

Machine Learning

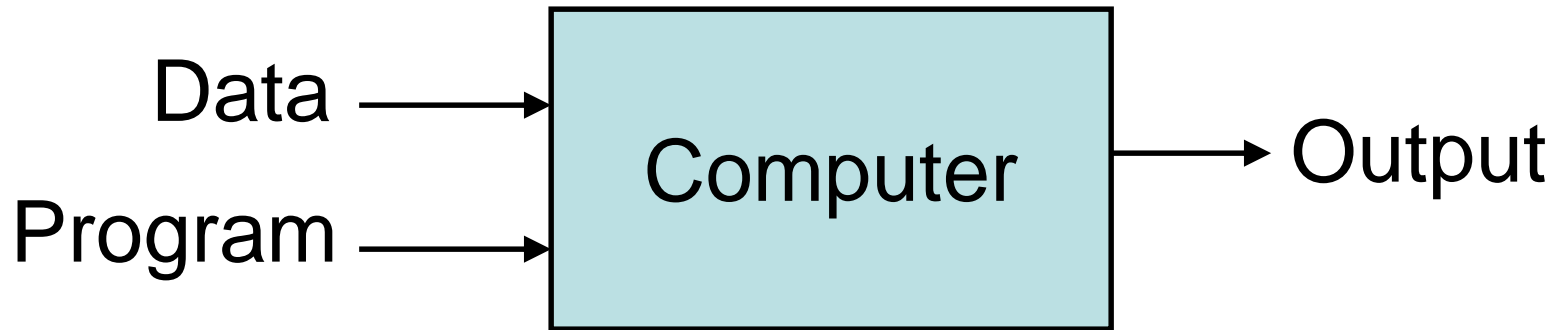
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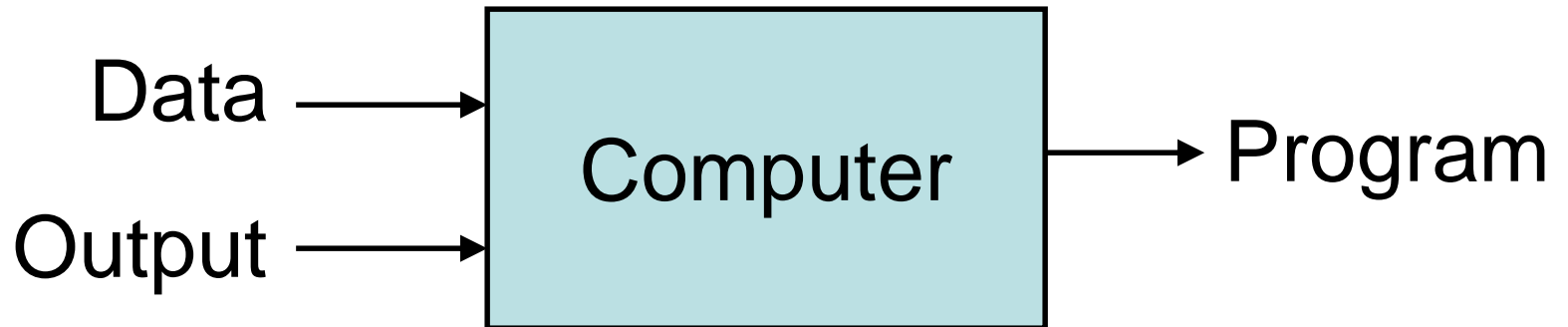
What Is Machine Learning?

- A subfield of computer science and artificial intelligence (AI) that focuses on the design of systems that can learn from and make decisions and predictions based on data.
- Machine learning enables computers to act and make data-driven decisions rather than being explicitly **programmed** to carry out a certain task

Traditional Programming



Machine Learning



Identification of unwanted spam messages in e-mail



Segmentation of customer behavior for targeted advertising



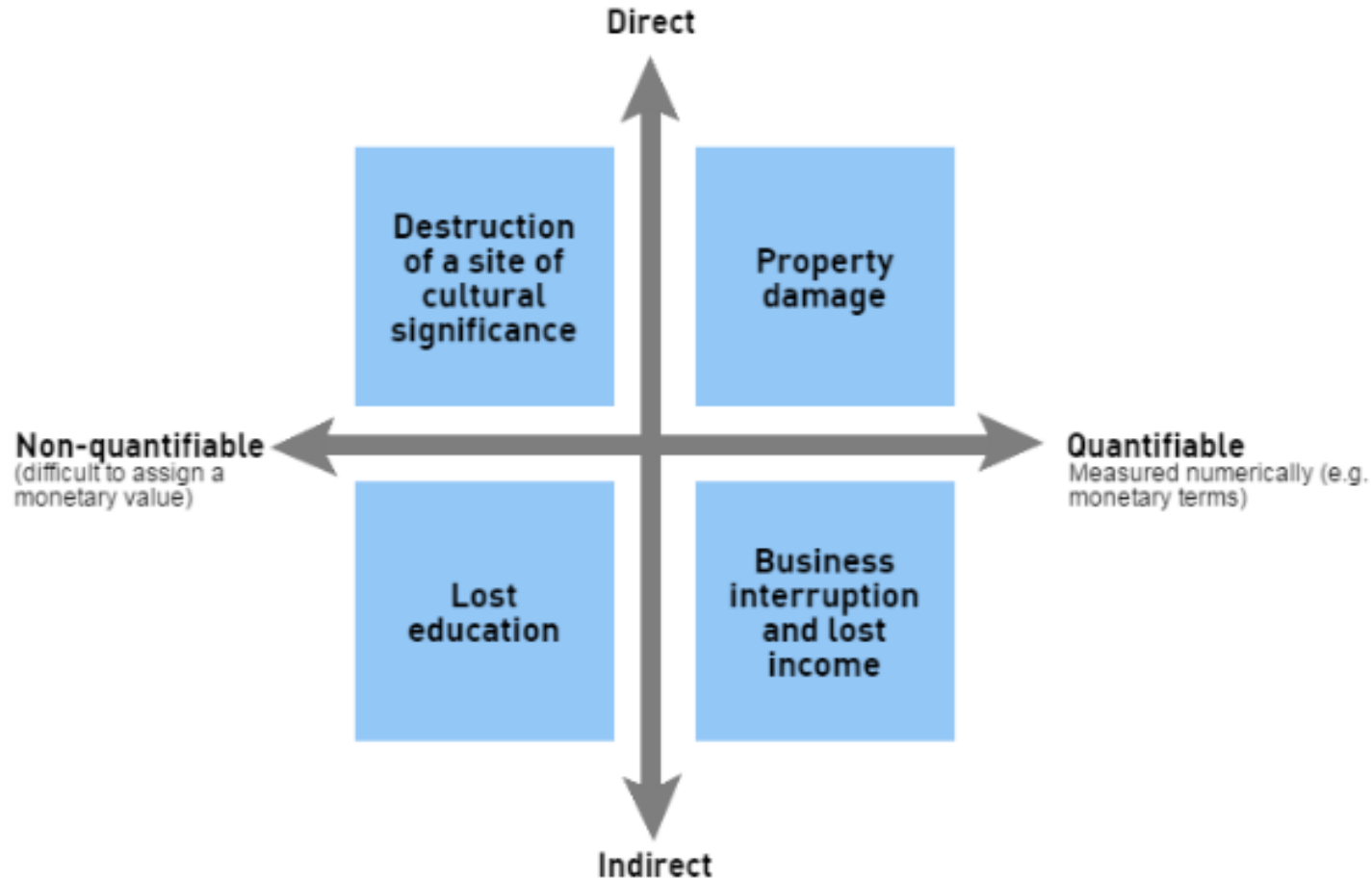
Forecasts of weather behavior and long-term climate changes



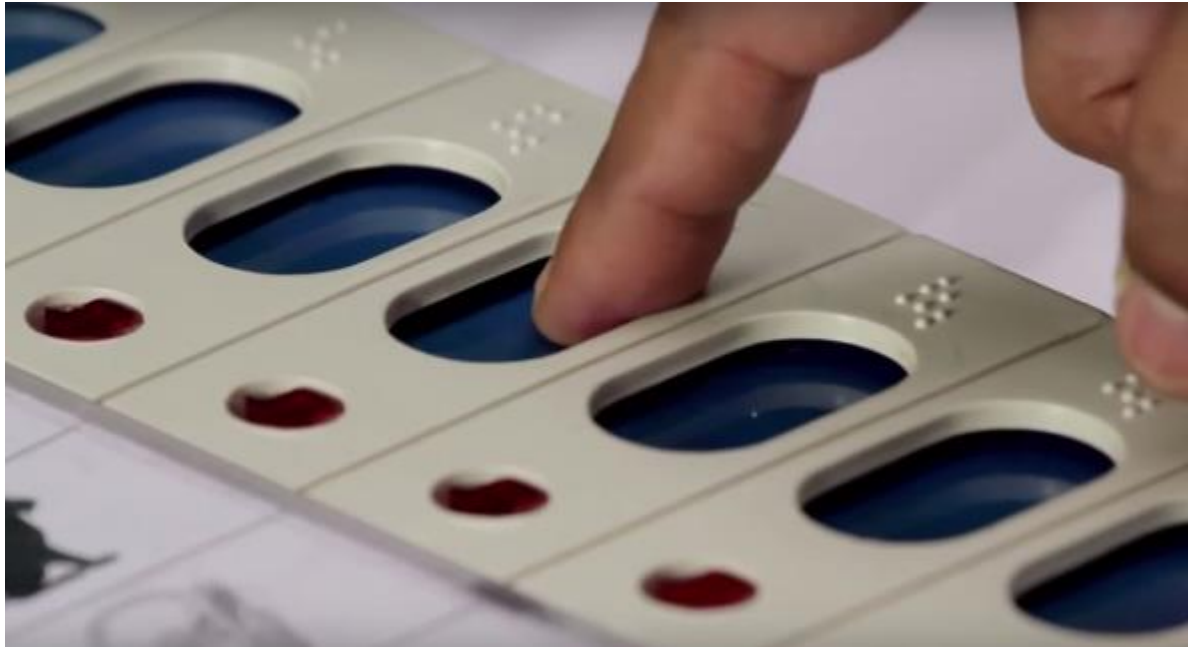
Reduction of fraudulent credit card transactions



Estimation of financial damage of natural disasters



Prediction of popular election outcomes

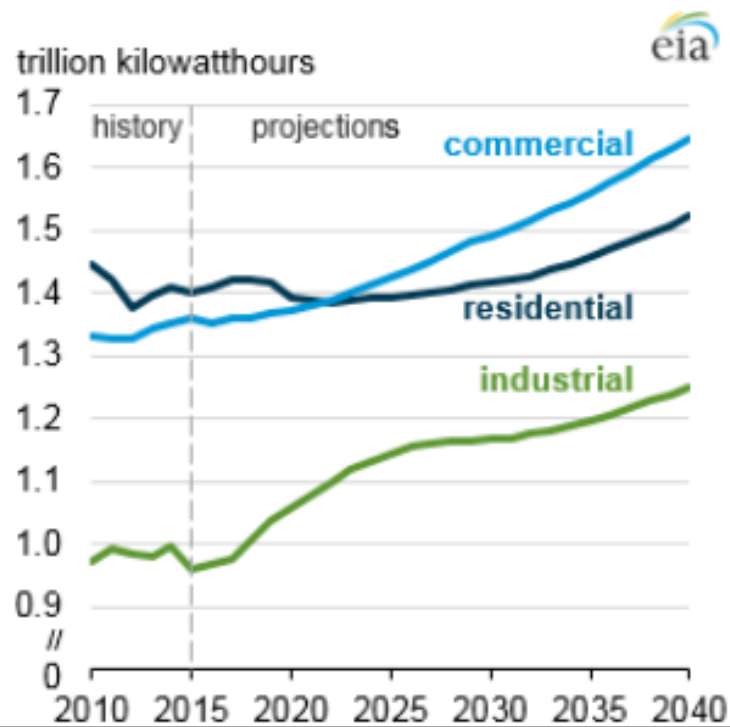
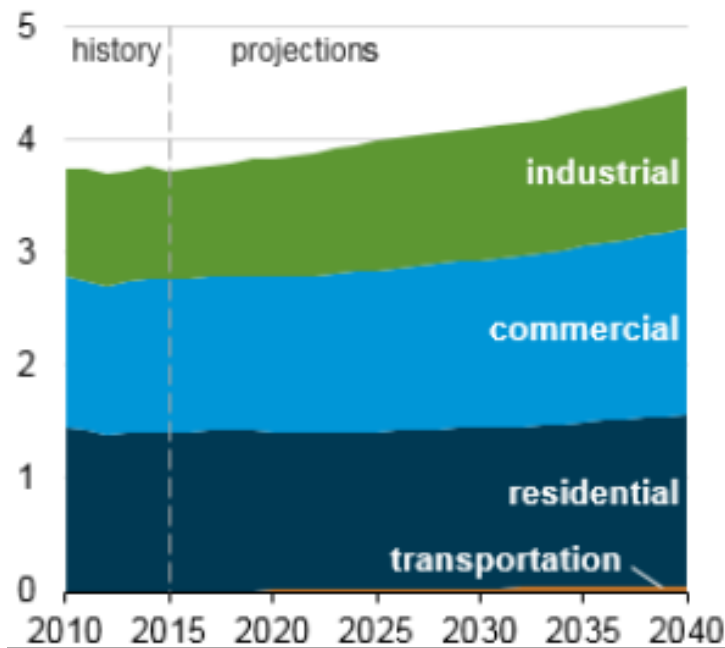


Development of algorithms for auto-piloting drones



Optimization of energy use in homes and office buildings

Electricity sales by sector (2010-40)
trillion kilowatthours



Projection of areas where criminal activity is most likely



Discovery of genetic sequences linked to diseases

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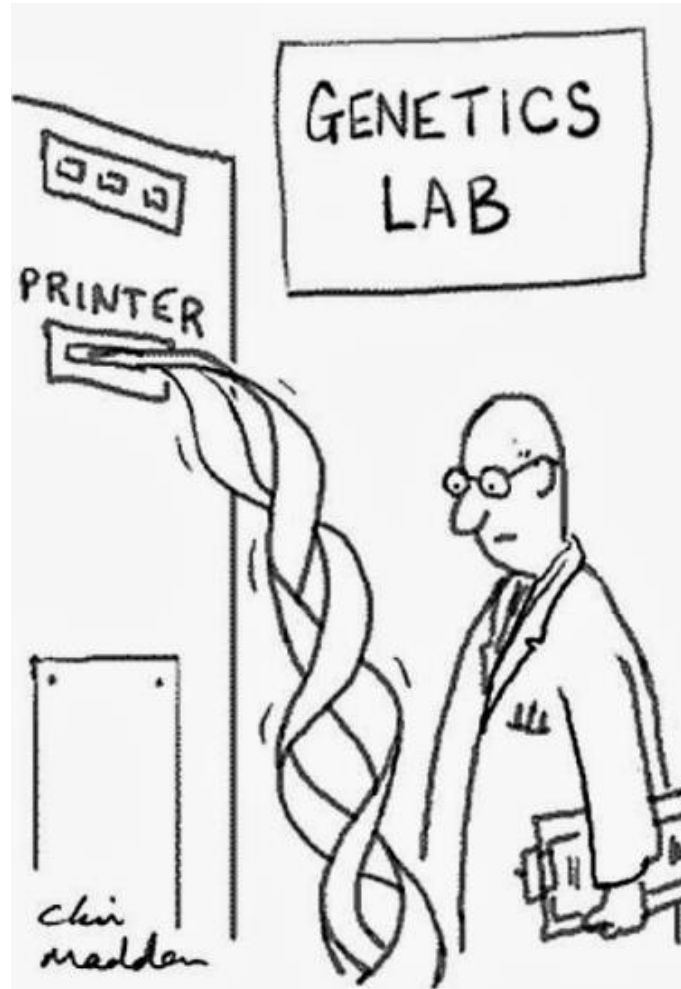
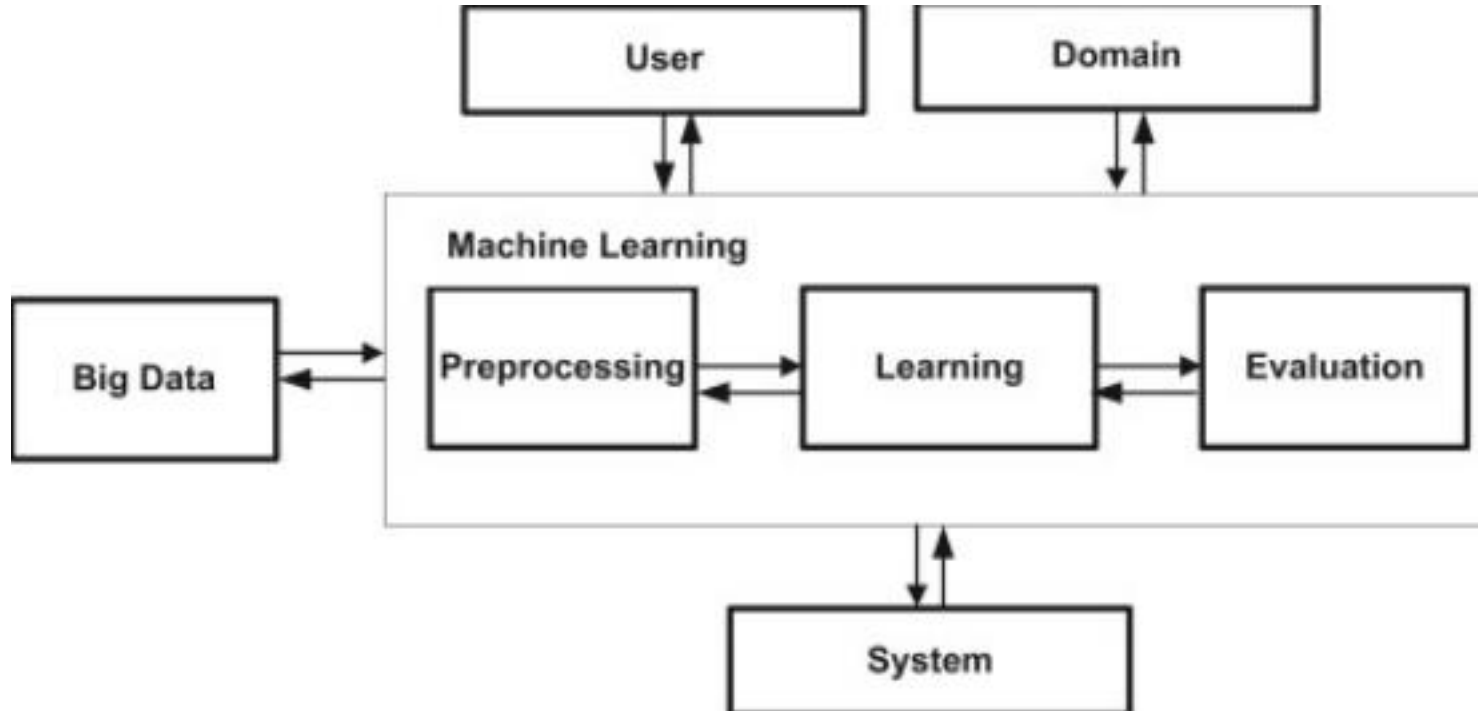


Image courtesy: <https://www.pinterest.com/pin/325596248037539989/>

[Your favorite area]

ML Model



ML Algorithms

- Tens of thousands of machine learning algorithms
- Hundreds new every year
- Every machine learning algorithm has three components:
 - **Representation**
 - **Evaluation**
 - **Optimization**

Representation

- Linear Regression
- Nearest Neighbour
- Naive Bayes
- Decision Trees
- Neural Networks
- Support Vector Machines
- Association Rules
- K-means clustering

Evaluation

- Accuracy
- Confusion Matrix
- Precision and recall
- F1 Score
- RMSE
- Loss Function
- Etc.

Optimization

- Combinatorial optimization
 - E.g.: Greedy search
- Convex optimization
 - E.g.: Gradient descent
- Constrained optimization
 - E.g.: Linear programming

Types of Learning

- **Supervised (inductive) learning**
 - Training data includes desired outputs
- **Unsupervised learning**
 - Training data does not include desired outputs
- **Semi-supervised learning**
 - Training data includes a few desired outputs
- **Reinforcement learning**
 - Rewards from sequence of actions

ML Algorithms Tasks

(Algorithms Grouped by its Task)

- Classification (Binary and Multiclass)**
- Regression (Numeric Prediction)**
- Clustering (Identifying Clusters)**
- Finding Associations (Pattern Detection)**

- Dimensionality Reduction**
- Feature Selection**

Feature Selection and Dimensionality Reduction

Both methods seek to reduce the number of attributes in the dataset

- Dimensionality reduction methods do so by creating new combinations of attributes,
- Feature selection methods include and exclude attributes present in the data without changing them.

Supervised Learning Algorithms and their category

- Nearest Neighbour -Classification
- Naive Bayes -Classification
- Decision Trees - Classification
- Linear Regression -Numeric prediction
- Regression Trees -Numeric prediction
- Neural Networks -Dual use
- Support Vector Machines -Dual use

Unsupervised Learning

- A priori algorithm - Association rule Mining/Pattern detection
- k-means clustering - Clustering

Supervised Learning

- **Given** examples of a function $(X, F(X))$
- **Predict** function $F(X)$ for new examples X
 - Discrete $F(X)$: Classification
 - Continuous $F(X)$: Regression

Question

- Identify 5 application areas of ML and say the task to be done by the algorithm (classification, regression, association mapping etc) and the method of learning required/possible to do the task (supervised/unsupervised)

Machine Learning Models deployment steps:

1. Data collection:
2. Data exploration and preparation:
3. Model training
4. Model evaluation
5. Model improvement

A Few Quotes

- “A breakthrough in machine learning would be worth ten Microsofts” (Bill Gates, Chairman, Microsoft)
- “Machine learning is the next Internet” (Tony Tether, Director, DARPA)
- “Machine learning is the hot new thing” (John Hennessy, President, Stanford)
- “Web rankings today are mostly a matter of machine learning” (Prabhakar Raghavan, Dir. Research, Yahoo)
- “Machine learning is going to result in a real revolution” (Greg Papadopoulos, CTO, Sun)
- “Machine learning is today’s discontinuity” (Jerry Yang, CEO, Yahoo)

Sample Applications

- Identification of unwanted spam messages in e-mail
- Segmentation of customer behavior for targeted advertising
- Forecasts of weather behavior and long-term climate changes
- Reduction of fraudulent credit card transactions
- Actuarial estimates of financial damage of natural disasters
- Prediction of popular election outcomes
- Development of algorithms for auto-piloting drones
- Optimization of energy use in homes and office buildings
- Projection of areas where criminal activity is most likely
- Discovery of genetic sequences linked to diseases
- [Your favorite area]