Munich Summer School of Applied Sciences 2024

Course Description

Course title: **Sustainability and AI**

Hours per week: 22h/week, 2 weeks

Number of credits allocated/ workload:

a) 44 contact hours
b) 3 US quarter credits

c) 4 ECTS credits

Course Description

The ecological impact of artificial intelligence (AI) is a timely topic as both the progress of this technology and the damage caused to the atmosphere and biosphere are of exponential nature.
Does AI enable better energy and raw material resources management? Do this technology's material and power requirements cause more harm than good?

To unveil these questions, this class aims to introduce the sustainability challenges and opportunities related to artificial intelligence, particularly machine learning. The class includes both lectures from experts and hands-on machine learning activities. This course offers a comprehensive exploration of the intersection between sustainability and AI. Throughout the lectures, participants will gain insights into the definition and concepts of sustainability. Additionally, the course covers the theoretical aspects of machine learning models. Case studies highlighting existing AI applications in environmental and climate protection, as well as innovative AI technologies aimed at achieving sustainability goals will be discussed. Students are encouraged to grasp the pivotal role of AI in the context of sustainability and understand how this technology can effectively address ecological, economic, and social challenges.

You will first learn the cause-effect relationships between human activities and the degradation of the biosphere and atmosphere, summarized by the Intergovernmental Panel on Climate Change (IPCC). You will also learn to estimate CO2 emissions from human activities, particularly computing-related ones.
Second, you will learn the basics of machine learning: data collection, processing, training, testing, and deployment of machine learning models. You will learn how to estimate your trained model's energy and resource costs and techniques to minimize them (transfer learning, pruning, distillation).
Third, you will form teams to tackle climate or energy-related problems using machine learning. Experts will assist you with the technological implementation of your project, and the project will result in a public presentation.

The practical segment of the course provides hands-on experience as students implement the steps involved in developing a machine learning model. This includes tasks such as preparing a dataset related to sustainability and actively participating in the development, training, and testing of a corresponding machine learning model. This immersive course teaches participants both the theoretical and practical skills to understand the dynamic relationship between sustainability and AI.

Prerequisites:

- ***Basic knowledge about programming, ideally in Python, is required***
- *Knowledge about machine learning is helpful but not required*

Lecture Content

- Introduction to the climate-energy predicament (collaborative climate fresk)
- How to estimate your carbon footprint?
- Introduction to machine learning
- Ecological cost of computing and machine learning
- Introduction to model pruning and distillation
- Machine learning model for images
- Machine learning model for time series forecasting
- State-of-the-art research on sustainable AI and its applications

Laboratory Content

- Group project
- Setting up an environment for training and testing machine learning models
- The programming language Python and the machine learning framework Pytorch are used
- The development cycle of machine learning (preparing a dataset, as well as training and testing the model)
- Model pruning and distillation

Recommended reading:

- Berkhout, F., & Hertin, J. (2001). Impacts of information and communication technologies on environmental sustainability: Speculations and evidence. Report to the OECD, Brighton, 21.
- Pargman, D., & Raghavan, B. (2014, October). Rethinking sustainability in computing: from buzzword to non-negotiable limits. In Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational (pp. 638-647).
- Strubell, E., Ganesh, A., & McCallum, A. (2019). Energy and policy considerations for deep learning in NLP. arXiv preprint arXiv:1906.02243.
- Training a single AI model can emit as much carbon as five cars in their lifetimes, MIT Tech Review
- Ligozat, A. L., Névéol, A., Daly, B., & Frenoux, E. (2020). Ten simple rules to make your research more sustainable. PLOS Computational Biology, 16(9), e1008148.

Teaching methods:

A typical day starts with a lecture followed by a discussion in the morning. The afternoon is usually dedicated to laboratory work, including group work on the project. Experts will be present for personalized feedback at any moment laboratory work.

Assessment methods:

Oral presentation and successful laboratory work

Language of instruction:

The course is offered in English

Names of lecturers:

Dr. Téo Sanchez (Munich Center for Digital Sciences and AI - Hochschule München of applied sciences)

Maximilian Dauner (Munich Center for Digital Sciences and AI - Hochschule München of applied sciences)