

- Module 1 - Introduction

Outline

- Era of Big Data
- What is Machine Learning?
- Real-World Applications
- When to use Machine Learning?
- Types of Machine Learning
- Machine Learning Workflow

AIML Today

“Artificial intelligence is a field of computer science that is not new and has been explored for decades.

What makes it exciting today is that we now not only have the ability to **gather large-scale data sets**, but also the **computational power** to **process** them efficiently, allowing artificial intelligent systems to **learn and gain insights** from the data for purposes of **better decision making** and **prediction**.

With the vast potential to apply artificial intelligence and machine learning techniques in a variety of untapped domains, this field will undoubtedly continue to bring about transformative impact going forward.”

Era of Big Data

- ~ **60 billion** indexed web pages¹
- YouTube:
 - > **100 hours** of video are **uploaded** every minute²
 - > **1,000,000,000 hours watched** every day²
- Walmart (world's biggest retailer):
 - ~ **2.5 petabytes** (2.5×10^{15}) of data **processed** per hour³

"We are drowning in information but starved for knowledge." – John Naisbitt, Megatrends

- With the ever increasing amounts of data, the need for automated methods for data analysis grows
 - The goal of **machine learning** is to develop methods that can automatically detect patterns in data, and then use the uncovered patterns to predict future data or other outcomes of interest

¹ <http://www.worldwidewebsite.com/>

² <https://www.youtube.com/about/press/>

³ <https://www.forbes.com/sites/bernardmarr/2017/01/23/really-big-data-at-walmart-real-time-insights-from-their-40-petabyte-data-cloud/#7ad5e1fe6c10>

What is Machine Learning?

- Informally, the field of machine learning seeks to answer the question

“How can we build computer systems that automatically improve with experience, and what are the fundamental laws that govern all learning processes?” – Tom M. Mitchell, CMU

- The question covers a broad range of learning tasks, including
 - Design autonomous robots that learn to navigate from their own experience
 - Data mine historical medical records to learn which future patients will respond best to which treatments
 - Build search engines that automatically customize to their user's interest
 - ...

Real-World Applications

- Significant real-world applications:
 - Handwriting recognition
 - Product recommendation
 - Spam filters
 - Price Prediction
 - Advertisement Placement
 - Fraud Detection
 - Speech recognition - Alexa, Cortana, Siri, ...
 - Computer vision - face recognition, image classification, ...
 - Robot control - autonomous robots, vehicles, ...
 - ...
- Note that as late as 1985 there were almost no commercial applications of machine learning

When to use Machine Learning?

- **Question:** Should one use machine learning to write matrix multiplication programs?
- Machine learning systems automatically learn programs from data and is often a very attractive alternative to manually constructing them. In particular, when
 - the application is too complex for people to manually design the algorithm
(E.g., software for sensor-base perception tasks such as computer vision - how does one write down an algorithm to label photographs that contain a picture of one's mother)
 - the application requires that the software customize to its operational environment after it is deployed
(E.g., speech recognition accuracy is better if the user trains the system, than if one attempts to program it by hand - machine learning provides the mechanism for adaptation)

Types of Machine Learning

- There are three types of feedback that determine the three main types of learning:
 - **supervised learning** where the agent observes from example input-output pairs and learns a function that maps from input to output, i.e., labeled data, predict outcome
→ **classification, regression**
 - **unsupervised learning** where the agent learns patterns in the input even though no explicit feedback is supplied, i.e., unlabeled data, find hidden structure
→ **clustering**
 - **semi-supervised learning** where the agent is given a few labeled examples and must make of what it can of a large collection of unlabeled examples
 - **reinforcement learning** where the agent learns from a series of reinforcements, i.e., rewards or punishments

Machine Learning Workflow

