Skoltech
Skolkovo Institute of Science and Technology

Course Syllabus

Course Title (in English)	Deep Learning
Course Title (in Russian)	Глубинное обучение
Lead Instructor(s)	Lempitsky, Victor

Contact Person	Victor Lempitsky
Contact Person's E-mail	lempitsky@skoltech.ru

1. Annotation

Course Description

The course is about Deep Learning, i.e. a new generation of neural network-based methods that have dramatically improved the performance of AI systems in such domains as computer vision, speech recognition, natural language analysis, reinforcement learning, bioinformatics. The course covers the basics of supervised and unsupervised deep learning. It also covers the details of the two most successful classes of models, namely convolutional networks and recurrent networks. In terms of application, the class emphasizes computer vision and natural language analysis tasks. The course involves a significant practical component with a large number of practical assignments.

Course Prerequisites / Recommendations	Linear algebra, Machine learning, confident mastery of Python coding basics.

Аннотация

The course is about Deep Learning, i.e. a new generation of neural network-based methods that have dramatically improved the performance of AI systems in such domains as computer vision, speech recognition, natural language analysis, reinforcement learning, bioinformatics. The course covers the basics of supervised and unsupervised deep learning. It also covers the details of the two most successful classes of models, namely convolutional networks and recurrent networks. In terms of application, the class emphasizes computer vision and natural language analysis tasks. The course involves a significant practical component with a large number of practical assignments.

2. Structure and Content

Course Academic Level	Master-level course suitable for PhD students
Number of ECTS credits	6

Topic	Summary of Topic	Lectures (# of hours)	Seminars (# of hours)	Labs (# of hours)
Introduction to Deep Learning	Deep networks, backpropagation, brief history of deep learning	1.5	1.5	0
Optimization for deep learning	Variants of optimization algorithms for deep learning and their properties.	1.5	1.5	0
Convolutional neural networks	Basics of convolutional neural networks, popular architectures, representations learned inside convolutional networks, transfer learning with ConvNets. Applications of ConvNet in computer vision.	4.5	4.5	0
Generative deep learning	Deep image processing and generation. Latent models, autoencoders, flow models. Adversarial learning and advanced synthesis.	4.5	4.5	0
Deep natural language processing	ConvNets for Deep Image processing, word embeddings, sequence modeling and recurrent neural networks, attention models and transformers.	4.5	4.5	0
Deep learning for 3D data	Deep learning for point clouds, 3D volumetric data. Deep image synthesis for virtual 3D worlds.	1.5	1.5	0

3. Assignments

Assignment Type	Assignment Summary
Homework	Writing and training neural network in numpy.
Homework	Implementing and training a high-performance convolutional network
Homework	Implementing and investigating semantic segmentaiton networks, variational autoencoders and GANs
Homework	Playing with natural language using recurrent networks+image captioning
Team Project	Propose and investigate experimentally new deep learning-related idea. Alternatively, reimplement and modify one or several of the recent papers. Write project report and prepare a video presentation.

4. Grading

Type of Assessment	Graded

Grade Structure

Activity Type	Activity weight, %
Homework Assignments	70
Projects	30

Grading Scale

A:	83
B:	73
C:	60
D:	50
E:	40
F:	0
Attendance Requirements	Optional

5. Basic Information

Maximum Number of Students

	Maximum Number of Students
Overall:	100
Per Group (for seminars and labs):	

Course Stream	Science, Technology and Engineering (STE)
Course Term (in context of Academic Year)	Term 4
Course Delivery Frequency	Every year

Students of Which Programs do You Recommend to Consider this Course as an Elective?

Masters Programs	PhD Programs
Data Science	Computational and Data Science and Engineering

Course Tags	Math Programming Engineering

6. Textbooks and Internet Resources

Recommended Textbooks	ISBN-13 (or ISBN-10)
Goodfellow, Bengio, Courville. Deep Learning. MIT press 2016 http://www.deeplearningbook.org/	9780262035613

Papers	DOI or URL
A large number of paper links will be provided within each lecture	

Web-resources (links)	Description
http://vision.stanford.edu/teaching/cs231n/	Stanford class on convolutional networks
http://web.stanford.edu/class/cs224n/	Stanford class on deep learning for natural language processing
http://ru.eclass.cc/courselists/117_deep_learning	Deep Learning @Eclass: all about online learning
http://yerevann.com/a-guide-to-deep-learning/	Deep learning guide by YN2 (Yerevan neural network group)

7. Facilities

Equipment
Audience, computer class)
Syllabus documents and materials on the topics of discipline.
Access to the Internet through a computer class and Wi-Fi network of the institute.

Software
Linux Ubuntu 16.04
Python 3.5 + iPython
PyTorch 1.0 or newer

8. Learning Outcomes

Knowledge
Know the algorithmic foundations of deep learning, including state-of-the-art variants of stochastic gradient descent and architectural peculiarities of modern convolutional and recurrent neural networks.
Be aware of the recent progress of deep learning concerned with image analysis, computer vision, and natural language analysis applications.

Skill
Prototype, train, and apply deep learning architectures, including architectures involving transfer knowledge from pretrained models, models with new layers.

Experience
Identify and design new deep network architectures suitable for non-standard machine learning tasks and applications.
Use deep learning packages such as PyTorch and other relevant Python packages.

9. Assessment Criteria

Input or Upload Example(s) of Assigment 1:

Select Assignment 1 Type	Computer Lab
Input Example(s) of Assignment 1 (preferable)	https://github.com/yandexdataschool/Practical_DL/tree/master/homework01
Assessment Criteria for Assignment 1	A filled-in Jupyter notebook + trained network with sufficiently good result

Input or Upload Example(s) of Assigment 2:

Select Assignment 2 Type	Final Project
Input Example(s) of Assignment 2 (preferable)	Final project presentation and reports. Examples of the project topics selected by the students: “A simple chat-bot trained on movie subtitles”, “A network that rectifies photos with slanted horizon”, “Autoencoders with artistic loss functions for image generation”

Input or Upload Example(s) of Assigment 3:

Input or Upload Example(s) of Assigment 4:

Input or Upload Example(s) of Assigment 5:

10. Additional Notes