Agnese Seminara

Full professor

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Education and training

2007
PhD
Transport and diffusion in complex flows
Université de Nice - Nice - FR

2004
M.Sc. and B.Sc in physics
Role of turbulence for the microphysics of warm clouds - 110/110 cum laude
University of Genoa - Genoa - IT

Academic experience

2021 - ONGOING
Professore Ordinario
University of Genoa - Genoa - IT
Teaching and research in fluid dynamics biology and machine learning

2019 - 2021
Directrice de Recherche
CNRS - Nice - FR

2013 - 2019
Chargée de Recherche
CNRS - Nice - FR
Research on physics and biology

2012 - 2013
Instructor of Applied Mathematics
Harvard University - Cambridge MA - US
Teaching and research in applied mathematics and physics of biological systems

2011 - 2012
Post-doctoral fellow
Institut Pasteur - Paris - FR
research on physics and biology

2008 - 2011

Post-doctoral fellow
Harvard University - Cambridge Massachusetts - US
Research in physics and biology

Language skills

Italian	English	French
Mother tongue	Proficient	Proficient

Teaching activity

A tour of reinforcement learning and applications (Environmental engineering PhD program, co teach with Alessandro Verri DIBRIS)
Mechanics of biological tissues (Bioengineering M.Sc. program, co teach with Rodolfo Repetto DICCA)
Fluid mechanics (Mechanical Engineering B.Sc. program, co teach with Alessandro Bottaro DICCA)
Modeling camp (Environmental engineering PhD program, co teach with Rodolfo Repetto, Andrea Mazzino, Jan Pralitz, DICCA)

Research interests

Interaction of an organism with its environment is largely mediated by fluids. Molecules travel through fluids both within and outside of an organism to elicit biological response. Organisms move through fluids to seek food, to find their mate or to escape danger. Microscopic propagules are carried by fluids to explore novel environments. Fluids transmit sound and interact with light. The physics of fluids thus shapes the evolution of living organisms.
My research activity blends physics, machine learning and biological behavior to ask how organisms acquire and process complex sensory information from their fluid environment to guide behavior. I deploy state-of-the-art simulations and asymptotic models to portray the fluid flows surrounding living organisms. These data inform machine learning algorithms that model behaviors ranging from sensory driven navigation to spore dispersal to the formation of complex bacterial colonies. I focus on model organisms like mice and bacteria as well as less studied organisms like higher fungi and octopus and real weirdos like piranhas and sea robins (a fish with legs!). I work closely with a number of longstanding collaborators to design (and also sometimes perform) experiments which nurture and are nurtured by theory.
Creatures and problems I currently focus on:

- Machine learning for turbulent navigation and prediction with M Vergassola CNRS Paris; G Reddy Harvard Univ; A Verri, L Rosasco MalGa DIBRIS
- Fungal spore discharge and dispersal with A Pringle, UW Madison; V Norros, Helsinki; A Mazzino, Univ Genoa; C Raufaste, F Celestini, R Arkowitz, Univ Cote d'Azur; A Barla MalGa DIBRIS
- Olfactory navigation in mice and octopus with D Gire Univ

Washington; N Bellono Harvard Univ
- Sensory biology in the sea robin and collective behavior in the piranhas with N Bellono Harvard Univ
- Bacterial Biofilms with P Thomen and C Claudet Univ Cote d'Azur

List of publications
at https://scholar.google.com/citations?user=OKTmpMQAAAAJ&hl=en

Grants

2021 - ONGOING

Physics informed algorithms for sensing and navigating turbulent environments

European Research Council

ERC Consolidator grant - Pricipal investigator
Living systems developed dramatically efficient strategies to sense and navigate turbulent environ- ments. Understanding these strategies is key to many real world applications required to function in the presence of turbulence: from search and rescue to demining and patrolling. While much is known on navigation in smooth environments, these approaches fail in the presence of turbulence. RID- ING aims at elucidating the computations organisms use to extract useful information from turbulent stimuli and navigate to a target. A key observation is that organisms rely on multiple sensory cues, despite the distortions due to turbulence. Explaining this puzzle requires blending fluid dynamics with biological behavior. I will achieve this goal by developing physics-based algorithms elucidating the computations that support three fundamental pillars of biological behavior: 1) combine naviga- tion with sensing, 2) balance multiple senses, 3) adapt to different environments. The result will be a comprehensive theory integrating biological behavior in a computational framework based on fluid dynamics. Predictions will be tested via experiments on fishes, known to routinely perform turbulent navigation combining multiple senses across distinct sensory environments. This multidisciplinary project leverages methods from physics, computer science and biology.
In summary, the objectives of RIDING are to:
O1. Assemble a massive dataset of chemical and mechanical signals emitted by a target using compu- tational fluid mechanics and asymptotic methods.
O2. Develop algorithmic approaches for sensing and navigation using tools from machine learning trained on multiple sensory signals from O1.
O3. Examine how sensory signals from O1 and algorithms from O2 vary in different environments. O4. Test predictions by recording prey capture in the laboratory using three species of fish. Analysis includes a fascinating species which evolved unique sensory “legs” to catch prey in different environ- ments.

2020 - ONGOING

Navigation with complex odor dynamics computational

principles and neural circuit implementation in mice
National Health Institute - US
RO1 - Pricipal investigator

2020 - ONGOING
Machine learning approaches to navigate turbulence
European Office of aerospace research and development - US
Participant

2019 - ONGOING
Dynamics of Cell Polarity establishment
Agence Nationale de la Recherche - FR
Participant

Editorial activity

2019-... Member of the Board of Reviewing Editors eLife.
2016-19 Editor for Fungal Ecology.
2013-... Reviewer for the following journals : Nature Physics; Nature Communication; Proceedings of the National Academy of Science; eLife; Physical Review Letters; Physical Review B; Physical Review E; Journ Stat Phys; Scientific Reports; Fungal Ecology; PLOS Computational Biology; Mycologia; Proceedings of the Royal Society B; Fungal Ecology; Ecology; SciPost.
External referee for: Human Frontiers in Science Program; German Science Foundation; CNRS (PEPS, Momentum, MECANOBIO); IDEX UCAJEDI; Institut Pasteur ACIP; IDEX Sorbonne Universite.

Assignments abroad

Teaching and research positions abroad:
Directrice de recherche CNRS, Universite Cote d'Azur, Institut de Physique de Nice, France.
Chargée de recherche CNRS, Université Côte d'Azur, Institut de Physique de Nice, France.
Lecturer of Applied Mathematics, Harvard University, School of Engineering and Applied Sciences, USA
Marie Curie postdoctoral fellow Institut Pasteur, Physics of Biological Systems, Paris, France
Marie Curie postdoctoral fellow Harvard University, School of Engineering and Applied Sciences, USA
I gave over 50 invited and 25 contributed presentations for conferences, workshops and invited seminars abroad.
Awards and fellowships:
2020 ERC Consolidator Grant
2018 Research and PhD Supervision Award CNRS (PEDR)
2017 Bronze Medal CNRS
2012 Rita Levi Montalcini young investigator award (declined)
2008 Marie Curie International Outgoing Fellowship
2010 Poster award, International Mycological Society Conference, Edinburgh

UK
2006 L'Oreal Italia–Unesco fellowship for women in science
2005 HPC-europa transnational access fellowship, super computing center CINECA (IT)
2005 Fellowship for double-badged PhD, Italian-French University
2004 Fellowship for education of young researchers in excellence centers, University of Genova