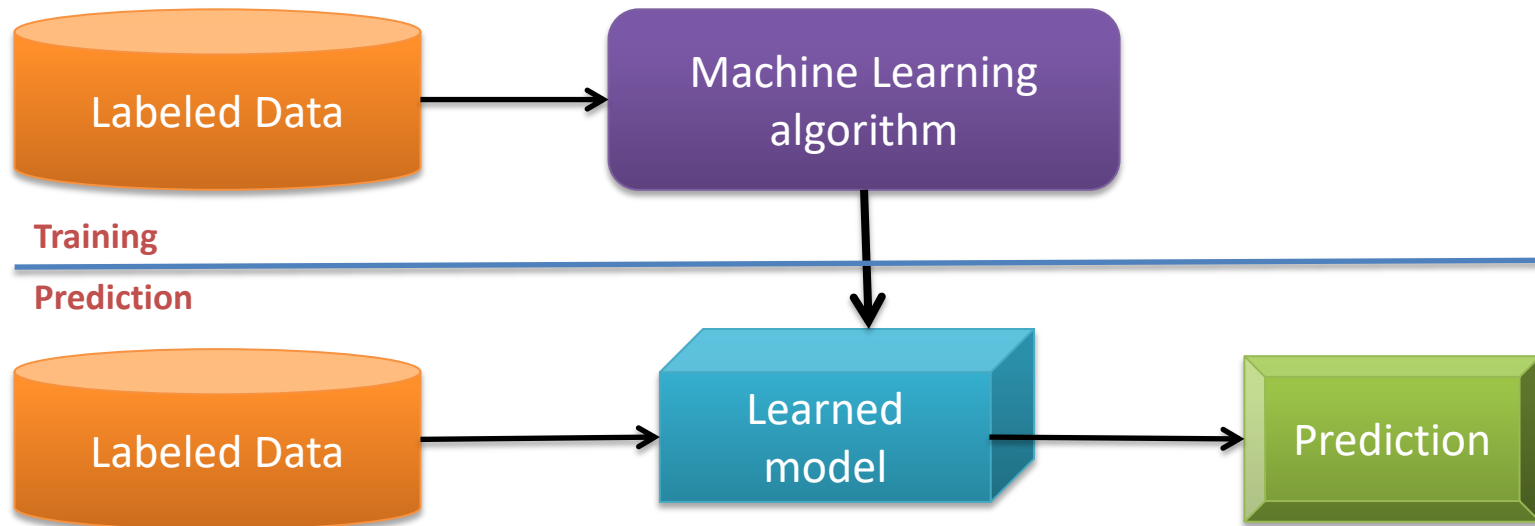
Deep, “end-to-end” learning:



Machine Learning Basics

Machine Learning Basics

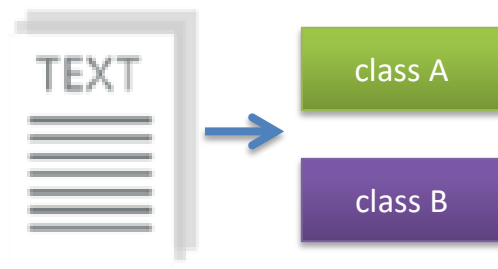
- **Artificial Intelligence** is a scientific field concerned with the development of algorithms that allow computers to learn without being explicitly programmed
- **Machine Learning** is a branch of Artificial Intelligence, which focuses on methods that learn from data and make predictions on unseen data



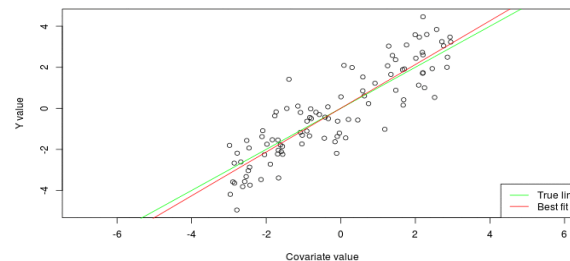
Machine Learning Types

Machine Learning Basics

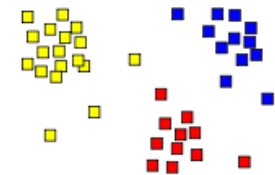
- **Supervised**: learning with **labeled data**
 - Example: email classification, image classification
 - Example: regression for predicting real-valued outputs
- **Unsupervised**: discover patterns in **unlabeled data**
 - Example: cluster similar data points
- **Reinforcement learning**: learn to act based on **feedback/reward**
 - Example: learn to play Go



Classification



Regression



Clustering

Supervised Learning

Machine Learning Basics

- *Supervised learning* categories and techniques
 - **Numerical classifier functions**
 - Linear classifier, perceptron, logistic regression, support vector machines (SVM), neural networks
 - **Parametric (probabilistic) functions**
 - Naïve Bayes, Gaussian discriminant analysis (GDA), hidden Markov models (HMM), probabilistic graphical models
 - **Non-parametric (instance-based) functions**
 - k -nearest neighbors, kernel regression, kernel density estimation, local regression
 - **Symbolic functions**
 - Decision trees, classification and regression trees (CART)
 - **Aggregation (ensemble) learning**
 - Bagging, boosting (Adaboost), random forest

Unsupervised Learning

Machine Learning Basics

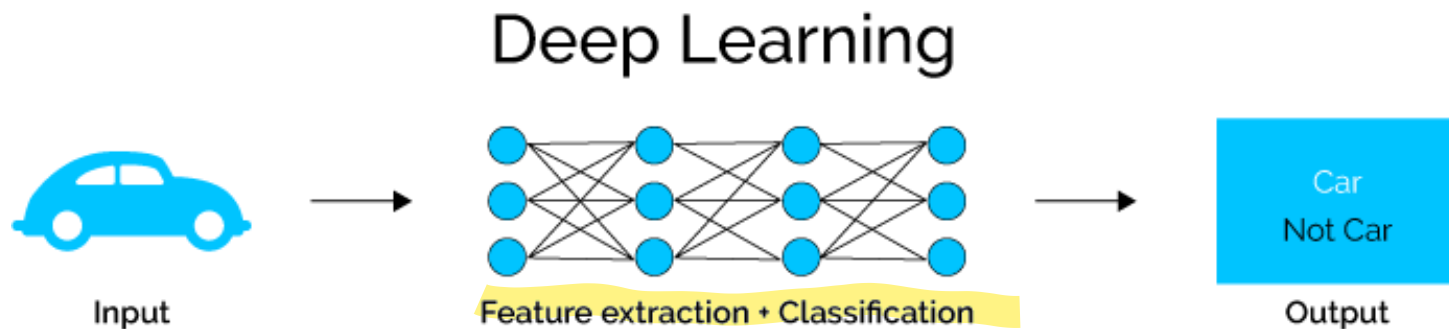
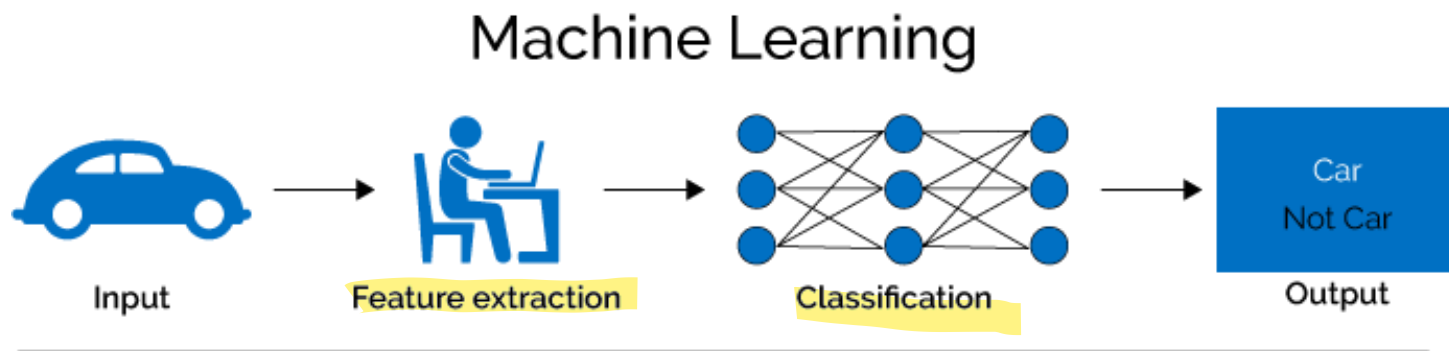
- *Unsupervised learning* categories and techniques
 - **Clustering**
 - *k*-means clustering
 - Mean-shift clustering
 - Spectral clustering
 - **Density estimation**
 - Gaussian mixture model (GMM)
 - Graphical models
 - **Dimensionality reduction**
 - Principal component analysis (PCA)
 - Factor analysis

What is Deep Learning (DL) ?

A machine learning subfield of learning **representations** of data. Exceptional effective at **learning patterns**.

Deep learning algorithms attempt to learn (multiple levels of) representation by using a **hierarchy of multiple layers**

If you provide the system **tons of information**, it begins to understand it and respond in useful ways.



Why is DL useful?

- Manually designed features are often **over-specified**, **incomplete** and take a **long time to design** and validate
- Learned Features are **easy to adapt**, **fast** to learn
- Deep learning provides a very **flexible**, (almost?) **universal**, learnable framework for representing world, visual and linguistic information.
- Can **learn both unsupervised and supervised**
- Effective **end-to-end** joint system learning
- Utilize large amounts of training data

In ~2010 DL started outperforming other ML techniques
first in speech and vision, then NLP

