Artificial Intelligence and Machine Learning

Module no. or code	2
Module name	Artificial Intelligence and Machine Learning
(If applicable) the module's courses	NA

Module content	• Main concepts and principles of machine learning
	  - Basic types of machine learning (supervised/ unsupervised / reinforcement learning) and their use
	  - Main learning goals (prediction - regression/ classification, knowledge discovery – clustering / density estimation, etc.)
	  - Formalism of the learning problem
	  - Ethical and societal impacts of machine learning
	• Foundations of learning from data
	  - Objective (loss) function
	  - Expected/ empirical risk
	  - Model complexity (over-/ under-fitting)
	  - Model training/ validation/ testing
	  - Model evaluation/ selection
	• Selected key machine learning algorithms
	  - Linear models for regression/ classification
	  - Regularization, ridge regression
	  - Variable selection, sparse models (lasso)
	  - Mixture models (k-means clustering, Gaussian mixtures)
	  - Non-parametric methods (kernels, trees, forests)
	• Programming for machine learning
	  - Python and packages (Numpy, Pandas, Sci-kit learn, Jupyter Notebooks, and other)

<table>
<tr><td>Module’s learning outcomes</td><td>Upon completion of the module students:
understand basic types of problems to which machine learning algorithms can be applied and can compare them in terms of data that the algorithm expects to receive and the objectives they use for training
have a general overview of key machine learning methods, understand their mechanism and major pros and cons, and can use these (relying on existing implementations) to solve typical learning problems by developing own pipelines and models
can evaluate results of learning exercises and compare different methods in terms of their accuracy as well as computational efficiency and can report on these in oral as well as written form using appropriate tools for expert or more general audience (e.g. via Jupyter Notebooks)
can follow and grasp formal description of standard machine learning algorithms and translate these into a working implementation in standard machine learning software
can critically assess data analytical and machine learning exercises in terms of quality of the experimentation pipeline and the clarity and transparency of the experimental protocol</td></tr>
<tr><td>Semester</td><td>1st semester</td></tr>
<tr><td>Duration of module</td><td>1 semester</td></tr>
<tr><td>Frequency</td><td>Summer term only</td></tr>
<tr><td>ECTS-Credits</td><td>5</td></tr>
<tr><td>Workload</td><td><table><tr><td>Workload (Total)</td><td>Attendance time</td><td>Self-Study time (incl. exam preparation)</td></tr><tr><td>150 h</td><td>60 h</td><td>90 h</td></tr></table></td></tr>
<tr><td>Type of module</td><td>Compulsory</td></tr>
<tr><td>Applicability of module</td><td>Foundation course to the topic of general data analysis (tasks, concepts and coding skills) which aligns with the respective module on neural networks (tools and algorithms). Can be integrated as optional course into M.Sc. Information Systems</td></tr>
<tr><td>Conditions for participation</td><td></td></tr>
<tr><td>Responsible for module</td><td>Prof. Dr. Frank-M. Schleif</td></tr>
<tr><td>Lecturer</td><td>NA</td></tr>
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Language of instruction, L. of examination	English
Type of examination; Conditions for the award of CPs	Written exam
Teaching and learning formats of the module	SU
Literature	1. Bishop, Christopher M. *Pattern Recognition and Machine Learning. Information Science and Statistics*. New York: Springer, 2006. 2. Murphy, Kevin P. *Machine Learning: A Probabilistic Perspective*. Adaptive Computation and Machine Learning Series. Cambridge, MA: MIT Press, 2012. 3. Hastie, Trevor, Robert Tibshirani, and Jerome Friedman. *The Elements of Statistical Learning*. Springer Series in Statistics. New York, NY, USA: Springer New York Inc., 2001.