# Artificial Neural Networks and Cognitive Models

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| Module no. or code | 03 |
| Module name | Artificial Neural Networks and Cognitive Models |
| (If applicable) the module's courses | NA |
| Module content | • Artificial neural networks (ANN) in machine learning (ML)<br>  - Basic concepts of learning algorithms and typical tasks<br>  - Model development workflow, hyperparameter tunning, performance measures and model selection<br>  - Ethical and societal aspects (open access, data governance, fairness, transparency, reproducibility, safety and robustness, interpretability and human oversight/ trust, ecological footprint)<br>• Basic ANN architectures<br>  - Multilayer perceptron (feed forward)<br>  - Convolutional neural networks<br>  - Recurrent neural networks<br>• ANN model regularization<br>  - Norm penalties<br>  - Data augmentation<br>  - Early stopping<br>  - Dropout<br>• ANN model optimization<br>  - (Stochastic) gradient descent<br>  - Backpropagation<br>  - Momentum methods<br>  - Learning rate scheduling<br>• Major ANN applications and selected advanced models<br>  - Computer vision (object detection, image classification, style transfer)<br>  - Natural language processing (word2vec, BERT)<br>  - Autoencoders<br>  - Generative models<br>• Deep learning software packages (one of these)<br>  - PyTorch<br>  - Tensorflow |

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<tr><td>Module's learning outcomes</td><td>Upon completion of the module students:<ul><li>can place artificial neural networks within the broader area of machine learning, understand their major advantages and disadvantages, and are aware of major applications of ANN as well as selected advanced models under research and their fundamental ideas</li><li>understand and assess the critical differences between the basic ANN architectures (MLP, CNN, RNN), can implement them in standard deep learning software packages, and can train, test, and evaluate the ANN models over real data</li><li>building on the experience of working with their own ANN implementations, can reuse publicly available implementations of more complex models to carry out experiments over real datasets, can compare the performance of these across various models and their hyperparameter setups</li><li>understand the importance of transparency and reproducibility in deep learning experimentation and can present in written as well as oral their learning and evaluation pipeline including relevant description of the selected software and hardware configuration</li><li>are aware of the ethical and societal impacts of machine learning and deep learning and can critically assess deep learning reports along these lines</li></ul></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 for the neural network based modules in the second semester. Can be integrated as optional course into M.Sc. Information Systems</td></tr>
<tr><td>Conditions for participation</td><td>Mathematical and Theoretical Foundations of AI</td></tr>
<tr><td>Responsible for module</td><td>Prof. Dr. Magda Gregorová</td></tr>
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| Lecturer | Prof. Dr. Magda Gregorová |
| Language of instruction, L. of examination | English |
| Type of examination;<br>Conditions for the award of CPs | Portfolio |
| Teaching and learning formats of the module | Seminar-based teaching |
| Literature | 1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep Learning*. MIT Press, 2016<br>2. Zhang, Aston, Zachary C. Lipton, Mu Li, and Alexander J. Smola. *Dive into Deep Learning*. https://d2l.ai/, 2021 |