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Large-scale integrating project

## *2<sup>nd</sup> Internal Workshop*

**Project acronym:** DEXMART

**Project full title:** DEXterous and autonomous dual-arm/hand robotic manipulation with sMART sensory-motor skills: A bridge from natural to artificial cognition

**Grant agreement no:** FP7 216239

**Project web site:** [www.dexmart.eu](http://www.dexmart.eu)



**Date and time:** April 19, 2010

**Venue:** DEIS- Dipartimento di Elettronica, Informatica e Sistemistica, UNIBO.

**Viale Risorgimento, 2, Bologna, 40136.**

# Motor Skills Learning for Robotics

(Jan Peters)

## Abstract

Autonomous robots that can assist humans in situations of daily life have been a long standing vision of robotics, artificial intelligence, and cognitive sciences. A first step towards this goal is to create robots that can learn tasks triggered by environmental context or higher level instruction. However, learning techniques have yet to live up to this promise as only few methods manage to scale to high-dimensional manipulator or humanoid robots. In this talk, we investigate a general framework suitable for learning motor skills in robotics which is based on the principles behind many analytical robotics approaches. It involves generating a representation of motor skills by parameterized motor primitive policies acting as building blocks of movement generation, and a learned task execution module that transforms these movements into motor commands. We discuss learning on three different levels of abstraction, i.e., learning for accurate control is needed to execute, learning of motor primitives is needed to acquire simple movements, and learning of the task-dependent "hyperparameters" of these motor primitives allows learning complex tasks. We discuss task-appropriate learning approaches for imitation learning, model learning and reinforcement learning for robots with many degrees of freedom. Empirical evaluations on several robot systems illustrate the effectiveness and applicability to learning control on an anthropomorphic robot arm.

## Bio

Jan Peters is a senior research scientist and heads the Robot Learning Lab (RoLL) at the Max Planck Institute for Biological Cybernetics (MPI) in Tuebingen, Germany. He graduated from University of Southern California (USC) with a Ph.D. in Computer Science. He holds two German M.S. degrees in Informatics and in Electrical Engineering (from Hagen University and Munich University of Technology) and two M.S. degrees in Computer Science and Mechanical Engineering from USC. Jan Peters has been a visiting researcher at the Department of Robotics at the German Aerospace Research Center (DLR) in Oberpfaffenhofen, Germany, at Siemens Advanced Engineering (SAE) in Singapore, at the National University of Singapore (NUS), and at the Department of Humanoid Robotics and Computational Neuroscience at the Advanced Telecommunication Research (ATR) Center in Kyoto, Japan. His research interests include robotics, nonlinear control, machine learning, reinforcement learning, and motor skill learning.

