Concluding Remarks for
The Art of Machine Learning
(ECE 208/408, TEE 408)

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What is Machine Learning?

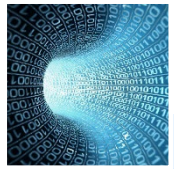
- "... the field of study that gives computers the ability to learn without being explicitly programmed."

---- Arthur Samuel, 1959

- "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."

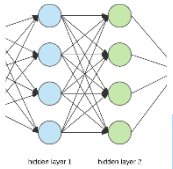
---- Tom Mitchell, 1997

Three Key Elements



Data

- "Experiences"
- Measurements
- Observations
- Annotations



Model

- Mathematical
- Architectural

Algorithm

- Random search
- Gradient descent
- Newton's method
- Genetic algorithm

Machine Learning Paradigms

- Supervised learning
  - Given examples $(\boldsymbol{X}, \boldsymbol{Y})$, learn $f\colon \boldsymbol{x} \mapsto \boldsymbol{y}$
- Unsupervised learning
  - Given examples $\boldsymbol{X}$, discover structures of data
- Semi-supervised learning
  - Given examples $(\boldsymbol{X}^l, \boldsymbol{Y}^l)$ and $\boldsymbol{X}^u$, learn $f\colon \boldsymbol{x} \mapsto \boldsymbol{y}$
- Reinforcement learning
  - Given sequences of (state, action, immediate reward): $(\boldsymbol{s}, \boldsymbol{a}, \boldsymbol{r})$
  - Learn optimal behavior $f\colon \boldsymbol{s} \mapsto \boldsymbol{a}$ that is good in the long run

Course Topics

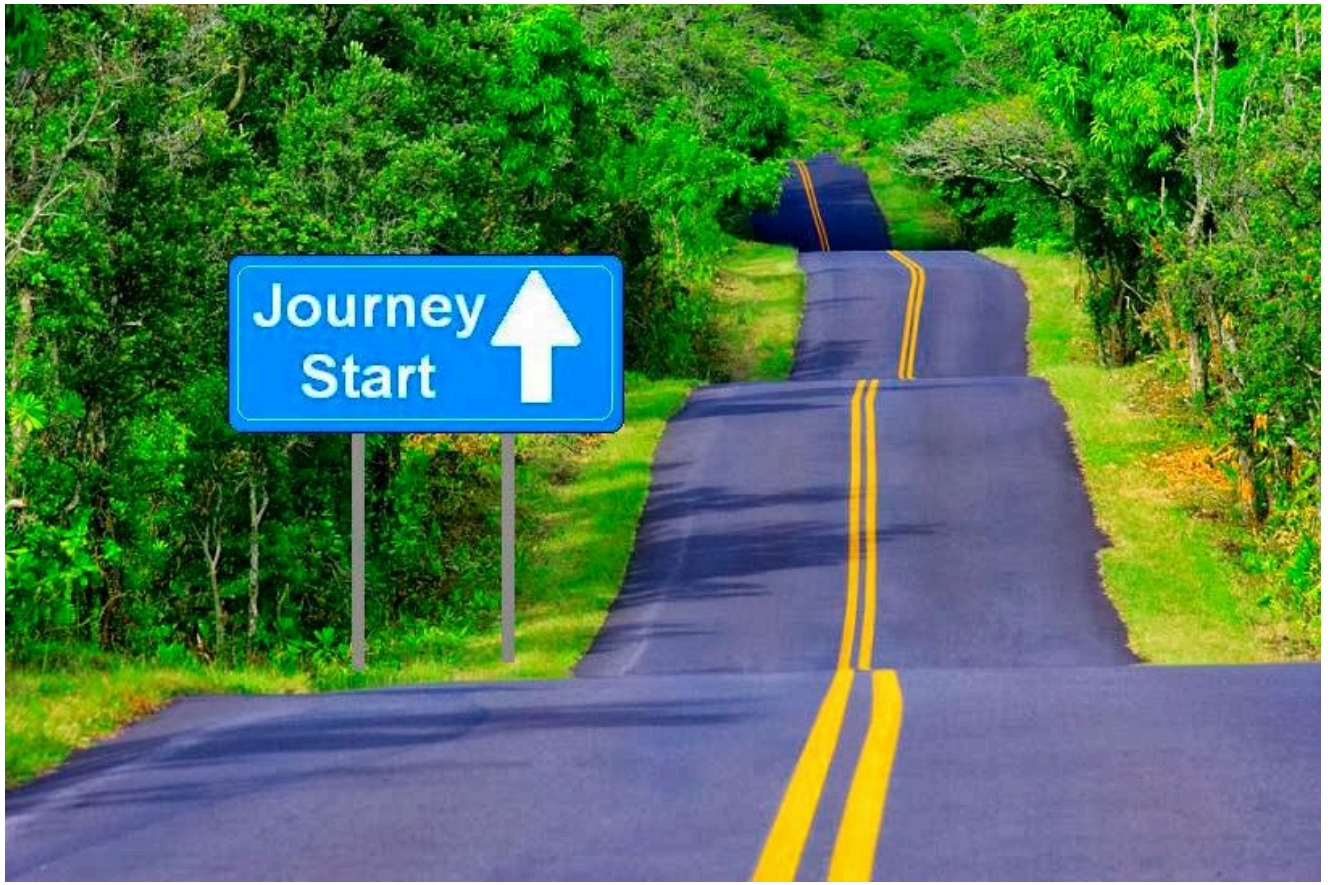
- Fundamental concepts of machine learning
  - Training, validation, testing
  - Overfitting, underfitting, cross validation
  - Bias/variance tradeoff, regularization, generalization
  - Supervised, semi-supervised, unsupervised, reinforcement learning
- Various machine learning models
  - Nearest neighbors, decision trees, linear models, generalized linear models, support vector machines, multi-layer perceptron, convolutional neural networks, recurrent neural networks, K-means, principal component analysis, dimensionality reduction
- Applications of machine learning in engineering problems
  - E.g., Circuit design, salary prediction, maternal health risk assessment, lung ultrasound image classification, music generation

Course Objectives

- Good understanding of fundamental concepts and various models and applications of machine learning
- Build intimate connections between theory and practice

- Gain experience in doing small-scale research projects
- Enhance capabilities of problem solving, team-working, presentation, etc.

We started here…



We are almost there!

Things To Do

- Present final project (Tuesday 5/7 @ 12:30-3 PM in CSB 601)
- Submit remaining assignments (due Wednesday 5/8 night)
  - Final paper
  - Presentation slides
- Evaluate the course online with detailed feedback
  - What did you like?
  - What did you hope to improve
- Consider taking Computer Audition and other machine-learning related courses in Fall 2024


Thank You!