INTRODUCTION TO MACHINE LEARNING

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* Some contents are adapted from Dr. Hung Huang and Dr. Chengkai Li at UT Arlington

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What is Machine Learning?

- Herbert A. Simon
  - “Learning is any process (algorithm) by which a system (model) improves performance (accuracy) from experience (data)”

- Data may include hidden knowledge that explains laws/rules/logics of a certain complex phenomenon

Turing Award, 1975
Nobel Prize in Economics, 1978
What is Machine Learning?

- Algorithms that train data and improve the performance by using the knowledge

- Why?
  - It is often too difficult to design a set of rules “by hand”
  - Machine learning is about automatically extracting relevant information from data and applying it to analyze new data

- Examples
  - Face Recognition
  - Speech recognition
  - Stock market prediction
Ramanathan and Chellappa, “Modeling Age Progression in Young Faces”, 2006
Machine Learning

Face dataset

**IMDb**

460,723 images

**Wikipedia**

62,328 images

1. Input image
2. Face detection
3. Cropped face
4. Feature extraction
5. Prediction

Mathias et al. detector
+ 40% margin

VGG-16 architecture

Softmax expected value

Σ = 23.4 years

Ref: [https://data.vision.ee.ethz.ch/cvl/rrothe/imdb-wiki/](https://data.vision.ee.ethz.ch/cvl/rrothe/imdb-wiki/)
Machine Learning

Perform a task
- yes
- no

• Tasks
  - Classification
  - Regression
  - Clustering
  - Feature Selection
  - Reinforcement
  - Anomaly detection

Data → Training → Model → $f(x)$ → New Data
What is Machine Learning?

- Let a machine find certain patterns automatically to make a decision
  - Very related to Optimization
- However, machine learning is not “MAGIC”
- We should give a minimum guideline to a machine
  - Data
  - Model
- Machine will find the best setting of the model computationally
Types of Learning

- Supervised learning (Classification and Regression)
  - Given labeled data, classifying or predicting unlabeled new data
- Unsupervised learning (Clustering)
  - Given unlabeled data, inferring a function to describe hidden patterns
- Feature Selection/Feature Reduction
  - Selecting a subset of relevant features
- Semi-supervised learning
  - Given both labeled/unlabeled data, classifying or predicting unlabeled new data
- Ensemble Learning
- And many topics…
Examples

- Google Vision API
  - [https://cloud.google.com/vision/](https://cloud.google.com/vision/)
- Age estimation from facial images
Discussion

- Let's discuss about machine learning examples
  - Problem?
  - Why should we consider machine learning for the problem?
  - What dataset do we need?
Discussion

- Algorithms are machine learning??
  - Shortest path algorithm (e.g., Dijkstra's algorithm)
  - Sorting algorithms

- Performance
  - Efficiency vs Accuracy
Foundation of Machine Learning

- Which Skills Are Most Valuable In Machine Learning? (Forbes)
  - Fundamentals of Statistics
  - Optimization (Mathematics, but don’t be scared)
  - Building quantitative models
  - Understanding how models and data analysis actually apply to products and businesses
  - Knowing how to write high quality software
  - Working with large data sets

Ref: https://www.forbes.com/sites/quora/2017/09/29/which-skills-are-most-valuable-in-machine-learning/#79d6061b7c43
Machine Learning

Conferences
- ICML, NIPS, CVPR, ICCV, AAAI, IJCAI, ECML, ECCV, KDD, UAI, COLT

Journals

See “Google Scholar Metrics”
More details

- **More details of Journals/Conferences**
  - **Scopes**
    - Original Papers, Discovery Notes, Application Notes, and Reviews (Survey)
  - **Paper types**
  - **Open-access journals**
    - Otherwise via UNLV Online Library

1 https://www.computer.org/web/tkde/about
2 https://www.computer.org/web/tkde/author