

## Curriculum vitæ – Antoine Cully

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### Dr. Antoine Cully

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**Keywords** Robotics, Learning Algorithms, Machine Learning, Evolutionary Computation, Evolutionary Robotics

### — Academic Positions

– **nov.2015-now** *Research associate in Robotics and Artificial Intelligence*, Imperial College London, United Kingdom  
– **2012-2015** *Ph.D. student in Artificial Intelligence and Robotics*, Pierre and Marie Curie University, France  
– **2012-2015** *Teaching assistant* in computer science and in control theory, Pierre and Marie Curie University, France

### — Education

– **2012-2015** *Ph.D. in Artificial Intelligence and Robotics*, Pierre and Marie Curie University (UPMC), France.

- Title: Creative adaptation through learning
- *Best Thesis Award* from the French Association of Artificial Intelligence (AFIA)
- Supervisors: Stéphane Doncieux and Jean-Baptiste Mouret
- Funding: Selective Ph.D. scholarship, received from the French ministry of research and the DGA (French DARPA)
- Graduation date: 21 December 2015
- Jury:
  - Marc Schoenauer - INRIA Saclay - Île-de-France
  - David Filliat - ENSTA - ParisTech
  - Raja Chatila - Univ. Pierre et Marie Curie - ISIR
  - Jan Peters - Technische Universität Darmstadt
  - Jonas Buchli - ETH Zurich
  - Eva Cruck - DGA/ANR (invitée)
- UPMC is considered as the top research university in France according to most rankings

– **2011-2012** *M.Sc. in Advanced Robotics and Intelligent Systems*. Pierre and Marie Curie University, France (Head of the class).

– **2009-2012** *Engineer Degree in Robotics*, Pierre and Marie Curie University, France (Head of the class).

### — Technical Abilities

– **Programming:** C/C++, Java, Matlab, Python, ROS and real time programming.

Experience:

- Ph.D.: Prototyping of algorithms in Matlab, then implementation in C++, communication between the algorithms and the robots through ROS and analysis of the results via Matlab/Python.
- Design of a template based library for Model based Optimization (<https://github.com/resibots/limbo>)
- Teaching in the “C”, “C++” and “JAVA” Classes.
- Master projects: Tetris game, Simulator of a Roomba robot.

– **Artificial Intelligence: Learning algorithm** (Bayesian Optimization, multi-objective optimization,...), **Machine Learning** (Classifier, neural network, support vector machine,...), SLAM, Planning.

Experience:

- Ph.D.: Data-Efficient Learning algorithm (Bayesian Optimization) based on prior knowledge autonomously learned from simulation via a novel type of evolutionary algorithm: Quality-Diversity Optimization.
- Teaching in the “Artificial Intelligence for Robotics” Class.
- Master projects: Mapping and Planning with turtleBot (C++ ROS). Implementation of an Intelligent Adaptive Curiosity for a simulated robot (JAVA).

– **Signal Processing:** Image processing, stereo-vision, filtering, sound localisation.

Experience:

- Master projects: Visual, verbal and gesture recognition with a NAO (C++ OpenCV). Target following with particle/Kalman filter. Beamforming for sound localisation (Matlab).

– **Control Theory:** Visual servoing, multi-task servoing, PID design, kinematic and dynamic modeling.

Experience:

- Ph.D.: Fine-tuning of the robot’s joints PID and design of controller governing all movements of the joints.
- Teaching in the “Advance Control Theory” Class.

– **Design:** Mechanical design with SolidWorks, Electrical design with Eagle and Proteus. Programming on microcontrollers (Pic, Arduino,...).

Experience:

- Design of a robotic crunch for medical experiments in the ISIR lab.
- Design of the head of the robot JAZZ during an internship at GOSTAI (french robotic firm).

### — Academic Duties

– **2014-2015** Member of the council of the Institute of Intelligent Systems and Robotics (ISIR), Pierre and Marie Curie University, France.

– **2014-2015** Representative of the PhD-students and the post-docs of the research team. ISIR, France.

### — Teaching Activities

– **2012-2015** Teaching assistant (64 hours/year) for master student in robotics (Polytech’Paris-UPMC); about 20% of classic classes and 80% of hands-on classes; topics:

- Artificial Intelligence for Robotics
- C/C++ Language
- Advanced Control Theory
- JAVA

### — Awards

– **Best Thesis Award** from the French Association of Artificial Intelligence (AFIA).

– **Outstanding Paper of 2015** from the International Society for Artificial Life (ISAL).

– **Article featured on the Cover of Nature:** issue 521 of the 28<sup>th</sup> of May 2015.

– Nominated for Best Video, *AAAI Video competition 2016*. A. Cully, J. Clune, D. Tarapore and J.-B. Mouret (Results not communicated yet).

– Nominated for Best Robot Video, *AAAI Video competition 2016*. A. Cully, J. Clune, D. Tarapore and J.-B. Mouret (Results not communicated yet).

– Nominated for Best Student video, *AAAI Video competition 2016*. A. Cully, J. Clune, D. Tarapore and J.-B. Mouret (Results not communicated yet).

– Nominated for Best Student video, *AAAI Video competition 2013*. A. Cully, S. Koos and J.-B. Mouret.

### — Reviewer and Program Committee Member

– **GECCO 2015** . GECCO is one of the main conference in artificial evolution (committee).

– **IROS 2013 & 2014** . IROS is one of the main conference in robotics (reviewer).

– **Advanced Robotics** (reviewer).

– **Trends in Biotechnology** (reviewer).

– **IEEE Transactions on Automatic Control** (reviewer).

## — Supervision of Graduate Students

- 2015 (master student) Pierre Ecarlat. *Self-exploration of object interactions with a robotic arm.*
- 2014 (master student) Luigi Tedesco. *Damage recovery with a 8 DOFs robotic arm.*
- 2014 (master student) Walid Abderrahmani. *Electrical design of a robotic bird for experiments in biology.*
- 2014 (master student) Frédéric Lauron. *Mechanical design of a robotic bird for experiments in biology.*
- 2013 (master student) Mathieu Nassar. *Open-ended interactions with unconstrained environment using the iCub.*

## — Publications (sorted according to their importance)

*Citations are counted using Google scholar and auto-citations were manually removed.*

### Peer-Reviewed Journal Paper

– **Cully, A., Clune, J., Tarapore, D. and Mouret, J.-B. (2015). *Robots that can adapt like animals.* Nature. Pages 503-507.**

- This paper shows how a legged robot can autonomously discover a new walking gait after a damage in less than 2 minutes. It combines the creativity of evolutionary computation techniques (Behavioral Repertoires) with the efficiency of state of the art active learning techniques (Bayesian Optimization).
- Nature is generally regarded as the most prestigious journal, all disciplines considered (impact factor: 42.351).
- This article has been selected by the International Society of Artificial Life as the *Outstanding paper of 2015*.
- This work has been featured on the cover of the Nature issue and has been covered by several outlets (Nature News, Science, Washington Post, The Times, The Economist, MIT Technology Review, IEEE Spectrum, BBC News, Le Monde ...). Several videos associated to the paper (<https://youtu.be/T-c17RKh3uE>) has been viewed more than 100,000 times.
- Citations: 48

– **Cully, A. and Mouret, J.-B. (2015). *Evolving a Behavioral Repertoire for a Walking Robot.* Evolutionary Computation Journal. Pages 1-33.**

- This paper uses the recently introduced concept of *Behavioral Repertoires* (see below our paper *Behavioral Repertoire Learning in Robotics*) to generate open-ended control abilities for a legged robot. In this paper a legged robot autonomously discovers how to walk in every direction.
- ECJ is one of the top journal in evolutionary computation/robotics (impact factor: 3.733).
- Citations: 7

– **Koos, S., Cully, A. and Mouret, J.-B. (2013). *Fast Damage Recovery in Robotics with the T-Resilience Algorithm.* International Journal of Robotics Research. Vol 32 No 14 Pages 1700-1723.**

- This paper shows how a legged robot can autonomously discover a new gait after a damage in less than 20 minutes. It is one of the few papers in which evolutionary computation clearly helps pushing the state of the art in mobile robotics.
- IJRR is the top journal in robotics (impact factor: 2.863). This work has been covered by several news outlets (IEEE Spectrum, Yahoo News, Discovery.com Gizmag, Gizmodo ...).
- citations: 18

### Peer-Reviewed Conference Papers

– **Cully, A. and Mouret, J.-B. (2013). *Behavioral Repertoire Learning in Robotics.* Proceedings of Genetic and Evolutionary Computation Conference (GECCO). Pages 175-182.**

- This work introduces a novel technique to autonomously generate *Behavioral Repertoires*. The concept of behavioral repertoires is to gather in a single archive all the possible actions of a robot. By autonomously generating them, the robot discovers by itself its own abilities.
- GECCO is one of the main conference about artificial evolution. The acceptance rate is below 36%.
- Citations: 11

– **Tarapore D., Clune J., Cully, A. and Mouret, J.-B. (2016). *How Do Different Encodings Influence the Performance of the MAP-Elites Algorithm?* Proceedings of Genetic and Evolutionary Computation Conference (GECCO). Pages 175-182.**

- This work analyzes the influence of different encodings on the MAP-Elites algorithms. This work reveals that the high evolvability of indirect encodings penalizes the evolutionary process compared to direct encodings.
- GECCO is one of the main conference about artificial evolution. The acceptance rate is below 36%.
- Citations: no citation yet (publication in July 2016)

– **Maestre, C., Cully, A., Gonzales, C. and Doncieux, S. (2015). *Bootstrapping interactions with objects from raw sensorimotor data: a Novelty Search based approach.* IEEE International Conference on Developmental and Learning and on Epigenetic Robotics (ICDL-EPIROB).**

- In this work, we show that evolutionary algorithms can provide promising tool for developmental learning. In particular we prove that the Novelty Search algorithm can be used to perform a babbling guided by raw perceptions.
- ICDL-EpiRob is one of the main conference about Developmental Learning (oral acceptance rate is about 30%).
- Citations: 1

– **Jehanno, J.-M., Cully, A., Grand, C. and Mouret, J.-B. (2014). *Design of a Wheel-Legged Hexapod Robot for Creative Adaptation.* Proceedings of Climbing and walking robot conference (CLAWAR).**

- This paper presents the design of a new wheel-legged hexapod robot. This robot is designed to be able to generate a large variety of locomotion modes (walking, rolling, walking on its back ...) and is devoted for future work on damage recovery.
- Citations: 1

#### Peer-Reviewed Workshop Papers

– **Chatzilygeroudis, K., Cully, A. and Mouret, J.-B. (2016). *Towards semi-episodic learning for robot damage recovery* International Conference on Robotics and Automation (ICRA) 2016 (accepted for oral presentation).**

- This paper presents how the Intelligent Trial and Error algorithm introduced in the article “Robots that can adapt like animals” (cully-2015) can be extended to allow a robot to adapt to a mechanical damage and continue its mission simultaneously.
- Citations: no citation yet (publication in May 2016)

– **Ecarlat, P., Cully, A., Maestre, C. and Doncieux, S. (2015). *Learning a high diversity of object manipulations through an evolutionary-based babbling* International Conference on Intelligent Robots and Systems (IROS) 2015.**

- This paper presents how the MAP-Elites algorithm introduced in the article “Robots that can adapt like animals” (cully-2015) can be used discover a large variety of ways for a robotic arm to manipulate a cube. This collection of actions contains, for instance, grasping and throwing behaviors.
- Citations: no citation yet (publication in October 2015)

– **Koos, S. and Cully, A. and Mouret, J.-B. (2014). *Abstract of: Fast Damage Recovery in Robotics with the T-Resilience Algorithm.* ALIFE 14: The Fourteenth Conference on the Synthesis and Simulation of Living Systems. Pages 156-157.**

- Peer-reviewed long-abstract of our paper “Fast Damage Recovery in Robotics with the T-Resilience Algorithm” selected for oral presentation.
- ALIFE is one of the main conference about artificial evolution (oral acceptance rate: 50%).
- Citations: no citation yet

– **Cully, A. and Mouret, J.-B. (2014). *Learning to Walk in Every Direction with the TBR-Learning algorithm.* ALIFE 14: The Fourteenth Conference on the Synthesis and Simulation of Living Systems. Pages 146-147.**

- Peer-reviewed long-abstract of our paper “Evolving a Behavioral Repertoire for a Walking Robot” selected for oral presentation.
- ALIFE is one of the main conference about artificial evolution (oral acceptance rate: 50%).
- Citations: no citation yet

## — Oral Presentations

### –Adaptation Créative par Apprentissage.

- Invited Talk for the Best-PhD award (AFIA/RFIA)
- Location: Clermont Ferrand / Date: June 2016

### –Practical Question for Learning with Bayesian Optimization in Robotics and Damage Recovery.

- Invited Talk
- Location: Technische Universität Darmstadt / Date: March 2015

### –Damage Recovery through Learning.

- Workshop Talk (Journée des Jeunes Chercheurs en Robotique 2014)
- Location: Paris / Date: October 2014

### –Damage Recovery through Learning.

- Workshop Talk (ICEIRA workshop)
- Location: Paris / Date: October 2014

### –Highly Resilient Hexapod Robot thanks to Evolution.

- Conference Talk (Alife - 2014)
- Location: New York / Date: August 2014

### –Learning to Walk in Every Direction with the TBR-Evolution Algorithm.

- Conference Talk (Alife - 2014)
- Location: New York / Date: August 2014

### –Bridging the gap between policy search algorithms and evolutionary robotics.

- Workshop Talk (Evolution of Physical Systems - Alife14)
- Location: New York / Date: August 2014

### –Creative Adaptation through Learning.

- Workshop Talk (Journée des Doctorants - ISIR)
- Location: Paris / Date: December 2013

### –Behavioral Repertoire Learning in Robotics.

- Conference Talk (GECCO - 2013)
- Location: Amsterdam / Date: July 2013

### –Resilience and Adaptation with Artificial Evolution

- Workshop Talk (JET - 2012)
- Location: Paris / Date: November 2012