

# Sylvain Calinon

## **Professional address:**

Advanced Robotics Dept, Italian Institute of Technology (IIT),  
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**Born January 12, 1980.**

**Swiss and French citizen. Single.**

## Areas of expertise

- Robot programming by demonstration
- Human-robot interaction
- Machine learning
- Learning by imitation
- Artificial intelligence

*Development of robot learning by imitation approaches to handle human-robot collaborative skills, and development of dynamical systems for versatile control in human-robot interaction.*

## Research experience

- April 2009–now Team leader at the *Advanced Robotics Dept* led by Prof. Darwin Caldwell, *Italian Institute of Technology (IIT)*, Genova, Italy.
- 2007–2009 Postdoctoral research fellow at the *Learning Algorithms and Systems Laboratory (LASA)* led by Prof. Aude Billard, *Ecole Polytechnique Fédérale de Lausanne (EPFL)*, Switzerland.
- March 2008 Visiting research fellow at the *CNRS-AIST Joint Japanese-French Robotics Laboratory (JRL)* led by Prof. Abderrahmane Kheddar, *National Institute of Advanced Industrial Science and Technology (AIST)*, Tsukuba, Japan (1 month).
- April 2005 Visiting research fellow at the *Adaptive Systems Research Group* led by Prof. Kerstin Dautenhahn and Prof. Chrystopher Nehaniv, *University of Hertfordshire (UH)*, Hatfield, UK (2 weeks).
- Sept. 2003 Visiting research fellow at the *Humanoid Robotics and Computational Neuroscience department (HRCN)* led by Prof. Gordon Cheng, *Advanced Telecommunication Research Institute (ATR)*, Kyoto, Japan (1 month).
- Oct. 2002 Visiting research fellow at the *Computational Learning and Motor Control Lab (CLMC)* led by Prof. Stefan Schaal, *University of Southern California (USC)*, Los Angeles, USA (1 month).

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## Education

- 2003–2007 **PhD in robot programming by demonstration** at the *LASA Laboratory*, EPFL, Switzerland.  
**"Continuous Extraction of Task Constraints in a Robot Programming by Demonstration Framework"**  
*Supervisor:* Prof. Aude Billard.  
*Committee:* Prof. Hannes Bleuler, EPFL, Prof. Hervé Bourlard, IDIAP Research Institute, Dr Yiannis Demiris, Imperial College London (ICL), UK, Prof. Stefan Schaal, University of Southern California (USC), USA.  
*Oral exam:* May 1<sup>st</sup>, 2007. *Public presentation:* July 6<sup>th</sup>, 2007.  
*Awards:* Robotdalen Scientific Award, Asea Brown Boveri (ABB) Award, EPFL-Press distinction.
- 2001–2003 **MSc in Microengineering**, specialization in robotics, EPFL, Switzerland. MSc thesis on human-robot interfaces at the Autonomous Systems Laboratory (ASL), EPFL, Switzerland  
**"PDA Interface for Humanoid Robots using Speech and Vision Processing"**  
*Supervisor:* Prof. Aude Billard.  
*Committee:* Prof. Jean-Daniel Nicoud, DIDEL S.A., EPFL.  
*Oral exam:* March 1<sup>st</sup>, 2003.
- 1998–2001 **BSc in Microengineering**. EPFL, Switzerland.

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## Awards

- 2008 Robotdalen International Scientific Award for best PhD thesis.  
*"The jury was impressed by the practical and economic importance of the problem, the systematic analysis and innovative layered approach of its implementation, the completeness of the solution, and the open release of source code, demonstrating confidence in the solution independence from specifics of any particular robot hardware or manipulation task."*
- 2008 ABB Award for best PhD thesis.  
*"For the thorough and exemplary work in his Ph.D. thesis and important scientific contributions resolving two major issues in robot programming by demonstration."*
- 2008 EPFL-Press distinction for PhD Thesis.
- 2008 First prize in the *Grand Challenge on Human-Robot Interaction* at the *International Conference on Robotics and Automation (ICRA)*.
- 2007 Best paper award of the *IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, Jeju, Korea. Paper on *"Active Teaching in Robot Programming by Demonstration"*.

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## Publications

- Book Calinon, S. (2009), *"Robot Programming by Demonstration: A Probabilistic Approach"*. EPFL/CRC Press.
- Book chapters Billard, A., Calinon, S., Dillmann, R. and Schaal, S. (2008), *"Robot Programming by Demonstration"*. Siciliano, B. and Khatib, O. (eds.). Handbook of Robotics. Springer.  
**(book winner of two PROSE awards)**

- Calinon, S. and Billard, A. (2007) *"Learning of Gestures by Imitation in a Humanoid Robot"*. Dautenhahn, K. and Nehaniv, C.L. (eds.). *Imitation and Social Learning in Robots, Humans and Animals: Behavioural, Social and Communicative Dimensions*. Cambridge University Press.
- International journals  
 Hersch, M., Guenter, F., Calinon, S. and Billard, A. (2008) *"Dynamical System Modulation for Robot Learning via Kinesthetic Demonstrations"*. *IEEE Transactions on Robotics*, 24:6.
- Calinon, S. and Billard, A. (2007) *"What is the Teacher's Role in Robot Programming by Demonstration? - Toward Benchmarks for Improved Learning"*. *Interaction Studies, Special Issue on Psychological Benchmarks in Human-Robot Interaction*, 8:3.
- Calinon, S., Guenter, F. and Billard, A. (2007) *"On Learning, Representing and Generalizing a Task in a Humanoid Robot"*. *IEEE Transactions on Systems, Man and Cybernetics, Part B, Special issue on robot learning by observation, demonstration and imitation*, 37:2.
- Guenter, F., Hersch, M., Calinon, S. and Billard, A. (2007) *"Reinforcement Learning for Imitating Constrained Reaching Movements"*. *Advanced Robotics, Special Issue on Imitative Robots*, 21:13.
- Billard, A., Calinon, S. and Guenter, F. (2006) *"Discriminative and Adaptive Imitation in Uni-Manual and Bi-Manual Tasks"*. *Robotics and Autonomous Systems*, 54:5.
- Billard, A., Epars, Y., Calinon, S., Cheng, G. and Schaal, S. (2004) *"Discovering Optimal Imitation Strategies"*. *Robotics and Autonomous Systems, Special Issue: Robot Learning from Demonstration*, 47:2-3.
- International conferences  
 Calinon, S. and Billard, A. (2008) *"A Probabilistic Programming by Demonstration Framework Handling Constraints in Joint Space and Task Space"*. In *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Nice, France.
- Calinon, S. and Billard, A. (2007) *"Active Teaching in Robot Programming by Demonstration"*. In *Proceedings of the IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, Jeju, Korea.  
**(RO-MAN'07 best paper award)**
- Calinon, S. and Billard, A. (2007) *"Incremental Learning of Gestures by Imitation in a Humanoid Robot"*. In *Proceedings of the ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, Arlington, Virginia, USA.
- Hersch, M., Guenter, F., Calinon, S. and Billard, A. (2006) *"Learning Dynamical System Modulation for Constrained Reaching Tasks"*. In *Proceedings of the IEEE-RAS International Conference on Humanoid Robots (Humanoids)*, Genova, Italy.
- Calinon, S. and Billard, A. (2006) *"Teaching a Humanoid Robot to Recognize and Reproduce Social Cues"*. In *Proceedings of the IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, Hertfordshire, UK.
- Calinon, S., Guenter, F. and Billard, A. (2006) *"On Learning the Statistical Representation of a Task and Generalizing it to Various Contexts"*. In *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, Orlando, USA.
- Calinon, S., Epiney, J. and Billard, A. (2005) *"A Humanoid Robot Drawing Human Portraits"*. In *Proceedings of the IEEE-RAS International Conference on Humanoid Robots (Humanoids)*, Tsukuba, Japan.
- Calinon, S. and Billard, A. (2005) *"Recognition and Reproduction of Gestures using a Probabilistic Framework combining PCA, ICA and HMM"*. In *Proceedings of the International Conference on Machine Learning (ICML)*, Bonn, Germany.

- Calinon, S., Guenter, F. and Billard, A. (2005) "*Goal-Directed Imitation in a Humanoid Robot*". In Proceedings of the IEEE International Conference on Robotics and Automation (ICRA), Barcelona, Spain.
- Calinon, S. and Billard, A. (2004) "*Stochastic Gesture Production and Recognition Model for a Humanoid Robot*". In Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Sendai, Japan.
- Calinon, S. and Billard, A. (2003) "*PDA Interface for Humanoid Robots*". In Proceedings of the IEEE International Conference on Humanoid Robots (Humanoids), Karlsruhe, Germany.
- International workshops  
Calinon, S. and Billard, A. (2008) "*A Robot Programming by Demonstration Framework Integrating Statistical and Social Cues*". Workshop on Interactive Robot Learning. Robotics: Science and Systems Conference (RSS), Zurich, Switzerland.
- Calinon, S. and Billard, A. (2008) "*A Framework Integrating Statistical and Social Cues to Teach a Humanoid Robot New Skills*". Workshop on Social Interaction with Intelligent Indoor Robots. International Conference on Robotics and Automation (ICRA), Pasadena, CA, USA.
- Conference abstracts and posters  
Calinon, S. and Billard, A. (2005) "*Learning of Gestures by Imitation in a Humanoid Robot*". International Symposium on Imitation in Animals and Artifacts (AISB), Hatfield, UK.
- Calinon, S. and Billard, A. (2004) "*Gesture Recognition and Reproduction for a Humanoid Robot using Hidden Markov Models*". AMI/PASCAL/IM2/M4 Workshop on Multimodal Interaction and Related Machine Learning Algorithms, Martigny, Switzerland.
- Theses  
Calinon, S. (2007) "*Continuous Extraction of Task Constraints in a Robot Programming by Demonstration Framework*". PhD thesis. Learning Algorithms and Systems Laboratory (LASA), Ecole Polytechnique Fédérale de Lausanne (EPFL).
- Calinon, S. (2003) "*PDA Interface for Humanoid Robots using Speech and Vision Processing*". MSc thesis. Autonomous Systems Laboratory (ASL), Ecole Polytechnique Fédérale de Lausanne (EPFL).

## Peer-reviewed videos

- Calinon, S. and Billard, A. (2007) "*Incremental Learning of Gestures by Imitation in a Humanoid Robot*". ACM/IEEE International Conference on Human-Robot Interaction (HRI), Arlington, Virginia, USA.
- Hersch, M., Guenter, F., Calinon, S. and Billard, A. (2006) "*Learning Dynamical System Modulation for Constrained Reaching Tasks*". IEEE-RAS International Conference on Humanoid Robots (Humanoids), Genova, Italy.
- Calinon, S., Guenter, F. and Billard, A. (2005) "*Goal-Directed Imitation in a Humanoid Robot*". IEEE International Conference on Robotics and Automation (ICRA), Barcelona, Spain.
- Calinon, S. and Billard, A. (2005) "*A Humanoid Robot Drawing Human Portraits*". IEEE-RAS International Conference on Humanoid Robots (Humanoids), Tsukuba, Japan.
- Calinon, S. and Billard, A. (2004) "*Stochastic Gesture Production and Recognition Model for a Humanoid Robot*". IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Sendai, Japan.
- Calinon, S. and Billard, A. (2003) "*PDA Interface for Humanoid Robots*". IEEE-RAS International Conference on Humanoid Robots (Humanoids), Karlsruhe, Germany.

## Academic service

Invited talks *"A Probabilistic Programming by Demonstration Framework Handling Constraints in Joint Space and Task Space"*. Workshop on Grasp and Task Learning by Imitation. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Nice, France, 2008.

*"A Robot Programming by Demonstration Framework Integrating Statistical and Social Cues"*. Workshop on Interactive Robot Learning. Robotics: Science and Systems Conference (RSS), Zurich, Switzerland, 2008.

*"Humanoid robots & learning by imitation"*. Industrial forum on robotics (RobotX), Yverdon, Switzerland, 2008.

*"Extraction of Task Constraints in a Robot Programming By Demonstration"*. Workshop on Concept Learning for Embodied Agents. International Conference on Robotics and Automation (ICRA), Roma, Italia, 2007.

*"Learning and Probabilistic Representation of a Task in a Humanoid Robot"*. Workshop on Collaborative Human-Robot Teamwork. International Conference on Robotics and Automation (ICRA), Orlando, Florida, USA, 2006.

Research committees External examiner of Diego Pargo's PhD thesis, Universitat Politècnica de Catalunya (UPC), Barcelona, Spain, 2009.

Program Committee of the IEEE International Symposium on Computational Intelligence in Robotics and Automation (CIRA), Daejeon, Korea, 2009.

Program Committee of the symposium on *New Frontiers in Human-Robot Interaction*, Edinburgh, Scotland, 2009.

Member of the Technical Committee on Robot Learning, IEEE Robotics and Automation Society (RAS), 2008.

Chair of the Learning and Control session at the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2008.

Member of FIBRS Student/Chair Mentorship Program, IROS, 2008.

Affiliations to research projects European Project **Robot@CWE** (Advanced robotic systems in future collaborative working environments, <http://www.robot-at-cwe.eu>). 3-years project started in 2006 under contract FP6-034002 involving 7 universities and 2 industrial partners.

European Integrated Project **Feelix Growing** (Feel, interact, express: a global approach to development with interdisciplinary grounding, <http://www.feelix-growing.org>). 4-years project started in 2006 under contract FP6-IST-045169 involving 6 universities and 2 industrial partners.

European Integrated Project **Cogniron** ("The Robotic Cognitive Companion", <http://www.cogniron.org>). 4-years project started in 2004 under contract FP6-IST-002020 involving 8 universities.

Refereeing *IEEE Transactions on Robotics (TRO)*, 2007 and 2008.

*IEEE Transactions on on Autonomous Mental Development (AMD)*, 2008.

*IEEE Transactions on Systems, Man, and Cybernetics (SMC)*, 2005, 2007 and 2008.

*Autonomous Robots (AR)*, 2008 and 2009.

*International Journal of Humanoid Robotics (IJHR)*, 2007 and 2008.

*Advanced Robotic Systems (ARS)*, 2007.

*International Journal of Robotics Research (IJRR)*, 2007.

*Neural Networks (NN)*, 2005.

*IEEE International Conference on Robotics and Automation (ICRA)*, 2006, 2007, 2008 and 2009.

*IEEE International Conference on Intelligent Robots and Systems (IROS)*, 2008 and 2009.

*IEEE International Conference on Development and Learning (ICDL)*, 2009.

*FIRA RoboWorld Congress*, 2009.

## Communication skills

- Languages French (native), English (fluent), German (good knowledge).
- Robots HOAP-2, HOAP-3 (Fujitsu), Katana (Neuronics), DB (Sarcos), HRP-2 (Kawada Ind., General Robotix), Robota (Didel).
- Computers Linux and Windows OS, C/C++, Matlab, Java, Assembler, PHP, OpenGL.

## Teaching experience

- Teaching associate Guest lecturer for the *Applied Machine Learning* course. Class on *Hidden Markov Models* for graduate students in Microengineering, EPFL (class of 2 hours, 2007 and 2008).
- Teaching assistant Supervision of *Applied Machine Learning* lab for graduate students in Microengineering, EPFL, 2006.  
Supervision of practical work on *human-robot interfaces and image processing* during one semester, robotics class of 3 hours per week for graduate students in Microengineering, EPFL, 2004.  
Supervision of a half-day workshop on *human-robot interfaces for humanoid robots and industrial robots* during the international *Winter School on Human Robot Interaction (CWSHRI)* organized by the COGNIRON European integrated project, Lausanne, Switzerland, January 21-25, 2008.  
Supervision of a half-day workshop on *human-robot interfaces and vision processing* for the international *Summer School on Human-Robot Interaction* organized by the *IEEE Robotics and Automation Society (RAS)* and the *International Foundation of Robotics Research (IFRR)*, Volterra, Italy, July 19-23, 2004.
- Expertise External expert for the exam of the *Autonomous Robots* course for PhD students, 2007.
- Supervision of MSc theses D'halluin, F. "*Robust learning and reproduction of gestures from human demonstrations*". MSc thesis, EPFL, 2008.  
Richard, M. "*Implementation of a learning-by-imitation algorithm on the Katana robot*". MSc thesis, EPFL, 2007.  
Magnard, F. "*Object tracking for a camera designed to be worn by children*". MSc thesis, EPFL, 2005.  
Brossard, A. "*Control of the humanoid robot HOAP-2*". MSc thesis, EPFL, 2004.  
Maurer, A. "*Artificial Neural Network (ANN) - Hidden Markov Model (HMM) Comparison for a gesture recognition application*". MSc thesis, EPFL, 2004.  
Kunze, M. "*Person recognition for the humanoid robot Robota*". MSc thesis, EPFL, 2003.
- Supervision of BSc projects Bungu, M. "*Automatic calibration of a 3D vision tracking system*". Semester project, EPFL, 2008.

Bodenmann, A. "*Hierarchical learning of a movement through Hidden Markov Model*". Semester project, EPFL, 2008.

D'halluin, F. "*Incremental learning of gestures through the support of a human teacher*". Semester project, EPFL, 2008.

Nadeau, C. "*Vocal analysis to teach a humanoid robot manipulation skills*". Semester project, EPFL, 2007.

Pulvin, M. "*Imitation of legs motion by a humanoid robot through the use of motion sensors*". Semester project, EPFL, 2007.

Hitz, A. "*Locomotion control module for the HOAP3 robot*". Semester project, EPFL, 2006.

Epiney, J. "*A Humanoid Robot that can paint*". Semester project, EPFL, 2005.

Schoeneich, P. "*Gaze direction detection using inertial sensors*". Semester project, EPFL, 2005.

Borter, J.-J. "*Motion data representation using motion sensors*". Semester project, EPFL, 2004.

Dubach, C. "*Recognition of trajectories using a stereoscopic vision system*". Semester project, EPFL, 2004.

Hentsch, V. "*Gestures analysis using gyroscopic sensors*". Semester project, EPFL, 2004.

Noth, A. "*Development of an auditory systems running on a Pocket-PC*". Semester project, EPFL, 2003.

Linder, Y. "*Robust visual arms and head tracking running on a Pocket-PC*". Semester project, EPFL, 2003.

Grivaz, C. "*Interactive game of a pair of mini-humanoid robot Robota*". Semester project, EPFL, 2003.

Lausanne, April 6th, 2009