[*Advanced Machine Learning*]

Course Administrative Details

Course Title	*Advanced Machine Learning*		
Instructor(s)	*Leonard Johard*	**Instructors' e-mail**	*l.johard@innopolis.ru*
Course #	*XXX*	**Course Type**	*Core*
Faculty	*Computer Science and Engineering*	**Major**	*MS(DS)*
Academic year	*2024*	**Semester Offered**	*Spring*
No. of Credits	*6 ECTS*	**Total workload on average**	*12 hrs. per week inc. 8 hrs. of self-study*
Lecture Hours	*3 hours per week*	**Lab Hours**	*N/A*
Language	*English*	**Frequency**	*Weekly*
Target Audience	*Graduate*	**Anticipated Enrollment**	*30 students*
Studying year	*2*		
Grading Mode	*A, B, C, D*	**Keywords**	Neural networks, Graphical models, Neural networks, interpretable Machine learning, generative models, HMM, unsupervised learning, transfer learning, LLMs

Course outline

This course is designed for graduate students to provide comprehensive and advanced topics in machine learning. Students will learn to implement the machine learning models in Python programming environment from a data science perspective. In this course, we will cover neural network architectures, Generative models, Recurrent Neural Networks, Recommendation Systems, Genetic Algorithms, Hidden Markov Models, interpretable machine learning, Differential Programming and knowledge distillation . Finally, the students will be able to apply machine learning algorithms to solve real-world problems.

Course Delivery

The course lecture will be delivered three hours per week. The course consists of lectures, labs and work in groups to do project.

Prerequisite courses

As a graduate level course, the students are expected to have engineering undergraduate background. Familiarity with basics concepts of probability, linear algebra and basics of machine learning.

Required background knowledge

An overview of artificial intelligence fundamentals and Python programming skills would be a plus point, but not required.

Course structure

Lecture	Topic	Timeline
Lecture 1	Generative Models 1: Autoencoders	
Lecture 2	Generative models 2: GANs	
Lecture 3	Generative models 3: Diffusion Models	
Lecture 4	Recurrent neural networks 1 : RNN	
Lecture 5	Recurrent neural networks 2 : GRU, LSTMs, Attention	
Lecture 6	Transformers and LLMs	
	Mid-term exam (Oral)	
Lecture 7	Generative models 4: Graphical and hidden Markov models	Project Start
Lecture 8	Recommendation Systems 1: *Collaborative Filtering*	Checkpoint 1
Lecture 9	Recommendation Systems 2: *Deep Learning Models*	Checkpoint 2
Lecture 10	Evolutionary Computation: Genetic Algorithms	Checkpoint 3
Lecture 11	Interpretable Machine Learning	Checkpoint 4
Lecture 12	Knowledge distillation and Quantization	Checkpoint 5
Lecture 13	Differentiable Programming	Checkpoint 6
-	Project final presentations	
TBA	**Final exam (Written + Oral)**	

Learning Outcome

This course will train you to apply machine learning methods for data science projects. After this course, you will be able to:

- *Understand how machine can learn the concepts*
- *Significant exposure to real-world implementations*
- *To develop research interest in the theory and application of machine learning*

Reference Materials and Textbook(s)

- *Machine Learning by Tom M Mitchel, McGraw Hill*
- *Deep learning by Ian Goodfellow, MIT press*
- *Machine Learning Probabilistic Approach by Kevin Murphy, MIT Press*
- *Pattern Recognition and Machine Learning by Christopher M. Bishop, Springer*

Computer Resources

Student should bring laptop machine during labs

Laboratory Exercises

Each week an intensive lab will be delivered

Laboratory Resources

Any Python IDE with SCIKit-Learn

Grading criteria

Project (30%), Mid-term Oral Exam (20%), Final Exam + Oral Exam (30% + 10%) and Lab (10%)

Late Submission Policy

This policy will be strictly applied in this course. Late submission automatically lowered one grade. If a personal emergency should arise that affects your ability to turn in group project in a timely fashion, you must contact the course instructor BEFORE the deadline to get a "Special Late Submission Approval" from the course instructor. No "Special Late Submission Approval" will be granted after the deadline. There are no makeup assignments or tasks.

Cooperation Policy and Quotations

We encourage discussion and cooperation in this class. You should feel free to discuss any aspects of the class with any classmates, but not to the extent that copy/learning by doing. Group project must include the efforts and participation of each individual member. We also insist that if you include exact text from any source, you clearly indicate it using standard conventions of quotation or indentation and a note to indicate the source.