Pierre-Yves Oudeyer
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Domains: artificial intelligence, machine learning, cognitive sciences, developmental robotics, educational technologies

Professional experience

2012-present : **Research director, Inria** (DR1), Head of Flowers Lab (Inria and Ensta ParisTech, up to 35 persons and 5 senior researchers), and consulting in machine learning and AI.
2008-2012 : **Research scientist, Inria** (CR1), Founder and head of Flowers Lab.
2003-2007 : **Senior researcher at Sony Computer Science Lab**., Paris.

Collective responsibilities

2008-présent : **Editor-in-chief of** IEEE CIS Newsletter on Cognitive and Developmental Systems ; **Associate editor of** IEEE Transactions on CDS, Frontiers in Neurorobotics
2015-2016 : **Chair of IEEE Technical Committee on Cognitive and Developmental Systems** (Comput. Intelligence Society)
2008-present : Member **IEEE ICDL-Epirob conference steering committee**
2008-présent : **Supervision of 17 PhD thesis** (12 finished, 5 ongoing)
2006-présent : **co-organisazion of international conferences/events** (co-org. workshop on Exploration in RL at ICML 19 // co-chair of conference on Curiosity : Emerging Sciences and Educational Innovations, 2018 // co-general chair IMOL 2017 // co-general chair, Designing for curiosity workshop at CHI 2017// co-general chair Neurocuriosity 2014, 2016 , 2018 // Workshop chair IJCNN 2015 // Program Chair Epirob 09 // General chair Epirob 06).

Education

2011 : **Habilitation to direct research**, Université de Bordeaux, France
2003 : **PhD doctoral thesis (AI and cog. sci.)**, Univ. Paris VI, with honours of the jury (dec. 2003).
1997-2000 : **Master in theoretical computer science**, ENS Lyon, France.

Distinctions and awards

2018 : **Prize Inria of National Academy of Science** (in computer science, researcher under 40)
2017 : 29th Eleanor J. Gibson and James J. Gibson Lecturer, by Cornell University, US.
2016 : **Lifetime Achievement Award**, awarded by the Evolutionary Linguistics Association
2015 : Excellence in science prize (PES), Inria
2009-2014 : **ERC Starting Grant** Explorers, European Research Council
2014 : Global Fab Award Finalist (for Poppy Project), international conference Fab 10
2014: Finalist of prize Tangente for best books in popular science
2012 : Best paper award (with C. Moulin-Frier), IEEE ICDL-Epirob Conference.
2005 : Implemented invention award (avec F. Kaplan), by Sony Corporation
2005 : **Prize "ASTI"** for the best pluridisciplinary national PhD thesis in 2003-2004 in ICT sciences.
2005 : **Prize "Le Monde for academic research** (2005)
2000: Best paper award in Sony Technical Forum 2000
Several of PY Oudeyer's PhD students obtained PhD awards : J. Grizou (prix Le Monde de la recherche universitaire), M. Lapeyre (CNRS GdR robotics), T. Cederborg (Region Aquitaine prize).

Publications: 50 international journals, 3 books (author), 3 conf. proceedings (editor), 16 book chapters, 87 articles in international conferences, 24 newsletters articles/editorials.
https://scholar.google.com/citations?user=gCqGj4sAAAAJ&hl=en Citations (Google schol. 2019) : 7009, h-index : 40

Keynote speeches at international conferences: ***Highlight : 2019 keynote at International Conference on Learning Representations (ICLR***), WMLAI 2019, ReWork Deep Learning Summit 2019, ICIS 2016, Evostar 2015, BICA 2015, Devoxx 2015, AAAI Spring Symposium 2014, WACAI 2014, AAAI Fall Symposium 2013, AAMAS 2011, IEEE Alife 2011, Robolift 2011, Epirob 2009, Interspeech 2007.

Technology transfer work and societal impact: 11 international patents (4 exploited commercially): http ://www.pyoudeyer.com/patents/
2018-present: Coordination of transfer of curiosity-based personalization algorithms for educational apps to edTech consortium of companies.
2014-2018: Coordination of team who developed **large-scale open-source educational robotics** projects, including Poppy Education kits (http://www.poppy-education.org) and the Inirobot project disseminated to > 25 000 schoolchildren in France, integrated in Main à la Pâte program ; https://goo.gl/u31gYE. This lead to the creation of Poppy Station (**non-governmental association**, http://poppy-station.org) and Pollen Robotics (**start-up company**, https://www.pollen-robotics.com) for large scale dissemination.
2013-present: Head of the team who designed, developed and disseminated the Poppy Platform (http://www.poppy-project.org and) which is the **first complete open-source 3D printed humanoid platform in the world**, for education, science and art. Poppy has been presented in highly visible and prestigious wide audience venues (François Hollande at Elysée, Axelle Lemaire in Bordeaux, Sénat, Le Web conference, Tedx Cannes), in numerous high quality media/press articles (full pages in Le Monde, Les Echos, Libération, interviews on France Inter, France Info as well as in international press such as Scientific American, El Mundo, japanese TV, https://www.poppy-project.org/in-the-press/). It was featured in the report of "Stratégie Nationale de Recherche France 2020".
2003-2018 : **Curiosity-driven learning technologies** used in Sony AIBO and Qrio commercial robots
2009: Co-laureate of OSEO competition in "Emergence" category for the project of creation of a start-up company in robotics.
2005 – 2007: Collaboration with **Sony Playstation** Europe (SCEE London and Cambridge) for the integration of my **emotional speech synthesis technology** (with associate patents, see patent section) into the standard audio libraries of Playstation 3.
2002: Collaboration with the Speech and Audio group of the R&D department of Sony in Tokyo: the emotional speech synthesis technology I developed (see patents) were adapted and included in the Sony Qrio humanoid robot speech system.
1999 – 2006: Extensive collaborations with the Digital Creature Lab. from Sony in Tokyo, where the AIBO and Qrio robots were created. This allowed the transfer of a technology of playful interactions, called "clicker-training", that I invented together with Frédéric Kaplan (and associated with a patent).

Expertise and other committees
2015-17: Expert for OPCST (French national assembly committee for evaluation of scientific and technological choices), French Senate and Academie des Technologies committees on artificial intelligence and ethical dimensions of digital technologies.
2015-2016: Expert for Main à la Pâte foundation for the large scale educational project "1, 2, 3: Codez!" to teach computer science in primary schools.
2005-present: Regular expert and reviewer for European Commission FP7 ICT, H2020 and FET programs (selection of projects to be funded and yearly reviews of funded projects in AI, robotics, machine learning, language processing, assistive technologies).
2010-present: **Expert for the ANR** (French national research agency) for AI and robot-related projects.
2011-present: Member of tenure track recruitment juries at Inria and universities.
2011: Member of Jury "Prime d'excellence scientifique (PES CR)", INRIA.
2010-present: Member of "Comité des projets", INRIA Bordeaux Sud-Ouest.
2010-2014: Member of "Commission Developpement Technologique (CDT)", INRIA Bordeaux Sud-Ouest.
2009: Secretary and member of "Groupe de reflexion sur la création potentielle d'un comité d'éthique à l'INRIA" (Committee for thinking about the creation of an ethical committee at INRIA).

2010-present: Jury of 34 PhD thesis

PhD students (main supervisor, see details on http://www.pyoudeyer.com/phd-students/)
Cédric Colas (co-supervision with O. Sigaud), Rémy Portelas (co-supervision with K. Hoffman), Alexander Ten, Sébastien Forestier (def. planned in 2019), Thibault Desprez (def. planned in 2019), William Schueller (2018, co-tutoring with Vittorio Loreto), Benjamin Clément (2018, co-supervision with M. Lopes), Florian Golemo (co-tutoring with A. Courville), Alexandra Delmas (defended in 2018, co-supervision with H. Sauzéon), Fabien Bénureau (defended in 2014), Olivier Mangin (defended in 2014), Thomas Cederborg (defended in 2014), Matthieu Lapeyre (defended in 2014), Jonathan Grizou (defended in 2014), Mai Nguyen (defended in 2014), Pierre Rouanet (defended in 2012), Adrien Baranes (defended in 2012).

Teaching

2016-present: Developmental machine learning course at Enseirb and ENSC Bordeaux
2016-present: Developmental robotics course at CogMaster, ENS and Sorbonne Université
2013-present: Design of educational resources for teaching computer sciences from primary schools to high-school (projects Inirobot and Poppy Education)
2008 –2009: Irrcyn, Nantes, EMARO European Master on Advanced Robotics, "Social and developmental robotics", 15 hours/year.
2006 – present: ENSTA, Paris, 3rd year engineering diploma, "Concepts and Algorithms for Social and Entertainment Robots" (creation of the first course in developmental and social robotics in France, one of the first in Europe), 24.5 hours/year.
+ regular punctual courses in several French universities and engineering schools.

Popular science

I have been strongly involved in popular science activities, involving regular writing of popular science articles, participation to wide audience radio and tv programs and intervention in the press to address scientific issues (e.g. Le Monde, Les Echos, France Inter, France Info, France Culture, …), participation to science festivals and museum exhibitions, and in particular coordinated the Ergo-Robot experiment, made in collaboration with moviemaker David Lynch, organized for 5 months during the exhibition « Mathematics : a Beautiful Elsewhere » at Fondation Cartier, Paris (50k visitors, https://flowers.inria.fr/robots/ergo-robots/). I have also given in 2014 a TedX talk (https://www.youtube.com/watch?v=AP8i435ztwE , video viewed by more than 16000 people).

Selected list of popular science articles, videos and events: http://www.pyoudeyer.com/popular-science/
Selected list of interventions in the press: http://www.pyoudeyer.com/press/
Youtube channel: https://www.youtube.com/channel/UC7QuDF8AaE6mqEM9W_S30RA
Twitter channel: https://twitter.com/pyoudeyer?lang=en

Grants obtained in the last 5 years

- French ministry of education grant, Adaptiv'Maths, 2019-21, 200 keuros
- DGA-Inria grant "DeepCuriosity for robust multi-goal Deep RL", 110 keuros
- Ubisoft/Région Aquitaine collaboration grant, "Unsupervised exploration in Deep RL3, 75 keuros.
- Région Aquitaine project Curiosity-driven RL, 2019-23, 140 keuros
- Microsoft PhD scholarship, 2018-21, 110 keuros
- Inria ADT grant, "Infrastructure for Deep RL experiments", 75 keuros
- HFSP Neurocuriosity project, 2016-2019, 270 kdollars
- Inria Neurocuriosity grant, from Inria, 2013-2019, 90 keuros
- eFran Perseverons, 2016-2019, 146 keuros
- DGA/Inria PhD grant, 2017-19, 59 keuros
- Poppy Education, from Inria/Region Aquitaine/Feder, 2014-2017, 1000 keuros
- Romeo 2, from FUI French founds, 2013-2016, 217 keuros,
- Hybrid, from PEPS CNRS, 2014-2016, 10 keuros
- KidLearn, from Inria/Region Aquitaine, 2015-2018, 129 keuros
- ERC Starting Grant Explorers, 2009-2015, 1.5 millions euros

Summary of major scientific contributions

My work has been focusing on the computational study, modelling and experimentation of lifelong learning processes in machines and humans. This includes **natural and artificial intelligence** processes for progressively and continuously discovering sensorimotor and language skills with high-dimensional bodies. In particular, I have worked on the foundations of computational understanding of autonomous learning and exploration, through my work on algorithmic models of curiosity-driven learning. I have built a complete and unified research approach and framework identifying and studying interacting families of guiding mechanisms which allow autonomous learners to collect efficiently informative data in the real world, and learn incrementally from it [J32, J25, J39, BC11]. This framework has been the backbone of the research teams I created, first at Sony CSL Paris (2003,2007), then at Inria (2008-present, 35 persons), supported by an ERC Starting Grant and various other prestigious international grants. This work developed in a series of publications, with strong impact in several domains (details below): developmental robotics, **machine learning and artificial intelligence** [J10, J12, J13, J17, J18, J20, J4, J21, J28, J32, J34, J37, J41, J42, C84-87], **educational technologies** [J36, J44,C72] and **psychology and cognitive neuroscience** [J6, J7, J8, J11, J14, J14A, J19, J25 J26, J33, J35, J39, J40, J44, J50].

Curiosity-driven exploration algorithms in machine learning, robotics and artificial intelligence: Intrinsic motivations are mechanisms that drive spontaneous curiosity-driven exploration in animals and humans, for whom they are central to organizing autonomous acquisition of novel skills and knowledge [J12, J13, J25, J31]. Together with my team and colleagues, I have played a leading role for introducing, formalizing and developing technically this concept in developmental robotics and artificial intelligence, showing its central importance for autonomous machine learning (i.e. learning of multiple tasks without intervention of an engineer for each task). At the international level, I pioneered the design and experimentation of curiosity-driven learning algorithms in real world robots [C12, J12, J21]. Within a framework where machine learners incrementally learn predictive models of the world (world models) as they acquire new data, the main idea of curiosity-driven learning models consists in introducing an intrinsic task-independent cost function measuring the speed at which internal world models are improving (e.g. decrease of prediction error), and use this cost function as the objective criterion to be maximized while the learner is exploring its environment. More recently, we extended this research program by introducing algorithms for autonomous goal setting, enabling machines to self-generate, self-select and self-order its own goals in order to maximize the quality of inverse models of the world [J21,C83,C87]. This lead to the successive elaboration of algorithmic architectures instantiating these ideas, based on formalisms combining reinforcement learning, population-based approaches and bandit algorithms (IAC [J10, J12], R-IAC [C29, C43], SAGG-RIAC [J21], McSAGG-RIAC [C25], SGIM [J27], SGIM-ACTS [J23], MACOB [C81], UGL-IMGEP [C83], CURIOUS [C87]), modelling various mechanisms for empirical estimation of learning progress in synergy with complementary techniques (maturation [C25], learning by imitation [J23, J27], sensorimotor primitives [BC11], incremental regression techniques for high-dimensions [C28]). They were experimentated in various real and simulated robots, and with the collaboration of several colleagues and students, I showed that: 1) Intrinsically motivated exploration and learning of motor skills can be scaled to high-dimensional real world robots [J12, J23, J27, J21]; 2) With only one general task-independent cost function a robot can learn a diverse and organized repertoire of reusable motor skills [J25, J39], including through learning representations of goal spaces with unsupervised deep generative models [C86]; 3) this enables to solve very difficult deep reinforcement learning problems with rare or deceptive rewards [TR1,C85], as well as to learn efficiently world models in high-dimensional robots [J21, J23, J27]. **Impact**: This contribution played a central role in setting curiosity-driven learning (also called intrinsically motivated learning) as a central scientific topic in robotics, artificial intelligence, and machine learning. In particular, in the current blooming development of machine learning, these algorithms are becoming a fundamental topic for autonomous learning, and large AI companies/labs use it to solve difficult deep reinforcement learning problems. The set of his articles related to this topic is cited > 4000 times (source: Google scholar, 2018). I have been invited to give **Keynote lectures** on this topic at the following conferences: ICLR (2019), WMLAI (2019), ReWork Deep Learning summit (2019), Evostar 2015 (Denmark), Devoxx 2015 (France), BICA 2015 (France), AAAI Fall Symposium 2013 (US), AAAI

Spring Symposium 2014 (US), WACAI 2014 (France), AAMAS 2011 (Taipei), IEEE Alife 2011 (France), Robolift 2011 (France).

Computational theory of curiosity for developmental psychology and cognitive neuroscience. The formalization and robotic experimentation of theories of intrinsic motivation led me and my collaborators to propose the following novel insights and hypothesis back into these disciplines: 1) Fundamental aspects of developmental trajectories, defined as the successive formation of stages of behavioural and cognitive structures of increasing complexity, can be self-organised as a side-effect of the dynamical interactions between intrinsically motivated learning, the body and the environment [J44, J39, J33, J26, J25]; 2) In particular, the discovery and learning of elementary social skills such as imitation and the first steps of speech and language can be generated as a result of general mechanisms of intrinsically motivated learning [J39, J26]; 3) Empirical measure of learning progress in the brain could be achieved by dopaminergic circuits in the brain [J25, J14A]; 4) several of these hypotheses were validated through behavioural experiments in humans [J31, J44]. **Impact**: This work directly impacted research in psychology and neuroscience, with direct collaborations and joint publications with high-profile psychologists (e.g. Linda Smith, Indiana Univ.) and neuroscientists (Jacqueline Gottlieb, Univ. Columbia, NY, US, through the Neurocuriosity Associate team). These collaborations led to two major milestone publications [J25, J50] presenting a unified theoretical landscape about curiosity in neuroscience and machines, published in a prestigious neuroscience and cognitive science journal (Nature Reviews Neuroscience, impact factor: 23; TICS, impact factor: 16,5). In this context, I also co-initiated and co-coordinated the organization of the First, Second and Third Interdisciplinary Symposium on Information Seeking, Curiosity and Attention (2014: Bordeaux; 2016: London, 150 participants; 2018 Univ. Pennsylvania), and I am co-editor of a special issue on models of speech acquisition in the Journal of Phonetics. In 2012, I was awarded with C. Moulin-Frier the Best Paper award (category models of cognitive dev.) at the IEEE ICDL-Epirob conference.

Social, multimodal and language learning in robots, and applications to BCI. Complementing mechanisms of curiosity-drive learning, I have been developing and studying with my team several algorithmic approaches allowing robots to learn from the social guidance of non-engineer humans, as well as to take advantage of multimodal information in such contexts, including: 1) probabilistic techniques that generalize imitation learning of a single motor skill to imitation learning of multiple motor and language skills [J24, J30, J42]; 2) multimodal perceptual and language learning techniques, based on matrix factorization approaches, to detect invariants and associations in low-level flows of speech, video and movement [C39, C44]; 3) techniques combining active imitation learning and curiosity-driven learning [J23, J27]; 4) techniques allowing a robot learner to simultaneously learn to interpret the meaning of teaching signals and a task [C59, C60], and this found **impact** through a groundbreaking application in the domain of Brain-Computer Interfaces, where it allows to remove the calibration phase in an important family of use cases [C62, C61], which is known to be a paramount challenge in the field (this latter work was made through supervising J. Grizou's PhD, who obtained the prize "Le Monde de la recherche universitaire" for the best PhD). I was co-editor of a special issue on behavioural understanding in IEEE TAMD [J29].

Models of language acquisition and evolution. I have also used algorithmic and robotic modelling as a tool to contribute to novel theories and understanding of language acquisition and evolution. In particular, I have developed a series of models and theoretical perspectives showing how coupled unsupervised learning mechanisms in local peer-to-peer language interaction could self-organize speech and language conventions at the scale of a population [J6, J7, J8, J11, J35, J39]. This has led to the writing of a book published at Oxford University Press [B2]. This work is now reused and cited in the human language evolution literature and in associated textbooks [E161, E162]. Recently, I have shown with my students how the dynamics of convergence of linguistic conventions in these models could be accelerated by the use of active learning and teaching mechanisms [C76, C74]. For this series of work, I have received in 2016 the Lifetime Achievement Award from the Evolutionary Linguistics Association.

Active teaching and applications to educational technologies. With my colleagues in the Flowers team, we extended methods of active learning to methods of active teaching, allowing a software teacher to choose dynamically and incrementally an optimal sequence of teaching examples to maximize the learning progress of a student: this naturally led us to design the KidLearn project, where the ZPDES algorithm we designed was put in a tablet based tutoring system to teach elements of maths to schoolchildren and tested on a large scale in primary schools of Gironde (500 schoolchildren, 15 schools). Doing this, we **impacted** the field of ITS through pioneering the use of Multi-armed bandits and cost functions based on empirical learning progress in the domain of Intelligent Tutoring Systems [C63, C66]. This technology is currently being transferred in companies for personalizing sequences of exercises in smartphone educational application.

Major contributions towards innovation and technology transfer

Curiosity-driven social robots. I am co-author of several international patents on curiosity-driven learning technologies [8,5], which have been used commercially in ***major Sony robotic products***: the Sony AIBO (https://en.wikipedia.org/wiki/AIBO) and Qrio robots (https://en.wikipedia.org/wiki/QRIO).

Emotional speech synthesis and recognition. While I was working at Sony Computer Science Lab, I developed several new technologies for emotional speech synthesis and emotional speech recognition, which led to several international patents and were integrated in several Sony products such as the Qrio humanoid robot and Playstation video games.

Open-source 3D printed Poppy robot platform for education. I coordinated the team who designed, developed and disseminated the Poppy platform, which is the first complete open-source 3D printed humanoid platform in the world: http://www.poppy-project.org [C71, C67, C54,C53]. The Poppy platform was initially designed within my ERC Grant project, with the goal of developing an experimental platform allowing the systematic scientific study of the role of morphology in sensorimotor skill acquisition (morphology can be changed easily and fastly). This has been a major innovation: this was before impossible because robot platforms were developed using classical machining techniques requiring a lot of time, energy and funding. Several research labs in Europe have already began to use the Poppy platform for their own projects.

As all aspects of the platform were designed to be highly modular, modifiable, robust, easily replicable, cheap, and accessible to beginners, this allowed us to apply and initiate its **transfer towards education** in lycées, engineering schools and universities (around 20 lycées are now using the platform in standard CS courses, in collaboration with Rectorat and Canope educational institutions), but also FabLabs, science museums and art/science projects (4 dance companies are now using the platform in their official performances/shows). It is now becoming a major **pedagogical innovation** (Poppy educational robotic kits are commercialized by the Generation Robots company), targeting education to the digital world and its interaction with the physical world through integration of the robotic platform with software web tools to support the community (> 600 users on the Poppy forum) and with interdisciplinary pedagogical content co-designed with users. No direct competitors exist so far. This led to the creation of the ***Pollen Robotics start-up company***, created in may 2016, which is now exploiting several of the technologies designed in this project.

Selected publications

Colas, C., Sigaud, O., Oudeyer, P-Y. (2019) CURIOUS : Intrinsically Motivated Modular, Multi-Goal Reinforcement Learning, Proceedings of International Conference on Machine Learning (***ICML 2019***).

Gottlieb, J.,Oudeyer, P-Y. (2018) Towards a neuroscience of active sampling and curiosity, ***Nature Reviews Neuroscience***, 19(758–770).

Laversanne-Finot, A., Péré, A., Oudeyer, P-Y. (2018) Curiosity Driven Exploration of Learned Disentangled Goal Spaces, in Proceedings of Conference on Robot Learning, ***CoRL 2018***.

Oudeyer, P-Y. (2018) Computational Theories of Curiosity-driven Learning, in The New Science of Curiosity, ed. Goren Gordon, NOVA (https://arxiv.org/abs/1802.10546)

Colas, C., Sigaud, O., Oudeyer, P. Y. (2018). GEP-PG: Decoupling Exploration and Exploitation in Deep Reinforcement Learning Algorithms. In Proceedings of International Conference on Machine Learning (***ICML 2018***), *arXiv preprint arXiv:1802.05054*.

Péré, A., Forestier, S., Sigaud, O., & Oudeyer, P. Y. (2018). Unsupervised Learning of Goal Spaces for Intrinsically Motivated Goal Exploration. In Proceedings of International Conference on Learning Representations (***ICLR 2018***), *arXiv preprint arXiv:1803.00781*.

Forestier S, Oudeyer P-Y. (2017) **A Unified Model of Speech and Tool Use Early Development.** Proceedings of the 39th Annual Meeting of the Cognitive Science Society.

Oudeyer P-Y., Gottlieb, J., and Lopes, M. (2016) Intrinsic motivation, curiosity and learning: theory and applications in educational technologies ***Progress in Brain Research****, 229, pp. 257-284.*

Oudeyer, P-Y. and Smith. L. (2016) How Evolution may work through Curiosity-driven Developmental Process ***Topics in Cognitive Science****, 1-11.*

Benureau, F., Oudeyer P-Y. (2016) Behavioral Diversity Generation in Autonomous Exploration Through Reuse of Past Experience, ***Frontiers in Robotics and AI***, 3(8).

Clement, B., Roy, D., Oudeyer, P-Y., Lopes, M. (2015) Multi-Armed Bandits for Intelligent Tutoring Systems ***Journal of Educational Data Mining (JEDM)***, Vol 7, No 2.

Mangin O, Filliat D, ten Bosch L, Oudeyer P-Y (2015) MCA-NMF: Multimodal Concept Acquisition with Non-Negative Matrix Factorization ***PLoS ONE*** 10(10).

Nguyen, M., Oudeyer, P-Y. (2014) Socially Guided Intrinsic Motivation for Robot Learning of Motor Skills ***Autonomous Robots***, 36(3), pp. 273-294.

Baranes, A., Oudeyer, P-Y. (2013) Active Learning of Inverse Models with Intrinsically Motivated Goal Exploration in Robots, ***Robotics and Autonomous Systems***, 61(1), pp. 49-73. (#citations 2015 : 74).

Moulin-Frier, C., Nguyen, S.M., Oudeyer, P-Y. (2014) Self-organization of early vocal development in infants and machines: the role of intrinsic motivation, **Frontiers in Psychology (Cognitive Science)**, 4(1006).

Lapeyre, M., N'Guyen, S., Le Falher, A., Oudeyer, P-Y. (2014) Rapid morphological exploration

with the Poppy humanoid platform, IEEE-RAS International Conference on Humanoid Robots, Nov 2014, Madrid, Spain. pp.8.

Grizou J., Iturrate I., Montesano L., Oudeyer P-Y., Lopes M. (2014) Calibration-Free BCI Based Control, Proceedings of ***AAAI 2014***.

Gottlieb*, J., Oudeyer*, P-Y., Lopes*, M., Baranes, A. (2013) Information Seeking, Curiosity and Attention: Computational and Neural Mechanisms, ***Trends in Cognitive Science***, , 17(11), pp. 585-596. * identical contribution. (impact factor : 16.5).

Oudeyer P-Y., Baranes A., Kaplan F. (2013) Intrinsically Motivated Learning of Real-World Sensorimotor Skills with Developmental Constraints, in Intrinsically Motivated Learning in Natural and Artificial Systems, eds. Baldassarre G. and Mirolli M., Springer.

Cederborg, T. and Oudeyer, P-Y. (2013) From Language to Motor Gavagai: Unified Imitation Learning of Multiple Linguistic and Non-linguistic Sensorimotor Skills, ***IEEE Transactions on Autonomous Mental Development***, pp. 222-239, 5(3).

Nguyen, M., Oudeyer, P-Y. (2013) Active Choice of Teachers, Learning Strategies and Goals for a Socially Guided Intrinsic Motivation Learner, ***Paladyn Journal of Behavioural Robotics***, 3(3):136–146.

Rouanet, P. *, Oudeyer, P-Y. *, Danieau, F., Filliat, D. (2013) The Impact of Human-Robot Interfaces on the Learning of Visual Object ***IEEE Transactions on Robotics***, 29(2), pp. 525-541. * joint 1st authors

Lopes M., Lang T., Toussaint M. and Oudeyer P-Y. (2012) Exploration in Model-based Reinforcement Learning by Empirically Estimating Learning Progress, Neural Information Processing Systems (***NIPS 2012***), Tahoe, USA.

Lopes M., Oudeyer P-Y. (2012) The Strategic Student Approach for Life-Long Exploration and Learning in Proceedings of IEEE International Conference on Development and Learning and Epigenetic Robotics (ICDL-Epirob), San Diego, USA.

Baranes, A., Oudeyer, P-Y. (2009) R-IAC: Robust intrinsically motivated exploration and active learning, ***IEEE Transactions on Autonomous Mental Development***, 1(3), pp. 155--169.

Oudeyer P-Y, Kaplan , F. and Hafner, V. (2007) Intrinsic Motivation Systems for Autonomous Mental Development, ***IEEE Transactions on Evolutionary Computation***, 11(2), pp. 265--286. (#citations mars 2015 : 497 // total citations on other articles on the same topic : 1656).

Kaplan F. and Oudeyer P-Y. (2007) In search of the neural circuits of intrinsic motivation, ***Frontiers in Neuroscience***, 1(1), pp.225--236.

Oudeyer P-Y. and Kaplan F. (2007) What is intrinsic motivation? A typology of computational approaches, ***Frontiers in Neurorobotics***, 1:6, doi: 10.3389/neuro.12.006.2007 (#cit: 230)

Oudeyer, P-Y. (2006) Self-Organization in the Evolution of Speech, **Oxford University Press** (new edition to appear in 2016). (#cit : 156)

Oudeyer, P-Y. (2005) The Self-Organization of Speech Sounds, ***Journal of Theoretical Biology***, 233(3), pp. 435—449. Cet article a introduit une nouvelle théorie computationnelle de l'auto-organisation non-supervisée de systèmes de vocalisations humains (#cit: 144)

Kaplan, F., Oudeyer, P-Y (2003) Motivational principles for visual know-how development. In Prince, C.G. and Berthouze, L. and Kozima, H. and Bullock, D. and Stojanov, G. and Balkenius, C., editor, Proceedings of *Epigenetics Robotics* 2003 (EPIROB 2003), no. 101, pages 73-80, 2003. Lund University Cognitive Studies.

Oudeyer P-Y. (2003) The production and recognition of emotions in speech: features and algorithms, ***International Journal in Human-Computer Studies***, 59(1-2), pp. 157--183, special issue on Affective Computing. (#citations : 459).

Autres publications et citations : https://scholar.google.com/citations?user=gCqGj4sAAAAJ&hl=en

Full list of publications

6 books, 51 journals, 20 newsletters (16 as editor), 15 book chapters, 87 international conference, 11 patents
Google Scholar (Sept. 2019) : 7009 citations, h-index: 40
https://scholar.google.fr/citations?user=gCqGj4sAAAAJ&hl=en

Books

[B6] Audouze, J., Chapouthier, G., Laming, D., Oudeyer, P-Y. (2015) Mondes Mosaiques: Astres, villes, vivant et robots, CNRS Editions.

[B5] Oudeyer, P-Y. (2013) Aux sources de la parole: auto-organisation et évolution, Odile Jacob, Paris.

[B4] (as co-editor) Salah, A. Ruiz-del-Solar, J., Mericli, C., Oudeyer, P-Y. (2012) Human Behavior Understanding, LNCS 7559, Springer.

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[C51] Clément Moulin-Frier; Pierre-Yves Oudeyer (2013) Exploration strategies in developmental robotics: a unified probabilistic framework, *ICDL-Epirob – International Conference on Development and Learning, Epirob*, Aug 2013, Osaka, Japan. [GitHub repository of Explauto library]

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Patents

I am the inventor or co-inventor of 11 patents covering 5 different technological issues. The full list of my patents is available at: http://www.pyoudeyer.com/patents/

Selecteed list of patents:
[P1] **Technology**: Human-robot interface for teaching novel visual objects to a robot
Title: *Mobile communication terminal, and method and device for recognizing shapes for a robot*
Zones: Europe
Patent number: WO2010116057 ; Publication date : 2009-04-08 ; Inventor : ROUANET PIERRE ; OUDEYER PIERRE-YVES ; Applicant : INRIA.
Actual use: Not used in a commercial product.

[P2] **Technology:** System for transforming the output of a text-to-speech system into emotional speech
Title : *Method and apparatus for speech synthesis, program, recording medium, method and apparatus for generating constraint information and robot apparatus*
Zones : Europe, Etats-Unis, Japon
Patent number:US2004019484 Publication date:2004-01-29 Inventor:KOBAYASHI ERIKA [JP]; KUMAKURA TOSHIYUKI [JP]; AKABANE MAKOTO [JP]; KOBAYASHI KENICHIRO [JP]; YAMAZAKI NOBUHIDE [JP]; NITTA TOMOAKI [JP]; OUDEYER PIERRE YVES [FR], Applicant : Sony France S.A. Application number:US20030387659 20030313 Priority number(s):EP20020290658 20020315 Also published as EP1345207 (A1) JP2003271174 (A)
Actual use: Used in Sony humanoid robot Qrio.

[P3] **Technology**: System for generating and transforming emotional speech through signal processing.
Title : *Method and apparatus for synthesizing emotion conveyed on sound*
Zones : Japon, Etats-Unis
Patent number:JP2003084800 Publication date:2003-03-19 Inventor:OUDEYER PIERRE YVES, Applicant : Sony France S.A., Application number:JP20020206012 20020715 Priority number(s):EP20010401880 20010713, Also published as: US2003093280 (A1)
Actual use: Used in Sony humanoid robot Qrio and Sony Playstation 3 audio-speech library.

[P4] **Technology:** System for automatic recognition of emotion in speech signals
Title : *Emotion recognition method and device*
Zones : Japon, Etats-Unis
Patent number:JP2003099084 Publication date:2003-04-04 Inventor:OUDEYER PIERRE YVES, Applicant : Sony France S.A., Application number:JP20020206011 20020715 Priority number(s):EP20010401879 20010713, Also published as: US2003055654 (A1)
Actual use: Not used in a commercial product.

[P5] **Technology**: Human-robobt interface and system for teaching new motors skills to a robot.
Title : *Training of autonomous robots*
Zones : Europe, Etats-Unis, Japon
Patent number:US2002183895 Publication date:2002-12-05 Inventor:KAPLAN FREDERIC (FR); OUDEYER PIERRE-YVES (FR), Applicant : Sony France S.A., Application number:US20020134909 20020429 Priority number(s):EP20010401127 20010430 Also published as: EP1254688 (A1) US6760645 (B2) JP2003039363 (A)
Actual use: Used in one of the commercial robot game of the “AIBO Mind” suite.

Outreach and dissemination of scientific knowledge

I have been coordinating the development of two large scale projects for the dissemination of computer science education at all school leves: Inirobot and Poppy Education:

Inirobot project. I worked on the development and dissemination/deployment of the IniRobot pedagogical kit, for the discovery of computer science and robotics in primary schools. This was done in strong collaboration with Didier Roy, a math teacher (college) and specialist of ICT in education which I recruited in the team to work on educational technologies. IniRobot provides a microworld for learning, and takes an enquiry-based educational approach, where kids are led to construct their understanding through practicing an active investigation methodology within teams. The kit was first developed and evaluated in primary schools in Gironde (during the activities of Temps d’accueil périscolaire), in collaboration with a group of teachers. Then, it was deployed to a large scale in France and abroad (see below). A dedicated web site has been created, allowing all users and contributors to access the kit (Creative Commons) and share their experiences (https://dm1r.fr).
Impact: The kit is free of use (under Creative Commons CC-BY-SA licence) now used by more than 10000 children in France, with around 900 adults educators/teachers, covering more than 1000 primary

schools in 35 towns, in France and Switzerland (e.g. Talence, Lille, Lormont, Bruges, Mérignac, Floirac, Pessac, Quinsac, Cenac, etc). This scaling up has been achieved through collaboration with Rectorats structures as well as the Canope network, with the organization of systematic training of teachers of educators, supported by projects such as the eFran project "Perseverons". An adaptation of the kit has been included in **the education book "1, 2, 3 codez" for the initiation to computer sciences and in preparation by Main à la Pate foundation**, to which I have directly contributed as scientific consultants and co-author of several parts (http://www.fondation-lamap.org/fr/123codez).

Poppy Education project. I am coordinating the Poppy Education project which aims to create, evaluate and disseminate complete pedagogical kits "turnkey solutions" (with Creative Commons licences), open-source and low cost, for teaching computer science and robotics https://www.poppy-project.org/education/?lang=fr). It is designed to help young people to take ownership with concepts and technologies of the digital world, and provide the tools they need to allow them to become actors of this world, with a considerable socio-economic potential. It is carried out in collaboration with teachers and several official french structures (French National Education, Highschools, engineers schools, ...). For secondary education and higher education, scientific literacy centers, Fablabs.
The Poppy robotic platform used in the project is free hardware and software, printed in 3D, and is intended primarily for:

- learning of computer science and robotics,
- introduction to digital manufacturing (3D printing ...)
- initiation to the integration of IT in physical objects in humanoid robotics, mechatronics.
- artistic activities.

Educational sectors covered by the project are mainly: Enseignement d'exploration ICN en seconde, enseignement ISN en terminale S et bientôt en 1ère , filière STI2D, MPS seconde.
Users and their needs are placed at the center of this project. The pedagogical tools of the project are being created directly with them and evaluated in real life by experiments. Experimentations have began to be setup in 10 high-schools of Region Aquitaine, and 3 university level institutions: Lycée Camille Jullian (Bordeaux), Lycée Victor Louis (Talence), Lycée Saint Genès (Talence), Lycée François Mauriac (Bordeaux), Lycée Jean Moulin (Langon), Lycée des Graves (Gradignan), Lycée Sud Medoc (Le Taillan Medoc), Lycée Alfred Kastler (Talence), Lycée Raoul Follereau (Nevers), Aérocampus Auqitaine, ENSEIRB/IPB, ENSAM Talence.

In the context of the projects Inirobot and Poppy Education, my team has organized two large conferences on "Robotics and education" in 2014 and 2015 Bordeaux: **http://dm1r.fr/colloque-robotique-education/**

Popular science. I have been strongly involved in popular science activities, involving regular writing of popular science articles, participation to wide audience radio and tv programs and intervention in the press to address scientific issues (e.g. Le Monde, Les Echos, France Inter, France Info, France Culture, …), participation to science festivals and museum exhibitions, and in particular coordinated the Ergo-Robot experiment, made in collaboration with moviemaker David Lynch, organized for 5 months during the exhibition « Mathematics : a Beautiful Elsewhere » at Fondation Cartier, Paris (50k visitors, https://flowers.inria.fr/robots/ergo-robots/). I have also given in 2014 a TedX talk (https://www.youtube.com/watch?v=AP8i435ztwE, video viewed by more than 12000 people).

Popular science books:

Audouze, J., Chapouthier, G., Laming, D., Oudeyer, P-Y. (2015) Mondes Mosaiques: Astres, villes, vivant et robots, CNRS Editions.

Oudeyer, P-Y. (sept. 2013) Aux sources de la parole: auto-organisation et évolution, Odile Jacob, Paris.

Selected list of popular science articles, videos and events: http://www.pyoudeyer.com/popular-science/
Selected list of interventions in the press: http://www.pyoudeyer.com/press/