

Francesco Corucci

PhD Fellow in BioRobotics, MEng BEng in Computer Engineering

Email: f.corucci [at] santannapisa.it (work) · f.corucci [at] gmail.com (personal) · **Skype:** francesco.corucci

[Academic webpage](#) · [Google Scholar](#) · [Research Gate](#) · [LinkedIn](#) · [Twitter](#)

Last update: June 6, 2017

BIOSKETCH

Francesco Corucci was born in Pisa, Italy, on August 2nd, 1988. He achieved his PhD in BioRobotics (*with honors*) from the [The BioRobotics Institute of Scuola Superiore Sant'Anna](#) (SSSA), advised by [Prof. Cecilia Laschi](#) (external Tutor: [Prof. Josh Bongard](#)). Since June 2017, he is a Post Doctoral Fellow in the same Institute. He develops part of his activities at the [Research Centre on Marine Robotics and Sea Technologies](#) (Livorno). Since November 2015 he is a member of the [Morphology, Evolution & Cognition Laboratory](#), [Vermont Complex Systems Center](#), University of Vermont (USA), where he works with [Prof. Josh Bongard](#). He previously worked in the Intelligent Automation Systems group of the [Perceptual Robotics Laboratory](#) (PERCRO, SSSA). He achieved a MEng and BEng in Computer Engineering (*summa cum laude*) from [University of Pisa](#) (IT), within the highly selective *Excellence Program* ("Percorso di Eccellenza") organized by the same University. He has been involved in a number of research projects both in Europe ([PoseiDRONE](#), [RoboSoft CA](#), [RoboCom++](#)) and in the United States of America, and served as external consultant for others ([COMAS](#)). He is Student Member of the [Association for Computing Machinery](#) (ACM), as a member of the [Special Interest Group on Genetic and Evolutionary Computation](#) (SIGEVO). His research interests include evolutionary and developmental robotics, artificial life, embodied cognition, morphological computation, soft robotics, computational biology, and artificial intelligence in general. His recent work is concerned with the free-form evolution and development of morphologically-plastic soft robots in different environments. His ultimate goal is to understand the general nature of cognition, evolving adaptive and intelligence artificial creatures approaching the complexity of biological ones.

APPOINTMENTS AND EDUCATION

PostDoctoral fellow, Scuola Superiore Sant'Anna

June 2017 - now

Teaching assistant for two graduate courses: "*Robotics*" class, MSc in Computer Science, University of Pisa and "*Human and animal models in biorobotics*" class, M.Sc. Bionics Engineering, jointly organized by University of Pisa and Scuola Superiore Sant'Anna

Main topics: evolutionary robotics, artificial life, embodied cognition, morphological computation, soft robotics, marine robotics, underwater locomotion.

PhD in BioRobotics, Scuola Superiore Sant'Anna (*with honors*)

Nov. 2013 - June 2017

Working at the [BioRobotics Institute](#) as well as at the [Research Centre on Marine Robotics and Sea Technologies](#), advised by [Prof. Cecilia Laschi](#) (external Tutor: [Prof. Josh Bongard](#)).

Visiting PhD Fellow, University of Vermont

November 2015 - November 2016

Visiting PhD Fellow in the [Morphology, Evolution & Cognition Laboratory](#), [Vermont Complex Systems Center](#), University of Vermont (USA), advised by [Prof. Josh Bongard](#).

Main topics: evolutionary and developmental soft robotics, artificial life, embodied cognition, morphological computation.

In addition to my own research, I have been involved in mentoring activities directed towards younger

members of the lab.

Research Collaborator, Scuola Superiore Sant'Anna *September 2012 - October 2013*

Working in the Intelligent Autonomous Systems group of the [PERCRO lab](#) (Perceptual Robotics and Virtual Environments).

Topics: autonomous and semi-autonomous industrial robots, 3D robotic perception in unstructured environments, human-robot interaction paradigms, apprenticeship learning paradigms.

M.Eng. in Computer Engineering, University of Pisa, Italy (*with honours*) *May 2013*

Final grade: 110/110 *summa cum laude*.

Concentrations: Embedded and Real-Time Systems.

Best GPA of the class, 30.94/30 (excess due to *honours*, granted for outstanding performances)

I graduated within the Excellence Program ("*Percorso di Eccellenza*"), a highly selective program requiring students to maintain outstanding academic records and follow additional classes on advanced topics. A yearly monetary prize is also granted to attendees that are able to fulfill the requirements of the program.

Final thesis: "*Robotic perception and control for a demolition task in unstructured environments*" (published) - Developed in the Intelligent Automation Systems group of the PERCRO lab (SSSA)

B.Eng. in Computer Engineering, University of Pisa, Italy (*with honours*) *October 2010*

Final grade: 110/110 *summa cum laude*.

GPA in the top 1% of the class, 30.79/30 (excess due to *honours*, granted for outstanding performances)

Final thesis: "*Wireless sensor and actuators networks for the energy efficiency of smart buildings*" (published)

High School Scientific Diploma

2007

Liceo Scientifico U.Dini, Pisa, Italy.

Final grade: 100/100.

OTHER APPOINTMENTS

- **Teaching assistant** for two graduate courses: "*Robotics*" class, MSc in Computer Science, University of Pisa and "*Human and animal models in biorobotics*" class, M.Sc. Bionics Engineering, jointly organized by University of Pisa and Scuola Superiore Sant'Anna. Teaching a module on *Evolutionary Robotics*, in charge of designing and delivering lessons and projectual activities, involved in students' grading and oral evaluation.
- **ACM Student Member**, Special Interest Group on Genetic and Evolutionary Computation (SIGEVO)
- I serve as **reviewer** for a number of Journals (e.g. Bioinspiration & Biomimetics, Royal Society Open Science) and conferences.
- **Founder of EVARKTM - Digital and Evolutionary Architecture**, an interdisciplinary team of roboticists, computer scientists and architects interested in innovating the field of architectural design by means of cutting-edge computational techniques.
- **Occasional consultant** – both for companies and academic institutions – in projects concerning Computer Engineering and Robotics.

AWARDS, PRIZES, SCHOLARSHIPS

- **Finalist in the 2016 GECCO Virtual Creatures Contest**, for the work *F. Corucci et al., "Evolving swimming soft-bodied creatures"* (Honorable Mention for Aesthetic Appeal)
- **2nd best poster at ALIFE 2016** for the work *F. Corucci et al., "Evolving swimming soft-bodied creatures"* (over 60 submissions)
- **Best paper award nomination at GECCO 2015** for the paper *F. Corucci et al., "Novelty-based evolutionary design of morphing underwater robots"* (Artificial Life, Generative and Developmental

Systems track)

- **Winner of a three-years fellowship** funded by the Italian Ministry of Instruction, University, Research.
- **Ranked 1st over more than 90 international applicants** in the 2013 selections for the PhD in BioRobotics at Scuola Superiore Sant'Anna (evaluation: 100/100).
- **Ranked 1st** in the 2013 selection for the PhD in Emerging Digital Technologies, Perceptual Robotics curriculum (declined).
- **Winner of a five-months scholarship** from Scuola Superiore Sant'Anna as Research Collaborator at the PERCRO lab (Perceptual Robotics and Virtual Environment).
- **Best GPA** of the M.Eng. in Computer Engineering, University of Pisa (2010-2013).
- Completed the **"Excellence Program"** in Computer Engineering, University of Pisa (2013), entailing a **yearly monetary prize**.
- **Top 1% GPA** of the B.Eng. in Computer Engineering, University of Pisa (2007-2010).
- During my B.Eng., academic merits granted me continuative **economic support** from University of Pisa.
- Selected from the **European Space Agency (ESA) among the final 10 international candidates** for a position in the Advanced Concepts Team in Artificial Intelligence (Young Graduate Trainees program) (2013).
- **Special mention** from potential investors for the EVARKTM project in the *Tuscan Startup Academy*, a hi-tech business plan competition.

RECENT INVITED TALKS

Ecole Polytechnique Federale de Lausanne (EPFL), LIS lab

April 21th, 2017

- Title: *"Evolutionary Developmental Soft Robotics: towards adaptive and intelligent machines following nature's approach to design"*

Soft Robotics Week, Marine Robotics Center, Livorno, Italy

April 26th, 2016

- Title: *"Evolutionary Soft Robotics: towards adaptive and intelligent machines following nature's approach to design"*, RoboSoft Spring School

Bristol Robotics Lab (BRL), Bristol, UK

July 17th, 2015

- Title: *"A case study in modeling, understanding and improving soft robots by applying embodied intelligence principles and evolutionary techniques"*

MEDIA COVERAGE

Some of my work was recently covered by popular websites such as *IEEE Spectrum* ([link](#)), *The Verge* ([link](#)), *Interesting Engineering* ([link](#)), *Electronic 360* ([link](#)).

RESEARCH PROJECTS INVOLVEMENT

Morphological Plasticity for the Design, Control, and Deployment of Complex Engineering Systems

USA

- A three-year project during which it will be shown that thermodynamically-open soft robots are more amenable to co-optimization of body plan and neural controller than more traditional robot systems. I am involved in both theoretical and experimental work, performed under the supervision of Prof. Josh Bongard. I am also involved in mentoring activities directed towards a PhD Student (Sam Kriegman) that recently joined the project.

RoboSoft CA

EU

- *RoboSoft CA*, a Coordination Action for Soft Robotics (FP7-ICT-2013-C # 619319, <http://www.robosoftca.eu>) is an European project aiming at consolidating and further developing the Soft Robotics field in Europe. I was involved in scientific and organizational activities related to the project. I performed dissemination activities, contributed to the design and organization of the *2016 RoboSoft Grand Challenge*, participated to all RoboSoft plenary meetings, both as a student (2014, 2015) and as invited speaker (2016).

PoseiDrone

IT

- The *PoseiDrone* project (supported by *Fondazione Livorno* and *RoboSoft CA*) aims at revolutionizing marine operations such as coastal and offshore engineering, underwater archeology and environmental protection, by developing a cheap, lightweight, easy to deploy, soft underwater drone, capable of multi-modal locomotion and advanced manipulation capabilities. In this context I have improved the dynamical model of the robot, studied its locomotion dynamics, and developed new methods for parameters identification based on evolutionary optimization. I have then applied innovative open-ended evolutionary techniques in order to explore in simulation the design space of the robot, harnessing the power of artificial evolution in order to discover design improvements.

RoboCom++ (FLAG-ERA JTC 2016)

EU

- The main objective of the RoboCom++ (“Rethinking Robotics for the Robot Companion of the future”) (FLAG-ERA JTC 2016 – <https://www.flagera.eu/>) project is to lay the foundation for a future global research programme (e.g., a FET-Flagship project) on a new, science-based Robotics by the end of the H2020 programme. RoboCom++ will aim at overcoming the limitations of current robots by rethinking their design principles and fabrication technologies in order to develop a new generation of cooperative robots through a deeply multidisciplinary and transnational effort. I had the chance to contribute to the proposal by designing one of the five *pilot projects* of RoboCom++: “*Evolutionary approaches for soft robots exploiting morphological computation*”. The goal of the pilot project is demonstrate the ability of evolutionary approaches to serve as general design automation tools for soft robots, to systematically discover and exploit solutions based on morphological computation, to increase robots’ robustness and adaptivity to different tasks and environments.

Human Brain Project

EU

- The Human Brain Project (HBP) (Specific Grant Agreement 1, GA n. 720270, www.humanbrainproject.eu) is a European Commission Future and Emerging Technologies Flagship. The HBP aims to put in place a cutting-edge, ICT-based scientific Research Infrastructure for brain research, cognitive neuroscience and brain-inspired computing. The Project promotes collaboration across the globe, and is committed to driving forward European industry. Although I was only very recently involved in the project, I will contribute in this context to studies related to morphological and neurological adaptation during growth and as a consequence of damages to the brain and/or to the body.

PHD SCHOOLS

Spring School on Soft Robotics

April 13-17, 2015

“*Applications and Frontiers of Soft Robotics*”, SMART-E & RoboSoft Joint School. Livorno, IT

- My team won the final competition organized as closing event of the school, in which soft robots designed and fabricated by teams during the school competed in a terrestrial race.

RegML2014 - Regularization methods for Machine Learning

June 30th-July 4th, 2014

- *PhD summer course organized by MIT, IIT, DIBRIS.* Genova, IT

WORK EXPERIENCE

TechnoDeal s.r.l.

September 2015

Consultant

- I performed a feasibility study and architectural design for a networked system for smart agriculture ("GAIA" project). The system was based on a cloud infrastructure integrating hundreds of field-installed wireless sensor nodes.

COMAS EU project

July, 2014 - October, 2014

Consultant

- The [COMAS project](#) aims at developing an underwater remotely operated vehicle (ROVs) equipped with a manipulator and some special tools, for the preservation and conservation of submersed archeological artifacts. I was involved in the design of the software architecture ensuring the communication between the robot and the ground control station. I designed and developed a communication infrastructure as well as advanced graphical user interfaces (2D and 3D) to remotely send commands to the robot, display sensor data as well as the current status of the robot and the manipulator, in real-time.

PUBLICATIONS

(See also my [Google Scholar](#) page).

- F. Corucci, N. Cheney, S. Kriegman, C. Laschi, and J. Bongard, "Evolutionary developmental soft robotics as a framework to study intelligence and adaptive behavior in animals and plants," 2017, (Journal paper, under review).
- S. Kriegman, N. Cheney, F. Corucci, and J. Bongard, "A minimal developmental model can increase evolvability in soft robots," 2017, (Conference paper, under review).
- F. Corucci, "Evolutionary developmental soft robotics: towards adaptive and intelligent soft machines following nature's approach to design," in *Soft Robotics: Trends, Applications and Challenges*. Springer, 2016.
- F. Corucci, N. Cheney, H. Lipson, C. Laschi, and J. Bongard, "Material properties affect evolution's ability to exploit morphological computation in growing soft-bodied creatures," in *ALIFE XV, The Fifteenth International Conference on the Synthesis and Simulation of Living Systems*, 2016.
- F. Corucci, N. Cheney, H. Lipson, C. Laschi, and J. Bongard, "Evolving swimming soft-bodied creatures," in *ALIFE XV, The Fifteenth International Conference on the Synthesis and Simulation of Living Systems, Late Breaking Proceedings*, 2016, - **Finalist in the 2016 GECCO Virtual Creatures Contest** and **2nd best poster at ALIFE 2016**.
- H. Hauser and F. Corucci, "Morphosis – taking morphological computation to the next level," in *Soft Robotics: Trends, Applications and Challenges*. Springer, 2016.
- F. Corucci, M. Calisti, H. Hauser, and C. Laschi, "Novelty-based evolutionary design of morphing underwater robots," in *Proceedings of the 2015 on Genetic and Evolutionary Computation Conference*. ACM, 2015, pp. 145–152, - **Best paper award nomination**.
- F. Corucci, M. Calisti, H. Hauser, and C. Laschi, "Evolutionary discovery of self-stabilized dynamic gaits for a soft underwater legged robot," in *17th International Conference on Advanced Robotics (ICAR)*. IEEE, 2015.
- F. Corucci, M. Calisti, H. Hauser, and C. Laschi, "Shaping the body to shape the behavior: a more active role of the morphology in the brain-body trade-off," in *13th European Conference on Artificial Life (ECAL2015), Late Breaking Proceedings*, 2015, pp. 7–8.

- M. Calisti, F. Corucci, A. Arienti, and C. Laschi, “Dynamics of underwater legged locomotion: modeling and experiments on an octopus-inspired robot,” *Bioinspiration & Biomimetics*, vol. 10, no. 4, p. 046012, 2015, - **Featured article**.
- V. Cacucciolo*, F. Corucci*, M. Cianchetti, and C. Laschi, “Evolving optimal swimming in different fluids: A study inspired by batoid fishes,” in *Biomimetic and Biohybrid Systems*. Springer, 2014, pp. 23–34, - (*equal contribution).
- M. Calisti, F. Corucci, A. Arienti, and C. Laschi, “Bipedal walking of an octopus-inspired robot,” in *Biomimetic and Biohybrid Systems*. Springer, 2014, pp. 35–46.
- F. Giorgio-Serchi, A. Arienti, F. Corucci, M. Giorelli, and C. Laschi, “Hybrid parameter identification of a multi-modal underwater soft robot,” *Bioinspiration & Biomimetics*, vol. 12, no. 2, 2017.
- M. Calisti, M. Cianchetti, M. Manti, F. Corucci, and C. Laschi, “Contest-driven soft-robotics boost: the roboSoft grand challenge,” *Frontiers in Robotics and AI*, vol. 3, p. 55, 2016.
- C. Picchi, F. Cinelli, R. Rubio, and F. Corucci, “Artificial life inspired architecture: a sustainable and adaptive treehouses ecosystem in the chilean forest,” in *ALIFE XV, The Fifteenth International Conference on the Synthesis and Simulation of Living Systems, Late Breaking Proceedings*, 2016.
- F. Corucci, “Evolutionary design of morphing underwater robots,” in *Soft Robotics Week 2015, Livorno, Italy*, 2015.
- F. Corucci, M. Calisti, A. Arienti, and C. Laschi, “The locomotion of an underwater soft robot as a case study for further investigating morphological computation and embodied intelligence,” in *RoboSoft Plenary Meeting, Pisa, Italy*, 2014.
- F. Corucci and E. Ruffaldi, “Toward autonomous robots for demolitions in unstructured environments,” in *Intelligent Autonomous Systems 13*. Springer, 2014, pp. 1515–1532.
- F. Corucci, “Robotic perception and control for a demolition task in unstructured environments,” *Master Thesis in Computer Engineering, University of Pisa*, 2013.
- G. Anastasi, F. Corucci, and F. Marcelloni, “An intelligent system for electrical energy management in buildings,” in *Intelligent Systems Design and Applications (ISDA), 2011 11th International Conference on*. IEEE, 2011, pp. 702–707.
- F. Corucci, G. Anastasi, and F. Marcelloni, “A wsn-based testbed for energy efficiency in buildings,” in *Computers and Communications (ISCC), 2011 IEEE Symposium on*. IEEE, 2011, pp. 990–993.

OTHER COMPETENCIES AND TECHNICAL STRENGTHS

Linguistic competencies	Excellent English proficiency (oral/written).
Preferred computer languages	C/C++, MATLAB, Python, Java.
Scientific computing	Comfortable in using large-scale computer clusters (thousands of nodes) for parallel scientific simulations. In 2016 my evolutionary simulations required more than <u>5 millions dedicated CPU hours</u> on the Vermont Advanced Computing Core (VACC) cluster (the equivalent of almost 600 years of computation).
Robotics simulators	VoxCAD, Webots, Gazebo.
Robotics frameworks and libraries	ROS, PCL
Tools	L ^A T _E X, Doxygen
OS	Comfortable with both Windows and Linux.

PERSONAL

I was born in Pisa (Tuscany, Italy) on August 2nd, 1988. I learned how to program (self-taught) when I was ~11 years old (~1999). Until the age of 15-16, I was interested in web programming (both client and server side) and web design. At that time I founded and administered some pretty successful web communities, designed and developed a content management system (CMS) written in PHP, and founded one of the first web radios in my region. I love nature and animals, which I deeply respect. I am particularly fascinated by the power of natural evolution and by the underwater world: these passions are at the root of my research interests. I used to practice rowing and swimming when I was a child. I recently found out and became very passionate about deep freediving and breathholding (apnea), a discipline which requires both physical and mental training. I also enjoy good music, have been playing the bass guitar for some years in a funk-rock band, and recently took some drumming lessons as well.

REFERENCES

- **Prof. Cecilia Laschi**, Full Professor of Biorobotics, Scuola Superiore Sant'Anna, Pisa, Italy
- **Prof. Josh Bongard**, Associate Professor, Department of Computer Science, University of Vermont, USA.
- **Dr. Helmut Hauser**, Lecturer in Robotics (assistant professor), Department of Engineering Mathematics, University of Bristol, United Kingdom.