Gianluca Aguzzi | Postdoctoral Researcher

STATEMENT OF TRUTH

I hereby certify that all content reported in this document is true. This document is digitally signed by the undersigned.

PERSONAL DATA

Citizenship	Italian
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SHORT BIO

Gianluca Aguzzi is a Postdoctoral Research Fellow at the Department of Computer Science and Engineering of the University of Bologna. His research combines software engineering, collective adaptive systems, and machine learning to build dependable, scalable distributed applications. His principal contributions advance macroprogramming for cyber-physical swarms, field-based coordination, cooperative multi-agent reinforcement learning, decentralized federated learning, and generative-AI support for modern software systems. He has designed or co-designed research software including Phyelds, MacroSwarm, FRASP, ScaRLib, and ScaFi-Web. He received his PhD with distinction in Computer Science and Software Engineering, earning the IEEE TCSC Outstanding PhD Dissertation Award. Alongside research, he teaches software design, advanced programming, distributed systems, reinforcement learning, and generative AI, and supervises Master's and Bachelor's theses.

HIGHLIGHTS

Education	PhD with distinction; IEEE TCSC Outstanding PhD Dissertation Award. See Education and Scientific Activities.
Appointment	Postdoctoral Research Fellow, University of Bologna, on two consecutive contracts: November 2023–November 2025 and November 2025–November 2026. See Research Positions.
Publications	63 publications: 20 journal articles, 26 conference papers, 11 workshop papers, 3 book chapters, and 3 preprints. See Publications.
Bibliometrics	605 citations, h-index 15 (Google Scholar); 419 citations, h-index 13 (Scopus). See Research Profile.

Teaching	326 course hours and 240 tutoring hours; 39 supervised theses. See Teaching.
Recognition	Five major awards, including the IEEE TCSC dissertation award and the Seal of Excellence (Marie Curie), European Commission 2025; USD 40,000 in Google research awards. See Scientific Activities.
Software	Principal research software: Phyelds, MacroSwarm, FRASP, ScaRLib, and ScaFi-Web. See Software Projects.

RESEARCH POSITIONS

2025–2026

Period	November 2025 — November 2026
Position	Postdoctoral Research Fellow (“assegno di ricerca”), second contract
Institution	Alma Mater Studiorum — University of Bologna, Cesena
Project	COMMONS-WEARS (PRIN-funded)
Supervisor	Prof. Mirko Viroli
Description	Renewal on the same project: engineering collective applications for layered, multi-mobile edge environments.

2023–2025

Period	November 2023 — November 2025
Position	Postdoctoral Research Fellow (“assegno di ricerca”), first contract
Institution	Alma Mater Studiorum — University of Bologna, Cesena
Project	COMMONS-WEARS (PRIN-funded)
Supervisor	Prof. Mirko Viroli
Description	Engineering collective applications for layered, multi-mobile edge environments.

RESEARCH PROFILE

My research sits at the intersection of *collective adaptive systems engineering* (software engineering) and *machine learning* methodologies for distributed systems. In particular, my work contributes to several specific areas:

- **Software Engineering for Collective Behaviors:** In this research area, I focus on advancing the macroprogramming paradigm (programming systems from a global perspective) in the context of very large distributed systems (e.g., swarm robotics, smart cities). I propose novel solutions for managing groups of robots in a distributed way based on spatial computing principles [17], along with new programming approaches through frameworks like MacroSwarm [11]. My work includes fundamental research on how to engineer such applications, leading to foundational publications on collective autonomy [20] and comprehensive roadmaps for future development [12]. This research covers several aspects of the programming pipeline, including runtime monitoring for system safety [50] and [31], programming frameworks like ScaFi [19] and MacroSwarm [38], low-code design tools like ScaFi-Blocks [1], and others [32, 45], novel reactive models for swarm programming [40] and field-based strategies for runtime replanning [24], and the development of novel architectural patterns for collective computation [18].
- **Hybrid Methodologies for Collective Intelligence:** In this research area, building on the advancements from my work on collective behaviors, I integrate machine

learning solutions to improve currently manual design approaches. The goal is to both enhance system adaptability (through learning) and improve overall efficiency. This integration was first outlined through comprehensive roadmaps [55, 56], then implemented in several ways: leveraging Multi-Agent Reinforcement Learning (MARL) for program synthesis [43], improving macroprogramming execution with scheduling learned via MARL [42], and enhancing current MARL solutions for swarms by using macroprogramming as a way to represent agent state [39], further exploring scaling issues through graph neural networks [8, 6] and leveraging differentiable simulators for efficient training [26].

- **Advanced Methodologies for Cooperative and Scalable Learning:** Based on the insights gained from programming scalable systems with macroprogramming, I bring these advancements to *cooperative learning*, highlighting the need for scalable solutions. In this regard, I propose novel MARL approaches based on neighborhood policies [30] and explore new federated learning solutions that avoid central points of failure [34, 35], decentralized proximity-aware clustering [13], and strategies for managing data heterogeneity [4] or improving energy efficiency [29] (work that led to a Marie Curie project with an associated Seal of Excellence award). In this area, I also proposed novel framework for cooperative many agent deep reinforcement learning in Scala [41] and novel simulation pipeline for large-scale systems [36].
- **Generative AI for Modern Applications:** This area represents a natural continuation of my previous work, particularly focusing on how to use generative AI for designing modern distributed applications. Initial work explores how to integrate small LLMs and RAG-enhanced solutions in chatbots for healthcare management [10, 15, 14]. Recently, I've proposed a language-based approach to macroprogramming through LLMs [9] and explored GenAI for plan generation in BDI agents [28]. During this period, I've also supervised several theses on code generation with LLMs for domain-specific languages, with the aim of integrating these advancements with macroprogramming paradigms to further enhance collective system development.

H-index 15 (Google Scholar), 13 (Scopus).

Citations 605 (Google Scholar), 419 (Scopus).

EDUCATION

2020–2023 **PhD in CS & Software Engineering**, *UniBO*, Cesena, with distinction
Focus: Design and engineering of large-scale systems, multi-agent reinforcement learning, and cyber-physical swarms.
Awarded Outstanding PhD Dissertation Award (IEEE TCSC).
Thesis: *A language-based software engineering approach for cyber-physical swarms*. Supervisor: Prof. M. Viroli.

2018–2020 **Master in CS & Software Engineering**, *UniBO*, Cesena, 110/110 cum laude
Focus: Distributed systems, aggregate computing, and MARL.
Awarded Best Master Thesis (Sergio Focardi Award).
Thesis: *ScaFi Web: a Scala-JavaScript platform for executing, simulating, and controlling aggregate computing systems*.

2015–2018 **Bachelor in CS & Software Engineering**, *UniBO*, Cesena, 110/110 cum laude
Awarded Prize for Meritous Students.
Thesis: *Sviluppo di un front-end di simulazione per applicazioni aggregate nel framework Scafi*.

2010–2015 **High School on Computer Science**, *ITIS E. Mattei*, Urbino, 100/100

PUBLICATIONS

Note: for Quartile (Q1-Q4), I took the highest quartile of the journal in which the paper is published in a range from the year it is accepted to the year of publication (e.g., if a paper is accepted in 2023, I took the max quartile of 2022 - 2023).

Journal Articles

[1] Gianluca Aguzzi, Matteo Cerioni, and Mirko Viroli. Low-code design of collective systems with ScaFi-Blocks. *Science of Computer Programming*, 247:103356, 2026. **Q3** (Scimago).

[2] Michele Braccini, Gianluca Aguzzi, and Paolo Baldini. Unraveling creativity through variability: A comparison of LLMs and humans in an educational Q&A scenario. *Technology, Knowledge and Learning*, pages 1–38, 2026. **Q1** (Scimago).

[3] Alessio Cocchieri, Luca Ragazzi, Gianluca Aguzzi, Giacomo Frisoni, Lorenzo Molfetta, Gianluca Moro, and Mirko Viroli. Java academic benchmark: Exam-based evaluation of LLMs on object-oriented programming. *Journal of Systems and Software*, page 113033, 2026. **Q1** (Scimago).

[4] Davide Domini, Gianluca Aguzzi, Lukas Esterle, and Mirko Viroli. FBFL: A field-based coordination approach for data heterogeneity in federated learning. *Logical Methods in Computer Science*, 22, 2026. **Q2** (Scimago).

[5] Davide Domini, Christian Otte Ingemann, Gianluca Aguzzi, Lukas Esterle, and Mirko Viroli. ProFed: a benchmark for proximity-based non-IID federated learning. *Journal of Open Research Software*, 14(1):13–13, 2026. **Q1** (Scimago).

[6] Nicolas Farabegoli, Davide Domini, Gianluca Aguzzi, and Mirko Viroli. Heterogeneous GNN for collective-task offloading in cloud-edge via deep Q-learning. *Future Generation Computer Systems*, page 108539, 2026. **Q1** (Scimago).

[7] Gianluca Aguzzi, Roberto Casadei, and Mirko Viroli. MacroSwarm: a field-based compositional framework for swarm programming. *Logical Methods in Computer Science*, 2025. **Q2** (Scimago).

[8] Gianluca Aguzzi, Davide Domini, Filippo Venturini, and Mirko Viroli. Scaling swarm coordination with GNNs—how far can we go? *AI*, 6(11):282, 2025. **Q1** (Scimago).

[9] Gianluca Aguzzi, Nicolas Farabegoli, and Mirko Viroli. A language-based approach to macroprogramming for IoT systems through large language models. *ACM Transactions on Internet of Things*, 6(4):1–30, 2025. **Q1** (Scimago).

[10] Gianluca Aguzzi, Matteo Magnini, Aqila Farahmand, Stefano Ferretti, Martino Francesco Pengo, and Sara Montagna. RAG-enhanced open SLMs for hypertension management chatbots. *Journal of Medical Systems*, 49(1):159, 2025. **Q1** (Scimago).

[11] Gianluca Aguzzi and Mirko Viroli. MacroSwarm: A Scala framework for swarm programming. *Science of Computer Programming*, 239:103182, 2025. **Q2** (Scimago).

[12] Roberto Casadei, Gianluca Aguzzi, Giorgio Audrito, Ferruccio Damiani, Danilo Pianini, Giordano Scarso, Gianluca Torta, and Mirko Viroli. Software engineering for collective cyber-physical ecosystems. *ACM Transactions on Software Engineering and Methodology*, 34(5):1–40, 2025. **Q1** (Scimago).

[13] Davide Domini, Nicolas Farabegoli, Gianluca Aguzzi, Mirko Viroli, and Lukas Esterle. Decentralized proximity-aware clustering for collective self-federated learning. *Internet of Things*, page 101841, 2025. **Q1** (Scimago).

[14] Matteo Magnini, Gianluca Aguzzi, and Sara Montagna. Open-source small language models for personal medical assistant chatbots. *Intelligence-Based Medicine*, 11:100197, 2025. **Q2** (Scimago).

[15] Sara Montagna, Stefano Ferretti, Lorenz Cuno Klopfenstein, Michelangelo Ungolo, Martino Francesco Pengo, Gianluca Aguzzi, and Matteo Magnini. Privacy-preserving LLM-based chatbots for hypertensive patient self-management. *Smart Health*, 36:100552, 2025. **Q2** (Scimago).

[16] Davide Domini, Filippo Cavallari, Gianluca Aguzzi, and Mirko Viroli. ScaRLib: Towards a hybrid toolchain for aggregate computing and many-agent reinforcement learning. *Science of Computer Programming*, 238:103176, 2024. **Q2** (Scimago).

[17] Gianluca Aguzzi, Giorgio Audrito, Roberto Casadei, Ferruccio Damiani, Gianluca Torta, and Mirko Viroli. A field-based computing approach to sensing-driven clustering in robot swarms. *Swarm Intelligence*, 17(1):27–62, 2023. **Q2** (Scimago).

[18] Gianluca Aguzzi, Roberto Casadei, Danilo Pianini, and Mirko Viroli. Dynamic decentralization domains for the Internet of Things. *IEEE Internet Computing*, 26(6):16–23, 2022. **Q1** (Scimago).

[19] Roberto Casadei, Mirko Viroli, Gianluca Aguzzi, and Danilo Pianini. ScaFi: A Scala DSL and toolkit for aggregate programming. *SoftwareX*, 20:101248, 2022. **Q2** (Scimago).

[20] Roberto Casadei, Gianluca Aguzzi, and Mirko Viroli. A programming approach to collective autonomy. *Journal of Sensor and Actuator Networks*, 10(2):27, 2021. **Q1** (Scimago).

Conference Papers

[21] Gianluca Aguzzi, Davide Domini, Nicolas Farabegoli, and Mirko Viroli. Phyelds: A Pythonic framework for aggregate computing. In *International Conference on Coordination Models and Languages*, pages 174–191. Springer, Cham, 2026.

[22] Nicolas Farabegoli, Luca Tassinari, Gianluca Aguzzi, and Mirko Viroli. ScalaTropy: Multiparty coordination with monadic communication primitives. In *International Conference on Coordination Models and Languages*, pages 115–135. Springer, Cham, 2026.

[23] Gianluca Aguzzi, Lorenzo Bacchini, Martina Baiardi, Roberto Casadei, Angela Cortecchia, Davide Domini, Nicolas Farabegoli, Danilo Pianini, and Mirko Viroli. A demonstrator for self-organizing robot teams. In *International Conference on Coordination Models and Languages*, pages 230–244. Springer Nature Switzerland Cham, 2025.

[24] Gianluca Aguzzi, Martina Baiardi, Angela Cortecchia, Branko Miloradovic, Alessandro Papadopoulos, Danilo Pianini, and Mirko Viroli. A field-based approach for runtime replanning in swarm robotics missions. In *2025 IEEE International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS)*, pages 1–10. IEEE, 2025.

[25] Gianluca Aguzzi, Matteo Magnini, Martino Francesco Pengo, Mirko Viroli, and Sara Montagna. A fine-tuning pipeline with small conversational data for healthcare chatbots. In *International Conference on Artificial Intelligence in Medicine*, pages 1–5. Springer Nature Switzerland Cham, 2025.

[26] Francesco Bertolotti, Gianluca Aguzzi, Walter Cazzola, Mirko Viroli, et al. SHAC++: A neural network to rule all differentiable simulators. In *Proceedings of the 27th European Conference on Artificial Intelligence (ECAI 2024)*, volume 413, pages 2818–2825, 2025. **RANK A - Core ranking**.

[27] Michele Braccini, Gianluca Aguzzi, Paolo Baldini, and Andrea Roli. On the LLM robustness in a simulated conversational XR scenario: A preliminary semantic analysis. In *International Conference on Image Analysis and Processing*, pages 637–648. Springer Nature Switzerland Cham, 2025.

[28] Giovanni Ciatto, Gianluca Aguzzi, Riccardo Battistini, Martina Baiardi, Samuele Burattini, Alessandro Ricci, et al. Exploiting GenAI for plan generation in BDI agents. In *Proceedings of the 27th European Conference on Artificial Intelligence (ECAI 2024)*, volume 413, pages 3495–3502, 2025. **RANK A - Core ranking**.

[29] Davide Domini, Laura Erhan, Gianluca Aguzzi, Lucia Cavallaro, Amirhossein Douzandeh Zenoozi, Antonio Liotta, and Mirko Viroli. Sparse self-federated learning for energy efficient cooperative intelligence in Society 5.0. In *2025 International Joint Conference on Neural Networks (IJCNN)*, pages 1–8. IEEE, 2025.

[30] Nicolò Malucelli, Davide Domini, Gianluca Aguzzi, and Mirko Viroli. Neighbor-based decentralized training strategies for multi-agent reinforcement learning. In *Proceedings of the 40th ACM/SIGAPP Symposium on Applied Computing*, pages 1250–1257, 2025.

[31] Gianluca Torta, Gianluca Aguzzi, Ferruccio Damiani, and Mirko Viroli. Aggregate runtime verification for emergency healthcare in crowded events. In *2025 IEEE 5th International Conference on Human-Machine Systems (ICHMS)*, pages 315–318. IEEE, 2025.

[32] Gianluca Aguzzi, Roberto Casadei, Matteo Cerioni, and Mirko Viroli. ScaFi-Blocks: a visual aggregate programming environment for low-code swarm design. In *International Conference on Coordination Models and Languages*, pages 258–276. Springer Nature Switzerland Cham, 2024.

[33] Gianluca Aguzzi and Claudio Savaglio. Engineering distributed collective intelligence in cyber-physical swarms. In *2024 20th International Conference on Distributed Computing in Smart Systems and the Internet of Things (DCOSS-IoT)*, pages 570–575. IEEE, 2024.

[34] Davide Domini, Gianluca Aguzzi, Lukas Esterle, and Mirko Viroli. Field-based coordination for federated learning. In *International Conference on Coordination Models and Languages*, pages 56–74. Springer Nature Switzerland Cham, 2024.

[35] Davide Domini, Gianluca Aguzzi, Nicolas Farabegoli, Mirko Viroli, and Lukas Esterle. Proximity-based self-federated learning. In *2024 IEEE International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS)*, pages 139–144. IEEE, 2024.

[36] Davide Domini, Gianluca Aguzzi, Danilo Pianini, and Mirko Viroli. A reusable simulation pipeline for many-agent reinforcement learning. In *2024 28th International Symposium on Distributed Simulation and Real Time Applications (DS-RT)*, pages 83–90. IEEE, 2024.

[37] Denys Grushchak, Jenna Kline, Danilo Pianini, Nicolas Farabegoli, Gianluca Aguzzi, Martina Baiardi, and Christopher Stewart. Decentralized multi-drone coordination for wildlife video acquisition. In *2024 IEEE International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS)*, pages 31–40. IEEE, 2024.

[38] Gianluca Aguzzi, Roberto Casadei, and Mirko Viroli. MacroSwarm: a field-based compositional framework for swarm programming. In *International Conference on Coordination Languages and Models*, pages 31–51. Springer Nature Switzerland Cham, 2023.

[39] Gianluca Aguzzi, Mirko Viroli, and Lukas Esterle. Field-informed reinforcement learning of collective tasks with graph neural networks. In *2023 IEEE International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS)*, pages 37–46. IEEE, 2023.

[40] Roberto Casadei, Francesco Dente, Gianluca Aguzzi, Danilo Pianini, and Mirko Viroli. Self-organisation programming: a functional reactive macro approach. In *2023 IEEE International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS)*, pages 87–96. IEEE, 2023.

[41] Davide Domini, Filippo Cavallari, Gianluca Aguzzi, and Mirko Viroli. ScaRLib: a framework for cooperative many-agent deep reinforcement learning in Scala. In *International Conference on Coordination Languages and Models*, pages 52–70. Springer Nature Switzerland Cham, 2023.

[42] Gianluca Aguzzi, Roberto Casadei, and Mirko Viroli. Addressing collective computations efficiency: towards a platform-level reinforcement learning approach. In *2022 IEEE International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS)*, pages 11–20. IEEE, 2022.

[43] Gianluca Aguzzi, Roberto Casadei, and Mirko Viroli. Towards reinforcement learning-based aggregate computing. In *International Conference on Coordination Languages and Models*, pages 72–91. Springer Nature Switzerland Cham, 2022.

[44] Roberto Casadei, Danilo Pianini, Gianluca Aguzzi, Giorgio Audrito, Gianluca Torta, Marco Ottina, Ferruccio Damiani, and Mirko Viroli. Towards automated engineering for collective adaptive systems: Vision and research directions. In *2022 IEEE Intl Conf on Dependable, Autonomic and Secure Computing, Intl Conf on Pervasive Intelligence and Computing, Intl Conf on Cloud and Big Data Computing, Intl Conf on Cyber Science and Technology Congress (DASC/PiCom/CBDCom/CyberSciTech)*, pages 1–6. IEEE, 2022.

[45] Gianluca Aguzzi, Roberto Casadei, Niccolò Maltoni, Danilo Pianini, and Mirko Viroli. ScaFi-Web: a web-based application for field-based coordination programming. In *International Conference on Coordination Languages and Models*, pages 285–299. Springer International Publishing Cham, 2021.

[46] Giovanni Delnevo, Gianluca Aguzzi, Simone Letizi, Marta Luffarelli, Andrea Petreti, and Silvia Mirri. Encouraging users in waste sorting using deep neural networks and gamification. In *Proceedings of the conference on information technology for social good*, pages 230–235, 2021.

Workshop Papers

[47] Gianluca Aguzzi, Sara Montagna, and Stefano Ferretti. Privacy leakage in small agentic healthcare models: An empirical analysis. In *2026 IEEE International Conference on Pervasive Computing and Communications Workshops and other Affiliated Events (PerCom Workshops)*, pages 1–6. IEEE, 2026.

[48] Andrei Ciortea, Katharine Beaumont, Gianluca Aguzzi, Matteo Baldoni, Cristina Baroglio, Amit K Chopra, Giovanni Ciatto, Rem Collier, Mehdi Dastani, Angelo Ferrando, et al. Engineering multi-agent systems and generative AI: report from the agent toolkits 2025 community session. In *Agent Toolkits Community Session: The 22nd European Conference on Multi-Agent Systems-EUMAS 2025*, page 25, 2025.

[49] Matteo Magnini, Gianluca Aguzzi, Leonardo Sanna, Simone Magnolini, Patrizio Bellan, Mauro Dragoni, and Sara Montagna. Automated machine learning to enhance knowledge retrieval in retrieval-augmented generation pipelines. In *International Joint Workshop on Artificial Intelligence for Healthcare, and Hybrid Models for Coupling Deductive and Inductive Reasoning*, pages 429–440. Springer Nature Switzerland Cham, 2025.

[50] Gianluca Aguzzi, Giorgio Audrito, and Mirko Viroli. Optimising aggregate monitors for spatial logic of closure spaces properties. In *Proceedings of the 7th ACM International Workshop on Verification and Monitoring at Runtime Execution*, pages 25–31, 2024.

[51] Gianluca Aguzzi, Matteo Magnini, Giuseppe Pio Salcuni, Stefano Ferretti, Sara Montagna, et al. Applying retrieval-augmented generation on open LLMs for a medical chatbot supporting hypertensive patients. In *CEUR WORKSHOP PROCEEDINGS*, volume 3880, pages 189–201. CEUR-WS. org, 2024.

[52] Davide Domini, Nicolas Farabegoli, Gianluca Aguzzi, Mirko Viroli, M Alderighi, M Baldoni, C Baroglio, R Micalizio, and S Tedeschi. Towards intelligent pulverized systems: a modern approach for edge-cloud services. In *WOA*, pages 233–251, 2024.

[53] Sara Montagna, Gianluca Aguzzi, Stefano Ferretti, Martino Francesco Pengo, Lorenz Cuno Klopfenstein, Michelangelo Ungolo, and Matteo Magnini. LLM-based solutions for healthcare chatbots: a comparative analysis. In *2024 IEEE International Conference on Pervasive Computing and Communications Workshops and other Affiliated Events (PerCom Workshops)*, pages 346–351. IEEE, 2024.

[54] Roberto Casadei, Gianluca Aguzzi, Danilo Pianini, and Mirko Viroli. Programming (and learning) self-adaptive & self-organising behaviour with ScaFi: for swarms, edge-cloud ecosystems, and more. In *2023 IEEE International Conference on Autonomic Computing and Self-Organizing Systems Companion (ACSOS-C)*, pages 33–34. IEEE, 2023.

[55] Gianluca Aguzzi, Roberto Casadei, and Mirko Viroli. Machine learning for aggregate computing: a research roadmap. In *2022 IEEE 42nd International Conference on Distributed Computing Systems Workshops (ICDCSW)*, pages 119–124. IEEE, 2022.

[56] Gianluca Aguzzi. Research directions for aggregate computing with machine learning. In *2021 IEEE International Conference on Autonomic Computing and Self-Organizing Systems Companion (ACSOS-C)*, pages 310–312. IEEE, 2021.

[57] Gianluca Aguzzi, Roberto Casadei, Danilo Pianini, Guido Salvaneschi, and Mirko Viroli. Towards pulverised architectures for collective adaptive systems through multi-tier programming. In *2021 IEEE International Conference on Autonomic Computing and Self-Organizing Systems Companion (ACSOS-C)*, pages 99–104. IEEE, 2021.

Book Chapters

[58] Gianluca Aguzzi, Roberto Casadei, Danilo Pianini, and Mirko Viroli. Self-organisation with aggregate computing: a reflection under the lenses of multi-agent systems engineering. In *The Agents Journey: Twenty-Five Years of Multi-agent Systems*, pages 147–178. Springer Nature Switzerland Cham, 2026.

[59] Gianluca Aguzzi, Roberto Casadei, Stefano Mariani, Mirko Viroli, and Franco Zambonelli. Learning opportunities in collective adaptive systems. In *Fluidware: Novel Approaches for Large-Scale IoT Systems*, pages 179–199. Springer International Publishing Cham, 2024.

[60] Danilo Pianini, Roberto Casadei, Stefano Mariani, Gianluca Aguzzi, Mirko Viroli, and Franco Zambonelli. Space-fluid and time-fluid programming. In *Fluidware: Novel Approaches for Large-Scale IoT Systems*, pages 107–134. Springer International Publishing Cham, 2024.

Preprints

[61] Davide Domini, Gianluca Aguzzi, Amirhossein Douzandeh Zenoozi, Laura Erhan, Lucia Cavallaro, Antonio Liotta, and Mirko Viroli. SParSeFuL: Self-organizing sparse federated learning over spatially non-IID data. *Available at SSRN 6584516*, 2026.

[62] Davide Domini, Gianluca Aguzzi, Ivana Dusparic, Danilo Pianini, and Mirko Viroli. Discovering collaboration from novelty: Random network distillation for clustered federated learning. *arXiv preprint arXiv:2606.30499*, 2026.

[63] Davide Domini, Gianluca Aguzzi, Lorenzo Pellegrini, Mirko Viroli, and Lukas Esterle. C2FL: Clustered continual federated learning under spatial and temporal drift. *arXiv preprint arXiv:2606.18003*, 2026.

TEACHING

Courses

Summary 326 documented course hours through 2026, across degree courses at the University of Bologna and invited teaching at PhD schools and partner universities.

2026

Course Advanced Software Modelling and Design
Role Module 3
Hours 20
Audience Master's in Computer Science and Engineering (English), University of Bologna
Topics Software modelling, development practices, testing, verification, and computational models for intelligent and distributed systems. Course page.

Course Advanced Software Engineering and Development
Role Module 2
Hours 20
Audience Master's in Computer Science and Engineering, University of Bologna
Topics Functional programming with Scala, logic programming with Prolog, software quality, refactoring, agile testing, and advanced design patterns.

Course Software Design and Development
Role Module 2
Hours 30
Audience Professional Bachelor's in Information Systems Technologies, University of Bologna
Topics Object-oriented programming, design patterns, Java, software architecture, testing, and agile methodologies.

2025

Course Advanced Software Modelling and Design
Role Module 2
Hours 30
Audience Master's in Computer Science and Engineering (English), University of Bologna
Topics Testing, simulation, verification, aggregate computing, reinforcement learning, multi-agent systems, and generative AI for software engineering.

Course Programming and Development Paradigms
Role Module 2
Hours 30
Audience Master's in Computer Science and Engineering, University of Bologna

Course Software Design and Development
Role Module 2

Hours 60
Audience Professional Bachelor's in Information Systems Technologies, University of Bologna

Course Aggregate Programming for the Internet of Things (July 2025)
Role Lecturer
Hours 12
Audience PhD School (English), University of Turin
Topics Time independence, spatial algorithms, and runtime verification; co-organised under the supervision of Prof. Ferruccio Damiani.

Course Compose in Android Development (April 2025)
Role Teaching module
Hours 10
Audience Bachelor's in Computer Science (English), Western Norway University of Applied Sciences (HVL), Norway
Topics Declarative UI programming with Compose, composable functions, state management, and UI design principles.

2024

Course Advanced Software Modelling and Design
Role Module 2
Hours 20
Audience Master's in Computer Science and Engineering (English), University of Bologna

Course Software Design and Development
Role Course lead, Module 1
Hours 60
Audience Professional Bachelor's in Information Systems Technologies, University of Bologna

2023

Course Software Design and Development
Role Module 2
Hours 30
Audience Professional Bachelor's in Information Systems Technologies, University of Bologna

Course Introduction to Reinforcement Learning (July 2023)
Role Lecturer
Hours 4
Audience Advanced School in Artificial Intelligence. Course information.

Thesis (Co-)Supervision

Summary 39 supervised theses: 18 Master's (LM-DM270) and 21 Bachelor's (L-DM270). Several led to peer-reviewed publications co-authored with the student, marked below.
Source Verifiable on the University of Bologna thesis repository: AMSLaurea — Aguzzi, Gianluca

2026

Master's theses

L. Pasini — A Comparative Analysis of Agentic AI Frameworks via an Automatic Quiz Correction Case Study

A. Venturini — Effectful Aggregate Computation: towards a monadic view

Bachelor's theses

A. Casali — Studio delle tecniche di localizzazione indoor mediante Ultra-Wideband

A. Gardini — Progettazione di un framework protocol-agnostic per il coordinamento di sciami nel contesto di Project Emerge

D. Marchetti — Un sistema di realtà aumentata per la Robotica di sciame

F. Mariani — Progettazione di un Chatbot Agentico per il Controllo di Sciami di Droni

L. Rossi — Progettazione di meccanismi di offloading computazionale in sistemi robotici e IoT

L. M. Spitaleri — Zenoh network per Aggregate Computing in Rust: verso comunicazioni peer-to-peer su reti eterogenee

2025

Master's theses

R. Battistini — Exploiting GenAI for Plan Generation in BDI Agents [28]

A. Spadoni — Processo di Transizione e Reingegnerizzazione di un Pannello Web per DNS Filtering

L. Tassinari — Scala-based Cross-platform and Polyglot Systems: General Architecture and Incarnation for Aggregate Computing [22]

Bachelor's theses

S. Bollini — Integrazione di RAG e LLM nello Sviluppo del Software

G. Bucci — Sviluppo di un assistente AI prototipale per Visual Studio Code

K. Osti — Evoluzione e Apprendimento per Rinforzo: Un Approccio Integrato per Agenti Autonomi in Contesti Videoludici

N. Ricci — Controllo di sciami robotici in ambiente ibrido fisico-virtuale: un dimostrativo

2024

Master's theses

G. Accursi — Progettazione e sviluppo di un prototipo di simulatore ad eventi discreti reattivo

J. G. Cesario — Event-driven simulation and verification of FRASP systems against spatio-temporal properties

L. Deluigi — Design and implementation of a scalable domain specific language foundation for ScaFi with Scala 3

N. Malucelli — Neighboring-based Strategies for Multi-Agent Reinforcement Learning [30]

L. Micelli — Design and development of a Rust-based execution platform for Aggregate Computing

G. P. Salcuni — Utilizzo di tecniche RAG per la Valutazione e Comparazione dei Modelli LLM in ambito medico [51]

F. Venturini — Multi-Agent Reinforcement Learning of Swarm Behaviours with Graph Neural Networks: prototype and first experiments [8]

F. Vissani — Feasibility of Reactive Aggregate Programming via Kotlin Flows

Bachelor's theses

A. Arfelli — Utilizzo di ChatGPT come supporto nello Sviluppo Software: Un'Analisi Completa

L. Bacchini — Sviluppo di un sistema di visione artificiale per la rilevazione e localizzazione di marker ArUco in un contesto di aggregate computing [23]

G. Garofalo — Quarkdown — Typesetting versatile di documenti articolati

E. Perlika — Eterogeneità dei sistemi di Aggregate Programming: un caso studio con WaveRobot e ThymioRobot

M. Terenzi — Utilizzo di Neverlang per la modellazione di Domain Specific Languages

L. Tosi — Simulazione di fenomeni emergenti in Alchemist: il caso dell'aggregazione di "slime-mold"

2023

Master's theses

L. Bazzocchi — Daily Medical Team Briefings in Ambiente Collaborativo con Schermi Multi-Touch

G. Cavalieri — Gestione degli effetti in linguaggi di programmazione funzionale: tecniche di modellazione e interpretazione

F. Dente — A functional-reactive perspective on the Aggregate Computing paradigm [40]

D. Domini — Aggregate Computing and Many-Agent Reinforcement Learning: Towards a Hybrid Toolchain [41]

A. Filaseta — Distributed monitoring and control with dynamic offloading: the case of the Alchemist Simulator

Bachelor's theses

F. Bonetti — Prototipazione di una applicazione collaborativa e distribuita per schermi multi-touch

2022

Bachelor's theses

M. Cerioni — Progettazione di un ambiente di programmazione visuale block-based per ScaFi [1]

D. Chavez Rejas — Prototipazione di applicazioni collaborative e distribuite per schermi Touch

K. Mancini — ScaFi: Integration and Performance Analysis with Scala Native

2021

Bachelor's thesis

D. Grushchak — Piattaforma a Supporto del Monitoraggio di Sistemi di Computazione Aggregata: Caso di Studio ScaFi-Web [37]

Tutoring

Summary — 240 hours over four academic years (2022–2025), as tutor for two Master's courses at the University of Bologna: 30 hours per course per year. Laboratory and exercise activities.

2025

Course — Concurrent and Distributed Programming
Role — Tutor
Hours — 30

Course — Programming and Development Paradigms
Role — Tutor
Hours — 30

2024

Course Concurrent and Distributed Programming
Role Tutor
Hours 30

Course Programming and Development Paradigms
Role Tutor
Hours 30

2023

Course Concurrent and Distributed Programming
Role Tutor
Hours 30

Course Programming and Development Paradigms
Role Tutor
Hours 30

2022

Course Concurrent and Distributed Programming
Role Tutor
Hours 30

Course Programming and Development Paradigms
Role Tutor
Hours 30

SCIENTIFIC ACTIVITIES

Awards

November 2025 **Outstanding PhD Dissertation Award**, *IEEE Technical Community on Scalable Computing*
https://www.ieee-tcsc.org/thesis.php

October 2025 **Best Student Paper Award**, *ACSOS 2025*
A Field-based Approach for Runtime Replanning in Swarm Robotics Missions [24].

March 2025 **Seal of Excellence (Marie Skłodowska-Curie Actions)**, *European Commission*
Awarded to a proposal on decentralised federated learning for large-scale systems, developed from the collaboration begun during the visiting period at Aarhus University.

September 2024 **Best Poster Award**, *ACSOS 2024*
https://github.com/DanySK/poster-2024-acsos-imageonomics-drones

November 2023 **Best Master Thesis — Sergio Focardi Award**
ScaFi Web: a Scala-JavaScript platform for executing, simulating, and controlling aggregate computing systems.

Research Grants

2025 **Gemma 3 Research Award (Google) — USD 30,000**. Credits supported research on healthcare chatbots [10, 15, 14] and work presented at AIME [25].

2024 **Gemma 2 Research Award (Google) — USD 10,000**. Credits supported research on human–LLM comparison in educational scenarios [2].

Conference Service

Legend Venue and role acronyms are expanded once under *Abbreviations*, at the end of this section.

2026 ACSOS (**Web Chair; AI Chair**) · COORDINATION (**Artifact Evaluation Chair**) · PerCom (AEC) · AAMAS (**Area Chair**)

2025 AAAI (PC) · iFM (AEC) · ACSOS (**Poster and Demo Session Organiser**) · ECOOP (AEC)

2024 SLE (AEC) · ACSOS (Demo and Poster Committee) · SAC (PC)

2023 PerCom (AEC)

2022 DisCoTec (AEC)

2021 ACSOS (AEC)

Workshop Service

2026 EmotionSense (PC) · DIGITA (PC) · HotDiML (PC) · DISCOLI (PC) · AI4AS (PC)

2025 NSE (PC) · SISSY (Special Invitation) · WoA (**Session Chair**) · HotDiML (PC) · LoStaN (PC) · DISCOLI (PC) · DIGITA (PC)

2024 DISCOLI (**Organising Chair**) · MADTECC (PC)

2023 DISCOLI (PC)

Service in International Journals

2025 – present **Guest Editor**, *Springer Discover Computing*
Special issue: *Engineering Foundational Models for Intelligent Robotic and Multi-agent Systems*.

2025 **Managing Guest Editor**, *MDPI Applied Sciences (IF 2.5)*
Special issue: *Emerging Techniques in Engineering Intelligent Agents and Multi-Agent Systems*. https://www.mdpi.com/journal/applsci/special_issues/36128M0RBR

Review Activity

Journals Nature Communications · ACM Transactions on Autonomous and Adaptive Systems · Autonomous Agents and Multi-Agent Systems · Future Generation Computer Systems · Pervasive and Mobile Computing · Artificial Intelligence Review · Frontiers in Robotics and AI · BMJ Open · Elsevier Journal of Medical Systems · Science of Computer Programming · Logical Methods in Computer Science · Elsevier IoT · PeerJ Computer Science · MDPI Sensors · MDPI AI · Scientific Programming

Conferences COORDINATION (2023–2025) · ACSOS (2023–2026) · AAMAS (2023, 2025) · PerCom (2023) · ICAART (2023)

Visiting

August–November 2023 **Visiting PhD Researcher**, *Aarhus University*, Denmark
Host: Prof. Lukas Esterle. Developed graph-neural-network-based distributed controllers, leading to work on field-informed reinforcement learning; continued collaboration on federated learning for large-scale systems contributed to the Marie Curie Seal of Excellence.

Invited Talks

2025

Title Autonomous Agents with Language Chains

Venue Mini School, WoA

Duration 1 hour

Title Introduction to LangChain
Venue Deep Learning, University of Urbino
Duration 1 hour

2024

Title Oltre l'IA Individuale: Il Potenziale dell'Intelligenza Artificiale Collettiva
Venue University of Urbino

Title Deep Reinforcement Learning: Introduction
Venue Fundamentals of Artificial Intelligence, University of Urbino
Duration 1 hour

2023

Title Multi-Agent Reinforcement Learning: Unleashing Collective Intelligence
Venue Advanced School in Artificial Intelligence Summer School
Duration 3 hours

Title Introduction to Deep Reinforcement Learning
Venue Fundamentals of Artificial Intelligence, University of Urbino
Duration 2 hours

2022

Title Engineering Cyber-Physical Swarms
Venue DIGIT Lunch Meetings, Aarhus University
Duration 1 hour

Presentations at International Conferences

2025 ACSOS: *A Field-based Approach for Runtime Replanning in Swarm Robotics Missions* [24].

2024 COORDINATION: *ScaFi-Blocks: A visual aggregate programming environment for low-code swarm design* [32].

2024 DISCOLI: *Engineering distributed collective intelligence in cyber-physical swarms* [33].

2023 ACSOS: *Programming (and learning) self-adaptive & self-organising behaviour with ScaFi: for swarms, edge-cloud ecosystems, and more* [54].

2023 ACSOS: *Field-informed Reinforcement Learning of Collective Tasks with Graph Neural Networks* [39].

2023 COORDINATION: *MacroSwarm: A field-based compositional framework for swarm programming* [38].

2023 COORDINATION: *Scarlib: A framework for cooperative many agent deep reinforcement learning in Scala* [41].

2023 DISCOLI: *Machine learning for aggregate computing: a research roadmap* [55].

2022 ACSOS: *Addressing Collective Computations Efficiency: Towards a Platform-level Reinforcement Learning Approach* [42].

2022 COORDINATION: *Towards reinforcement learning-based aggregate computing* [43].

2021 ACSOS DS: *Research directions for aggregate computing with machine learning* [56].

2021 COORDINATION: *ScaFi-Web: A Web-Based Application for Field-Based Coordination Programming* [45].

PhD Schools

2023 10^{th} DeepLearn Summer School (Gran Canaria, Spain)

2022 Bertinoro International Spring School (Bertinoro, Italy)

2021 22^{nd} European Agent Systems Summer School (online)

Abbreviations

Roles PC — Program Committee · AEC — Artifact Evaluation Committee · DS — Doctoral Symposium

Conferences AAAI — AAAI Conference on Artificial Intelligence · AAMAS — International Conference on Autonomous Agents and Multiagent Systems · ACSOS — IEEE International Conference on Autonomic Computing and Self-Organizing Systems · AIME — International Conference on Artificial Intelligence in Medicine · COORDINATION — International Conference on Coordination Models and Languages · DisCoTec — International Federated Conference on Distributed Computing Techniques · ECOOP — European Conference on Object-Oriented Programming · ICAART — International Conference on Agents and Artificial Intelligence · iFM — International Conference on Integrated Formal Methods · PerCom — IEEE International Conference on Pervasive Computing and Communications · SAC — ACM/SIGAPP Symposium on Applied Computing · SLE — ACM SIGPLAN International Conference on Software Language Engineering

Workshops AI4AS — Artificial Intelligence for Autonomous Computing Systems (at ACSOS) · DIGITA — Digital Twins Ecosystems and Applications (at PerCom) · DISCOLI — DIStributed COLlective Intelligence (at ICDCS, DCOSS-IoT) · EmotionSense — Human-centred Emotion-Awareness and Sensing in Pervasive Computing (at PerCom) · HotDiML — Hot Topics in Distributed Machine Learning (at ICDCS) · LoStaN — Logic, Statistical and Neural AI (at JELIA) · MADTECC — Medical Applications with Digital Twins and Edge-Cloud Continuum (at PerCom) · NSE — Neuro-Symbolic Software Engineering (at ICSE) · SISSY — Self-Improving System Integration (at ACSOS) · WoA — Workshop "From Objects to Agents"

PARTICIPATION IN RESEARCH PROJECTS

2023–2025 **COMMONS-WEARS (PRIN)**. Research on community-oriented wearable computing, collective systems, and machine learning for healthcare and emergency response. Principal contributions addressed federated learning for decentralised, large-scale applications [34, 35, 29] and [13, 4], and engineering collective applications [33, 31] and [50].

2022–2024 **FLUIDWARE (PRIN)**. Research on programming models for large-scale IoT services, field-based coordination, and event-flow management in the edge–cloud continuum. As a PhD student, contributed programming models [39, 38, 41], machine-learning integration [43, 42], and a related book chapter [59].

SOFTWARE PROJECTS

2025 – present **Phyelds**, *Designer*
Python framework for aggregate computing. https://github.com/phyelds/phyelds

2023 – present **MacroSwarm**, *Designer*
Field-based compositional framework for swarm programming [11]. https://github.com/scafi/macro-swarm

2023 – present **FRASP**, *Co-designer*
Framework for reactive self-organising programming [40]. https://github.com/cric96/distributed-frp

2023 – present **ScaRLib**, *Designer*
Framework for cooperative many-agent deep reinforcement learning in Scala [16]. https://github.com/ScaRLib-group/ScaRLib

2021 – present **ScaFi-Web**, *Co-designer and main contributor*
In-browser editing and execution of ScaFi programs [45]. https://github.com/scafi/scafi-web

2021 – present **scalapy-gym**, *Designer*
Scala facade for using OpenAI Gym environments on the JVM. https://github.com/cric96/scalapy-gym

Open Source Contributions

2018 – present **Development of GUI & simulator for ScaFi**
https://github.com/scafi/scafi

2021 – present **Contributions to ScaFi incarnations in Alchemist**
https://github.com/AlchemistSimulator/Alchemist

PROFESSIONAL EXPERIENCE

2026 – present **AI-Assisted Software Engineering Consultant**, *Mixer S.p.A.*
Consulting on coding-agent adoption, software-development workflows, code generation, and developer productivity.

2025 **Invited Lectures on AI-assisted Coding**, *Emilia-Romagna Region*, Bologna, Italy, 8 hours
Training on applying AI tools to coding, debugging, and software design.

2025 – present **Software Engineering Consultant**, *SOILMEC S.p.A.*, Cesena, Italy
Strategic consulting on legacy-system modernisation and architectural improvements.

2024 – present **Software Engineering Consultant**, *Flash Start*, Cesena, Italy
Software architecture redesign and adoption of modern development practices.

TECHNICAL SKILLS

How to read the scale **1**: used once or basic exposure; **2**: limited practical experience; **3**: regular working knowledge; **4**: able to give a seminar on the subject; **5**: able to write a book on the subject.

Programming Languages

Bash	●●●○○	Haskell	●○○○○	Python	●●●●●
C	●●●●○	Java	●●●●●	Prolog	●●●●○
C++	●●●●○	JavaScript	●●●●○	Scala	●●●●●
C#	●●●○○	Kotlin	●●●●○	TypeScript	●●○○○

Other Languages

CSS	●●●○○	Markdown	●●●○○	SQL	●●○○○
HTML	●●●○○	OWL	●○○○○	Typst	●●●○○
JSON	●●●○○	RDF	●○○○○	XML	●●○○○
LaTeX	●●●●○	SPARQL	●○○○○	YAML	●●○○○

Libraries and Frameworks

Akka	NetworkX	Scala Native	
Astro	NumPy	ScalaTest	
Cats	Pandas	scikit-learn	
Gymnasium	PettingZoo	SciPy	
Jetpack Compose	Plotly	Seaborn	
Kotlin Multiplatform	pytest	TensorFlow	
Matplotlib	PyTorch	TorchRL	
Monix	PyTorch Geometric	VMAS	
Mockito	React	Vue	
MUnit	Scala.js	ZIO	

LLM and RAG Tools

ChromaDB	LangChain4j	Google Gen AI SDK	
DeepEval	LangGraph	OpenAI SDK	
FAISS	llama.cpp	Ragas	
Hugging Face	Ollama	vLLM	
LangChain	Qdrant		

Development Tools and Platforms

Claude Code	IntelliJ IDEA	PyCharm	
Codex	Jupyter	Python venv	
Docker	Linux	Qwen CLI	
Docker Compose	Maven	sbt	
Gemini CLI	Node.js	SLURM	
Git	npm	SSH	
GitHub Actions	OpenCode	uv	
Gradle	pip	VS Code	
Hugo	Poetry		

Creative and Communication Tools

Blender	draw.io	Inkscape	
Canva	GIMP	Kdenlive	

MISCELLANEOUS

2026 **Presentation at UniJunior: "Collective Intelligence: From Nature to Robots"**
Outreach lesson for children aged 11–13 on collective intelligence, swarm robotics, and how groups of robots can cooperate, inspired by collective behaviours in nature. https://www.unijunior.it/calendario/campus-di-cesena-romagna/lintelligenza-collettiva-dalla-natura-ai-robot-cesena

2025 **Presenting Project Emerge @ Researcher Night**
Demonstrated "Project Emerge", an open-source swarm robotics platform, to promote science and technology among the general public. https://experiment.com/projects/project-emerge-an-open-source-swarm-robotics-platform

2025 **Presentation at GENERARE**
Delivered an engaging talk on Large Language Models, demystifying advanced concepts for a broader audience.

2024 **Presenting Aggregate Computing @ Researcher Night**
In that occasion I presented Aggregate Computing with physical robots highlighting the potential of the paradigm.

2023 **Scala Italy 2023**
Scala in machine learning scenario: a personal experience

2020 **Student class representative @ Alma Mater Studiorum**

2019 **Seminar: Create your own video game in Snap!**
Orientation Fair - Forlì

2018 - 2019 **Snap! courses**, *CRIAD Coding*, Grade schools

2018 **Presenting Snap! @ Researcher Night**
In that occasion I presented Snap! to the public as a tool for teaching the computational thinking to the youngest.

August 3, 2026 Gianluca Aguzzi