03-IMAP-DGM	Deep Generative Models

Lehrform *(teaching format)* / **SWS** *(hours per week)*: 2VL + 2UE

Kreditpunkte *(credit points)*: 6

Turnus *(frequency)*: each winter term

Inhaltliche Voraussetzungen *(content-related prior knowledge/skills)*: Fundamental knowledge of machine learning models and algorithms, as taught in e.g. the Fundamentals of Machine Learning course.

Sprache *(language)*: English

Lehrende *(teaching staff)*: AG OWL-ML (Prof. Dr. Martin Mundt)

Studiengang *(degree program)*	Module	Semester
Informatik (Master)	IMAP, IMA-AI	ab 1.Sem.
AI and Intelligent Systems (Master)	AI-M-MLCS	from 2nd sem.
Informatik (Bachelor)	(nur *Freie Wahl*)	

Lernergebnisse / *Learning Outcome*:

In many applications of AI and machine learning the goal transcends a mere decision making process. In general, decisions should be grounded in estimates of model uncertainty, understand the underlying training distribution through learned representations, or they need to rely on data imputation. Generative models aim to address these factors, while also providing the means to further synthesize data, compress it, as well as estimate density and discover structure. Upon successful completion of the course, students will have gained an understanding of why generative models are critical, independently of whether the goal is to arrive at a decision or to generate data. They will learn the different ways to design generative models, from mixture models and probabilistic circuits, to variational, adversarial and flow-based models, all the way to large-scale models that are being referred to as Gen AI. In the process they will be equipped with the necessary mathematical skills to understand the underlying technical foundations and engage with potential applications.

Inhalte / *Contents*:

- Learning and probabilistic inference
- From Gaussian mixture models to probabilistic circuits
- Latent variable models and variational inference
- Generative adversarial networks
- Flow models and change of variables
- Energy-based generative models and diffusion
- Autoregression, large language modeling, and GenAI
- Applications of generative models

Hinweise *(remarks)*: The table lists only the primary / most specific modules to which this course is assigned.