Joe Watson

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Education

Technische Universität Darmstadt	*Darmstadt, Germany*	**2019 – 2024**
Computer Science Ph.D	Summa cum laude	

Thesis: Inference, Models and Priors for Control, examining the intersections of statistical machine learning and control for robot learning.

Part of the Intelligent Autonomous Systems group researching Robot Learning, supervised by Prof. Jan Peters. Defending December 2024.

From 2024, I was funded by the German Research Center for Artifical Intelligence (DFKI), as part of the Systems AI for Robot Learning group.

Peterhouse, University of Cambridge	*Cambridge, UK*	**2012 – 2016**
Information & Computer Engineering MEng, BA (Hons)	Distinction, First class	

Thesis: Deep Learning for Robotic Grasping, vision-based grasping with a Baxter robot using Caffe and ROS, supervised by Dr. Fumiya Iida

Modules include: Robotics, Computer Vision, Statistical Pattern Processing, Digital Filters & Spectrum Estimation, Nonlinear Systems & Control

	Jack Weinstock Prize for Electrical and Information Sciences (2016, 2017)	Peterhouse Engineering College Prize (2015, 2016, 2017)
Honours	Charles Babbage Senior Scholarship of Peterhouse (2015–2017)	2nd Year Integrated Design Project Prize (2014)
	Engineering Professors' Council Essay Prize, Highly Commended (2013)	1st Year Computing Prize (2013)

Experience

University of Oxford, *Postdoctoral Research Assistant*	*London, UK*	**2025 – current**

- Working in the Applied Artificial Intelligence group with Prof. Ingmar Posner at the Oxford Robotics Institute.

Google DeepMind, *Research Scientist Intern*	*London, UK*	**Winter, 2022 – 2023**

- Worked on entropy-regularized deep imitation learning, hosted by Sandy Huang and Nicolas Heess in the robotics team
- The research was accepted as a spotlight paper at NeurIPS 2023

CMR Surgical, *Software Engineer*	*Cambridge, UK*	**2016 – 2018**

- Worked on Verisus, a novel robotic system designed to revolutionize laparoscopic surgery, through to CE Mark accreditation
- Focused on the robot control and signal processing algorithms for the manipulators, through research, experimentation and software development using C and Python

Publications

IN PREPARATION

Posterior Sampling Reinforcement Learning for Continuous Control with Function Approximation,

Watson, J., Flynn, H., Peters, J., 2024

Posterior Sampling Active Learning of Dynamical Systems,

Watson, J., Peters, J., 2024

Tractable Bayesian Dynamics Models from Differentiable Physics for Learning and Control,

Watson, J., Hahner, B., Peters, J., 2024

PREPRINTS

Machine Learning with Physics Knowledge for Prediction: A Survey,

Watson, J., Song, C., Weeger, O., Gruner, T., Le, A. T., Hansel, K., Hendawy, A., Arenz, O., Trojak, W., Cranmer, M., D'Eramo, C., Bülow, F., Goyal, T., Peters, J., Hoffman, M. W., *Under review*, 2024

Efficient Stochastic Optimal Control through Approximate Bayesian Input Inference,

Watson, J., Abdulsamad, H., Findeisen, R., Peters, J., 2021

JOURNAL PUBLICATIONS

Benchmarking Structured Policies and Policy Optimization for Real-World Dexterous Object Manipulation, Funk, N. et al.,

IEEE Robotics and Automation Letters, Special Issue: Robotic Grasping and Manipulation Challenges and Progress, 2021

CONFERENCE ARTICLES

Coherent Soft Imitation Learning [SPOTLIGHT PRESENTATION],

Watson, J., Huang, H. S., Heess, N., Advances in Neural Information Processing Systems (NeurIPS), 2023

Inferring Smooth Control: Monte Carlo Posterior Policy Iteration with Gaussian Processes, [ORAL PRESENTATION]

Watson, J., Peters, J., Conference on Robot Learning (CoRL), 2022

Differentiable Physics Models for Real-world Offline Model-based Reinforcement Learning,

Lutter, M., Silberbauer, J., **Watson, J.**, Peters, J., International Conference on Robotics and Automation (ICRA), 2021

Latent Derivative Bayesian Last Layer Networks, **Watson, J.***, Lin, J.A.*, Klink, P., Pajarinen, J., Peters, J.,

International Conference on Artificial Intelligence and Statistics (AISTATS), 2021

Advancing Trajectory Optimization with Approximate Inference: Exploration, Covariance Control and Adaptive Risk,

Watson, J., Peters, J., American Control Conference (ACC), 2021

Stochastic Optimal Control as Approximate Input Inference,

Watson, J., Abdulsamad, H., Peters, J., Conference on Robot Learning (CoRL), 2019

Real-World, Real-Time Robotic Grasping with Convolutional Neural Networks,

Watson, J., Hughes, J., Iida F., Towards Autonomous Robotic Systems (TAROS), 2017

WORKSHOP PAPERS

Tractable Bayesian Dynamics Priors from Differentiable Physics for Learning and Control,

Watson, J., Hahner, B., Belousov, B., Peters, J., ICRA@40, 2024

Sample-Efficient Online Imitation Learning using Pretrained Behavioural Cloning Policies,

Watson, J., Peters, J., NeurIPS Robot Learning workshop, 2023

Function-Space Variational Inference for Deep Bayesian Classification,

Lin, J., **Watson, J.**, Klink, P., Peters, J., Advances in Approximate Bayesian Inference (AABI), 2023

Inference, Models and Priors for Control,

Watson, J., Robotic: Science and Systems (R:SS) Pioneers Workshop, 2022 [30% acceptance rate]

Differentiable Physics Models as Gaussian Processes,

Watson, J., Hahner, B., Peters, J., R:SS Workshop on Differentiable Simulators, 2022

Stationary Posterior Policy Iteration with Variational Inference,

Watson, J., Peters, J., The Multi-disciplinary Conference on Reinforcement Learning and Decision Making (RLDM), 2022

Neural Linear Models with Gaussian Process Priors,

Watson, J.★, Lin, J.A.★, Kink, P., Peters, J., Advances in Approximate Bayesian Inference (AABI), 2021

Active Inference or Control as Inference? A Unifying View,

Imohiosen, A★, **Watson, J.★**, Peters, J., International Workshop on Active Inference, 2020

A Differentiable Newton Euler Algorithm for Multi-body Model Learning,

Lutter, M., Silberbauer, J., **Watson, J.**, Peters, J., R:SS Structured Approaches to Robot Learning Workshop, 2020

BOOK CHAPTERS

Robot Learning: An Introduction,

Watson, J., Urain, J., Carvalho, J., Funk, N., Peters, J., Robotics Goes MOOC, Springer 2025.

A Differentiable Newton-Euler Algorithm for Real-World Robotics,

Lutter, M., Silberbauer, J., **Watson, J.**, Peters, J., Inductive Biases in Machine Learning for Robotics and Control, Springer, 2023

Control as Inference? Comparing Path Integral and Message Passing Methods for Optimal Control,

Watson, J., Reinforcement Learning Algorithms: Analysis and Applications, Springer, 2020

Teaching

Robot Learning, 2020–22. Lead teaching assistant for the TU Darmstadt course and MOOC, hosted on the KI Campus platform. Designed lectures on probabilistic graphical models, approximate optimal control, state estimation, model-based reinforcement learning, system identification and Bayesian reinforcement learning.

Academic Supervision

MSC THESIS	Z. Hu	*On Entropy-regularized Policy Improvement in Offline RL*	
MSC THESIS	F. Hahner	*Posterior Sampling RL with Function-space Variational Inference*	
MSC THESIS	F. D'Aquino Hilt	*Statistical Model-based Reinforcement Learning*	(with J. Carvalho)
MSC THESIS	T. Gossard	*Approximate Bayesian Inference for Structured Model Learning*	(with M. Lutter)
MSC THESIS	Y. Eich	*Distributionally Robust Optimization for Hybrid Systems*	(with H. Abdulsamad)
MSC THESIS	J. Lin	*Functional Variational Inference for Bayesian Neural Networks*	(with P. Klink)
MSC THESIS	J. Silberbauer	*Differentiable Newton Euler Algorithm for Multi-body Model Learning*	(with M. Lutter)
MSC THESIS	L. Williamson	*Learning Nonlinear Dynamical Systems with the Koopman Operator*	
BSC THESIS	D. Nikitina	*Inference Methods for Markov Decision Processes*	
BSC THESIS	M. Ali	*An Educational Framework for Robot Learning*	
BSC THESIS	F. Damken	*Variational Autoenconders for Koopman Dynamical Systems*	
INTERNSHIP	A. Imohiosen	*Variational Input Inference for Control*	
HON. THESIS	C. Voelcker	*Sequential Monte Carlo Input Inference for Control*	
SEMINAR	B. Hahner	*Differential Dynamic Programming for Humanoid Robotics*	

Academic Service

Reviewed for NeurIPS (2020*, 2021*, 2022, 2023), ICML (2021, 2022*), AISTATS (2021), CoRL (2021, 2022, 2023), ICLR (2022), IROS (2023, 2024), Neurocomputing, IEEE Robotics and Automation Letters, TMLR (*Reviewer award)

Invited Talks

Imperial	London, UK	Coherent Soft Imitation Learning	2024
ELLIS PNPIL[1] workshop	Helsinki, Finland	Tractable Physics-based Function Priors for Learning and Control	2024
NYU	New York, USA	Coherent Soft Imitation Learning	2023
Huawei R&D	London, UK	Inferring Smooth Control	2023
University of Hertfordshire	Hertfordshire, UK	Inferring Smooth Control	2022
KIT	Karlsruhe, Germany	Inferring Smooth Control	2022
IOB	Basel, Switzerland	The Promise and Pitfalls of Control as Inference	2021
IFAT, Universität Madgeburg	Madgeburg, Germany	Advancing Trajectory Optimization with Approximate Inference	2021
ATR Institute	Kyoto, Japan	Stochastic Optimal Control as Approximate Input Inference	2019
RIKEN Institute	Tokyo, Japan	Stochastic Optimal Control as Approximate Input Inference	2019
Preferred Networks	Tokyo, Japan	Stochastic Optimal Control as Approximate Input Inference	2019

[1] Probabilistic Numerics and Physics-Informed Learning.

Competencies

Software engineering (Python, C, git), machine learning (JAX, PyTorch), robotics (ROS), design (TikZ, LaTeX, Adobe Suite)

Academic Interests

robotics, sequential decision making, approximate inference, uncertainty quantification, physics-informed learning, inductive biases

References available on request