João Müller Carvalho

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Research Interests

My research interests lie in developing **machine learning** algorithms for **robotics,** particularly in **robot manipulation**. My work focuses on **deep generative models** for **imitation learning** of visuomotor policies, motion planning, and grasping, as well as on deep reinforcement learning for solving contact-rich tasks.

Education

Ph.D. in Computer Science — Intelligent Autonomous Systems (IAS), TU Darmstadt, Germany **2020 - 2025**
- Focused on machine learning for robotics.
- Thesis: Enhancing Robot Manipulation Skills through Learning (advisor: Prof. Jan Peters)
- Grade: 1.0 (magna cum laude) (5-1 scale)

M.Sc. in Computer Science — Universität Freiburg, Germany **2016 - 2019**
- Focused on machine learning and reinforcement learning.
- Thesis: Nonparametric Off-Policy Policy Gradient (advisor: Prof. Samuele Tosatto)
- Grade: 1.3 (5-1 scale)

M.Sc. & B.Sc. in Electrical and Computer Engineering — Instituto Superior Técnico, Portugal **2007 - 2012**
- Focused on energy systems and control.
- Thesis: Electric Distribution Network Loss Calculation and Minimization (advisor: Prof. Pedro Carvalho)
- Grade: 17 (0-20 scale)

Exchange student — TU Delft, The Netherlands **2011 - 2012**
- ERASMUS programme

Professional Experience

Postdoctoral Researcher — IAS, TU Darmstadt, Darmstadt, Germany **2025 - present**
- Conducted independent research in machine learning and robotics.
- Led research projects (from concept development to planning and execution).
- Wrote research proposals to acquire funding.
- Supervised 3+ Ph.D. candidates and 6+ master's theses.

Research Assistant & Ph.D. Candidate — IAS, TU Darmstadt, Darmstadt, Germany **2019 - 2025**
- Conducted independent research in machine learning and robotics.
- Developed novel algorithms for robot manipulation using deep generative models and reinforcement learning.
- Authored and co-authored 10+ works at top-tier ML and robotics conferences/journals/workshops (T-RO, RA-L, IROS, PAMI, ICLR, AISTATS, IROS, NeurIPS).
- Set up and maintained the first HPC cluster computer of IAS, with 100+ GPUs, serving 100+ users.
- Prepared teaching materials, presented exercise lectures with 300+ students, and supervised 20+ theses and projects.

Student Teaching Assistant — IAS, TU Darmstadt, Darmstadt, Germany **2019**
- Prepared teaching material for the Statistical Machine Learning lecture with 200+ students.

Software Developer (part-time) — Medizinische Planungssysteme GmbH, Freiburg, Germany **2017 - 2018**
- Developed software for infrastructure and deployment tools within the DevOps team.

Electrical Engineer — Energias de Portugal SA, Lisbon, Portugal **2012 - 2016**
- Developed home automation products using different communication protocols (Wi-Fi, ZigBee, PLC).
- Extracted and analyzed power consumption data and built electricity demand forecasting models.
- Developed software tools to automate analysis and reduce simulation times of electricity and gas forecasting models.

Student Research Assistant — Instituto Superior Técnico / INESC-ID, Lisbon, Portugal **2010 - 2012**
- Developed statistical algorithms to estimate and minimize power losses in low-voltage distribution networks. (supervisor: Prof. Pedro Carvalho)
- Developed discrete optimal control algorithms to optimize a vehicle's fuel consumption in cruise control mode. (supervisor: Prof. João Miranda Lemos)

Technical Skills & Languages

- **Programming:** Python, Numpy, PyTorch, JAX, C++, Linux, Git, GitHub, LaTeX, PyBullet, IsaacGym, MuJoCo, ROS1/ROS2
- **Languages:** Portuguese (native), English (fluent), German (advanced), Spanish (intermediate)

Awards & Grants

- **ROBOSTRUCT project** — cooperation with Volkswagen AG within the Software Campus 2023, sponsored by the German Federal Ministry of Education and Research (BMBF). Wrote the proposal and secured 115k Eur in research funding.
- **Best paper award** — R:SS 2024 Workshop Priors4Robots
- **Best interactive paper award finalist** — 2022 IEEE-RAS 21st International Conference on Humanoid Robots (Humanoids)
- **Travel award** — 2022 Multi-disciplinary Conference on Reinforcement Learning and Decision Making (RLDM)

Others

Research projects

Project	Funding agency	Role
RobInTime (100702283)	German Federal Ministry of Education and Research (BMBF)	Postdoctoral researcher
ROBOSTRUCT (01S23067)	German Federal Ministry of Education and Research (BMBF)	Researcher, project manager
IKIDA (1IS20045)	German Federal Ministry of Education and Research (BMBF)	Researcher
Kobo34 (16SV798)	German Federal Ministry of Education and Research (BMBF)	Researcher
SE2A (109580PRJ)	Portuguese Foundation for Science and Technology (FCT)	Student researcher

Further education

Mediterranean Machine Learning Summer School 2021
Nordic Probabilistic AI School 2022

Scientific reviewing

Robotics and Automation Letters (RA-L)
International Conference on Intelligent Robots (IROS)
Robotics: Science and Systems (R:SS)
Transactions on Robotics (T-RO)
Conference on Robot Learning (CoRL)
International Conference on Robotics and Automation (ICRA)
Conference on Neural Information Processing Systems (NeurIPS)

Teaching

- Teaching assistant at TU Darmstadt for the lectures:

Robot Learning Integrated Project (2022)
Robot Learning (2020)
Computational Engineering and Robotics (German) (2020, 2021)
Statistical Machine Learning (2019)

- Supervised 30+ students' master's and bachelor's theses and research projects.

Invited talks

- Enhancing Robot Manipulation Skills through Learning, Agile Robots SE (Dr.-Ing. Jun Deng), 2025
- Motion Planning Diffusion, University of Mannheim (Prof. Dr. Leif Döring), 2023

Workshop organization

- Organizer of the International Workshop on Intelligent Autonomous Learning Systems 2022, Kleinwalsertal, Austria

Publications

Full list at https://scholar.google.com/citations?user=xYUxMF0AAAAJ&hl=en

Preprints

1. Holzmann, P.; Pfefferkorn, M.; **Carvalho, J.**; Younes, A.; Le, A.; Chalvatzaki, G; Peters, J.; Findeisen, R. (submitted). Learning Paths, Following Safely: Flow Matching Meets Predictive Control
2. **Carvalho, J.**; Le, A.; Jahr, P. ; Sun, Q. ; Urain, J.; Koert, D.; Peters, J. (submitted). Grasp Diffusion Network: Learning Grasp Generators from Partial Point Clouds with Diffusion Models in SO(3)xR3
3. Funk, N.; Urain, J.; **Carvalho, J.**; Prasad, V.; Chalvatzaki, G.; Peters, J. (submitted). ActionFlow: Equivariant, Accurate, and Efficient Policies with Spatially Symmetric Flow Matching
4. Palenicek, D.; Lutter, M.; **Carvalho, J.**; Dennert, D.; Ahmad, F.; Peters, J. (submitted). Diminishing Return of Value Expansion Methods

Journal Papers

5. **Carvalho, J.**; Le, A.; Kicki, P.; Koert, D.; Peters, J. (2025). Motion Planning Diffusion: Learning and Adapting Robot Motion Planning with Diffusion Models, IEEE Transactions on Robotics (T-RO)
6. Le, A. T.; Nguyen, K.; Vu, M. N.; **Carvalho, J.**; Peters, J. (2025). Model Tensor Planning, Transactions on Machine Learning Research (TMLR)
7. Le, A.; Hansel, K.; **Carvalho, J**.; Watson, J.; Urain, J; Biess, A.; Chalvatzaki, G.; Peters, J. (2025). Global Tensor Motion Planning, IEEE Robotics and Automation Letters (RA-L)
8. Tosatto, S.; **Carvalho, J.**; Peters, J. (2022). Batch Reinforcement Learning with a Nonparametric Off-Policy Policy Gradient, IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI)

Conference Papers

9. Holzmann, P.; Pfefferkorn, M.; **Carvalho, J.**; Younes, A.; Le, A.; Chalvatzaki, G; Peters, J.; Findeisen, R. (2026). Robot Path Planning via Flow Matching with Safety and Adaptivity through Predictive Control, German Robotics Conference (GRC)

10. Le, A.; Hansel, K.; **Carvalho, J**.; Watson, J.; Urain, J; Biess, A.; Chalvatzaki, G.; Peters, J. (2026). Global Tensor Motion Planning, IEEE International Conference on Robotics & Automation (ICRA), Journal-to-Conference Track
11. Le, A. T.; Nguyen, K.; Vu, M. N.; **Carvalho, J.**; Peters, J. (2026). Model Tensor Planning, International Conference on Learning Representations (ICLR), Journal-to-Conference Track
12. **Carvalho, J.**; Le, A.; Kicki, P.; Koert, D.; Peters, J. (2025). Motion Planning Diffusion: Learning and Adapting Robot Motion Planning with Diffusion Models, AAAI Conference on Artificial Intelligence (AAAI), Journal-to-Conference Track
13. Holzmann, P.; **Carvalho**, J; Younes, A.; Le, A.; Pfefferkorn, M.; Chalvatzaki, G; Peters, J.; Findeisen, R. (2025). Diffusion Meets Control: Constrained Motion Planning with Predictive Safety Guarantees, German Robotics Conference (GRC)
14. Funk, N.; Urain, J.; **Carvalho, J.**; Prasad, V.; Chalvatzaki, G.; Peters, J. (2025). ActionFlow: Equivariant, Accurate, and Efficient Policies with Spatially Symmetric Flow Matching, German Robotics Conference (GRC)
15. Le, A.; Hansel, K.; **Carvalho, J**.; Watson, J.; Urain, J; Biess, A.; Chalvatzaki, G.; Peters, J. (2025). Global Tensor Motion Planning, German Robotics Conference (GRC)
16. **Carvalho, J.**; Le, A.; Jahr, P. ; Sun, Q. ; Urain, J.; Koert, D.; Peters, J. (2025). Grasp Diffusion Network: Learning Grasp Generators from Partial Point Clouds with Diffusion Models in SO(3)×R3, German Robotics Conference (GRC)
17. **Carvalho, J.**; Le, A.; Baierl, M.; Koert, D.; Peters, J. (2023). Motion Planning Diffusion: Learning and Planning of Robot Motions with Diffusion Models, 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
18. Palenicek, D.; Lutter, M.; **Carvalho, J.**; Peters, J. (2023). Diminishing Return of Value Expansion Methods in Model-Based Reinforcement Learning, International Conference on Learning Representations (ICLR)
19. **Carvalho, J.**; Koert, D.; Daniv, M.; Peters, J. (2022). Adapting Object-Centric Probabilistic Movement Primitives with Residual Reinforcement Learning, 2022 IEEE-RAS 21st International Conference on Humanoid Robots (Humanoids)
20. Vorndamme, J.; **Carvalho, J.**; Laha, Riddhiman; Koert, D.; Figueredo, L.; Peters, J.; Haddadin, S. (2022). Integrated Bi-Manual Motion Generation and Control shaped for Probabilistic Movement Primitives, 2022 IEEE-RAS 21st International Conference on Humanoid Robots (Humanoids) — ***Best interactive paper award finalist***
21. **Carvalho, J.**; Tateo, D.; Muratore, F.; Peters, J. (2021). An Empirical Analysis of Measure-Valued Derivatives for Policy Gradients, International Joint Conference on Neural Networks (IJCNN)
22. Tosatto, S.; **Carvalho, J.**; Abdulsamad, H.; Peters, J. (2020). A Nonparametric Off-Policy Policy Gradient, Proceedings of the 23rd International Conference on Artificial Intelligence and Statistics (AISTATS)

Workshop Papers

23. Le, A. T.; Nguyen, K.; Vu, M. N.; **Carvalho, J.**; Peters, J. (2025). Model Tensor Planning, R:SS 2025 Workshop Motion Planning and Control via Parallelization
24. Le, A. T.; Nguyen, K.; Vu, M. N.; **Carvalho, J.**; Peters, J. (2025). Model Tensor Planning, ICRA 2025 Workshop RoboARCH: Robotics Acceleration with Computing Hardware and Systems
25. Le, A. T.; Hansel, K.; **Carvalho, J.**; Urain, J.; Biess, A.; Chalvatzaki, G.; Peters, J. (2024). Global Tensor Motion Planning, CoRL 2024 Workshop on Differentiable Optimization Everywhere
26. Funk, N., Urain, J., **Carvalho, J.**, Prasad, V., Chalvatzaki, G., Peters, J. (2024). ActionFlow: Equivariant, Accurate, and Efficient Manipulation Policies with Flow Matching, CoRL 2024 Workshop on Mastering Robot Manipulation in a World of Abundant Data
27. Funk, N., Urain, J., **Carvalho, J.**, Prasad, V., Chalvatzaki, G., Peters, J. (2024). ActionFlow: Efficient, Accurate, and Fast Policies with Spatially Symmetric Flow Matching, R:SS 2024 Workshop Priors4Robots — ***Best paper award***
28. **Carvalho, J.**; Baierl, M; Urain, J; Peters, J. (2022). Conditioned Score-Based Models for Learning Collision-Free Trajectory Generation, NeurIPS 2022 Workshop on Score-Based Methods
29. **Carvalho, J.**; Peters, J. (2022). An Analysis of Measure-Valued Derivatives for Policy Gradients, Multi-disciplinary Conference on Reinforcement Learning and Decision Making (RLDM) — ***Travel award***

Book Chapters

30. Watson, J., Urain, J., **Carvalho, J.**, Funk, N., Peters, J. (2025). Learning, Robotics Goes MOOC: Knowledge, Springer Nature Switzerland

STUDENT SUPERVISION

Ph.D. Supervision (as PostDoc)

1. Ken-Joel Simmoteit
2. Kay Pompetzki
3. Junning Huang

M.Sc./B.Sc. Theses

1. Zhou, X. (2025). Bimanual Action Flow (w/ Niklas Funk)
2. Prakash, A. (2025). Learning manipulation with RL
3. Zhang, L. (2025). Lightning Fast Grasp and Motion Planning
4. Princisgh, M. (2025). Learning for Planning (w/ Davide Tateo, Matteo Luperto, Tomasz Kucner)
5. Dierking, M. (2025). Model Tensor Planning (w/ An Thai Le)
6. Jahr, P. (2025). Comparing Residual Reinforcement Learning Strategies With A Stable Vector Field Base Policy
7. Striebel, N. (2025). Bimanual Robotic Manipulation through Imitation with Deep Generative Models and Expressive Representations (w/ Niklas Funk, Michael Drolet)
8. Sun Q. (2024). Grasp Diffusion Network (w/ An Thai Le)
9. Kappes, N. (2023). Natural Gradient Optimistic Actor-Critic
10. Hilt, F. (2023). Statistical Model-Based Reinforcement Learning (w/ Joe Watson)
11. Keller, L. (2023). Context-Dependent Variable Impedance Control with Stability Guarantees (w/ Dorothea Koert)

12. Herrmann, P. (2023). 6DCenterPose: Multi-object RGB-D 6D pose tracking with synthetic training data (w/ Suman Pal)
13. Brosseit, J. (2023). The Principle of Value Equivalence for Policy Gradient Search
14. Baierl, M. (2023). Score-Based Generative Models as Trajectory Priors for Motion Planning (w/ Julen Urain, An Thai Le)
15. Hellwig, J. (2023). Residual Reinforcement Learning with Stable Priors
16. Xue, C. (2022). Robot Task Classification and Local Manipulation Controllers (w/ Suman Pal)
17. Zhao, P. (2021). Improving Gradient Directions for Episodic Policy Search
18. Kaemmerer, M. (2021). Measure-Valued Derivatives for Machine Learning
19. Daniv, M. (2022). Graph-Based Model Predictive Visual Imitation Learning

Research Projects

1. Striebel, N., Mulder, A. (2024). Reinforcement Learning of Insertion Tasks: A Comparison Between Policy Structures
2. Striebel, N., Mulder, A. (2023). Building a Framework to Solve Insertion Tasks with Residual Reinforcement Learning in the Real World
3. Meier, H. (2023). Model-Based Multi-Object 6D Pose Estimation (w/ Felix Kaiser, Arjun Datta)
4. Kappes, N., Herrmann, P. (2021). Trust Region Optimistic Actor-Critic
5. Kappes, N., Herrmann, P. (2021). Second Order Extension of Optimistic Actor-Critic
6. Hellwig, J., Baierl, M. (2021). A Hierarchical Approach to Active Pose Estimation (w/ Julen Urain)
7. Hellwig, J., Baierl, M. (2021). Active Visual Search with Partially Observable Monte-Carlo Planning (w/ Julen Urain)
8. Hilt, F., Kolf, J., Weiland, C. (2021). Graph neural networks for robotic manipulation
9. Hilt, F., Kolf, J., Weiland, C. (2020). Balloon Estimators for Improving and Scaling the Nonparametric Off-Policy Policy Gradient (w/ Samuele Tosatto)
10. Musekamp, D., Rettig, M. (2020). Learning Robot Skills From Video Data (w/ Dorothea Koert)
11. Shi, J. (2023). Rapid Adaptation for Contact-Rich Tasks