Moritz Reuss

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Research Interest

My primary research goal is to build intelligent embodied agents that assist people in their everyday lives and communicate intuitively. One of the key challenges to be solved towards this goal is learning from multimodal, uncurated human demonstrations without rewards. Therefore, I am working on novel methods that exploit multimodality and learn versatile behaviour, as demonstrated in my work on Score-based Diffusion Policies.

Education

Ph.D in Computer Science

Karlsruhe, Germany

Karlsruhe Institute of Technology (KIT) *01/2022 - Present*

- Supervised by Prof. Rudolf Lioutikov

MSc in Mechanical Engineering

Karlsruhe, Germany

Karlsruhe Institute of Technology (KIT) *03/2019 - 09/2021*

- GPA: 1.3 (on scale of 1-5 with 1 being the highest score)
- Exchange Semester at Chalmers University of Technology, Sweden - 2020/21

BSc in Mechanical Engineering

Karlsruhe, Germany

Karlsruhe Institute of Technology (KIT) *10/2015 - 02/2019*

- GPA: 2.0 (on scale of 1-5 with 1 being the highest score)

German A-Levels

Barcelona, Spain

German School of Barcelona *2015*

- GPA: 1.2 (on scale of 1-6 with 1 being the highest score)
- Graduated as Top of the Year with distinction.

Work Experience

Graduate Research Assistant

Karlsruhe, Germany

Karlsruhe Institute of Technology (KIT) *01/2022 - Present*

- Introduced a novel imitation learning policy, called 'Score-based Diffusion Policies', to learn expressive, multimodal behavior from offline data.
- Proposed a scalable transformer-based architecture for the diffusion policy to learn language-guided behavior from multimodal reward specifications.
- Developing a novel algorithm for zero-shot annotation of uncurated demonstrations with vision-language foundation models.

Master Thesis Candidate

Renningen, Germany

Bosch Corporate Research *04/2021 - 09/2021*

- Research on hybrid models for control, combining recurrent neural networks with physic-based models for precise inverse dynamics prediction in a 7-DoF robotic arm, enhancing impedance control capabilities.
- Devised a fully-differentiable formulation of barycentric parameters, inherently ensuring compliance with all physical constraints.
- Successfully implemented and tested the hybrid model in real-time impedance control on a Franka robot arm using C++ and ROS.

Student Research Assistant

Karlsruhe, Germany

Research Center for Information Technology (FZI) *05/2019 - 02/2021*

- Conducted research in energy consumption models for electric vehicles using recurrent neural networks, such as LSTMs and Transformers, effectively leveraging supplemental road information data in Tensorflow.
- Designed and implemented a Python framework for efficient data extraction and preprocessing, enhancing EV driving range estimation with contextual weather, traffic and road data.

Student Intern and Bachelor Thesis Candidate

Neckarsulm, Germany

Audi AG *04/2018 - 01/2019*

- Bachelor Thesis project on using dimension-less parameters models for predicting the air humidity in hydrogen fuel-cell cars in real-time.
- Functional development for optimizing the control of pressure systems in hydrogen fuel-cell systems.

Student Intern

Karlsruhe, Germany

IPG-Automotive GmbH *10/2016 - 03/2018*

- Executed a V2X demonstrator in CarMaker and Matlab, with additional research in hybrid drive architectures and tire models.
- Specialized in powertrain parameterization for hybrid vehicles and digitalization of real-world routes for fuel-consumption investigations.

Publications

- **Multimodal Diffusion Transformer for Learning from Play**
  Moritz Reuss, Rudolf Lioutikov.
  preprint, 2023. **Spotlight Presentation** at the Workshop on Language and Robot Learning @ CoRL 23.
- **Towards Diverse Behaviors: A Benchmark for Imitation Learning with Human Demonstrations**
  Xiaogang Jia, Denis Blessing, Xinkai Jiang, **Moritz Reuss**, Atalay Donat, Rudolf Lioutikov, Gerhard Neumann.
  ICLR, 2024.
- **Goal-Conditioned Imitation Learning Using Score-based Diffusion Policies**
  Moritz Reuss, Maximilian Li, Xiaogang Jia, Rudolf Lioutikov.
  RSS, 2023. **Best Paper Award** at the Workshop on Learning from Diverse, Offline Data (L-DOD) @ ICRA 2023.
- **Information Maximizing Curriculum: A Curriculum-Based Approach for Learning Versatile Skills**
  Denis Blessing, Onur Celik, Xiaogang Jia, **Moritz Reuss**, Maximilian Li, Rudolf Lioutikov, Gerhard Neumann.
  NeurIPS, 2023.
- **End-to-End Learning of Hybrid Inverse Dynamics Models for Precise and Compliant Motion Tracking**
  Moritz Reuss, Niels van Duijkeren, Robert Krug, Philipp Becker, Vaisakh Shaj, Gerhard Neumann.
  RSS, 2022.

Teaching

Explainable Artificial Intelligence — *Teaching Assistant*

Karlsruhe Institute of Technology — *SS 2023*

- Thaught two lectures on "*Introduction to Transformer Models*" and "*Explainability and Bias in Generative Diffusion Models*".

Student Supervision

2023	**Nils Blank**, Zero-Shot Labeling of Uncurated Play Data using Foundation Models	*Master Thesis*
2023	**Marcel Rühle**, Fast Adaptation of Pre-trained Policies in unseen Environments	*Master Thesis*
2023	**Fabian Wenzel**, Benchmarking Real Robot Learning from Play	*Master Thesis*
2023	**Felix Minzenmay**, Language-conditioned Imitation Learning with Diffusion Policies	*Bachelor Thesis*
2022	**Paul Mattes**, Guiding Diffusion Policies with Energy-based Models	*Master Thesis*
2022	**Yinglin Yuan**, Reinforcement Learning for Robot Waypoints Tracking Optimization	*Master Thesis*
2022	**Noah Petry**, Learning Hybrid Models for Precise Impedance Control	*Bachelor Thesis*

Community Support

Reviewing

- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE Robotics and Automation Letters (RA-L)
- International Conference on Intelligent Robots and Systems (IROS)
- Robotics: Science and Systems (RSS)

Open Source Contributions

- **diffusion-literature-for-robotics** Created a comprehensive guide on diffusion models for robotics, regularly updated, to support research and learning in the field.

Skills

Language	German (native), English (fluent), Spanish (B1), French (B1)
Machine Learning	Pytorch, MuJoCo, Numpy, Pandas, Scipy, Tensorflow, JAX
Programming	Python, Matlab, Docker, Git, ROS, C++
Other	LaTeX, Linux–Ubuntu, Microsoft Office