FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

Modulbezeichnung: **Artificial Motor Learning (AML)** **5 ECTS**
(Artificial Motor Learning)

Modulverantwortliche/r: Thomas Seel
Lehrende: Ive Weygers, Simon Bachhuber, Thomas Seel

Startsemester: SS 2022	Dauer: 1 Semester	Turnus: jährlich (SS)
Präsenzzeit: 60 Std.	Eigenstudium: 90 Std.	Sprache: Englisch

Lehrveranstaltungen:

Artificial Motor Learning (SS 2022, Vorlesung mit Übung, 4 SWS, Thomas Seel et al.)

Empfohlene Voraussetzungen:

Participants should be familiar with fundamental methods and concepts in machine learning. They should, for example, have completed one of the following courses

- Machine Learning for Engineers
- Maschinelles Lernen für Zeitreihen
- Pattern Recognition
- Reinforcement Learning
- Deep Learning

Inhalt:

This course is concerned with methods of artificial intelligence that enable biomimetic motor learning in intelligent systems. We consider a range of methods from systems-and-control methods to machine-learning approaches, with a focus on data-driven learning control and model-based reinforcement learning. We discuss the core concepts of the methods, analyze and compare their potential and shortcomings, and apply them to example problems. The covered topics include but are not limited to:

- the role of motor learning in biological and AI systems
- definition and classification of motor learning tasks
- parametric and non-parametric models of motor dynamics
- learning control methods (model-based and data-based) for motor learning tasks
- reinforcement learning (model-free and model-based) for motor learning tasks
- advanced approaches from recent literature
- combination and implementation of methods
- stability, optimality, robustness and usability properties
- performance assessment in simulation and experiment

The example problems to which we will apply the concepts and methods will stem from application domains in which artificial motor learning is considered crucial, such as robotics, neuroprosthetics and autonomous vehicles.

Lernziele und Kompetenzen:

Fachkompetenz

Wissen

Participants will be familiar with different models of motor dynamics and with several learning control methods and reinforcement learning approaches for motor learning tasks, and they will know their advantages and limitations.

Verstehen

Participants will understand the role of motor learning in AI systems. They will understand the ideas and concepts behind the taught learning control and reinforcement learning methods, and they will be able to classify and compare.

Anwenden

Participants will be familiar with the employment of several learning control methods and reinforcement learning approaches, and they will be able to combine them and apply them to example problems.

Lern- bzw. Methodenkompetenz

Participants analyze and discuss scientific publications in the context of a given broader topic.

Participants deepen and challenge their understanding of the taught concepts by designing and answering short quizzes.

Sozialkompetenz

Participants successfully collaborate in small teams, they effectively exchange arguments and self-organize to produce a joint result within a given time frame.

Literatur:

- D. A. Bristow, M. Tharayil, A. G. Alleyne, and Z. Z. Han, "A Survey of Iterative Learning Control," Kongzhi yu Juece/Control and Decision, vol. 20, no. 9, pp. 961 - 966, 2005.
- L. Buşoniu, T. de Bruin, D. Tolić, J. Kober, I. Palunko. "Reinforcement Learning for Control: Performance, Stability, and Deep Approximators", Annual Reviews in Control, 46:8 - 28, 2018
- I. Grondman, L. Busoniu, G. A. Lopes, and R. Babuška, "A survey of actor-critic reinforcement learning: Standard and natural policy gradients," IEEE Transactions on Systems, Man and Cybernetics Part C: Applications and Reviews, vol. 42, no. 6, pp. 1291 - 1307, 2012.
- C. E. Rasmussen and C. K. I. Williams, Gaussian Processes for Machine Learning (Adaptive Computation and Machine Learning). The MIT Press, 2005.
- N. Amann, D. H. Owens, and E. Rogers, "Predictive optimal iterative learning control," International Journal of Control, vol. 69, no. 2, pp. 203 - 226, Jan. 1998. [Online].
- M. P. Deisenroth and C. E. Rasmussen, "PILCO: A model-based and data-efficient approach to policy search," Proceedings of the 28th International Conference on Machine Learning, ICML 2011, pp. 465 - 472, 2011.
- S. Lupashin, A. Schoellig, M. Sherback, and R. D ' Andrea, "A simple learning strategy for high-speed quadrocopter multi-flips," in 2010 IEEE International Conference on Robotics and Automation. IEEE, May 2010.
- Z. Xie, P. Clary, J. Dao, P. Morais, J. Hurst, and M. Van De Panne, "Learning Locomotion Skills for Cassie: Iterative Design and Sim-to-Real," Conference on Robotic Learning, no. CoRL, 2019.

Verwendbarkeit des Moduls / Einpassung in den Musterstudienplan:

Das Modul ist im Kontext der folgenden Studienfächer/Vertiefungsrichtungen verwendbar:

[1] **Data Science (Bachelor of Science)**

(Po-Vers. 2022s | Gesamtkonto | Anwendungsfächer | Artificial intelligence in biomedical engineering (AIBE) | Artificial Motor Learning)

Studien-/Prüfungsleistungen:

Artificial Motor Learning (Prüfungsnummer: 76941)

(englische Bezeichnung: Written Exam AML)

Prüfungsleistung, Klausur mit MultipleChoice, Dauer (in Minuten): 60

Anteil an der Berechnung der Modulnote: 100%

weitere Erläuterungen:

Answering the questions requires understanding of the concepts taught throughout the course and the ability to apply these concepts to specific example problems. The exam contains multiple-choice questions. It counts 100% of the course grade. By submitting small homework assignments, up to 20% of bonus points can be obtained, which will be added to the result of the exam.

Prüfungssprache: Englisch

Erstablegung: SS 2022, 1. Wdh.: WS 2022/2023 (nur für Wiederholer)

1. Prüfer: Thomas Seel

Organisatorisches:

StudOn-Kurs: https://www.studon.fau.de/crs4417441.html