Vito Trianni

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Research Summary

I am an expert in the study of collective behaviours in natural and artificial systems. To this end, I employ mathematical models, multiagent simulations and (automatic) design methods to uncover the microscopic rules and interaction patterns that lead to the observed/desired dynamics characterising the macroscopic, system-level behaviour. My research team focuses on a variety of collective systems composed of interacting agents, spanning from neurons/neuroglia in the brain to people in a crowd, from insects in a colony to robots in a swarm. The overarching aim is to understand how cognitive processes like attention, decision making or categorisation emerge in a system from the numerous interactions among the system components, possibly organised in complex network topologies. The insights gathered in this endeavour are exploited to synthesise cyber-physical systems like robot swarms and cognitive radio networks to optimally deal with the complexity inherent to real-world applications.

Research Impact

Research Independence Since 2011, I am a tenured researcher at the ISTC-CNR (*Ricercatore Livello III*, matr. 10492), where I carry out research activities in complete independence. My role is equivalent to a faculty member, considering that the ISTC-CNR is an official training node for the University of Plymouth (UK) for the post-graduate level. I have obtained a Marie Skłodowska-Curie Career Integration Grant for the study of cognition in distributed systems, an international collaborative grant as coordinator (SAGA —swarm intelligence in agriculture) and a H2020 project as unit Co-PI (PROTON—modelling the collective dynamics behind recruitment in organised crime and terrorist networks). My research group is composed by a post-doctoral researcher (also ERCIM Fellow) and two Ph.D. students, and occasionally master students and visiting researchers (4+2 since 2014). The variety of research themes and international collaborations in which I am involved testifies the ability to provide valuable expertise in multiple domains.

Scientific Output I have published >80 publications since 2001, which have been cited about 2500 times, with an H-index of 26 according to Google Scholar. More than 30 of my publications are first- or last-authored articles and they include works in high-impact generalist journals and leading specialist journals in swarm intelligence, robotics and artificial life. My publications record demonstrates the expertise matured over the years in the above mentioned domains.

Press Coverage My research has been covered at large on the mainstream media, both international (*The Economist*, *BBC News*) and national (*Repubblica*, *Corriere della Sera*, *Rai*). Press releases on specific research outputs have been widely cited in printed and online magazines worldwide, with a significant impact on specialists and the general public. In 2016, I appeared in the TV program *Memex* by Rai Scuola covering cutting-edge research in biomimetics and artificial intelligence. The interest demonstrated by the national and international media on the research activities showcases the wide recognition obtained for the research activities, as well as the ability to communicate widely to a large public.

Public Engagement I have participated to several public events dedicated to science and technology, giving 'outreach' lectures, performing live experiments with people and demonstrations with robots, ranging from international fairs and conferences (e.g., a keynote given at the European Science Schools Symposium) to invited classes in high schools. The latter is included in a wide range of activities with school children to promote science education and motivate students by providing them a genuine picture of research.

Knowledge Transfer I maintain relationships with associations active in the educational sector—e.g., *Fondazione Mondo Digitale* (IT); *Mobsya* (CH)—to promote the usage of robots as a practical and diverting tool for students to improve programming skills, as well as to convey messages related to other disciplines, from biology to physics, mathematics and psychology. I act as tutor for secondary school students engaged in work experience schemes (*alternanza scuola/lavoro*). I am involved in research projects dedicated to bringing robotics research "from lab to the market", hence providing a concrete path to innovation.

Academic Qualifications

Date	Qualification
2002–2006:	**Ph.D.** in Applied Sciences, IRIDIA, Faculty of Applied Sciences, Université Libre de Bruxelles, Belgium. Awarded with the "European Doctorate" label *Delivered by* the Université Libre de Bruxelles, Ecole Polytechnique, Faculté de Sciences Appliquées; *Date*: 26/06/2006; *Certification number* (*protocollo*): 2005/2006/18
2002–2003:	**Diplôme d'Études Approfondies (DEA)** in Applied Sciences, IRIDIA, Faculty of Applied Sciences, Université Libre de Bruxelles, Belgium. *Delivered by* the Université Libre de Bruxelles, Ecole Polytechnique, Faculté de Sciences Appliquées; *Date*: 02/07/2003; *Certification number* (*protocollo*): not available for the specific diploma
2000-2001:	**Master Diploma** in Information Technology, CEFRIEL, Milan, Italy, within the Electronic Design Automation area (100/100 cum Laude). *Delivered by* CEFRIEL; *Date*: 04/07/2001; *Certification number* (*protocollo*): not available on the official certificate
1994–2000:	**M.Sc.** in Computer Science Engineering Politecnico di Milano, Milan, Italy (100/100 cum Laude) *Delivered by* the Politecnico di Milano, Corso di Laurea in Ingegneria Informatica; *Date*: 17/10/2000; *Certification number* (*protocollo*): X009821

Career History

Date	Job Title	Organisation
Since 16/12/2011:	Tenured Researcher (*Ricercatore Livello III*)	ISTC-CNR, Rome, Italy
2011–2014:	Visiting Scholar	IRIDIA, ULB, Brussels, Belgium
2010–2011:	Post-doctoral Researcher	IRIDIA, ULB, Brussels, Belgium
2007–2010:	Researcher (*Ricercatore a contratto Art. 23*)	ISTC-CNR, Rome, Italy
2005–2007:	Research Fellow (*Assegno di ricerca*)	ISTC-CNR, Rome, Italy
2002–2006:	Ph.D. student	IRIDIA, ULB, Brussels, Belgium
2001–2002:	Marie Curie Early Stage Research Fellow	IRIDIA, ULB, Brussels, Belgium

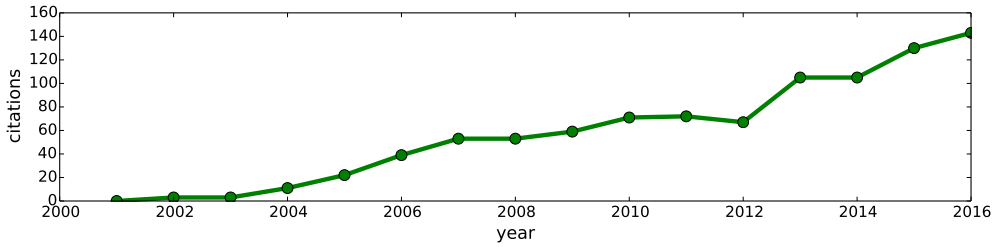
Languages

Mother tongue: Italian

Other languages	Writing skills	Reading skills	Verbal skills
English	Excellent	Excellent	Excellent
French	Good	Excellent	Excellent
Spanish	Basic	Good	Good

Bibliometrics

	Google Scholar	Scopus	ISI Web of Science
H-index	27	19	15
Citations	$\sim$ 2600	$\sim$ 1000	$\sim$ 700



Source: Scopus

Funding Awarded and Research Grants

Total awarded: >2M€

SAGA: Swarm Robotics for Agricultural Applications (ECHORD++ FP7 experiment). Develop a swarm of drones for weed monitoring and mapping.
Role: Project coordinator, responsible for the scientific and management activities
Years: 2016–2017 (18 months)
Funding: 0.4M€

PROTON: Modelling the Processes leading to Organised crime and Terrorist Networks (H2020-FCT-2015, GA 699824). Study the processes of recruitment to organised crime and terrorist networks.
Role: Co-PI responsible for mathematical modelling and evolutionary game-theory approaches
Years: 2016–2019
Funding: 0.3M€ (Total: 4.5M€)

DICE: Distributed Cognition Engineering (Marie Curie Career Integration Grant, GA: 631297). Develop an engineering methodology for cognitive distributed systems.
Role: Principal Investigator
Years: 2014–2018
Funding: 0.4M€

H^{2}Swarm: Hierarchical Heterogeneous Swarm (EUROCORES–EuroBioSAS project funded by the European Science Foundation). Studies the intra- and inter-group dynamics supporting coordination and cooperation within swarms of heterogeneous robots.
Role: Principal scientific investigator of the IRIDIA-ULB unit
Years: 2011–2014
Funding: 0.8M€

EUROCORES Networking Grant Grant awarded by the European Science Foundation (ESF) for networking activities within the EUROCORES programme.
Role: Organistion of a workshop at the ECAL2013 conference
Year: 2013
Funding: 10K€

F.R.S.-FNRS Chargé de Recherche Post-doctoral research grant awarded by the Fund for Scientific Research - FNRS of the Wallonia-Brussels Federation.
Role: Principal Investigator

Year: 2013
Funding: 250K€

ISTC Innovation Award Funding to kick-start novel research programs within the ISTC-CNR.
Role: Principal Investigator
Year: 2009
Funding: 7.5K€

Professional Presentations

Conference/Workshop Presentations:

2018 **Keynote Talk**: "Collective Decisions in Robot Swarms: From Honeybees to Language Games", Sixth International Workshop on Computational Economics and Econometrics IWCEE 2018), June 26–28, 2018, Rome, Italy

2018 **Invited Talk**: "SAGA: Drone swarm in the field", Workshop on Small UAVs for Precision Agriculture, May the 13th, 2018, Pianello Vallesina,âĂİMonte Roberto, Ancona, Italy

2017 **Invited Talk**: "Random walks in swarm robotics", Anomalous Dynamics in Complex Systems: From Chaos on Nanoscales to Search in Biology (ANOCOS), August the 30th, 2017 Tampere, Finland

2017 **Keynote**: "Few rules to make evolution an intelligent design method", Evolving Collective Behaviors in Robotics, 2nd ECBR Workshop, GECCO 2017, July 15th-19th, 2017, Berlin, Germany

2016 **Talk**: " Random Walks in Swarm Robotics, an experiment with Kilobots ", The 10th International Conference on Swarm Intellgience, ANTS 2016, Brussels, Belgium, September 7–9, 2016

2016 **Talk**: " Random Walks, Information Diffusion and Consensus Decisions in Swarm Robotics ", Collective Motion 2016, Uppsala, Sweden, June the 8th, 2016

2016 **Invited Talk**: " A design pattern for swarm-centric decision making", NATO SET-222 Specialists' Meeting on Swarm centric solutions for intelligent sensor networks, Rome, Italy, June the 7th, 2016

2016 **Invited Talk**: " Self-organisation in the physical realm: Structures, Forms and Functions", Crossing into Physical Realms with Collaborative and Interactive Machine Learning, Workshop co-hosted by the Centre for IT and Architecture (CITA) and the Robotics, Evolution and Art Lab (REAL), Copenaghen Technical University, Denmark, February the 12th, 2016

2015 **Invited Talk**: " Collective Decisions: Where Swarms Dare" Multi-agent Learning and Control Workshop, NIPS 2016, Montreal, Canada, December the 12th, 2015

2012 **Keynote**: "Evolution, self-organisation and swarm robotics". Research Days 2012, Klagenfurt, Austria, July 14th, 2012

2012 **Invited talk**: "A FET success story.. or not?". ICT Competitiveness Week, Session on Future and Emerging Technologies , Brussels, Belgium, September the 18th, 2012

2010 **Talk**: "Re-Engineering Evolution: A Study In Self-Organising Synchronisation". *Artificial Life XII, Twelfth International Conference on the Synthesis and Simulation of Living Systems*. Odense, Denmark, August 21st

2009 **Talk**: "Swarm Cognition and Artificial Life". *The 10th European Conference on Artificial Life (ECAL'09)*. Budapest, Hungary, September 16h, 2009

2009 **Keynote**: "Swarm Cognition and Artificial Life". *31th International Meeting of the Cognitive Science Society (CogSci'09)*. Amsterdam, The Netherlands

2008 **Talk**: "Self-Organising Sync in a Robotic Swarm". *The 11th International Conference on Artificial Life (ALife XI)*. Winchester, UK, 5–8 August 2008

2008 **Talk**: "Self-Organising Sync in a Robotic Swarm". *The 1st International Workshop on Non-Linear Dynamics and Synchronization (INDS-08)*. Klagenfurt, Austria, 18–19 July 2008

2008 **Invited Talk**: "Self-Organising Sync in a Robotic Swarm. A Dynamical Systems View". *Embodied Cognition Symposium*. Maastricht, The Netherlands, June 25th, 2008

2007 **Invited Talk**: “Embodied Agent-Based Modelling”. *From Data to Models Workshop*. ISTC-CNR, Rome, Italy, 11–12 October 2007
2007 **Talk**: “From Solitary to Collective Behaviours: Decision Making and Cooperation”. *The 9th European Conference on Artificial Life (ECAL 2007)*. Lisbon, Portugal, 10–14 September 2007
2007 **Talk**: “Evolutionary Robotics for Self-Organising Behaviours”. *Workshop Italiano di Vita Artificiale e Computazione Evolutiva (WIVACE-07)*. Sampieri (Ragusa), 5–7 September 2007
2007 **Talk**: “Minimal communication strategies for self-organising synchronisation behaviours”. *The 1st IEEE Symposium on Artificial Life*, Honolulu, Hawaii, 1–5 April 2007
2004 **Talk**: “Evolution of direct communication for a swarm-bot performing hole avoidance”. *The 4th International Workshop Ant Colony Optimization and Swarm Intelligence (ANTS 2004)*, Bruxelles, Belgium, 5–8 September 2004
2004 **Talk**: “The SWARM-BOTS project”. *The 1st International Workshop on Swarm Robotics, Simulation of Adaptive Behaviour Conference*, Santa Monica, CA, USA, July 17th, 2004
2004 **Talk**: “Evolving functional self-assembling in a swarm of autonomous robots”. *The 8th International Conference on Simulation of Adaptive Behaviour Conference (SAB-04)*, Santa Monica, CA, USA, 13–17 July 2004
2004 **Talk**: “Hole avoidance: Experiments in coordinated motion on rough terrain”. *The 8th International Conference on intelligence Autonomous Systems (IAS-8)*, Amsterdam, The Netherlands, 10–13 March 2004. Best Paper Award
2003 **Talk**: “Evolving aggregation behaviors in a swarm of robots”. *The 7th European Conference on Artificial Life (ECAL 2003)*, Dortmund, Germany, 14–17 September 2003

Seminars:

2017 “Collective Decisions: Where Swarms Dare”, Numerical Differential Models Seminar Series, Math Department, Sapienza University of Rome, Italy
2017 “ Random Walks, Information Diffusion and Consensus Decisions in Swarm Robotics ”, Department of Computer Science, Sheffield University, UK
2016 “Collective Decisions: Where Swarms Dare”, Department of Computer Science, Delft University of Technology, The Netherlands
2016 “ Self-organisation in the physical realm: Structures, Forms and Functions”, GiovedISTC Seminar Series, ISTC-CNR, Rome, Italy
2015 “A design pattern for decentralised decision-making”, Distributed Algorithms and Complex Netowrks Seminar Series, Math Department, University of Rome Tor Vergata
2014 “A cognitive design pattern for collective decisions in distributed systems”. Artificial Intelligence and Robotics Seminar Series, DIIAG, La Sapienza University, Rome, Italy
2014 “Engineering Distributed Cognition”. ACrossSocial Seminar Series, ISTC-CNR
2013 “Swarm Cognition. From Natural to Artificial Systems (and back)”. Storns seminar series, ISTC-CNR
2012 “Engineering Methods for Swarm Robotics”. IRIDIA-ULB
2010 “Evolution, Self-Organisation and Swarm Robotics”. ISTC Seminar series, ISTC-CNR
2010 “Evolution, Self-Organisation and Swarm Robotics”. DIS, Sapienza University of Rome
2006 “On the Evolution of Self-Organising Behaviours in a Swarm of Autonomous Robots”. Univesité Libre de Bruxelles

Science Communication and Knowledge Transfer:

2018 Exhibition of the SAGA experiment results at Automatica 2018, Munich, Germany
2017 Decisioni collettive e robotica educativa di sciame con Thymio, Festival Internazionale della Robotica, Pisa, Italy
2017 Intelligenza collettiva: dagli sciami ai robot, Salento 4.0 - Incontri Leucani 2017, Leuca, Lecce, Italy
2017 SAGA: Swarm Robotics for Agricultural Applications, TechnologyHub Fair, Milan, Italy
2016 Exhibition of the SAGA experiment prototype and results at the CNR-DIITET Conference, Rome, Italy

2016 Exhibition and robotics demonstrations with Thymio II educational robots at the Maker Faire 2016, Rome, Italy
2016 Exhibition of the SAGA experiment prototype and results at the Maker Faire 2016, Rome, Italy
2016 "Robotics, Super-Organisms and Collective Intelligence": seminar, live experiments and robotics demonstration at the Istituto Tecnico Enrico Fermi, Rome, Italy
2016 "Robotics, Super-Organisms and Collective Intelligence" seminar including live experiments at the RomeCup 2016, Fondazione Mondo Digitale, Rome, Italy
2016 Exhibition and robotics demonstrations at the RomeCup 2016, Fondazione Mondo Digitale, Rome, Italy
2015 "Robotics, Super-Organisms and Collective Intelligence": seminar, live experiments and robotics demonstration at the Rome Maker Faire, Rome, Italy
2015 "Robotics, Super-Organisms and Collective Intelligence": keynote talk at the Wired Next Festival 2015, Milan, Italy
2015 Exhibition, live experiments and robotics demonstrations at the Wired Next Festival 2015, Milan, Italy
2014 "Robotics, Super-Organisms and Collective Intelligence": seminar, live experiments and robotics demonstration at 'Light! Turn on the Light on Science', a public event within the context of the 2014 European Researchers' Night, Rome, Italy
2013 "Robotics, from Humanoids to Swarms". Keynote talk at the European Schools Science Symposium 2013, Brussels, Belgium
2008 "Self-Organisation in Natural and Artificial Systems". *La Notte Bianca della Ricerca*. Istituto Superiore di Sanità, Rome, Italy

Prizes

2016 **Best Paper Award**, 10th Intern. Conf. on Swarm Intelligence (ANTS 2016), Brussels, BE
2014 **Best Paper Award**, 13th Intern. Conf. on Intelligent Autonomous Systems (IAS-13), Padua, Italy
2012 **Prix Wernaers**, "Swarmanoid. The Movie", recherche et la diffusion des connaissances, F.R.S.-FNRS
2012 **Botsker Award**, "Swarmanoid. The Movie", Most Innovative Technology, Robot Film Festival, NY
2011 **AAAI-2011 Best Video Award**, "Swarmanoid. The Movie", 25th Conf. on Artificial Intelligence (AAAI-11), San Francisco, CA
2010 **Best Student Paper Award**, Intern. Conf. on Evolutionary Computation (ICEC 2010), Valencia, ES
2004: **Best Paper Award**, 8th Intern. Conf. on Intelligent Autonomous Systems (IAS-8), Amsterdam, NL

Professional Activities

Institutional Activity

Since 2016, I act as a member of the ISTC Advisory Committee (*Consiglio d'Istituto*), following the election from the research personnel of the Institute.
In 2017, I acted as responsible for advanced training courses dedicated to the ISTC personnel. I organised courses on scientific communication and data visualisation.
Since 2016, I act as responsible for the re-factoring of the ISTC website.

Editorial Activity

Associate editor for the Frontiers in Robotics and AI Journal, special section on Evolutionary Robotics.
Associate editor for the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).
Associate editor for the Italian journal Sistemi Intelligenti.
Editorial Board Member of the Swarm Intelligence Journal.

Editorial Board Member of Paladyn, Journal of Behavioral Robotics.
Research Topic editor for Frontiers In, "Novel Technological and Methodological Tools for the Understanding of Collective Behaviors" (2017).
Guest editor of the Special Issue on Swarm Cognition for the journal Swarm Intelligence (volume 5, number 1, 2011).
Guest editor of the special issue Intelligenze collettive: dagli Sciami alle Reti sociali for the italian journal Sistemi Intelligenti (volume 26, number 3, 2014).

Organisation of Conferences/Meetings

Local organisation and publicity chair, Eleventh International Conference on Swarm Intelligence (ANTS 2018), 29–31 October 2018, Rome, Italy
Organiser of the special session on Hierarchical Heterogeneous Swarms within the 9th International Conference on Swarm Intelligence (ANTS 2014). September the 10th 2014, Brussels, Belgium.
Organiser of the workshop on Collective Behaviours and Social Dynamics, within the 12th European Conference on Artificial Life (ECAL 2013). September the 2nd 2013, Taormina, Italy.
Local organisation support for the 11th European Conference on Artificial Life (ECAL 2011), 8–12 August 2011, Paris, France.
Organiser of the Swarm Cognition Workshop, within the Annual Meeting of the Cognitive Science Society (CogSci 2009). June the 29th 2009, Amsterdam, The Netherlands.
Since 2014, I act as responsible for the organisation of the ISTC group meetings for the Laboratory of Autonomous Robotics and Artificial Life (LARAL).

Committees and Juries

2017: *Member of the Ph.D. Jury* of Fernando Perez Diaz, Ph.D. student at Sheffield University, UK, supervised by Prof. Roderich Groß
2017: *Member of the Ph.D. Jury* of Ardiny Hadi, Ph.D. student at EPFL, Switzerland, supervised by Prof. Francesco Mondada
2016: *Member of the Ph.D. Jury* of Andreagiovanni Reina, Ph.D. student at IRIDIA-CoDE-ULB, supervised by Prof. Marco Dorigo
2015: *Examiner* for the MPhil of Mudiyanselage Dhananjalee Madhubhashi Senanayake, Monash University, Melbourne, Australia
2014: *Examiner* for the Final Honours/Minor Thesis of Nicholas Craig, Caulfield School of Information Technology, Monash University, Melbourne, Australia
2013: *Member of the Jury* for the Ph.D. 1st year advancement report of Roman Miletitch, Ph.D. student at IRIDIA-CoDE-ULB
2013: *Member of the Jury* for the Ph.D. 1st year advancement report of Touraj Soleymani, Dhananjay Ipparthi, Gabriele Valentini and Gianpiero Francesca, Ph.D. students at IRIDIA-CoDE-ULB
2012: *Member of the Jury* for the Ph.D. advancement of Miguel Duarte, University Institute of Lisbon, ISCTE-IUL
2011: *Member of the Ph.D. Jury* of Alexandre Campo, Ph.D. student at IRIDIA-CoDE-ULB, supervides by Prof. Marco Dorigo
2011: *Member of the Jury* for the scientific advancement report within the Ph.D. program of Manuele Brambilla, Ph.D. student at IRIDIA-CoDE-ULB

Peer Reviewing Activities

International Journals:
Scientific Reports, Entropy, IEEE Robotics and Automation Magazine, IEEE Transactions on Evolutionary Computation, IEEE Transactions on Robotics, IEEE Transactions on Cybernetics , IEEE Transactions on Neural Networks, IEEE/ASME Transactions on Mechatronics, IEEE Computational Intelligence Magazine, ACM Transactions on Autonomous and Adaptive Systems, Artificial Life, Swarm Intelligence, Adaptive Behaviour, Autonomous Robots, Robotics and Autonomous Systems, Swarm and Evolutionary Computation, Robotica, Connection Science, Cognitive Systems Research, Neural Computing & Applications, Intelligent Service Robotics, Journal on Self Computing, ACTA Futura Journal, Scholarpedia

International Conferences:

International Conference on Robotics and Automation (ICRA), IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), International Conference on Parallel Problem Solving from Nature (PPSN), International Symposium on Distributed Autonomous Robotics Systems (DARS), International Conference on Autonomous Agents and Multiagent Systems (AAMAS), European Conference on Artificial Life (ECAL) , Artificial Life (ALIFE), Simulation of Adaptive Behaviours (SAB), Genetic and Evolutionary Computation Conference (GECCO), International Conference on Swarm Intelligence (ANTS), Towards Autonomous Robotic Systems (TAROS), IEEE Congress on Evolutionary Computation (IEEE CEC), IEEE Symposium Series on Computational Intelligence (SSCI), International Conference on Reconfigurable Mechanisms and Robots (ReMAR), The Annual Meeting of the Cognitive Science Society (COGSCI), International Conference on Evolutionary Computation (ICEC), Conference on Artificial General Intelligence (AGI), International Micro Air Vehicle Conference (IMAV), Evolutionary Computation Theory and Applications (ECTA)

Expert referee:
2015: referee for the SIR (Scientific Independence of young Researchers) programme of the Italian Ministry of Education, University and Research (MIUR)
2013: referee for phd projects for the Institute for Complex Systems, Paris, France
2010: referee for the Belgian National Research Funds (F.R.S.-FNRS)
2009: referee for the French National Research Agency (ANR)

Active Collaborations (besides founded research projects)

- **James AR Marshall**, University of Sheffield, UK (ERC Consolidator grant *DIODE*). Theme: theory and applications of collective decision making.
- **Tom Wenseleers**, KU Leuven, Belgium. Theme: evolution of division of labour in insect colonies.
- **Simon Garnier**, New Jersey Institute of Technology, NJ; **Andrew King**, Swansea University, UK; **Elio Tuci**, Middlesex University, UK. Theme: methodological tools for the study of collective behaviour.
- **Marco Dorigo**, Université Libre de Bruxelles, Belgium (ERC Advanced Grant *e-Swarm*). Theme: swarm robotics design and applications.
- **Angela Sara Cacciapuoti**, **Marcello Caleffi**, Universtià di Napoli Federico II, Italy. Theme: distributed design for cognitive radio networks.
- **Francesco Mondada**, EPFL, CH. Theme: swarm robotics for educational purposes.
- **Giuseppe Oriolo**, Sapienza University of Rome, Italy; **Emiliano Cristiani**, IAC-CNR, Italy. Theme: random walks in natural and artificial swarms.
- **Daniele Nardi**, Sapienza University of Rome, Italy. Theme: swarm robotics in agricultural applications.
- **Rosa Paolicelli**, University of Zurich, CH. Theme: collective behaviours in microglia.

Teaching and Supervision

Teaching experience:

2017 **Invited Lecture** on Swarm Robotics within the course “Multi-Robot Systems (Elective in Robotics)”” of the “Master in Artificial Intelligence and Robotics” and “Master in Control Engineering”, Sapienza University of Rome, Rome, Italy

2017 **Invited Lecture** on Swarm Robotics within the course “Artificial Intelligence” of the “Master in Artificial Intelligence and Robotics”, Sapienza University of Rome, Rome, Italy

2017 **Invited Lecture** on Swarm Robotics within the course on “Multi-Robot Systems (Elective in Robotics)” of the “Master in Artificial Intelligence and Robotics” and “Master in Control Engineering”, Sapienza University of Rome, Rome, Italy

2017 **Invited Lecture** on “Collective Decisions in Super-Organisms: from Swarms to Robots”, SIBIL Seminar Series, Master Degree on Cognitive Sciences, Roma Tre University, Italy
2016 **Invited Lecture** on Swarm Robotics within the course “Artificial Intelligence” of the “Master in Artificial Intelligence and Robotics”, Sapienza University of Rome, Rome, Italy
2015 **Invited Lecture** on Dynamical Systems and Swarm Robotics within the course “Intelligenza Artificiale ed Elementi di Programmazione”, Facoltá di Scienze della Formazione, Corso di Laurea in Scienze e Tecniche di Psicologia Cognitiva, Universitá Suor Orsola Benincasa, Napoli, Italy
2013 **Invited Lecture** on Evolutionary Robotics within the course “New research trends in AI”, Master II of Polytechnic, Université Libre de Bruxelles
2012 **Invited Lecture** on Evolutionary Robotics within the course “Research trends in AI”, Master II of Polytechnic, Université Libre de Bruxelles
2012 **Lecturer** within the course “INFO-H-414 Swarm Intelligence” , Master II of Polytechnic, Université Libre de Bruxelles, responsible for the module on Particle Swarm Optimisation
2011 **Invited Lecture** on Evolutionary Robotics within the course “Research trends in AI”, Master II of Polytechnic, Université Libre de Bruxelles
2001 **Lectures** in “C++ Programming”, XIV Master in Information Technology, CEFRIEL
2001 **Lectures** in “Cultura Tecnologica del Progetto - Informatica” (Fundamentals in Computer Science), Industrial Design Faculty, Politecnico di Milano - Bovisa
2000 **Tutoring** in Statistics and Computer Science at SPEU - Servizi Preparazione Esami Universitari, Milan, Italy

Supervision and tutoring:

2016–2017 *Heleen ten Have*, M.Sc in Biosystem Engineering, Wageningen University, Netherlands (co-supervisor)
2016–2017 *Valerio Dolci*, Master in Criminology and Cyber-Security, University Roma Tor Vergata, Rome, Italy (supervisor)
2016– *Luis Alberto Martínez Vacuero*, ERCIM Fellow, Postdoctoral researcher at ISTC-CNR (supervisor)
2016– *Dario Albani*, Ph.D. student, Department of Computer, Control, and Management Engineering “Antonio Ruberti” at Sapienza University of Rome, Italy (supervisor)
2016 *Priscilla Conforti*, BSc in Scienze e Tecniche di Psicologia Cognitiva, Universitá Suor Orsola Benincasa, Napoli, Italy. Thesis title: “Presa di decisione collettiva nella robotica di sciame” (co-supervisor)
2016 *Fernando Wario*, Visiting PhD Student from the Free University of Berlin, Germany (two months).
2015-2016 *Eliseo Ferrante*, Visiting Scholar from KU Leuven, Belgium (one year)
2015–2016 *Cristina Dimidov*, MSc in Robotics and AI, Sapienza University of Rome, Italy. Thesis title: “Random Walks is Swarm Robotics” (co-supervisor)
2014 *Daniele De Simone*, MSc in Robotics and AI, Sapienza University of Rome, Italy. Supervision for projects carried out within the courses “Machine Learning” and “Microcontroller system design”.
2012 *Istvan Fehérvári*, visiting PhD student from Lakeside Labs - Alpen Adria University, Austria
2012 *Alessandra Vitanza*, visiting PhD student from University of Catania, Italy
2012– *Roman Miletitch*, within the doctoral school in Applied Sciences at the Université Libre de Bruxelles (co-supervisor)
2011–2016 *Andreagiovanni Reina*, within the doctoral school in Applied Sciences at the Université Libre de Bruxelles. Thesis title: “Engineering swarm systems : A design pattern for the best-of-n decision problem” (co-supervisor)
2011–2014 *Touraj Soleymani*, within the doctoral school in Applied Sciences at the Université Libre de Bruxelles (co-supervisor)
2009–2010 *Giuseppe Morlino*, Ph.D. student in Computer Science, Università di Roma “La Sapienza”, within the project “Exploring the foundations of Swarm Cognition” financed by the ISTC-CNR (tutoring)
2006–2010 *Valerio Sperati* within the PhD in Cognitive Psychology, Università di Roma “La Sapienza” (co-supervisor)

2004–2008 *Christos Ampatzis* within the Ph.D. in Applied Sciences. Thesis title: “On the evolution of autonomous time-based decision-making and communication in collective robotics”, Université Libre de Bruxelles (tutoring)

2005 *Philippe Duchesne* within the DEA (Diplôme d’Études Approfondies) in Cognitive Sciences. Thesis title: “Évolution d’un comportement de synchronisation par des agents collaboratifs” (in French), Université Libre de Bruxelles (co-supervisor)

2004–2005 *David Tran Dinh Dũng* within the Master in Applied Sciences. Thesis title: “Simulation 3D d’un groupe de robots” (in French), Université Libre de Bruxelles (co-supervisor)

2004 *Stefano Lanza* within the “Laurea” degree in Computer Science Engineering. Thesis title: “Active Vision in a Collective Robotics Domain”, Politecnico di Milano (co-supervisor)

Participation in International Research Projects

SAGA: Swarm Robotics for Agricultural Applications Project founded within the ECHORD++ FP7 Project.
Brief Description: Robotics is expected to play a major role in the agricultural/farming domain, and often multi-robot systems and collaborative approaches are mentioned as potential solutions to improve efficiency and system robustness. Swarm robotics, in particular, stresses aspects like flexibility, scalability and robustness in solving complex tasks, and is considered extremely relevant for precision farming and large-scale agricultural applications. However, swarm robotics research is still confined into the lab, and no application in the field is currently available. With this experiment, we will demonstrate for the first time the application of swarm robotics principles to the agricultural domain. Specifically, we target a decentralised monitoring/mapping scenario, and implement a use case for the detection and mapping of volunteer potatoes in sugar beet fields by a group of small unmanned aerial vehicles
Role: I am the project coordinator, responsible for the scientific and management activities.
Years: 2016–2017 (18 months)
Project Founding: 0.4M€

PROTON: Modelling the PRocesses leading to Organised crime and TerrOrist Networks Project founded within the H2020 Programme (H2020-FCT-2015, ID: 699824).
Brief Description: PROTON aims at improving existing knowledge on the processes of recruitment to organised crime and terrorist networks (OCTN) through an innovative integration between social and computational sciences. Moving beyond the state of the art, this integration will support evidence-based policies at the international, national and local level.
Role: Co-PI, responsible for the mathematical modelling and evolutionary game theory activities.
Years: 2016–2019
Project Founding: 4M€

DICE: Distributed Cognition Engineering Project founded within the FP7 People programme under the Marie Curie Career Integration Grant scheme (ID: 631297).
Brief Description: The project aims at the study of cognition in collective, swarm-like systems (swarm cognition), with two main goals: on the one hand, the theoretical understanding of the mechanisms that support cognitive processing and behavioural optimality in collective systems; on the other hand, the definition of an engineering methodology that provides formal methods and tools for the design of cognitive capabilities in large-scale distributed systems (e.g., distributed multi-robot systems).
Role: PI, responsible for the scientific and management activities.
Years: 2014–2018
Project Founding: 0.4M€

H^{2}Swarm: Hierarchical Heterogeneous Swarm Collaborative project founded by the EUROCORES–EuroBioSAS Programme of the European Science Foundation (ESF).
Brief description: The project studies the intra- and inter-group dynamics supporting coordination and cooperation within swarms of heterogeneous robots. The project features both a theoretical component—dedicated to the understanding of the evolutionary mechanisms leading to the emergence of hierarchi-

cal, heterogeneous organisations—and an applied component—dedicated to the implementation of coordinated and cooperative strategies in heterogeneous robotic swarms.
Role: I organised and coordinated the proposal preparation and submission to the ESF. I was the principal scientific investigator within the IRIDIA-ULB unit, responsible of the scientific and organisational activities of IRIDIA-ULB, and supervised two Ph.D. students sponsored by the project. Within the project, I coordinated the networking among the project partners. I proposed and organised the "Workshop on Collective Behaviours and Social Dynamics" within the 12th European Conference on Artificial Life (ECAL 2013) as a networking event between H^2Swarm and DRUST, another ESF-founded project. The workshop received a 10K€ founding from ESF, which was awarded under my personal initiative.
Years: 2011–2014
Project Founding: 0.8M€.

Swarmanoid: Towards Humanoid Robotic Swarms STREP project founded by the Future and Emerging Technologies programme of the Information Society Technologies of the European Commission (IST-FET project, grant IST-022888)
Brief description: The project aimed at designing and prototyping an innovative distributed robotic system, composed of a swarm of heterogeneous robots able of coordination and cooperation. Three robotic platforms were designed and prototyped: the *foot-bot*, a small-size wheeled robot, the *hand-bot*, a robot capable of climbing standard office furniture, and the *eye-bot*, a flying robot for indoor operations. The project demonstrated the capabilities of heterogeneous robotic swarms in a real-world scenario in which the three platforms collaborated to retrieve desired objects in a 3D human-made environment.
Role: I was the principal scientific investigator within the ISTC-CNR, responsible of the scientific and organisational activities of the unit. I co-supervised one Ph.D. student sponsored by the project. I was a member of the Scientific Committee of the project, a steering committee that coordinates the exchange of scientific results, hypotheses, research ideas, and implement any action required by the project planning. In particular, I was the coordinator of the activities of Workpackage 5 "Communication" dedicated to the communication strategies to support coordination and collaboration among heterogeneous robots. I also took active part to the Workpackage 4 "Control", dedicated to the control strategies for heterogeneous swarms, and Workpackage 3 "Simulation" dedicated to the development of ARGoS, a custom-tailored simulator for large-scale collective robotics systems.
Years: 2006–2010
Project funding: 2.73M€ (UE: 2.5M€).

ECAgents: Embodied and Communicating Agents IP research project founded by the Future and Emerging Technologies programme of the Information Society Technologies of the European Commission (IST-FET project, grant 001940)
Brief description: The project aimed at providing a better understanding of the role of communication in collections of embodied and situated agents using the methodological and theoretical tools of complex systems and computer science. The studies ranged from communication in robotic swarms to the establishment of a proto-language in artificial agents, from the understanding of the evolutionary preconditions for the emergence of communication to the development of mobile tools for portable devices.
Role: I joined the project in 2006 and actively worked on it for about 18 months. During this period, I was involved in the study of the evolutionary dynamics leading to the emergence of group synchronisation in robotic swarms. I was member of the Scientific Committee and participated to the project meetings, providing feedback and suggestions on the planning of the project activities.
Years: 2004–2008
Project founding: 7.12M€ (UE: 4,3M€)

SWARM-BOTS: Swarms of self-assembling artefacts STREP project founded by the Future and Emerging Technologies programme of the Information Society Technologies of the European Commission (IST-FET project, grant IST-2000-31010)
Brief description: The SWARM-BOTS project aimed at the design and implementation of self-organising and self-assembling artefacts called swarm-bots. A novel autonomous robot was developed, with the unique capability of docking to other similar platforms to create a large physical structure capable of solving problems that the individual robots could not cope with (e.g., navigating on rough terrain, passing over large gaps, pulling heavy weights).

Role: I carried out my Ph.D. studies actively working on the project. I focused on the evolution of self-organising behaviours for such a swarm of self-assembling robots, and produced several interesting control strategies for coordinated motion, collective decisions and self-assembly. I proved the feasibility of the evolutionary approach for swarm robotics in several real-word demonstrators. A revised version of the Ph.D. thesis has been published as a book within the series "Studies on Computational Intelligence" by Springer Verlag. I was member of the Scientific Committee for the whole project duration. Within the IRIDIA-ULB bode, I was responsible of the organisational activities within the Workpackage 4 "Control", managing the redaction of project reports and ensuring the meeting of internal and EU-requested deadlines.
Years: 2001–2005
Project founding: 2.17M€ (UE: 1M€)

POET: Power Optimisation for Embedded sysTems Collaborative research project founded by the Future and Emerging Technologies programme of the Information Society Technologies of the European Commission (IST-FET project, grant IST-2000-30125)
Brief description: The POET project aimed at the development of a new design methodology and a tool suite for power estimation and optimisation in heterogeneous embedded system-on-chip designs.
Role: at the early stages of my scientific career, I was a technical consultant at CEFRIEL for 9 months, during which I developed a model for assembly-level execution-time estimation in complex computing architectures (pipelined and/or superscalar processors), as well as a simulator for assembly instruction timing and power consumption estimation.
Years: 2001–2004
Project founding: 6.12M€(UE: 3.55M€)

Selected Press Features

International:

24/08/2017	Horizon, the EU Research & Innovation Magazine, *EU's future cyber-farms to utilise drones, robots and sensors* `http://goo.gl/LA1dL6`
29/06/2017	Inside unmanned systems, *Swarming the Skies* `http://insideunmannedsystems.com/swarming-the-skies`
25/11/2016	BBC News, *In the future, will farming be fully automated?* `http://www.bbc.com/news/business-38089984`
28/10/2016	Fresh Plaza, *Drones for Agriculture* `http://www.freshplaza.com/article/165879/Drones-for-agriculture`
21/10/2016	RoboHub, *Swarms of precision agriculture robots could help put food on the table* `http://goo.gl/y3sKVl`
19/10/2016	Cordis News and Events, *Will precision agriculture bring you food grown by a swarm of robots?* `http://cordis.europa.eu/news/rcn/135935_en.html`
12/08/2010	The Economist, *Riders on a swarm* `http://www.economist.com/node/16789226`

National:

01/06/2018	*Sciami di api e psicofisica*, Rai Memex Galileo
15/05/2018	*Sciami di api e psicofisica*, Radio Cusano Network
30/04/2018	Sciami di api e cervello, SIF Prima Pagina `https://www.primapagina.sif.it/article/768/sciami-di-api-e-cervello`
19/04/2018	*Le api spiegano il cervello*, Il Giornale.
06/04/2018	*Come capire il cervello guardando le Api*, Considera l'Armadillo, Radio Popolare.
01/07/2017	Macchine Agricole, *Quale Futuro per i Droni in Agricoltura?*
16/06/2017	CNR Web TV, *Un giorno da ricercatore* `http://www.cnrweb.tv/vito-trianni`

12/11/2016	Quotidiano di Sicilia, *Droni come supporto per l'agricoltura* `http://www.qds.it/23645-droni-come-supporto-agricoltura.htm`
09/11/2016	Italia Oggi, *Sciami di droni a coltivare i campi* `http://goo.gl/mvzSND`
29/10/2016	Corriere della Sera – Io Donna, *Gli sciami di droni che cacciano le erbe cattive* `http://goo.gl/Whgjhp`
14/10/2016	Libreo Quotidiano, *Agricoltura: Cnr, da progetto Ue sciami di droni per coltivazioni* `http://goo.gl/aQHVne`
14/10/2016	Duurzaam Bedrijfsleven (NL), *Zwerm drones verbetert opbrengst (bio-)landbouw* `http://goo.gl/IJ7RWG`
14/10/2016	ADNKronos, *Sciami di droni e robot nei campi, proteggeranno le colture dagli infestanti* `http://goo.gl/ujPshG`
19/03/2016	Rai Tg3 Pixel, *Coverage of the RomeCup 2016* `https://goo.gl/MTPJKO`
04/02/2016	Rai Memex, *Biomimetica - L'uomo artificiale* `http://goo.gl/CZ9w2i`
09/01/2016	D di Repubblica, *Sciami di droni per l'agricoltura* `http://goo.gl/yttQ32`
06/12/2015	Corriere della Sera – La Lettura, *Sciami di robot che imitano le api per cercare le vittime dei disastri* `http://goo.gl/ZMfn4T`
18/11/2015	Rai Scienze, *I robot? Imparino dalle api. Lo dimostra uno studio congiunto del Cnr con l'universitá di Bruxelles* `http://goo.gl/OEHa2r`
15/11/2015	La Repubblica, *Cnr, robot a lezione dalle api per imparare l'organizzazione sociale* `http://goo.gl/2Uaivl`
01/08/2014	Focus Extra, Robot `http://www.focus.it/mondo-focus/focus-e-speciali/focus-extra/64`
16/11/2013	Almanacco della Scienza, *Se i robot fanno squadra* `http://goo.gl/TXlGNo`
29/07/2009	La Repubblica, *Sfrutta meccanismi naturali per risolvere calcoli complessi* `http://goo.gl/Bo8QZ8`

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IJ. 1 Andreagiovanni Reina, Thomas Bose, Vito Trianni, and James A R Marshall. Psychophysical Laws and the Superorganism. *Scientific Reports*, 8(1):4387–8, 2018

IJ. 2 Gabriele Valentini, Anthony Antoun, Marco Trabattoni, Bernát Wiandt, Yasumasa Tamura, Etienne Hocquard, Vito Trianni, and Marco Dorigo. Kilogrid: a novel experimental environment for the Kilobot robot. *Swarm Intelligence*, 4(4):1–22, 2018

IJ. 3 Dario Albani and Vito Trianni. Drone Swarms in the Field. *ERCIM News*, 113:31–32, 2018

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