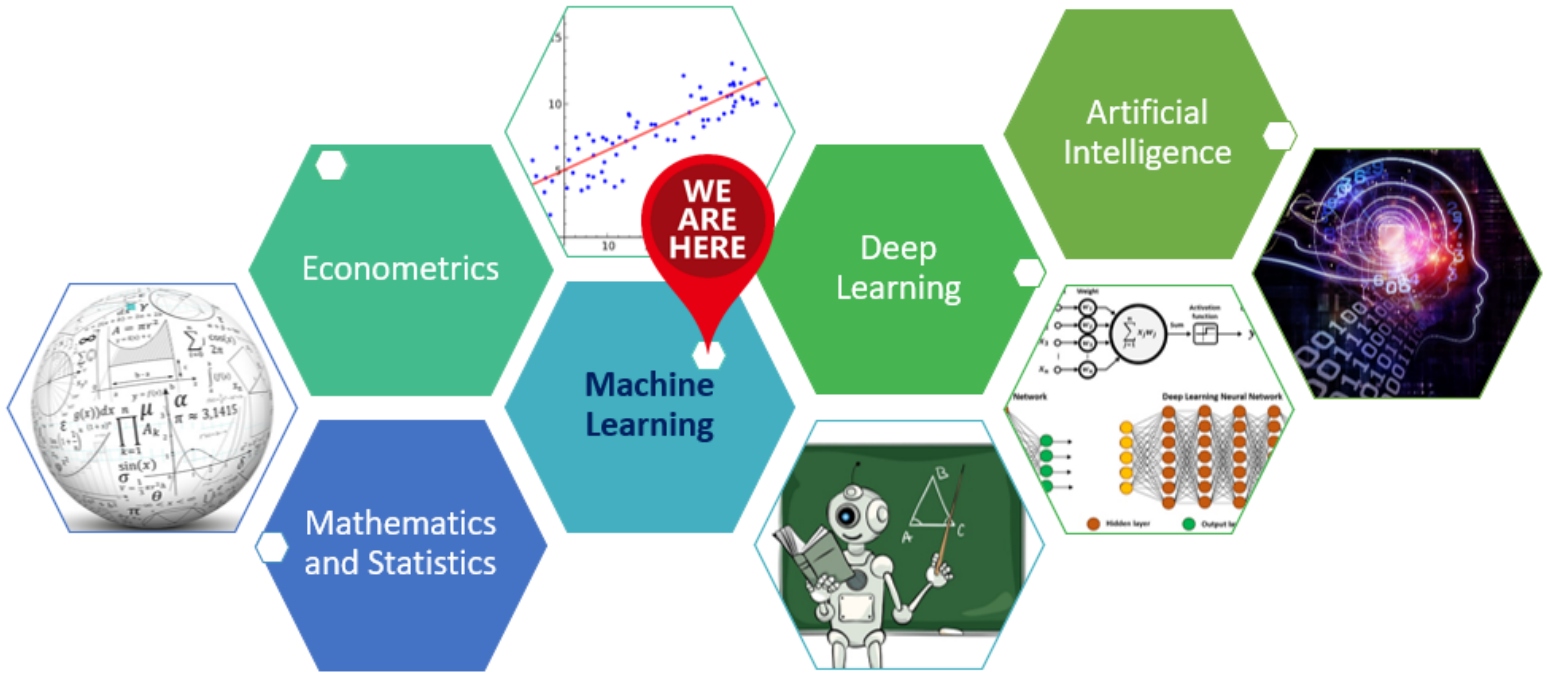
Module 1- Part I
Welcome to the magic world of Machine Learning



Jon M. Huntsman School of Business
UtahStateUniversity

Pedram Jahangiry

Big picture: Econometrics vs Machine Learning

What are we trying to do as a researcher?

Solve real world problems, right?

Is there a theory?

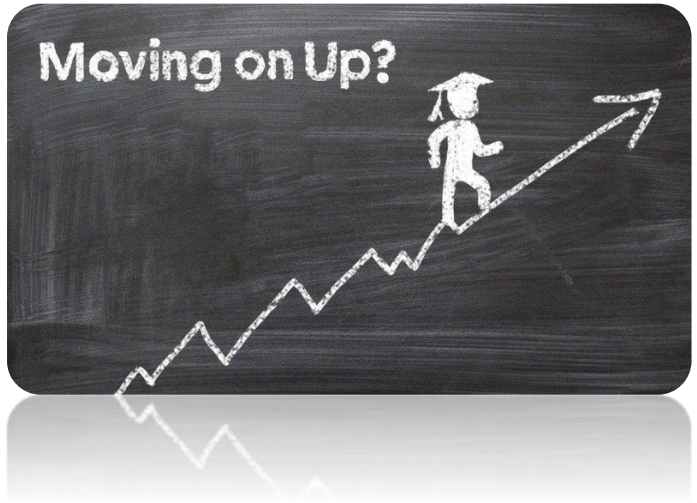
What is the relationship between

- Sales and advertisement / R&D expenditure / seasonality / industry / … ?
- Quantity demanded and price / income / technology / price of competitors / … ?
- Wage and education/ age/ gender/ experience/ …?

Jon M. Huntsman School of Business
UtahStateUniversity

Pedram Jahangiry

A simple example



- Quantifying wage components! (is there a theory?)
- What are the drivers:
  - Education, age, experience, IQ, …
  - Ethnicity, race, gender, …
  - Industry, location, working hours, …
- Let's build a model (assuming a linear functional form!)

$$wage = \beta_0 + \beta_1 educ + \beta_2 age + \beta_3 exper + \beta_4 IQ + \cdots + \beta_k hours + u$$

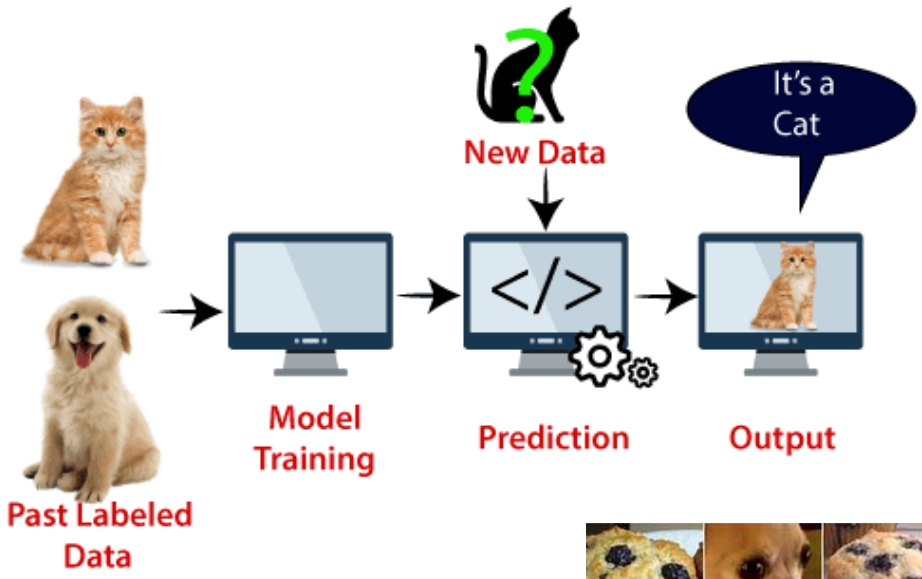
- Can you interpret this model? Do you care about the interpretability?
- Can you make predictions using your model?
- Can you make this functional form more flexible? What are the caveats?

Jon M. Huntsman School of Business
UtahStateUniversity

Pedram Jahangiry

A different example

- Cat vs dog classification problem (image classification)



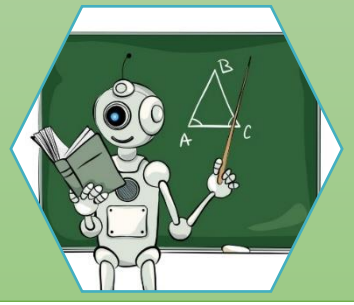
- Do you really care about interpretability of the model here?
- What about accuracy of your predictions?

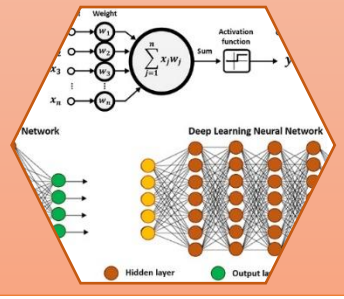
Artificial intelligence vs Machine learning vs Deep learning

Artificial intelligence: Any technique which enables machines to mimic human behavior

Machine Learning: Subset of AI that enables computers to learn from data. the model is trained with a set of algorithms

Deep Learning: Subset of ML that extract patterns from data using neural networks.





1950's 1980's 2010's

Jon M. Huntsman School of Business
UtahStateUniversity

Pedram Jahangiry

Statistical learning vs machine learning

	Statistical Learning	Machine Learning / Deep Learning
Focus	Hypothesis testing & interpretability	Predictive accuracy and extracting complex patterns
Driver	Math, theory, hypothesis	Fitting data
Data size	Any reasonable set	Big data
Data type	Structured	Structured, unstructured, semi-structured
Dimensions / scalability	Mostly low dimensional data	High dimensional data
Strength	Understand **causal** relationship & behavior	Prediction (forecasting and nowcasting)
Interpretability	High	Medium to Low

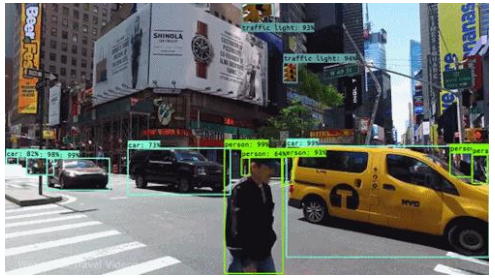
Limitations of Econometrics/Structured ML

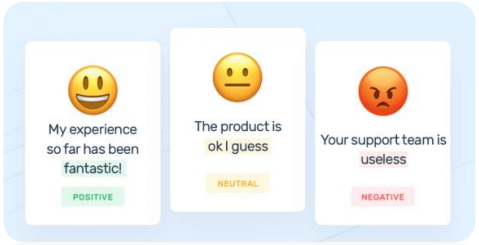
Econometrics/structured ML can only handle structured data (tabular data)!

Structured Data

	A	B	C	D
1	Date	Account	Transaction Type	Amount
2	2017-01-12	123	Credit	6089.78
3	2017-01-12	123	Fee	9.99
4	2017-01-12	456	Debit	1997
5	2017-01-12	123	Debit	20996.12
6	2017-01-13	123	Debit	17
7	2017-01-13	123	Debit	914.36
8	2017-01-14	789	Credit	11314
9	2017-01-14	789	Fee	9.99
10	2017-01-14	456	Debit	15247.89
11	2017-01-14	123	Debit	671.28
12	2017-01-15	456	Credit	5072.1
13	2017-01-15	456	Fee	9.99
14	2017-01-16	456	Debit	5109.07
15	2017-01-19	123	Credit	482.01

Unstructured Data (everything else!!)





Jon M. Huntsman School of Business
UtahStateUniversity

Pedram Jahangiry

A more complex example

Stock price prediction $$$

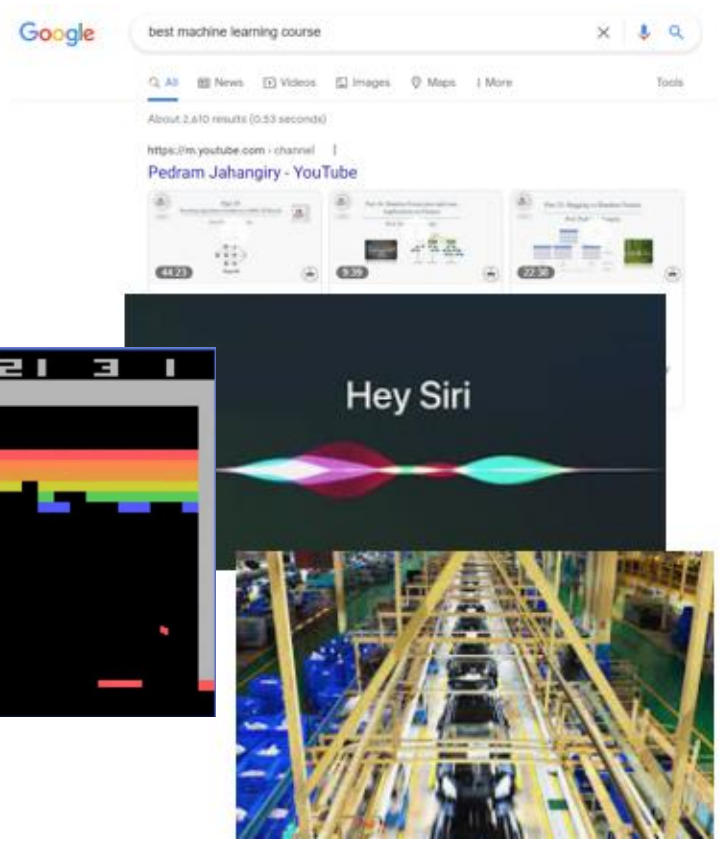
- What are the classical drivers:
  - Company's fundamentals (balance sheet, income statement, cash flow statement)
  - Competitors (comparing multiples)
  - Technical analysis!
  - Seasonality (holidays, months, days, …)

What else?

- Market sentiment (news, tweets, blogger opinions, conference calls, …)
- Satellite images from parking lots!

Why should I learn it?

- It’s a bid deal, it is everywhere!
- Better career opportunities
- Hedge against next recession



Jon M. Huntsman School of Business
UtahStateUniversity

Pedram Jahangiry

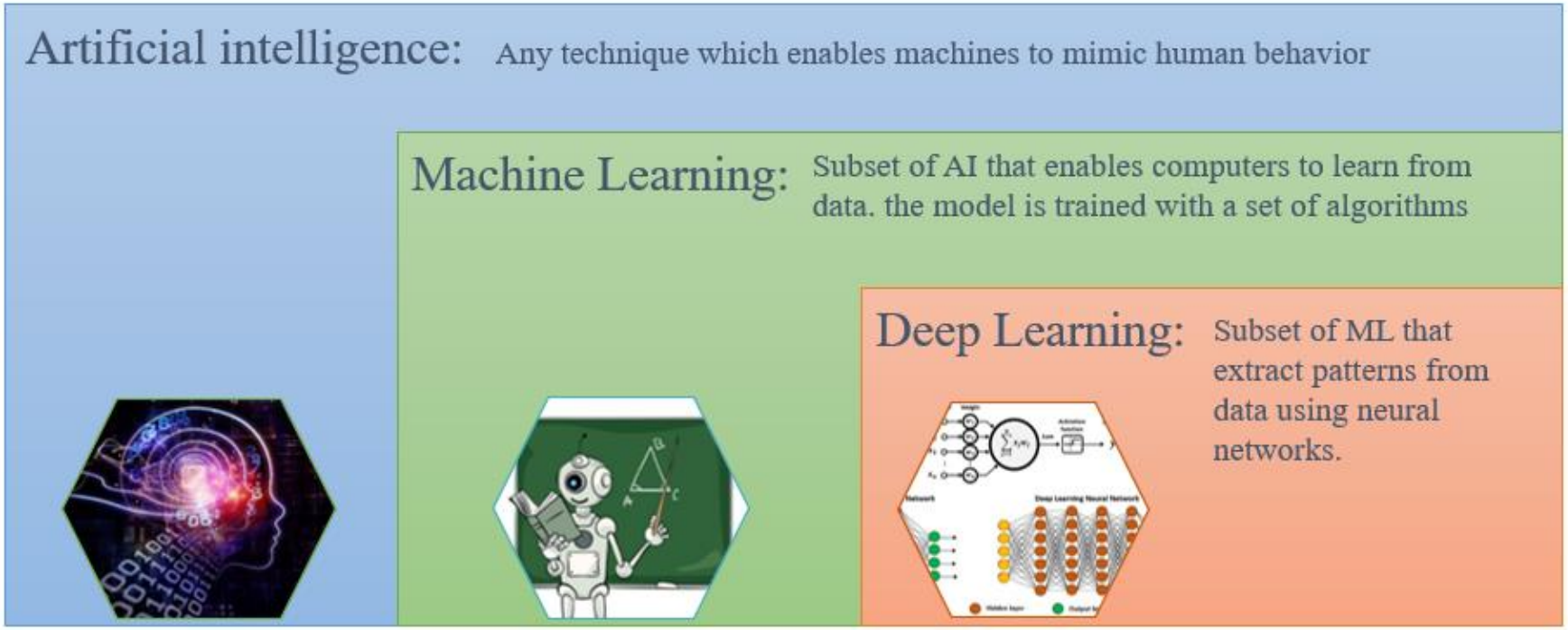
Class Modules

- Module 1- Introduction to Deep Learning
- Module 2- Setting up Machine Learning Environment
- Module 3- Linear Regression (Econometrics approach)
- Module 4- Machine Learning Fundamentals
- Module 5- Linear Regression (Machine Learning approach)
- Module 6- Penalized Regression (Ridge, LASSO, Elastic Net)
- Module 7- Logistic Regression
- Module 8- K-Nearest Neighbors (KNN)
- Module 9- Classification and Regression Trees (CART)
- Module 10- Bagging and Boosting
- Module 11- Dimensionality Reduction (PCA)
- Module 12- Clustering (KMeans – Hierarchical)

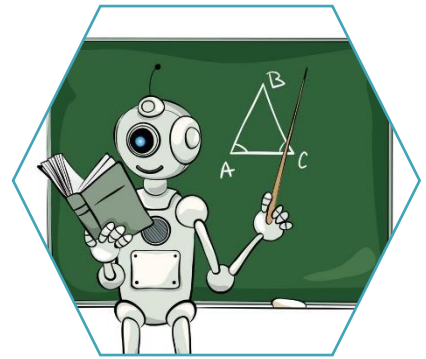
Jon M. Huntsman School of Business
UtahStateUniversity

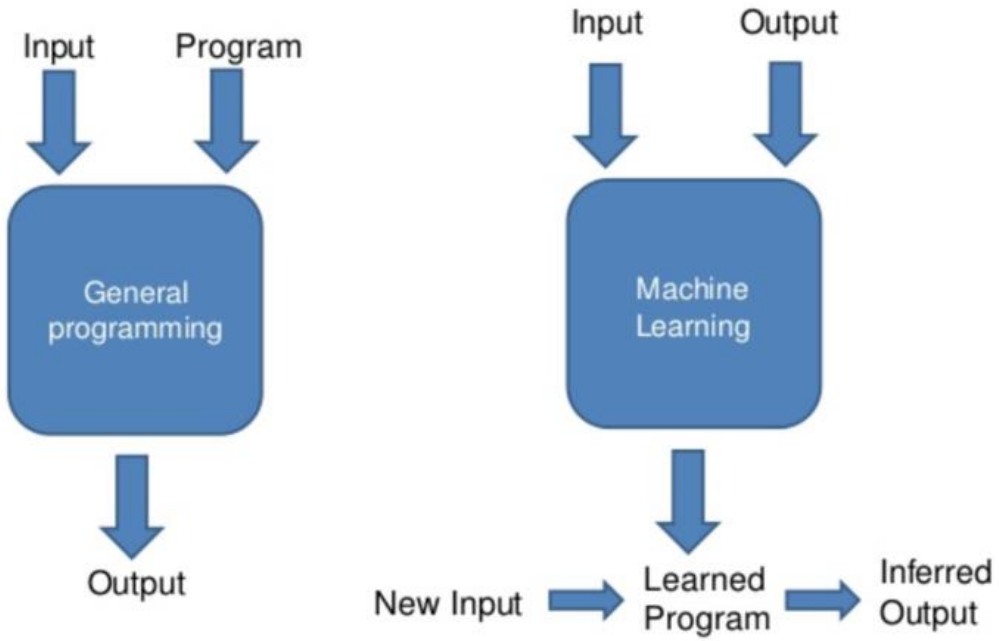
Pedram Jahangiry

Module 1- Part II
What is Machine Learning



General programming vs Machine learning

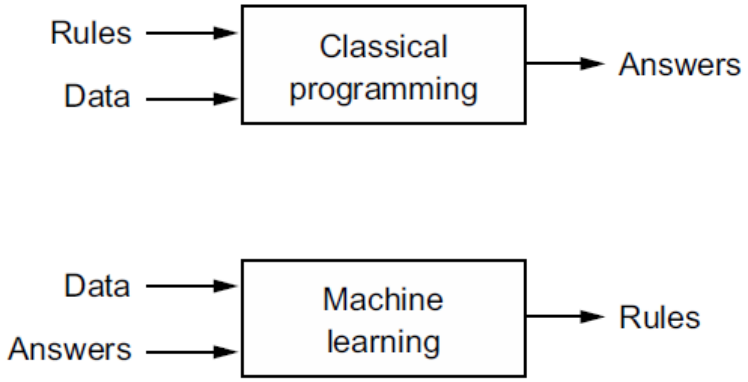




- Machine Learning: Involves automated detection of meaningful patterns in data and apply the pattern

What is Machine Learning?

- A machine learning system is **trained** (with algorithms) rather than explicitly **programmed**.
- Machine Learning is a subset of AI that enables computers to learn from data.
- ML involves automated detection of meaningful patterns in data and apply the pattern to make predictions on unseen data!
- This is done by minimizing the loss on the training data.
- The goal is to maximize the performance on the unseen data.



Jon M. Huntsman School of Business
UtahStateUniversity

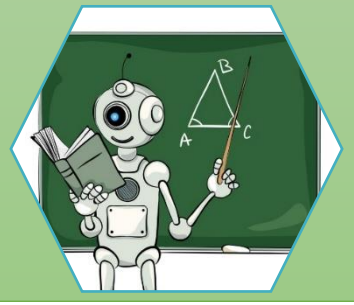
Pedram Jahangiry

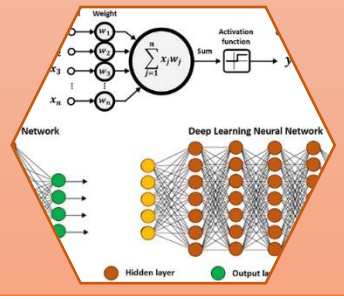
Artificial intelligence vs Machine learning vs Deep learning

Artificial intelligence: Any technique which enables machines to mimic human behavior

Machine Learning: Subset of AI that enables computers to learn from data. the model is trained with a set of algorithms

Deep Learning: Subset of ML that extract patterns from data using neural networks.



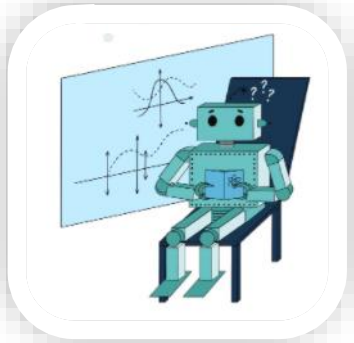


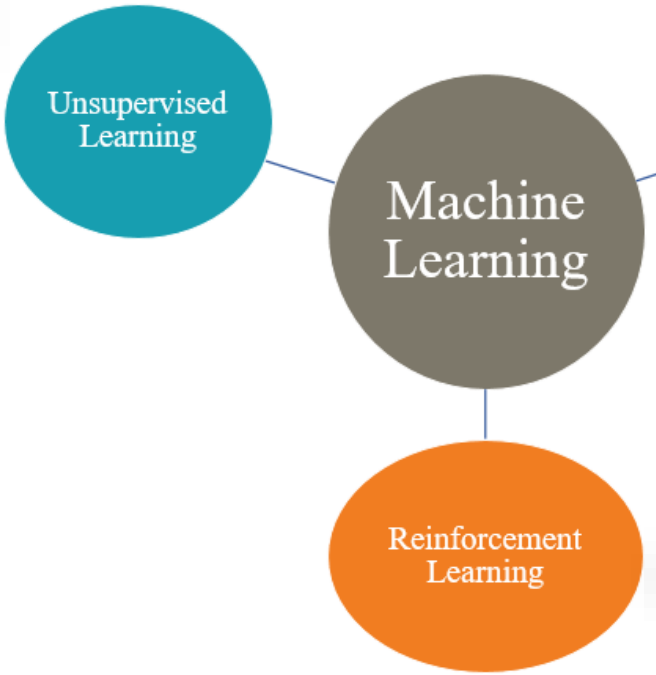
1950's 1980's 2010's

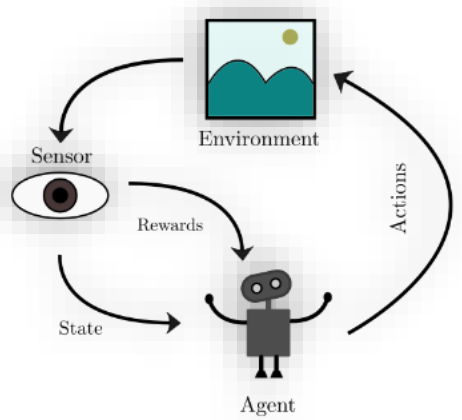
Jon M. Huntsman School of Business
UtahStateUniversity

Pedram Jahangiry

Types of Machine Learning





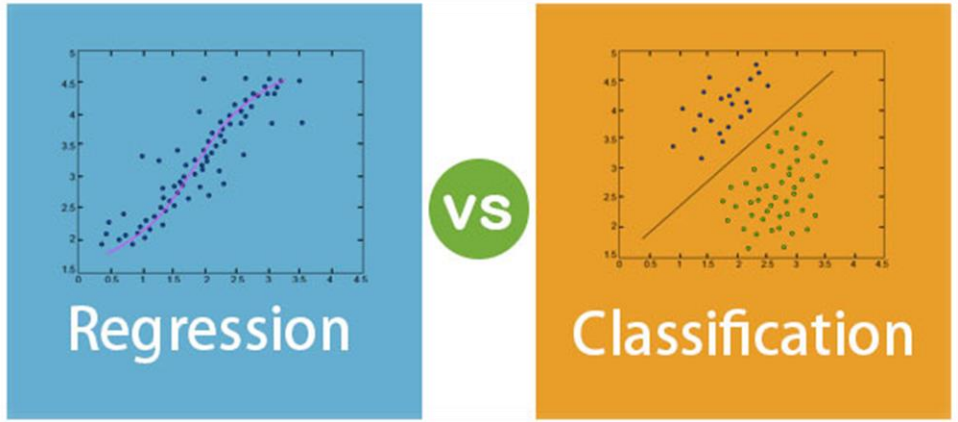


Supervised Learning

- Supervised learning is a type of machine learning where the algorithm is trained on labeled data.
- The data is labeled, meaning that the data has been tagged with the correct output.
- The model is then able to learn the relationship between the input data and the corresponding output labels and can make predictions on new data.

- Regression:
  - Predicting housing price
  - Predicting stock market returns

- Classification:
  - Generating buy, sell, hold signals.
  - Predicting credit default rate.

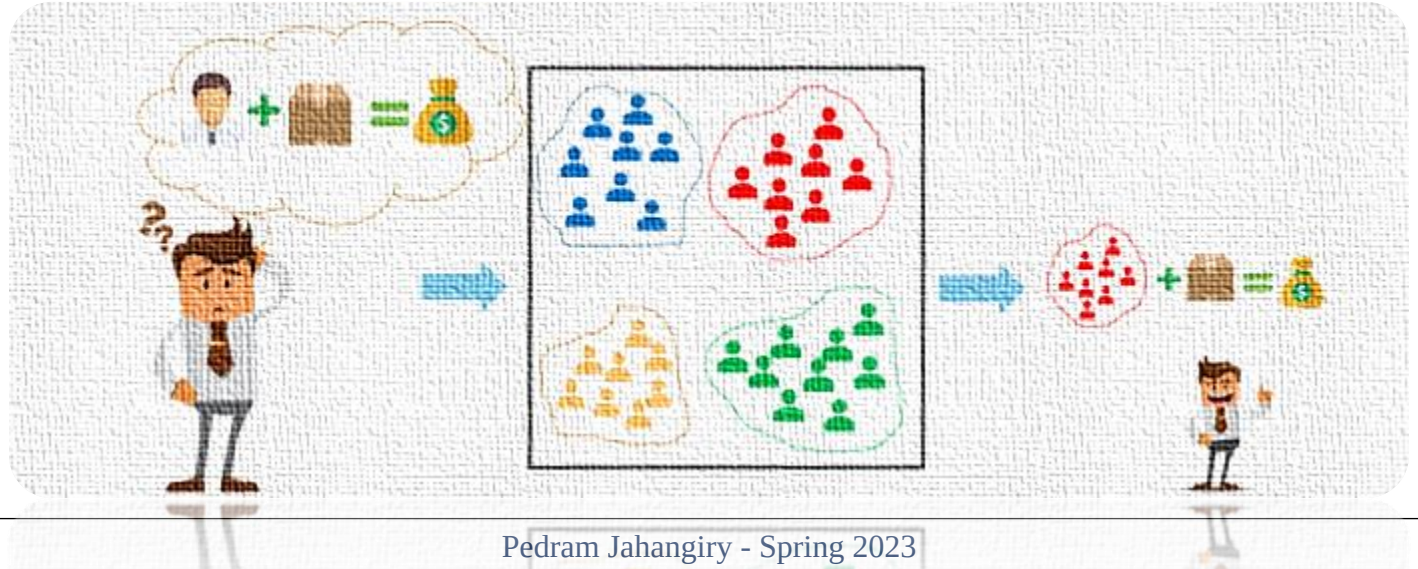


Class exercise

- Can you think of an example of Regression? Classification?

Unsupervised Learning

- Unsupervised learning is a type of machine learning where the algorithm is not given any labeled training data.
- The goal is to discover the underlying patterns and find groups of samples that behave similarly. Find something interesting!
- Clustering**:** group similar data points together
  - ✓Mall customer segmentation
  - ✓Client profiling and asset allocation



Unsupervised Learning

- Unsupervised learning is a type of machine learning where the algorithm is not given any labeled training data.

- Anomaly detection: Find anomalies (unusual data points)
  - ✓Fraud detection

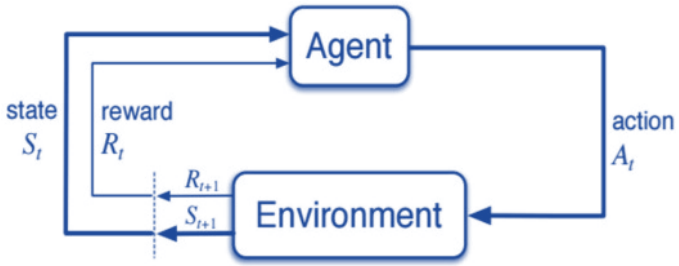
- Dimensionality Reduction: compress data in lower dimension
  - ✓Identify the most predictive factors underlying asset price models.

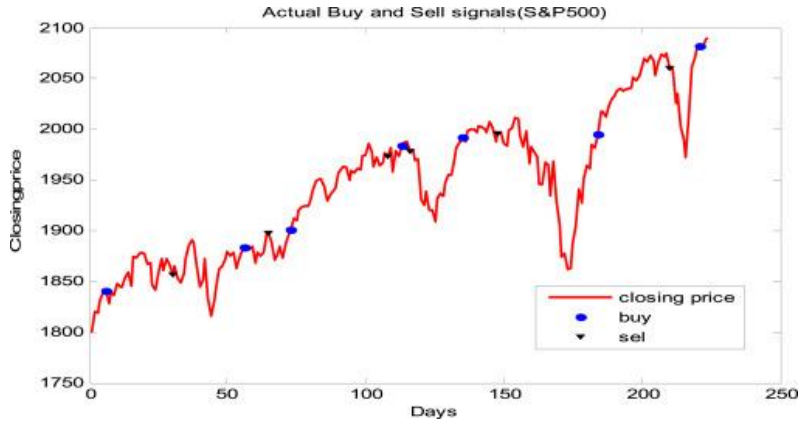
Class exercise

- Can you think of an example of Clustering? Anomaly detection?

Reinforcement Learning

- Reinforcement learning is a type of machine learning where an agent learns to interact with its environment in order to maximize a reward.
- The agent receives rewards for performing actions that lead to successful outcomes and learns to repeat successful actions and avoid unsuccessful ones. (Explore and Exploit)



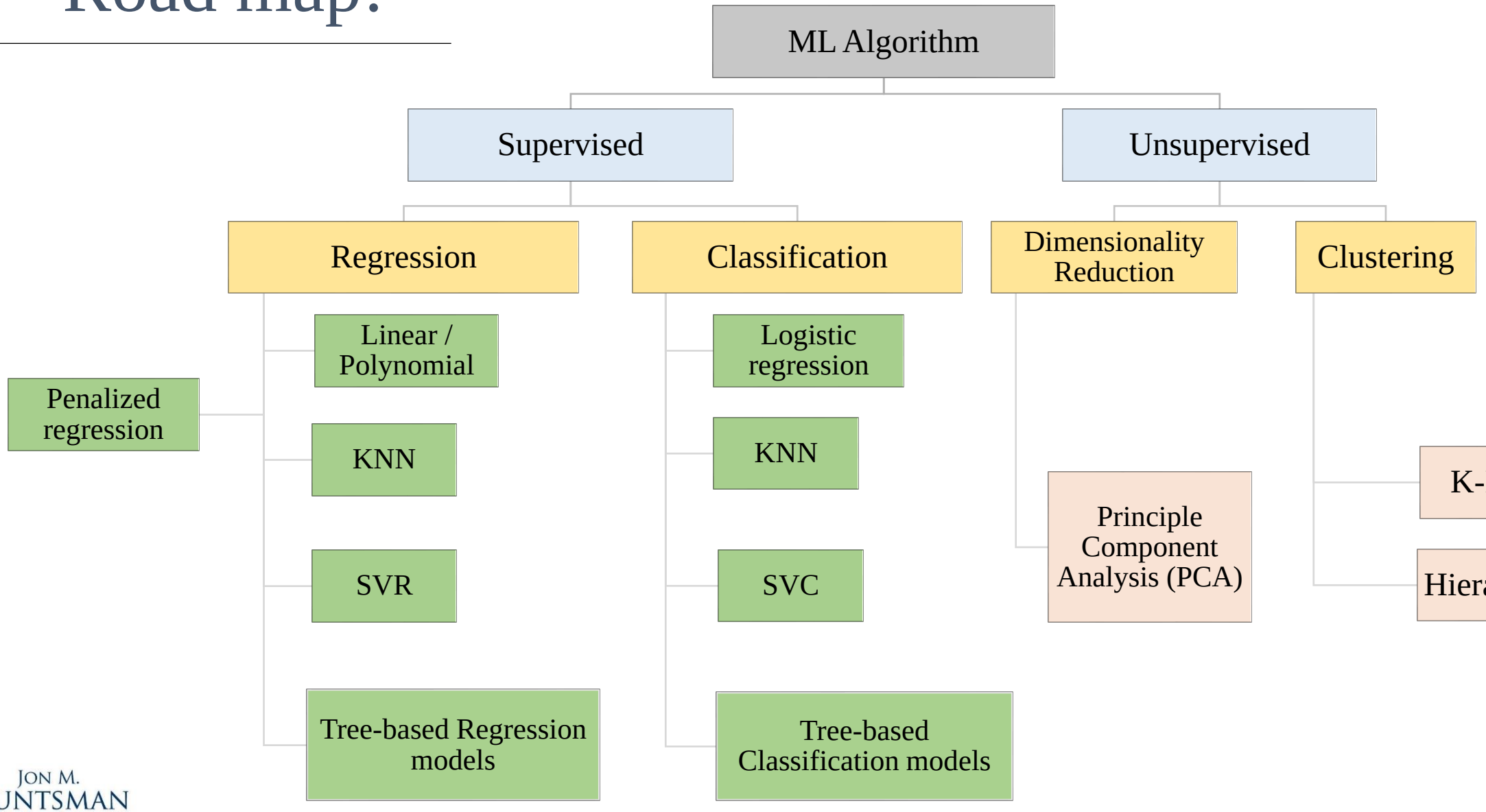


- Example: a virtual trader (agent) who follows certain trading rules (actions) in a specific market (environment) to maximize its profits (reward).

Class exercise

- Can you think of an example of reinforcement learning?

Road map!


ML Algorithm
Supervised
Unsupervised
Regression
Classification
Dimensionality Reduction
Clustering
Linear / Polynomial
Penalized regression
KNN
SVR
Tree-based Regression models
Logistic regression
KNN
SVC
Tree-based Classification models
Principle Component Analysis (PCA)
K-Mean
Hierarchical

What's on GitHub

- ✓ Module 1- Introduction to Deep Learning
- Module 2- Setting up Machine Learning Environment
- Module 3- Linear Regression (Econometrics approach)
- Module 4- Machine Learning Fundamentals
- Module 5- Linear Regression (Machine Learning approach)
- Module 6- Penalized Regression (Ridge, LASSO, Elastic Net)
- Module 7- Logistic Regression
- Module 8- K-Nearest Neighbors (KNN)
- Module 9- Classification and Regression Trees (CART)
- Module 10- Bagging and Boosting
- Module 11- Dimensionality Reduction (PCA)
- Module 12- Clustering (KMeans – Hierarchical)

JON M. HUNTSMAN SCHOOL OF BUSINESS
UtahStateUniversity

Pedram Jahangiry

Having said that…

- **Warning**: A ML algorithm will always find a pattern, even if there is none.