THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

CSIT 5910: Machine Learning

Fall 2024

Announcements

Course Info

Schedule

Project

Canvas

Piazza

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Course Information

- **Instructor:**
  Nevin L. Zhang (张连文)
  Room 2541, phone: 2358-7015, Email: lzhang@cse.ust.hk Home page
  Office Hours: After classes or by appointment

- **TAs:** XIE Weiyan wxieai@connect.ust.hk , MIN Rui rminaa@connect.ust.hk

- **Class Date and time:** Saturday, 15:00pm – 17:50pm; **Venue**: Rm 2306 (lifts 17-18)

- **Course Description:**
  This course covers core and recent machine learning algorithms. Topics include supervised learning algorithms (linear and logistic regression, generative models for classification, learning theory), deep learning algorithms (feedforward neural networks, convolutional neural networks, recurrent neural networks, adversarial attacks), unsupervised learning algorithms (variational autoencoders, generative adversarial networks, stable diffusion), and reinforcement learning (classic RL, deep RL).

- **Course outcomes:**
  Upon successful completion of the proposed course, students will be able to:
  - To gain an overview of Machine Learning as a subject of study.
  - To gain an understanding of the fundamental issues in machine learning.
  - To gain an understanding of core and recent machine learning algorithms.
  - To gain an ability to apply core and recent machine learning algorithms to solve real-world problems

- **Syllabus (tentative):**
  - Part 0: Introduction and Preparation
    - Introduction to Course
    - Basics of Probability/Information Theory
  - Part 1: Foundation of Machine Learning
    - Linear and Polynomial Regression
    - Logistic and Softmax Regression
    - Generative Models for Classification
    - Learning Theory
  - Part 2: Basic Deep Learning Models
    - Feedforward Neural Networks
    - Convolutional Neural Networks
    - Recurrent Neural Networks
  - Part 3: Advanced Deep Learning Models
    - Transformer, BERT and GPT
    - Vision Transformers
    - Vision-Language Models
  - Part 4: Unsupervised Deep Learning
    - Variational autoencoders
    - Generative adversarial networks

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- Generative adversarial networks
- Diffusion Models

- Part 5: Reinforcement Learning
  - Introduction to RL
  - Value-Based Deep RL
  - Policy-Based Deep RL
- Part 6: Deployment Issues
  - Adversarial Attacks
  - Explainable AI

Part 6 might not be covered if we run out time. It will not be included in the final exam even if we have time to discuss it in class.

- **Tutorials**

  The lectures will focus on conceptual frameworks, models, principles and algorithms. Tutorials will be provided to illustrate how to turn the theory into practice and help student get started with hands-on experiences. At HKUST, tutorials are not officially scheduled for postgraduate courses. We will mostly use video recordings from past offerings.

  - PyTorch Basics
  - Feedforward Neural Networks in PyTorch
  - Convolutional Neural Networks in PyTorch
  - Recurrent Neural Networks in PyTorch
  - BERT
  - CLIP
  - GAN and VAE
  - Stable Diffusion
  - Deep Q-Network
  - Adversarial Attack
  - Explainable AI

- **Reference Books/Materials:**
  - Andrew Ng. Lecture Notes on Machine Learning. Stanford. http://cs229.stanford.edu/syllabus.html
  - I Goodfellow, Y Bengio, A Courville (2016). Deep Learning. MIT Press. http://www.deeplearningbook.org/
  - K. P. Murphy (2012). Machine Learning: A Probabilistic Perspective. MIT Press. (Available online via university library)
  - E. Alpaydin (2014). Introduction to Machine Learning. Third Edition. MIT Press. (Available online via university library)
  - C. M. Bishop (2006). Pattern Recognition and Machine Learning. Springer. (Available online via university library)
  - R. Sutton and A. Barto (1998). Reinforcement Learning. MIT Press.

- **Workload and Grading:**
  - 4 Written Assignments: 4x5% = 20%

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- **Workload and Grading:**
  - 4 Written Assignments: 4x5% = 20%
  - Hands-on Assignments (HA): 30%
    - Option 1: 6 Hands-on assignments (6x5%) with at most 2 from HA1-HA4
    - Option 2: 2 Hands-on assignments (from HA5-HA9, different from Term project) (2x5%) and Term Project (20%)
  - Final examination: 50%

The written assignments are designed to sharpen the students' understanding of course materials and to help the students prepare for the final exam. The questions in the final exam will be similar to some of the homework questions.

Hands-on experience is very important to this course. 10 hands-on assignments are prepared: (1) Program softmax; (2) Program backpropagation for a simple neural network; (3) Experiment with hyper-parameters of CNN on MNIST; (4) Test several popular CNN models on a set of images; (5) Use BERT for sentiment analysis; (6) Experiment with GAN, (7) Experiment with Stable Diffusion, (8) Try out the Q-learning algorithm for reinforcement learning; (9) Generate adversarial examples; (10) Generate explanations for CNN results. Students can only submit the required number of HA's. Additional ones will not be accepted.

The term project will allow the students to gain more extensive hands-on experiences and conduct in-depth explorations on some aspects of machine learning.

Similarity Score: All submissions are to be made via Canvas. Unless explicitly stated otherwise, a similarity score will be automatically computed by Turnitin for each of your submissions. Penalty will apply to those with similarity scores higher than 40. Specifically, the formula for penalty is:

(max { similarity score − 40, 0 } / 60) x 100% (of the total grade of the item).

This formula is pretty generous. According to https://edumanias.com/elearning/acceptable-turnitin-similarity-percentage/, the most commonly acceptable Turnitin percentage limit is 60% to 70% for freshman year (First year at University), 50% for the sophomore year (2nd year at University), 40% for the junior year (3rd year at University), and 20% to 30% for senior year students.

To enable similarity score calculations, your answers must be typed up and be submitted as an MS Word or PDF file, or a text file in the case of programming assignments. Handwritten answers will not be accepted, although hand-drawn figures are accepted. When making a submission, you should check your similarity score. If it is higher than 40%, reduce it. Note that the score might increase as more submissions come in. To safeguard yourself, take a screenshot of your similarity score at the time of the final submission, together with a timestamp (at the bottom-right corner on Windows OS). You can show the screenshot to the TA if your score increases to higher than 40% later. Of