dfki ai Robotics Innovation Center

MACHINE LEARNING FOR AUTONOMOUS ROBOTS

Melvin Laux
AG Robotik, Universität Bremen

Prof. Dr. Dr. h.c. Frank Kirchner
Arbeitsgruppe Robotik, Universität Bremen
https://robotik.dfki-bremen.de/
robotik@dfki.de
1st February, 2024 – Bremen, Deutschland

University of Bremen

Questions

Any questions?

Admin

Exercise sheets

- Exercise sheet 6 is due tonight

Written exam

- Date and Time: 15/02/2024, 14:00 - 15:30
- Location: RH1 B0.10
- Duration: 90 minutes
- Allowed material: 1 one-sided, handwritten A4 sheet
- Remember to bring a photo ID and student ID card

Feedback

Please participate in the official teaching evaluation via StudIP!

Feedback

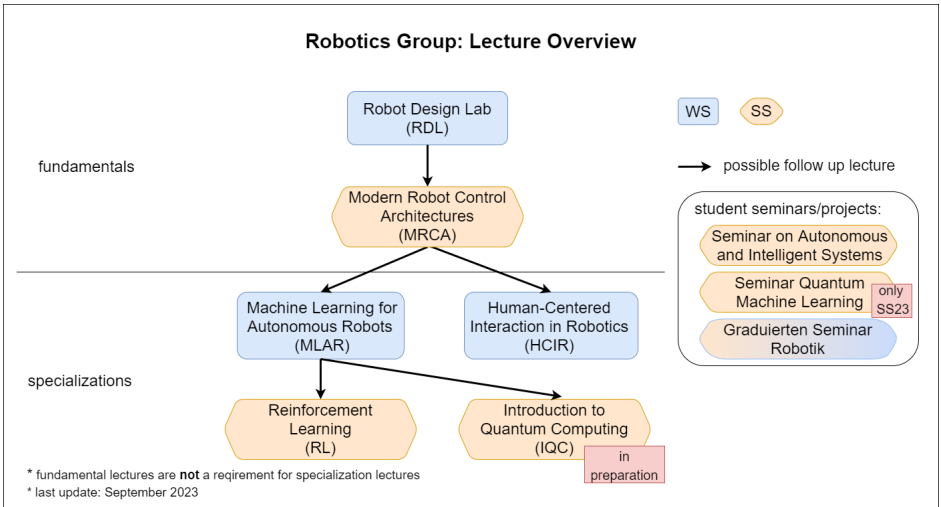
How were...

- ...the quality and structure of the (video) lectures?
- ...structure and content of the tutorials?
- ...the difficulty/workload of the exercise sheets?
- ...the overall organisation of the course?
- ...how can we improve?

Do you have any additional feedback?

Advertisements

AG Robotik Course Overview



What next?

Reinforcement Learning

- Description: Learn the fundamentals of reinforcement learning, while getting hands-on experience with the learnt concepts by applying them in the field of robotics
- Next offered: Summer 2024
- Credits: 6
- Contact: melvin.laux@uni-bremen.de

Modern Robot Control Architectures

- Modern Robot Control Architectures is a course for higher Bachelor or Master studies. It focuses on the fundamentals of kinematics, dynamics and control of robot manipulator arms and legged robots. Tutorials consist in practical programming tasks carried out in Python.
- Next offered: Summer 2024
- Credits: 6
- Contact: popescu@uni-bremen.de

Human-Centered Interaction in Robotics

- Teaches the concepts necessary to understand human-robot interaction and the models needed to implement HRI architectures and an introduction into how to perceive human behavior and conduct human interaction studies using robots
- Next offered: Winter 2024/25
- Credits: 6
- Contact: lisa.gutzeit@uni-bremen.de

Robot Design Lab:

- Learn the basics of mobile robots' algorithms such as sensing and actuators, localisation and mapping, visual perception, path planning and task planning. The practical tutorials are carried out with Turtlebot 3 Burger robots that emply the Robot Operating System ROS2 as software framework and Python as programming language
- Next offered: Winter 2024/25
- Credits: 6
- Contact: popescu@uni-bremen.de

Seminar on Autonomous and Intelligent Systems

- Learn how to do research, get an overview of a variety of state-of-the-art methods in machine learning and robotics and (potentially) jumpstart your thesis
- Next offered: Summer 2024
- Credits: 3
- Contact: melvin.laux@uni-bremen.de

Introduction to Quantum Computing

- Learn about how to utilise quantum computing in the field of machine learning. Knowledge in ML and QC are not required. Decent understanding of university level mathematics is necessary.
- Planned start: Winter 2024/25
- Credits: 6
- Contact: hans.hohenfeld@uni-bremen.de

Projects

We will offer several student projects this year:

- HelloRIC
- GRIPS4Students
- Mars Rover
- Autonomie und Navigation in komplexen Unterwasserszenarien mit dem AUV Flatfish

Theses

We are currently offering various theses:

- Robust Nonlinear Model Predictive Control for Hydrobatic Underwater Vehicles with a Single Vectored Thruster
- Perception
- Parkour MPC

All offers: `https://robotik.dfki-bremen.de/en/teaching/thesis/announcements`

Contact Melvin directly if you have your own topic ideas, want to be directed to potential supervisors

Interactive course recap

Recap questions

- What are features? What types of features were discussed in the lecture?
- What is one-hot encoding and why is it useful?
- Explain data preprocessing in the context of Machine Learning.
- What is feature generation?
- What is feature selection?
- What is dimensionality reduction?
- Why are we interested in reducing the number of features?
- Explain Principal Component Analysis.
- What is unsupervised learing?
- What is clustering and why do we need it?
- Explain k-means, Expectation-Maximisation, and DBSCAN.

Recap questions

- What is classification?
- How does k-nearest-neighbours work?
- Explain Bayes' theorem. How can we use it for classification?
- What is logistic regression?
- How can we build decision trees efficiently?
- Why are Random forests useful?
- What is regression?
- How does gradient descent work?
- Explain linear regression
- What is regularisation?
- What is ridge regression?

Recap questions

- What are support vector machines?
- Explain the difference between hard and soft margins?
- What is the kernel trick?
- What are ensemble methods?
- Explain the bias/variance trade-off
- What is a weak learner?
- Explain the difference between sequential and parallel ensembles.
- What is bagging?
- How does boosting work and how does it differ from bagging?

Recap questions

- What is logistic regression?
- How do you represent a neuron?
- What is a hidden layer in a neural network?
- What do you understand by activation functions?
- What is a sigmoid function?
- Describe how you learn the parameters of the neural network
- What is your understanding of "training" a neural network?
- What is the role of cost functions in training a neural network
- What is gradient descent?
- How are the weights of the neural network updated?

Recap questions

- Why is the dataset split into train and test data?
- What is meant by binarization of the data performed?
- What are the advantages of binarizing the data?
- What is deep learning?
- How is deep learning different from typical machine learning?
- What are the steps involved in a deep learning pipeline?
- What is meant by a convolution?
- What is the LeNet architecture?
- What is the architecture of VGGNet?
- What is meant by evaluation metrics?
- Which metrics are used for evaluation?

Further Reading

- Machine Learning - A Probabilistic Perspective, Kevin Murphy, 2012. (`https://probml.github.io/pml-book/book0.html`)
- Pattern Recognition and Machine Learning, Christopher Bishop, 2006. (`https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf`)
- Artificial Intelligence - A Modern Approach, Stuart Russell and Peter Norvig, 2012.
- Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, 2016. (`https://www.deeplearningbook.org/`)
- Reinforcement Learning: An Introduction (2nd edition), Richard Sutton and Andrew Barto, 2018. (`https://www.andrew.cmu.edu/course/10-703/textbook/BartoSutton.pdf`)

Thank You!