Learning Transferable Dynamics Skills for Robot Manipulation Tasks

Dr Claudio Zito, PhD, University of Birmingham, UK.

Abstract (300 word limit)

As robot make their way out of factories into human environments, outer space, and beyond, they require the skill to manipulate their environment in multifarious, unforeseeable circumstances. It is clear that the ability of predicting how their actions affect the environment is a key skill that they need to possess to operate in safety and gain our trust in such environments.

Humans perform skillful manipulation tasks from an early age on, and are able to transfer behaviours learned on one object to objects of novel sizes, shapes, and physical properties. For robots, achieving those goals is challenging. For one thing, this complexity arises from the fact that physical and geometrical properties of the environment are usually uncertain, or even unknown, but play a significant role for manipulation tasks.

I will present in this talk a set of models that can learn transferable skills for manipulation tasks. The key insight is to represent these tasks in terms of local contacts and how these contacts change over time. These models allow us to generalise within and across object categories by exploiting local similarities between objects of different shapes. I will present the mathematical formulation to compute and use such models, focusing on robotic task such as grasping and pushing of novel objects.

Image

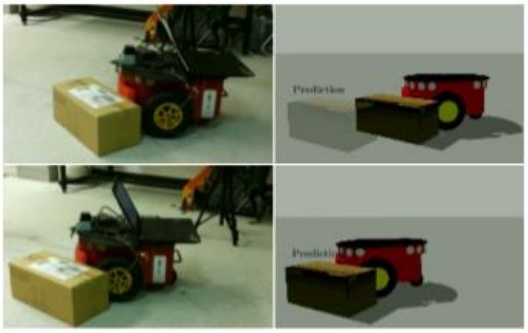


Fig. 1: Our test scenario. A Pioneer 3DX equipped with a 3D printed bumper pushing a novel object. The robot is capable of predicting the effects of the push even if the carton box is not present in the training data. Left: the real robot executing the action. Right: the action is repeated in simulation where our prediction for the pose of the object at the end of the pushing action is shown.

Recent Publications (minimum 5)

1. J. Stüber, C. Zito and R. Stolkin. Let's Push Things Forward: A Survey on Robot Pushing. Frontiers in Robotics and AI 7:8. 2020.
2. C. J. Rosales, F. Spinelli, C. Zito, M. Gabiccini and J. L. Wyatt. GPAtlasRRT: A tactile exploration strategy for novel object shape modeling. International Journal of Humanoid Robotics 15:1. 2018.
3. K. Heiwolt, C. Zito, M. Nowak, C. Castellini and R. Stolkin. Automatic Detection of Myocontrol Failures Based upon Situational Context Information. IEEE/RAS-EMBS Int'l Conf. on Rehabilitation Robotics (ICORR). 2019.
4. J. Stuber, M. Kopicki and C. Zito. Feature-Based Transfer Learning for Robotic Push Manipulation. Proc. of IEEE Int'l Conf. on Robotics and Automation (ICRA). 2018.
5. C. Zito, M. S. Kopicki, R. Stolkin, C. Borst, F. Schmidt, M. A. Roa and J. L. Wyatt. Sequential trajectory re-planning with tactile information gain for dextrous grasping under object-pose uncertainty. Proc. of IEEE/RSJ Int'l Conf. on Intelligent Robots and Systems, pp. 2013-2040. 2013.
6. C. Zito, R. Stolkin, M. Kopicki, J. L. Wyatt. Two-level RRT Planner for Robotic Push Manipulation. Proc. of IEEE/RSJ Int'l Conf. on Intelligent Robots and Systems, pp. 678-685. 2012.

Photograph



Biography (150 word limit)

Dr Claudio Zito is a Senior Research Fellow at the University of Birmingham, UK. His main research interest is mapping perception into actions to model intelligent behaviours for next-gen AI systems. He contributed to several EU projects (FP7 GeRT, FP7 PaCMan, EUROC) and EPSRC projects, and his work was recognized with several awards and personal grants. He has a BA in Math and Computer Science (UoS, Siena (IT), 2006), a MPhil in Artificial Intelligence (AI) and Machine Learning (UoP, Pisa (IT), 2010), and a PhD in AI and Robotics (UoB, Birmingham UK, 2015). He also worked as Lecturer in AI at the School of Computer Science at UoB and as Senior Research Fellow at the Extreme Robotics Lab at the UoB.

Email: C.Zito@bham.ac.uk

Notes/Comment