CSE 4621
Machine Learning

Lecture 0

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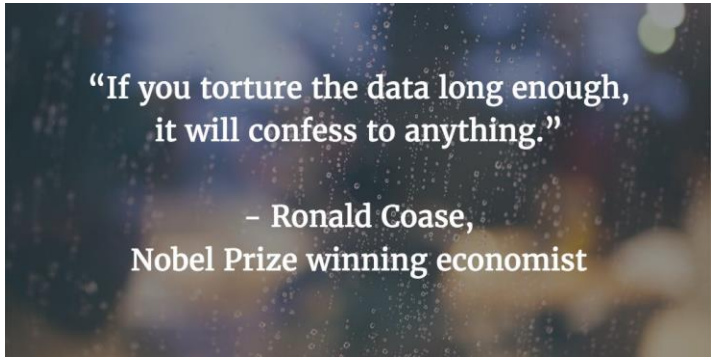
Why Machine Learning?

- This is the age of “Big Data”
  - Due to computerization and development of powerful data collection & storage tools.

- We all are producer/generator of data.
  - Purchase, clicks, social media, blogs, and many more
- We also the consumer of data!
  - Products and services specialized to user.
  - Dependent on person, time, location, etc.

- There are patterns in data.
- Who will do it? Computers!



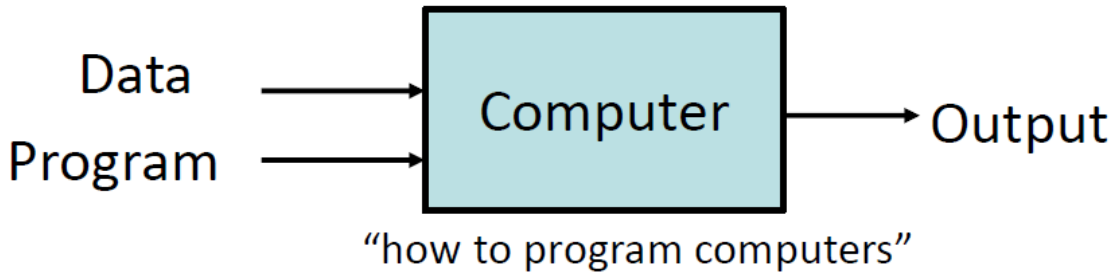
Why Machine Learning?

- Computer/Computing science aims to develop **automated** machinery (i.e., programs) to accomplish non-trivial tasks. This is known as **programming**.

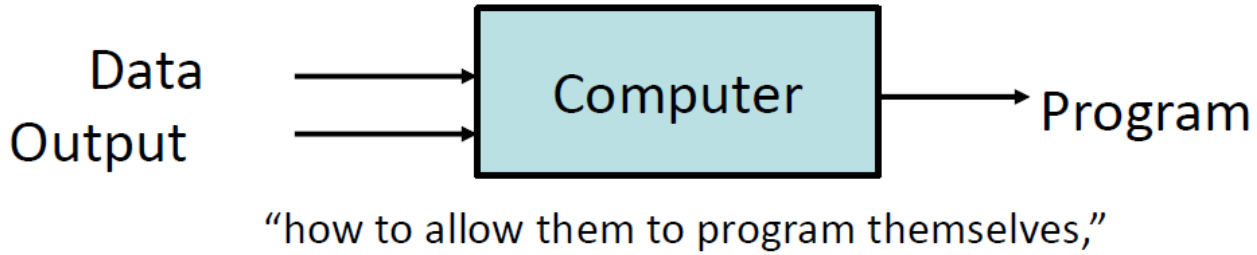
- A large number of tasks cannot be programmed explicitly by humans
  - E.g., spam detection, hand written digit recognition
  - Such programs **do exist**, but humans cannot program explicitly.
  - We may not be able to identify the process completely.
  - Some machinery (e.g., a machine learning model) is able to yield a program that almost accomplishes the task.

Conventional Programming vs. Machine Learning

– **Conventional Programming**

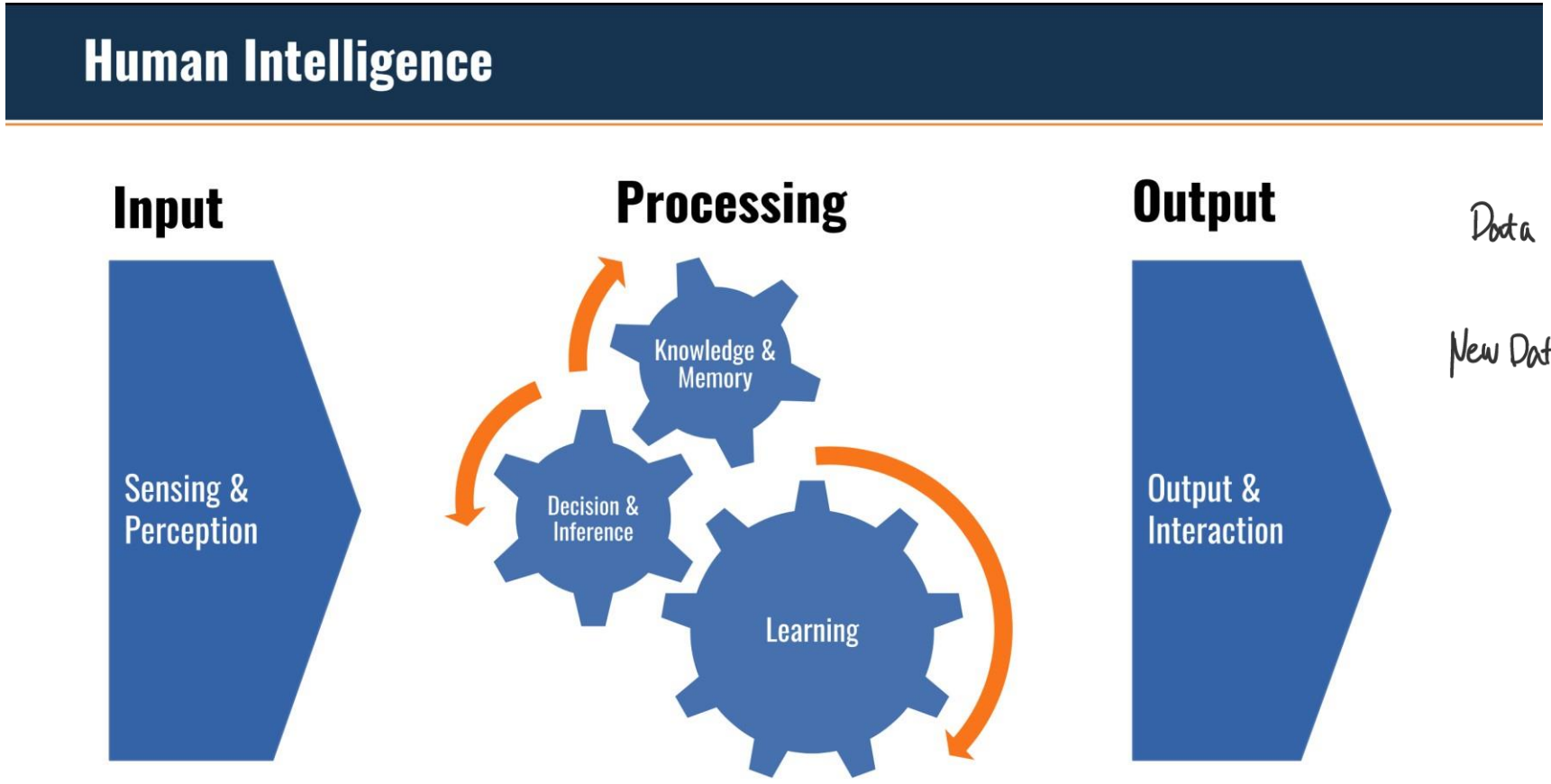


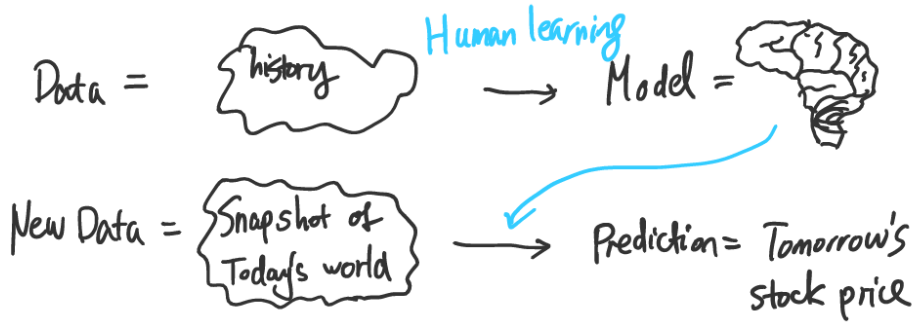
– **Machine Learning**



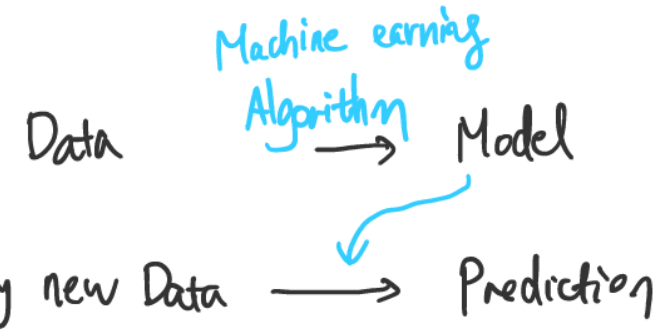
– **Example: Sentiment Analysis**

Human Learning vs. Machine Learning

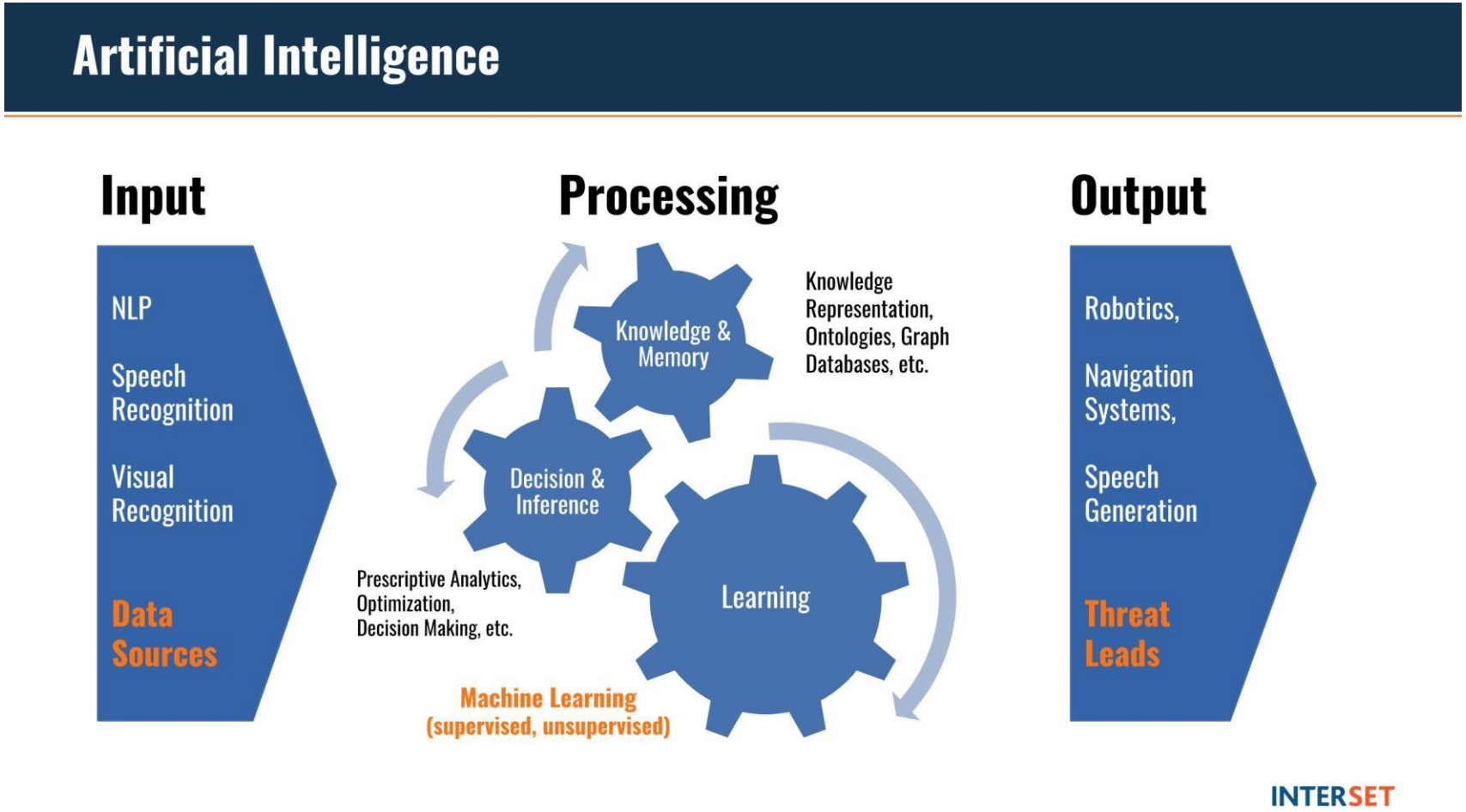




Machine Learning



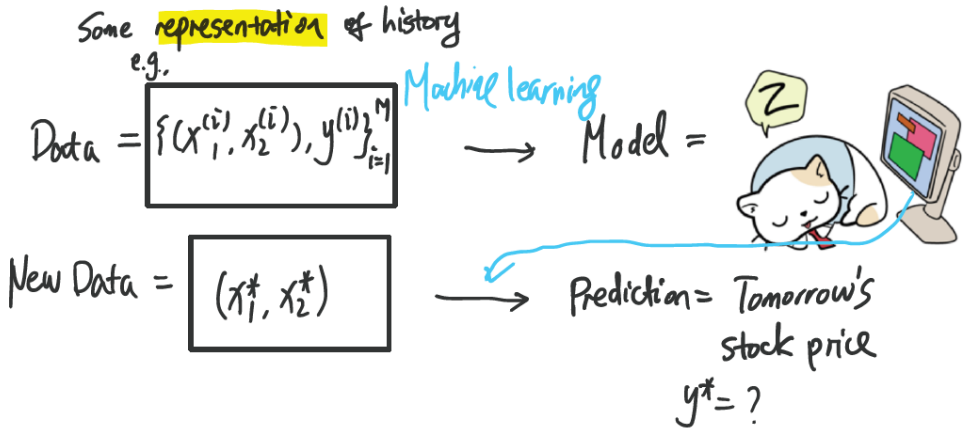
Machine Learning is AI?



Source: https://interset.com/2018/02/20/ai-101-part-1-machine-learning/

What is Machine Learning (ML)

- Machine learning is programming computers to optimize a performance criterion using example data or past experience. (E. Alpaydin, 2014)
- We have a **model** defined up to some parameters, and learning is the **execution of a computer program to optimize the parameters** of the model using the training data or past experience.
- The model may be predictive to make predictions in the future, or descriptive to gain knowledge from data, or both



More ML Definitions

- Arthur Samuel (1959). Machine Learning: Field of study that gives computers the ability to learn without being explicitly programmed.

- Tom Mitchell (1998) Well-posed Learning Problem: A computer program is said to *learn* from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E.

Example

> "A computer program is said to *learn* from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E."

Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task T in this setting?

- Classifying emails as spam or not spam. T
- Watching you label emails as spam or not spam. E
- The number (or fraction) of emails correctly classified as spam/not spam. P
- None of the above—this is not a machine learning problem.

Some Applications of Machine Learning

- **Learning to recognize spoken words.**
  - All of the most successful speech recognition systems employ machine learning in some form that are effective for automatically customizing to individual speakers, vocabularies, microphone characteristics, background noise, etc. Similar techniques have potential applications in many signal-interpretation problems.

- **Learning to drive an autonomous vehicle.**
  - Machine learning methods have been used to train computer-controlled vehicles to steer correctly when driving on a variety of road types.

Some Applications of Machine Learning

- **Learning to classify new astronomical structures.**
  - Machine learning methods have been applied to a variety of large databases to learn general regularities implicit in the data. For example, decision tree learning algorithms have been used by NASA to learn how to classify celestial objects

- **Learning to play world-class backgammon or chess.**
  - The most successful computer programs for playing games such as backgammon are based on machine learning algorithms. Learned its strategy by playing over one million practice games against itself. It now plays at a level competitive with the human world champion.

Course Content (as per Syllabus)

Introduction: Defining machine learning, Scalability, Privacy issues and social impact, Applications in AI, Computer vision, Computer games, Search engines, Marketing, Bioinformatics, Robotics, HCI and Graphics. Graphical models: Introduction to discrete probability, Inference in Bayesian networks, Maximum likelihood and Bayesian learning Model selection.

Supervised learning: Introduction to continuous probability, Linear regression and classification (least squares and ridge), Model assessment and cross-validation, Introduction to optimization, Nonlinear regression (neural nets and Gaussian processes), Boosting and feature selection.

Unsupervised learning: Nearest neighbors and K-means, Spectral kernel methods for clustering and semi-supervised learning. The EM algorithm, Mixture models for discrete and continuous data, Temporal methods: hidden Markov models & Kalman filters, Boltzmann machines and random fields, Examples: web mining, collaborative filtering, music and image clustering, automatic, translation, spam filtering, computer games and object recognition.

Neural Network: Fundamentals of Neural Networks, Back-propagation and related training algorithms, Hebbian learning, Cohen-Grossberg learning, The BAM and the Hopfield Memory, Simulated Annealing, Different type of Neural Networks: Counter-propagation, Probabilistic, Radial Basis Function, Generalized Regression, etc., Adaptive Resonance Theory, Dynamic Systems and Neural Control, The Boltzmann Machine, Self-organizing maps, Spatiotemporal Pattern Classification, The Neocognition, Practical aspects of Neural Networks.

Other forms of learning: Semi-supervised learning, Active learning, Reinforcement learning, Self-taught learning, Evolutionary learning: Genetic algorithm, Genetic programming, CGA.

Course Objectives & Outcomes

- Master the basic techniques on machine learning techniques, including supervised learning, unsupervised learning, and reinforcement learning.
- Apply and implement algorithms to enable machine learning.
- Analyse both strengths and weakness of the machine learning algorithms.
- Design and develop solutions/algorithms for small to medium scale problems.

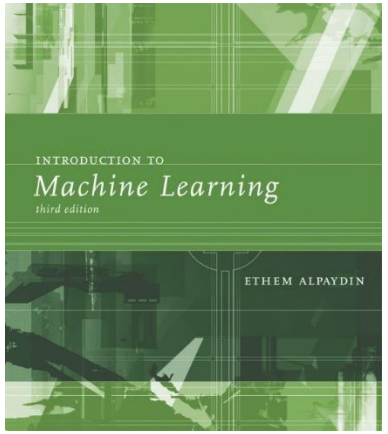
Course Outcomes (BAETE)

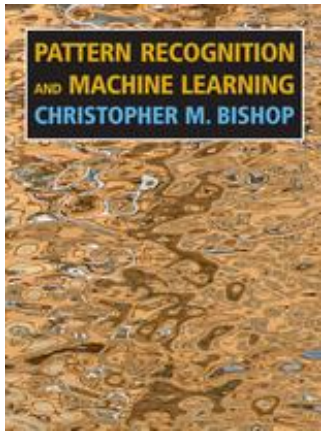
(CO1) Apply algorithms to enable machine learning.

(CO2) Analyse both strengths and weakness of the machine learning algorithms.

(CO3) Design solutions/algorithms for small to medium scale problems.

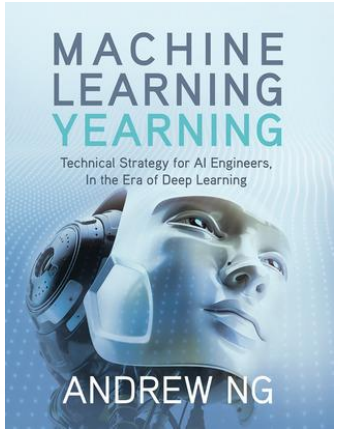
Reading Materials

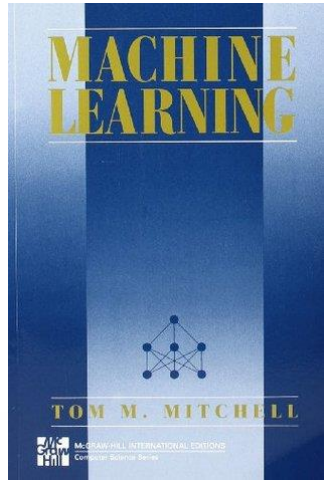




Text Book:

- Introduction to Machine Learning, (3rd/2nd Ed.), MIT Press, 2014
  - E. Alpaydin
- Pattern Recognition and Machine Learning (1st Ed.) Berlin: Springer-Verlag, 2006
  - C. Bishop
- Machine Learning Yearning (Online Version), 2018
  - Andrew Ng



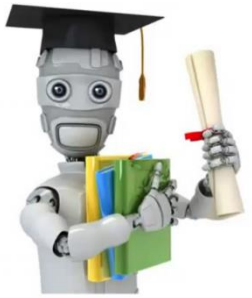


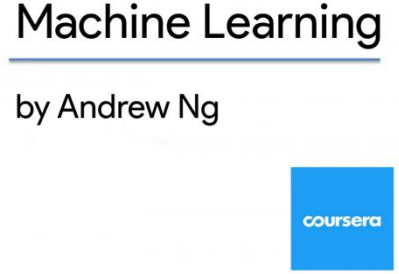
Reference books:

- Machine Learning (1st Ed.), McGraw Hill, 1997
  - T. Mitchell
- Pattern Classification (2nd Edition), Wiley & Sons, 2001.
  - Richard O. Duda, Peter E. Hart & David G. Stork

Online (Coursera) Course:

- Machine Learning - Andrew Ng. at *http://ml-class.org*


Machine Learning



Course Evaluation

As per guidelines provided by CSE Dept., IUT

- Class Tests
- Assignments
- Examinations

Course Material & Announcement:

- Google Classroom Code: **wk3xbql**