## **COURSE DESCRIPTION**

Course Title	Machine Learning for Graphics and Computer Vision			
Course Code	MAI645			
Course Type	Elective			
Level	Master's degree			
Year / Semester	Spring Semester			
Teacher's Name	Andreas Aristidou			
ECTS	8 Lectures / week 3 hours Laboratories / 1.5 hours (+ 1 hour)			
Course Purpose and Objectives	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.			
	<ul> <li>Classification, Regression</li> <li>Random Forests</li> <li>Deep Neural Networks</li> <li>Recurrent Neural Networks</li> <li>Generative Models</li> <li>Generative Adversarial Networks</li> <li>Transformers</li> </ul>			
	<ul> <li>Vision and Graphics Applications:</li> <li>Image Recognition, Object Detection</li> <li>Semantic Segmentation</li> <li>Stereo &amp; Multi-view Reconstruction</li> <li>Inpainting, Rendering Faces,</li> <li>Composite Image generation, Style transfer</li> <li>Motion capture and synthesis,</li> <li>Denoising, virtual reality</li> </ul>			
Learning Outcomes	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.			
	<ul> <li>By the end, participants will:</li> <li>Be familiar with fundamental concepts and applications in computer vision and graphics.</li> <li>Grasp the principles of state-of-the art deep neural networks.</li> <li>Gain knowledge of high-level vision tasks, such as object recognition, scene recognition, face detection and human motion categorization.</li> </ul>			

	<ul> <li>Gain knowledge of high-level graphics tasks, such as composite image generation, style transfer, motion reconstruction, and motion synthesis.</li> <li>Develop practical skills necessary to build highly-accurate, advanced computer vision and graphics applications</li> </ul>				
Prerequisites	Knowledge of a high-level programing language, and experience in programming with Python.	Required	Previous knowledge on Computer graphics and Computer Vision is encouraged.		
	Experience with linear algebra, calculus, statistics, and probability.				
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 we load irregular data (3D graphs environment and also how to for them. They will deepen the extends to unstructured data,	re regular, but now s, 3D meshes, 3D p process them as w eir knowledge of co a generalization. T	students will learn how to point clouds) into their ell as to learn tunable filters nvolution by seeing how it he 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		
	<ul> <li>Computer Vision: Advanced Techniques and Applications, by Steve Holden, Clanrye International, 2019</li> </ul>		
	<ul> <li>Pattern Recognition and Machine Learning, <u>Christopher Bishop</u>, Springer, 2016</li> </ul>		
Assessment	Student paper presentations (15%); Programming assignment (35%); Final course project (50%)		
Language	English		