COURSE DESCRIPTION

<table>
<tr><td>Course Title</td><td colspan="5">Machine Learning for Graphics and Computer Vision</td></tr>
<tr><td>Course Code</td><td colspan="5">MAI645</td></tr>
<tr><td>Course Type</td><td colspan="5">Elective</td></tr>
<tr><td>Level</td><td colspan="5">Master’s degree</td></tr>
<tr><td>Year / Semester</td><td colspan="5">Spring Semester</td></tr>
<tr><td>Teacher’s Name</td><td colspan="5">Andreas Aristidou</td></tr>
<tr><td>ECTS</td><td>8</td><td>Lectures / week</td><td>3 hours
(+ 1 hour)</td><td>Laboratories / week</td><td>1.5 hours</td></tr>
<tr><td>Course Purpose and Objectives</td><td colspan="5">This course will offer an introduction to machine learning algorithms, the use of deep learning and its applications in computer vision and graphics. The course will also operate as a graduate-level seminar with weekly readings (1 hour per week), summarizations, and discussions of recent papers.
Machine Learning Topics:
• Classification, Regression
• Random Forests
• Deep Neural Networks
• Recurrent Neural Networks
• Generative Models
• Generative Adversarial Networks
• Transformers
Vision and Graphics Applications:
• Image Recognition, Object Detection
• Semantic Segmentation
• Stereo & Multi-view Reconstruction
• Inpainting, Rendering Faces,
• Composite Image generation, Style transfer
• Motion capture and synthesis,
• Denoising, virtual reality</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">Participants will explore the latest developments in neural network research and deep learning models that are enabling highly accurate and intelligent computer vision and graphics systems.
By the end, participants will:
• Be familiar with fundamental concepts and applications in computer vision and graphics.
• Grasp the principles of state-of-the art deep neural networks.
• Gain knowledge of high-level vision tasks, such as object recognition, scene recognition, face detection and human motion categorization.</td></tr>
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	• Gain knowledge of high-level graphics tasks, such as composite image generation, style transfer, motion reconstruction, and motion synthesis. • Develop practical skills necessary to build highly-accurate, advanced computer vision and graphics applications		
Prerequisites	Knowledge of a high-level programing language, and experience in programming with Python. Experience with linear algebra, calculus, statistics, and probability.	Required	Previous knowledge on Computer graphics and Computer Vision is encouraged.
Course Content	**L01** *Introduction* Basic regression, understanding of linearity and non-linearity. DL for Computer Vision **L02** *Learning from Images* Deep learning for image classification and object detection. **L03** *Learning from Videos* Deep learning for video classification. **L04** *Feature Extraction* Deep learning for feature extraction and face recognition. **L05** *Semantic Understanding* Deep learning for semantic segmentation, Deep learning: visualizing networks, impainting, saliency detection (GAN). **L06**: *Creative applications* Photo collections: style and enhancement, Ambiguity and style, style transfer. **L07**: *Vision->Graphics* Computer vision as inverse computer graphics, Novel image synthesis – compositional image generation. **DL for Computer Graphics** **L08** *From 2D to 3D* 3D meshes and point clouds. (Until now data structures were regular, but now students will learn how to load irregular data (3D graphs, 3D meshes, 3D point clouds) into their environment and also how to process them as well as to learn tunable filters for them. They will deepen their knowledge of convolution by seeing how it extends to unstructured data, a generalization. The resulting attitude should		

	be, that a well-defined convolution works on regular data as well as irregular ones) **L09** *Inverse graphics in practice*: Generation Audio synthesis - Audio/2D/3D images and pixel processing: Load and stored images/3D data, audio in the coding environment they use. 3D labeling/classification **L10** *Creative Applications* Generative networks, generating faces, landscapes, portraits, Sketches, denoising. **L11** *Motion* Motion capture, character animation, and synthesis (style transfer, retargeting, control), deep reinforcement learning for physics-based animation and authoring. **L12** (neural) rendering, physics, materials, virtual reality. **L13** *Advanced Topics in Deep Learning* Levels of supervision; Adversarial training, open problems. (Students here will acquire the skill to replace the supervision in form of pairs that are mapped to each other by a paradigm where only random samples form a target distribution are given. To this end they have to understand that the loss is replaced by another network.)
Teaching Methodology	Weekly lectures, discussions of practical examples and (unsupervised) lab activities where the active learning element is encouraged and supported. Weekly or bi-weekly recitation and discussion on recent papers, with students' presentations. Students would be strongly guided to view all topics presented and discussed with a critical eye.
Bibliography	• Deep Learning, by Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, 2016 • Computer Vision: Advanced Techniques and Applications, by Steve Holden, Clanrye International, 2019 • Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2016
Assessment	Exams (30%); Student paper presentations (15%); Programming assignments (25%); Final course project (30%)
Language	English