UNIVERSITY OF PUTHISASTRA

Master of Science in Information Technology

ICT606: Machine Learning

(Academic Year: 2020-2021)

COURSE SYLLABUS

Lecturer	Long Ang LIM (Mr.)
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Class Hours	45 hours, Saturday 2:00pm – 5:10pm
Credits	3 credits

I. COURSE DESCRIPTION

Machine Learning has become an important aspect the digital world and has been essential to the success of many application areas such as autonomous driving, object recognition and detection, anomaly or fraud detection, recommender system, speech recognition, and sentiment analysis, to name a few. Machine learning is able to extract hidden patterns/features from raw data and learns from experience without being explicitly programmed.

This course will familiarize students with the fundamental concepts, theories, and practical algorithms of deep/machine learning to enable students to gain the necessary knowledge for their future industry job/research. Moreover, this course will also introduce students about the latest and powerful technology called deep learning, which is a subset of machine learning, and prepare students for future research or career in any technology industries.

II. COURSE TOPICS

- Machine learning concepts
- Machine learning methods (supervised, unsupervised, reinforcement)
- Machine learning tasks (classification, regression, clustering, transcription etc.)
- Challenges in machine learning (underfitting, overfitting)
- Model of a biological neuron, multilayer perceptron, activation functions, neural network architecture.
- Data preprocessing, weight initialization, batch normalization, regularization (L2/dropout), loss functions
- Backpropagation, intuitions (chain rule interpretation)
- Python for machine learning, plotting & machine learning's models visualization
- Deep learning frameworks (Keras & Tensorflow 2)
- Model evaluation/cross validation
- Convolutional neural networks

- Deep/machine learning domains (classification, segmentation etc.)
- Model ensemble and transfer learning
- Keras/deep learning tips and tricks
- Journal/conference papers
- Many more…

III. PRE-REQUISITES

To successfully complete the course, students should have:

- Basic programming knowledge skills, especially Python.
- High school calculus, linear algebra, derivatives.

IV. LEARNING OUTCOMES

By the end of this course, students should be able to:

- Understand basic concepts of machine learning.
- Understand how machine learning and its real-world applications impact everyday life.
- Understand a wide variety of learning algorithms.
- Understand basic concepts of neural network and how it is applied in deep/machine learning.
- Understand the latest deep learning technology, which is a subset of machine learning, in details.
- Know how to implement machine learning algorithms to solve real-world problems, optimize and visualize the models learned etc.
- Understand various deep/machine learning frameworks and know how to use google cloud to speed up the learning process.
- Implement their own deep/machine learning algorithms and deploy to the web or mobile.
- Understand deep/machine learning tips and tricks which lead to success of any research
- Understand about deep/machine learning research and its direction toward successful journal/conference publication.
- many more...

V. COURSE SCHEDULE

Week	Date	Topic	Hours
1	05/12/2020	▪ Introduction to machine learning ▪ A brief overview of machine learning domain areas & its applications.	3
2	12/12/2020	▪ Basic linear algebra, vector, matrix operation, & derivatives ▪ Basic Python for machine learning	3
3	19/12/2020	▪ Machine learning libraries, datasets, & data preprocessing. ▪ Practical machine learning algorithms with real datasets. ▪ Image classification pipeline	3
4	26/12/2020	▪ Loss function and optimization ▪ Backpropagation ▪ Part 1: Artificial neural networks (ANN)	3
5	02/01/2021	▪ Part 2: Artificial neural networks	3

		▪ Convolutional neural networks (CNN)	
6	09/01/2021	▪ Training neural networks	3
7	16/01/2021	▪ CNN architectures ▪ Deep learning software	3
8	23/01/2021	▪ Detection and segmentation ▪ Visualization and understanding CNN	3
9	30/01/2021	▪ Introduction to Keras and Tensorflow 2.0 framework ▪ Advanced Keras framework with practical machine learning algorithm and datasets.	3
10	06/02/2021	Midterm	3
11	13/02/2021	▪ Introduction to Google Cloud GPU/TPU for deep learning ▪ Speed comparison with practical algorithm	3
12	20/02/2021	▪ Transfer Learning and fine-tuning CNN ▪ Combining different models for ensemble learning	3
13	27/02/2021	▪ Deep learning tips and tricks ▪ Keras framework tips	3
14	06/03/2021	Project presentation/demo	3
15	13/03/2021	Project presentation/demo	3
-	28/03/2021	Final deadline to submit project paper	-

Note: The topics and schedule are flexible and subjected to change without prior notice.

VI. COURSE FORMAT

This course is conducted once a week; students are expected to attend and actively participate. Slide presentation and whiteboard are primary materials for this course. Slides will be shared to students in advance before the class starts and students are expected to take notes on key points by using computer, tablets, or textbook during the class. Irrelevant activities, e.g. playing games, are not allowed during the class.

VII. STUDENT ASSESSMENT

Students will be assessed as follows:

#	Items	Weights
1	Homework	10%
2	Midterm	30%
3	Research Project	60% will be divided into: ▪ Proposal paper (10%) ▪ Presentation & Demo (30%) ▪ Project paper (20%)

Attendance Requirement:
All students are required to attend more than 70% of the class hours. If not, they will be considered as failed the course and students need to retake the course again.

Homework:
Homework will be provided during the course. No copyright is allowed. Failed or late to submit the assigned homework, 10% of the overall scores will be deducted.

Grading Scale:
Grade will be classified as follows:

Score	Grade	Explanation
90 - 100	A	Excellent
85 - 89	B+	Good
80 - 84	B	Above Average
75 - 79	C+	Average
70 - 74	C	Below Average
60 - 69	D	Poor
$\leq$ 59	F	Fail
IP	IP	In Progress

VIII. PROJECT

Project is an important part of the course since it allows students to understand and practice on how to implement their own deep/machine algorithms. The class will also provide students ideas on how to write research papers similarly to journal or conference papers.

1. Project Implementation Steps

- Select a vision problem.
- Find 2 papers from the journal/conference list provided below.
- Read and understand the papers.
- Prepare a presentation explaining the approaches in the papers, compare methods in the papers, and compare methods' performance etc.
- Implement the selected approach in the papers or implement a new approach based on selected vision problem and use the same or similar datasets.
- Presentation and demo are at the same day
- **Submission**:
    - Selected papers
    - Presentation
    - Source code
    - Project paper

2. Possible Research Topics

- Image classification
- Skin detection
- Foreground segmentation/background subtraction
- Semantic segmentation/scene understanding
- Object detection
- Action recognition
- Pedestrian detection
- Gesture recognition
- Video surveillance
- Self-driving cars
- Face detection
- Fraud detection
- Weather forecasting/prediction
- Speech recognition
- Sentiment analysis
- Recommender systems/product recommendation
- etc.

3. Journal and Conference List

- **Journal list:**
  - Pattern Recognition
  - Pattern Recognition Letters
  - IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)
  - Journal of Machine Learning Research(JMLR)
  - International Journal of Computer Vision (IJCV)
  - Computer Vision and Image Understanding (CVIU)
  - Machine Learning
  - Machine Vision and Its Applications
  - etc.

- **Conference list**:
  - International Conference on Computer Vision (ICCV)
  - International Conference on Computer Vision and Pattern Recognition (CVPR)
  - European Conference on Computer Vision (ECCV)
  - Neural Information Processing System (NIPS)
  - International Conference on Machine Learning (ICML)
  - International Conference on Pattern Recognition (ICPR)
  - etc.

4. Project Rules

Students can form their own project groups that consist of 3 students at maximum, except that there is one student left so that a group can contain 4 students. Each student within a group will be assessed individually based on project's participation and level of contribution in that group. Project copyright is not allowed across the group.

IX. REFERENCES AND TEXTBOOK

There is no specific machine learning textbook/reference that cover in this course. All deep/machine learning tutorials, textbooks, and references are recommended to read.