Todor Davchev

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Research Interests

My work is in the intersection of robotics and machine learning. The focus is on improving the sample efficiency and robustness of learnt models using inductive biases. I have studied ways of building such biases through learning modular and re-usable across tasks world models; demonstrations; transfer and meta learning; as well as self-supervised reinforcement learning. I have particular interest in fast contact-rich skill acquisitions, such as peg, gear and plug insertions. In other work I have also studied ways to improve 2D trajectory generation in crowded and collaborative settings as well as extracting representations that are task specific and robust to perturbations. A recent problem that I am curious about is the role of goal-conditioned reinforcement learning in the context of acquiring contact-rich manipulation skills, e.g. as advertised in the NIST challenge. With this, I am generally excited about projects combining ML/RL/DL and robotics, including working on algorithms, simulations, actual robot experimentation, and the relevant software/hardware environments.

Education

2021 PhD in Robot Learning, The University of Edinburgh
2016 MSc in Machine Learning, The University of Edinburgh
2014 BSc in Artificial Intelligence, The University of Aberdeen

Work Experience

6 Months, 2021 Google, DeepMind
Research Scientist Intern
• Invented a task-constrained self-supervised RL algorithm.
• Filed a patent application.
• Wrote a paper, accepted at ICLR 2022.

6 Months, 2021 Google X, project Intrinsic
AI Research Intern
• Work on long-horizon sparse reward problems for RL in collaboration with DeepMind.
• Work on instantiating a dual-arm robotic environment.
• Advise implementation and design of a LfD framework using Acme.

5 Months, 2019 Google, The team at X
AI Research Intern
• Built a library for teleoperation using in-house hardware;
• Built a residual learning framework that operates two policies in parallel and learns on-robot RL policies directly using TF-Agents [link].
• Wrote a paper, accepted at RA:L and ICRA 2022

6 Months, 2016 RSpace, Edinburgh
Software Developer (test automation)
• Used Java and Selenium to automate the designed tests for a small start-up comprised of 10 people.

1 Year, 2014 Broadridge Financial Solutions, Edinburgh
Graduate Developer
• Contributed to a wide variety of projects by building, maintaining, testing and deploying software solutions for a large-scale system.
• Proejcts include building a SWIFT message parser in Java, used both internally and by clients, improving and expanding the Server side system;

2 years, 2012 Chillchaser, Westhawk Ltd, Aberdeen
Developer/Technology Consultant
• Developed an enterprising mind-set towards advertising and project development
• Built and maintained websites in HTML5, CSS3, JavaScript and PHP;

Publications

2022a **T. Davchev**, O. Sushkov, J. Regli, S. Schaal, Y. Aytar, M. Wulfmeier, J. Scholz, Wish you were here: Hindsight Goal Selection for Long-horizon Dexterous Manipulation, **ICLR 2022**;

2022b **T. Davchev**, K. Luck, M. Burke, F. Meier, S. Schaal, S. Ramamoorthy, Residual Learning from Demonstration **RA:L** and **ICRA 2022**;

2021a **T. Davchev**, O. Sushkov, J. Scholz, Task-constrained Hindsight Experience Replay, **Patent** filed;

2021b **T. Davchev**, S. Bechtle, S. Ramamoorthy, F. Meier, Learning Time-Invariant Reward Functions through Model-Based Inverse Reinforcement Learning **under review**;

2020a **T. Davchev**, M. Burke, S. Ramamoorthy, Learning Structured Representations of Spatial and Interactive Dynamics for Trajectory Prediction in Crowded Scenes, **R:AL 2020**, Special Issue on Long-term Human Motion Prediction

2020b N. Das, S. Bechtle, **T. Davchev**, D. Jayaraman, A. Rai, F. Meier, Model-Based Inverse Reinforcement Learning from Visual Demonstrations, **CoRL 2020**;

2019a M. Asenov, M. Burke, D. Angelov, **T. Davchev**, S. Ramamoorthy Vid2param Online System Identification from Video for Robotics Applications, **RA:L** and **ICRA 2020**, Paris;

2019b **T. Davchev**, T. Korres, S. Fotiadis, N. Antonopoulos, and S. Ramamoorthy, An Empirical Evaluation of Preservation of Robustness under Transfer Learning, **ICML 2019** Workshop on Understanding and Improving Generalization in Deep Learning, Long Beach, [code];

2016 **T. Davchev**, and M. Lapata, "Modelling Entailment with Neural Networks" Improved the state-of-the-art on entailment modelling using a CNN-based architecture, **MSc Thesis**, [code];

2014 **T. Davchev**, and N.Oren, "Opponent Modelling for Strategic Argumentation" Built a framework for argumentation using α-β pruning, **BSc Thesis**, [code];

Scholarships & awards

Dec 2020 Google AI Residency at X

May 2019 Google AI Residency at X

Jul. 2017 DeepLearn 2017 Summer School, Certificate of Completion.

Sept. 2016 iCASE Award, University of Edinburgh.

Sept. 2015 The Informatics UK/EU Master's Scholarship.

Sept. 2015 University of Edinburgh Postgraduate Bursary.

June. 2014 International Knowledge Measurement (IKM) test. Scored 98.% better than everyone since 1987.

May 2013 The Chartered Institute for IT Prize for Best Robot Team.

Relevant Skills

JAX Used substantially throughout the past year;

PyTorch Used substantially throughout the course of PhD;

Tensorflow Used substantially throughout the course of PhD;

Panda Franka Used for the majority of Robotics-related projects;

Python Used for majority of work done;

C++/SL Used for real-time control applications;

Acme Used for research in the past year during both internships;

Tf-Agents Used for research on residual learning [link];

Contribution Framework for Stochastic Trajectory Prediction [code];

Invited Talks

2021a Learning Time-invariant Rewards with Model-based Inverse Reinforcement Learning, **FAIR, 2021**;

2021b Adapting DMPs with Reinforcement Learning for contact-rich manipulation, **Google Brain, 2021**;

2020a Residual Learning from Demonstration, **Google X, 2020**;

2020b Gentle Force Control for contact-rich manipulations, **Mistry's Lab, 2020**;

2019a Model-based Predictions for Model-based Planning, **PCC 2019, invited talk**, PhD day at Thales, Paris;

Community Contributions

Co-Organised **T. Davchev**, S. Bechtle, Y. Chebotar, T. Hospedales, F. Meier, Workshop on Learning to Learn for Robotics, **ICRA 2021**

Co-Organised S. Bechtle, **T. Davchev**, Y. Chebotar, T. Hospedales, F. Meier, Workshop on Learning to Learn, **ICLR 2021**

Tutorial "Tutorial on Stochastic Future Trajectories Prediction", [code];

Reviewer RA-Letters, R:SS, ICRA, CoRL, IROS, ICLR, NeurIPS.