

# Iñaki Fernández Pérez

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## Education

**Oct. 2013 - Nov. 2017**

**Ph.D. candidate in Computer Science** MaIA and LARSEN teams  
Subject: Incremental Evolutionary Learning LORIA Nancy (France)  
**Supervisors:** François Charpillet (Research Dir., Inria)  
Amine Boumaza (Associate Prof., Lorraine Univ.)

I design distributed approaches to learning behaviors in swarms of robots (cf. Research Section).

**2011 - 2013 M.Sc. in Computer Science** Lorraine Univ.  
Artificial Intelligence (Reasoning, Learning and Recognition) Nancy, France  
Ranked first.

**2006 - 2011 B.Sc. in Systems Computer Science** Higher CS Engin. School  
Ranked first. Valladolid Univ., Spain

## Scientific Experience

**February - June 2013 Master's thesis internship** in research MaIA team  
Subject: Incremental Evolutionary Robotics LORIA Nancy  
**Supervisor:** Amine Boumaza (Assoc. Prof., Lorraine Univ.)

**2010 - 2011 Research Engineer** Orpailleur Team  
Technological transfer in Spinal Images project Inria Nancy  
Knowledge representation and discovery in Semantic Wikis WikiTaaable project  
**Reference:** Emmanuel Nauer (Assoc. Prof., Lorraine Univ.)

## Publications

I have published my work in three of the most important international conferences in my field: GECCO 2015, the Genetic and Evolutionary Computation Conference, organized by ACM, which is the major conference about Evolutionary Algorithms and Artificial Evolution; ALIFE14, the International Conference on the Synthesis and Simulation of living systems, and ECAL 2017, the European Conference on Artificial Life, organized both by ISAL (International Society for Artificial Life), both concerning the simulation and synthesis of artificial life systems. I have also published my work in RJCIA 2015, a french national conference for young researchers in AI. The list of publications can be found at the end of this document.

## Research Interests

- **Artificial Intelligence**, Machine Learning (supervised, unsupervised, reinforcement), Artificial Neural Networks (discrete, continuous and spiking), reservoir computing

- **Artificial Evolution**, Evolutionary Robotics, Neuroevolution, Bioinspired Computation, Swarm Intelligence
- **Embodied Evolutionary Robotics**, Asynchronous and Distributed Computing, Swarm Robotics, Multiagent Systems

## Computer Science skills

**Software engineering** Analysis and design, design patterns, UML, software deployment, project planning

**Programming** C++, Python, Java, C, R, BASH, Eiffel, Pascal, PROLOG, MatLab

**Data** Data structures, Databases SQL (MySQL, SQL Server), Data modeling

**Distributed Systems** Communication models (Java RMI), Distributed software deployment models (client-server, P2P)

**Networking** OSI model, IP model, protocols and services, QoS

**Web Development** HTML, CSS, PHP, JavaScript, JQuery, AJAX, JSON, Laravel, Web APIs and services, Ergonomy

## Teaching Experience

<b>2016-2017 Teaching and research fellow</b>	UFR Maths-Informatics
200h (lectures and practical sessions)	Lorraine Univ.
B.Sc. and M.Sc. in Computer Science and Cognitive Science	
<b>2013 - 2016 Teaching assistant doctoral</b>	IUT Charlemagne
64h per year, total 192h (cf. Teaching section)	Lorraine Univ.
<b>2011 External interventions</b>	School of Sciences
C2I (Office automation, 32h)	Henri Poincaré Univ., Nancy

## Distinctions

**Nov. 2011 Extraordinary award** for remarkable accomplishments in the pursue of studies. Given by the director of the CS school, Valladolid.

## Languages

**Spanish** : native

**French** : fully fluent, B2 certificate, School of Languages, Valladolid.

**English** : fluent, proficient scientific level, B2 certificate, School of Languages, Valladolid.

## Research Section

My Ph.D. thesis, named “Incremental Evolutionary Learning”, has been funded by a scholarship grant from the French Ministry of Higher Education and Research. This has been supervised by Research Director François Charpillet and Assistant Professor Amine Boumaza.

In my Ph.D. thesis, I am interested in the automatic synthesis of controllers for autonomous agents (or robots), by the means of learning. In this context, a controller is the program that,

from an agent's perceptions (its sensor values), and possibly an internal memory, decides the agent's actions (its motor values) to execute in order to perform a given task in an environment. Particularly, I am interested in learning behaviors in a team of agents, that need to solve a global task in a collaborative manner (swarm robotics). The approaches that I use in my work fall into the family of Evolutionary Algorithms, and they take inspiration from the Darwinian theory of Natural Evolution. Such approaches require relatively limited *a priori* information about the task to solve, and they exploit only a general measure, or objective function, of the final outcome of a robot's behavior for learning to progress.

Classical Artificial Evolution approaches, dubbed *offline*, advocate for a preliminar learning phase on the considered task, and, once such learning is finished, the agent is deployed in the actual targeted environment to solve the corresponding task. At that moment, the agent's controller is fixed, and its behavior is no longer adapted. A relatively recent class of Evolutionary Algorithms, dubbed *online*, takes a different point of view, in which the agent learns a behavior during the execution of the actual task in the final environment. These approaches possess several advantages over offline approaches: 1) *a priori* knowledge about the environment where the agents will be deployed is no longer required, and 2) they potentially allow to perform open-ended learning, and, as such, agents may progressively adapt to changing environments or goals. Additionally, a particular class of online algorithms, named distributed Embodied Evolution algorithms, includes separate individual learning processes for each individual robot in a swarm, along with communication mechanisms to foster learning in the group of robots. Although these online approaches are interesting, they open several questions.

The **challenge** in my work concerns how to perform incremental behavior learning. Incremental learning refers to learning skills in sequence, *i.e.* learning new skills while avoiding forgetting previously learned ones. To do so, I study how such skills are stored in a controller, or in a population of controllers, and if it is possible to augment the structure of a controller or to bias the update of a population, to allow to integrate new skills without erasing old ones. Concerning the experimental methodology, I define measures relevant to online evolution, to validate the incremental learning methods that I develop in my research.

Concerning my **contributions** I have studied the influence of the intensity of local selection pressure in distributed evolutionary settings. I showed in a set of experiments that higher selection pressure leads to better performances in distributed evolutionary algorithms. I have studied the neuroevolution of topologies in such distributed settings. I proposed and experimentally validated a novel completely decentralized mechanism to improve an existing algorithm, odNEAT, to evolve such neural topologies. I have studied the distributed evolution of a collaborative item collection task, in which food items need to be collected by pairs of robots. I showed the feasibility of learning such collaborative task in a distributed manner, with a thorough analysis that shows good properties of such approach, such as allowing the robots to collect food items of different types without neglecting any of them.

Recently, I have developed a more formal definition of incremental learning. I am also interested in the necessary conditions for an algorithm to learn new tasks without forgetting, and have designed such an algorithm, based on research in the Evolutionary Dynamic Optimization literature. I have defined a set of experiments on a sequence of tasks as a proof of concept to test this algorithm, based on approximating 2D functions. The goal is to apply the algorithm to learn a sequence of tasks including collaboration in a swarm of autonomous agents, so that they learn new tasks without forgetting old ones. The defense of my doctoral thesis, including the aforementioned works, will take place in November 2017.

## Teaching Section

In the context of:

- External interventions at the FST (School of Science), Henri Poincaré University, Nancy
- *DCCE* contract (teaching assistant during doctoral studies) at IUT Charlemagne (Technological University Institute), Lorraine University, Nancy
- *ATER* contract (Teaching and research fellow) at UFR Mathematics-Informatics, Lorraine University, Nancy

I have taught a total of 417 hours, in both lectures and practical sessions, summarized in the following table:

Course subject	Year of studies	Hours
C2I (office automation)	L1 Biology, CS, Humanities	68
OO modeling, design and programming	S2 DUT CS, M1 CS	124
Databases and data structures	S1 DUT CS, L3 CS	82
Web Development	S1 DUT CS, L2, L3 CS & Cogn.Sc	108
Reasoning Formalisms	L3 Cogn. Sc.	35
		Total 417

## Scientific reviewer

I have reviewed publications for the following conferences and journals:

- IEEE/RSJ International Conference on Intelligent Robotics (IROS)  
Reviewer for IROS in 2015
- ACM Genetic and Evolutionary Computation Conference (GECCO)  
Reviewer for GECCO in 2016 and 2017
- Royal Society Open Science Journal (RSOS)  
Reviewer for RSOS in 2017

## Publication list

- International peer-reviewed conferences
  - Comparison of Selection Methods in On-line Distributed Evolutionary Robotics  
Iñaki Fernández Pérez, Amine Boumaza and François Charpillet  
Proceedings of ALIFE14: the fourteenth international conference on the synthesis and simulation of living systems, pp. 282-289, MIT PRESS, July 2014, New York, NY, USA
  - Decentralized marking of innovation for neural controllers in Embodied Evolution  
Iñaki Fernández Pérez, Amine Boumaza and François Charpillet  
Proceedings of GECCO '15, the Genetic and Evolutionary Computation Conference, July 11 – 15, 2015, Madrid, Spain, pp. 161-168, ACM, 2015
  - Learning Cooperative Foraging in Embodied Distributed Evolutionary Robotics  
Iñaki Fernández Pérez, Amine Boumaza and François Charpillet  
To be published in the Proceedings of ECAL 2017, the European Conference in Artificial Life, September 4 – 8, 2017, Lyon, France

- National (French) peer-reviewed conferences
  - Influence of Selection Pressure in Online, Distributed Evolutionary Robotics  
 Iñaki Fernández Pérez, Amine Boumaza and François Charpillet  
 Proceedings of the 13th *Rencontres des Jeunes Chercheurs en Intelligence Artificielle*  
 (RJCIA'15), pp. 31-36. 2015, Rennes, France

## Communication section

Communication activities related to research and scientific seminars. Communications and presentations in conferences are not included here (cf. next section):

- Jan. 2016** I presented a poster sur reporting my thesis work, entitled *Incremental Learning in Distributed Embodied Evolutionary Robotics* in the *Forum Entreprises* (industrial forum) organized by the Charles Hermite Federation, Nancy.
- Oct. 2015** I presented a poster reporting my thesis work, entitled *Incremental Learning in Distributed Embodied Evolutionary Robotics* at the IAEM Doctoral School day, Nancy.
- July 2015** I presented my work, entitled *Decentralized innovation marking for neural controllers in Embodied Evolution* in a team seminar (LARSEN team, Inria Nancy).
- July 2014** I presented my work, entitled *Comparison of Selection Methods in On-line Distributed Evolutionary Robotics* at the *Journées Évolutionnaires Thématiques (JET)* (Evolutionary thematic meetings), organized by the Artificial Evolution association in Paris, as well as in a team seminar (MaIA team, Inria Nancy).

Communication activities related to teaching and scientific popularization:

- April 2015** I supervised a highschool student for a visiting internship as a first contact with research (one week). I showed the main aspects of the day-to-day work of a researcher, as well as my work and other research topics developed in the LORIA/Inria lab, Nancy.
- 2014-2016** I was an internship liason for three students in *DUT* in Computer Science (one per year). I visited the corresponding companies, interviewed them and their respective supervisors, followed their advances, reviewed their reports and participated to their defense jurys.
- 2014-2017** I participated to the pedagogical teaching meetings concerning the organization of the taught subjects at the IUT Charlemagne, and at the UFR Maths-Informatics. I contributed to updating the course contents and supports (course notes and slides). For the courses in Databases and in Reasoning Formalisms courses at UFR Maths-Informatics, in which I was head of the course, I organized the syllabus, created the supports, and organized all the interactions with the students and the teaching assistants.
- 2015** In the context of a doctoral training course, I wrote a document for scientific divulgation of my research topics, aimed at a general audience. Such document was then printed and published in a series of divulgation flyers: *Évolution Artificielle, ou comment des robots construisent automatiquement leurs «cerveaux»* (Artificial Evolution, or how robots automatically build their “brains”) .