Gianluca **Aguzzi** | Postdoctoral Researcher

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Current Placement

Alma Mater Studiorum – University of Bologna **Cesena**

Postdoctoral Fellow (“assegno di ricerca”) *2023 November – 2026 November*

Currently appointed as a Postdoctoral Research Fellow in the COMMONS-WEARS project (funded as a PRIN), focusing on the engineering collective applications in complex, layered environments with multi-mobile edge computing architectures.

Research Profile

My research sits at the intersection of *collective adaptive systems engineering* (software engineering) and *machine learning* methodologies for distributed system. Particularly, 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 [16], along with new programming approaches through frameworks like Macroswarm [9]. My work includes fundamental research on how to engineer such applications, leading to foundational publications on collective autonomy [19] and comprehensive roadmaps for future development [10]. This research covers several aspects of the programming pipeline, including runtime monitoring for system safety [31, 30], programming frameworks like ScaFi [18] and Macroswarm [**?**], low-code design tools like ScaFi-Blocks [1], and others [32, 53], novel reactive models for swarm programming [46] and field-based strategies for runtime replanning [22], and the development of novel architectural patterns for collective computation [17].
- **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 [49, 52], then implemented in several ways: leveraging Multi-Agent Reinforcement Learning (MARL) for program synthesis [50], improving macroprogramming execution with scheduling learned via MARL [48], and enhancing current MARL solutions for swarms by using macroprogramming as a way to represent agent state [44], further exploring scaling issues through graph neural networks [6, 4] and leveraging differentiable simulators for efficient training [24].
- **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 [29] and explore new federated learning solutions that avoid central points of failure [36, 37], decentralized proximity-aware clustering [12], and strategies for managing data heterogeneity [3] or improving energy efficiency [28] (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 [47] and novel simulation pipeline for large-scale systems [38].
- **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 [8, 14, 13]. Recently, I've proposed a language-based approach to macroprogramming through LLMs [7] and explored GenAI for plan generation in BDI agents [26]. 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.

Bibliometrics:

- **H-index:** 15 (Google Scholar), 12 (Scopus)
- **Citations:** 510 (Google Scholar), 333 (Scopus)

Education

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

UniBO **Cesena**
Master in CS & Software Engineering, 110/110 cum laude *2018–2020*
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.*

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

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

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).

Journals

[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] 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).

[4] 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*, 2026. **Q1** (Scimago), accepted (in press).

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

[6] 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).

[7] 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).

[8] 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).

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

[10] 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).

[11] Davide Domini, Gianluca Aguzzi, and Mirko Viroli. Profed: a benchmark for proximity-based non-iid federated learning. *Journal of Open Research Software*, 2025. **Q1** (Scimago), accepted (in press).

[12] 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).

[13] Matteo Magnini, Gianluca Aguzzi, Sara Montagna, et al. Open-source small language models for personal medical assistant chatbots. *INTELLIGENCE-BASED MEDICINE*, (100197), 2025. **Q2** Scimago.

[14] Sara Montagna, Gianluca Aguzzi, Stefano Ferretti, Martino Francesco Pengo, Lorenz Cuno Klopfenstein, Michelangelo Ungolo, and Matteo Magnini. Privacy-preserving llm-based chatbots for hypertensive patient self-management. *Smart Health*, 2025. **Q2**.

[15] 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).

[16] 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).

[17] 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).

[18] Roberto Casadei, Mirko Viroli, Gianluca Aguzzi, and Danilo Pianini. Scafi: A scala dsl and toolkit for aggregate programming. *SoftwareX*, 20:101248, 2022. **Q2** (Scimago).

[19] 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, Workshops, and Chapters

[20] 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.

[21] Gianluca Aguzzi, Lorenzo Bacchini, Martina Baiardi, Roberto Casadei, Angela Cortecchia, Davide Domini, Nicolas Agreement 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.

[22] 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.

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

[24] 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**.

[25] 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.

[26] 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**.

[27] 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.

[28] 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.

[29] 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.

[30] 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.

[31] 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.

[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, 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.

[34] 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 *Proceedings of the 3rd AIxIA Workshop on Artificial Intelligence ForHealthcare (HC@ AIxIA 2024) co-located with the 23rd InternationalConference of the Italian Association for Artificial Intelligence (AIxIA 2024), Bolzano, Italy, 27-28 November 2024*, volume 3880, pages 189–201. CEUR-WS. org, 2024.

[35] 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.

[36] 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.

[37] 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.

[38] 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.

[39] Davide Domini, Nicolas Farabegoli, Gianluca Aguzzi, and Mirko Viroli. Towards intelligent pulverized systems: a modern approach for edge-cloud services. In *Proceedings of the 25th Workshop "From Objects to Agents", Bard (Aosta), Italy, July 8–10, 2024, ser. CEUR Workshop Proceedings*, volume 3735, pages 233–251, 2024.

[40] 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.

[41] 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.

[42] 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.

[43] Gianluca Aguzzi, Roberto Casadei, and Mirko Viroli. Macroswarm: A field-based compositional framework for swarm programming. In Sung-Shik Jongmans and Antónia Lopes, editors, *Coordination Models and Languages*, pages 31–51, Cham, 2023. Springer Nature Switzerland.

[44] 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.

[45] 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.

[46] 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.

[47] 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.

[48] 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.

[49] 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.

[50] 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.

[51] 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.

[52] 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.

[53] 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.

[54] 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.

[55] 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.

Participation in Research Projects

2023–2025: **COMMONS-WEARS**: I participated in this PRIN project on community-oriented wearable computing, collective systems, and machine learning for healthcare and emergency response. My main contributions were federated learning solutions for decentralized and large-scale applications [36, 37, 12, 3, 28] as well as modern approaches for engineering collective applications in this domain [35, 31, 30]

2022–2024: **FLUIDWARE**: I participated in this PRIN project on programming models for large-scale IoT services, field-based coordination, and event-flow management in the edge-cloud continuum. I took part in this project as a PhD student and mainly contributed to the development of novel programming models for large-scale IoT services [44, **?**, 47] and to the integration of machine learning in this domain [50, 48]; see also the chapter in the book [33]

Scientific Activities

Conference Service

Legend: ***PC*** *(Program Committee),* ***AEC*** *(Artifact Evaluation Committee)*

2026: ACSOS (Web Chair) · COORDINATION (Artifact Evaluation Chair) · PerCom (AEC)

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: DIGITA (PC) · HotDiML (PC) · DISCOLI (PC)

2025: EmotionSense (PC) · NSE (PC) · SISSY (Special Invitation) · WoA (Session Chair) · Hot Topics in Distributed ML (PC) · LoStaN (PC) · DISCOLI (PC) · DIGITA (PC)

2024: NSE (PC) · DISCOLI (Organising Chair) · MADTECC (PC)

2023: DISCOLI (PC)

Service in International Journals

Springer's Discover Computing
Guest Editor *2025 – Today*
Engineering Foundational Models for Intelligent Robotic and Multi-agent Systems

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

Review Activity

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

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

Presentations in International Conferences

ACSOS *2025*
A Field-based Approach for Runtime Replanning in Swarm Robotics Missions [22]

COORDINATION *2024*
Scafi-blocks: A visual aggregate programming environment for low-code swarm design [32]

DISCOLI *2024*
Engineering distributed collective intelligence in cyber-physical swarms [35]

ACSOS *2023*
Programming (and learning) self-adaptive & self-organising behaviour with scafi: for swarms, edge-cloud ecosystems, and more [45]

ACSOS *2023*
Field-informed Reinforcement Learning of Collective Tasks with Graph Neural Networks [44]

COORDINATION *2023*
Macroswarm: A field-based compositional framework for swarm programming [**?**]

COORDINATION *2023*
Scarlib: A framework for cooperative many agent deep reinforcement learning in Scala [47]

ACSOS *2022*
Addressing Collective Computations Efficiency: Towards a Platform-level Reinforcement Learning Approach [48]

DISCOLI *2023*
Machine learning for aggregate computing: a research roadmap [49]

COORDINATION *2022*
Towards reinforcement learning-based aggregate computing [50]

ACSOS DS *2021*
Research directions for aggregate computing with machine learning [52]

COORDINATION *2021*
ScaFi-Web: A Web-Based Application for Field-Based Coordination Programming [53]

Awards

Best Student Paper Award
ACSOS 2025 *October 2025*
A Field-based Approach for Runtime Replanning in Swarm Robotics Missions [22]

Outstanding PhD Dissertation Award
IEEE TCSC: `https://www.ieee-tcsc.org/thesis.php` *November 2025*

Seal of Excellence (Marie Curie)
European Commission *March 2025*

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

Best Master Thesis
Sergio Focardi Awards *November 2023*
Scafi web: a Scala-JavaScript platform for executing, simulating, and controlling aggregate computing systems.

Research Grant

2025: Gemma 3 Research Award (Google) – 30k USD. Credits used to support research on healthcare chatbots [8, 14, 13] and work presented at the AIME conference [23].

2024: Gemma 2 Research Award (Google) – 10k USD. Credits used to support research on human-LLM comparison in educational scenarios [2].

Visiting

Aarhus University – Prof. Lukas Esterle **Denmark**
Visiting PhD *August 2023 - November 2023*
Focused on applying graph neural networks to develop distributed controllers. This research culminated in the publication of the paper entitled "Field-informed reinforcement learning of collective tasks with graph neural network". Continued collaboration on federated learning for large-scale systems, leading to the Marie Curie Seal of Excellence.

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)

Teaching

Courses

Aggregate Programming for Internet Of Things – 12 hours
PhD School (taught in English), Turin *July 2025*
In this course I teach some advanced stuff in aggregate computing, which implies understanding the notion of time independence, spatial algorithms (gradient, data collection) and introduction for runtime verification. This course was co-organized with the University of Turin with the supervision of Damiani Ferruccio

Compose in Android Development – 10 hours (teaching module) **HVL, Norway**
Bachelor in Computer Science (taught in English) *April 2025*
In this course, I teach the Compose library in Android development, focusing on its declarative programming model and how it simplifies UI development. The curriculum covers the fundamentals of Compose, including composable functions, state management, and UI design principles. Students engage in hands-on projects to apply their knowledge in real-world Android applications.

Advanced Software Design and Modelling (teaching module) **University of Bologna**
Laurea Magistrale in Ingegneria e Scienze Informatiche (taught in English) *2024 – today*
In this advanced course, I lead modules on integrating generative AI into software engineering practices (20h in **2024**, 30h in **2025**), with particular emphasis on leveraging large language models for automated code generation, design pattern implementation, and technical documentation. Additionally, I teach cutting-edge reinforcement learning concepts with focus on multi-agent systems and distributed intelligence architectures.

Software Design and Development **University of Bologna**
Laurea Professionalizzante in Tecnologie dei Sistemi Informatici *2023 – today*
In this course, I teach fundamental software design and development principles (30h as module in **2023**, 60h as *in charge* in **2024**, 60h as module in **2025**), emphasizing object-oriented programming concepts, design patterns, and agile methodologies. The curriculum covers software architecture, testing strategies, and best practices for building maintainable and scalable applications.

Programming and Development Paradigms (teaching module) **University of Bologna**
Laurea Magistrale in Ingegneria e Scienze Informatiche *2025 – today*
In this course, I lead the module on advanced programming and development paradigms (30h in **2025**). The curriculum provides specialist knowledge on techniques and methodologies for advanced software development, including declarative programming (functional programming with Scala and logic programming with Prolog), software quality (clean coding, refactoring, agile testing), and advanced design patterns.

Advanced School in Artificial Intelligence `https://asai-er.github.io/services/docenti/`
Introduction to Reinforcement Learning – 4 hours *July 2023*

Tutoring

Concurrent and Distributed Programming **University of Bologna**
Master in Computer Science and Engineering – 30 hours *2022–2025*

Programming and Development Paradigms **University of Bologna**
Master in Computer Science and Engineering – 30 hours *2022–2025*

Thesis (Co)Supervisor

Master Thesis, Student: Alberto Spadoni *2025*
Processo di Transizione e Reingegnerizzazione di un Pannello Web per DNS Filtering.

Master Thesis, Student: Giacomo Accursi *2024*
Progettazione e sviluppo di un prototipo di simulatore ad eventi discreti reattivo.

Master Thesis, Student: Jahrim Gabriele Cesario *2024*
Event-driven simulation and verification of FRASP systems against spatio-temporal properties.

Master Thesis, Student: Luca Deluigi *2024*
Design and implementation of a scalable domain specific language foundation for ScaFi with Scala 3.

Master Thesis, Student: Nicolò Malucelli *2024*
Neighboring-based Strategies for Multi-Agent Reinforcement Learning.

Master Thesis, Student: Leonardo Micelli *2024*
Design and development of a Rust-based execution platform for Aggregate Computing.

Master Thesis, Student: Giuseppe Pio Salcuni *2024*
Utilizzo di tecniche RAG per la Valutazione e Comparazione dei Modelli LLM in ambito medico.

Master Thesis, Student: Filippo Venturini *2024*
Multi-Agent Reinforcement Learning of Swarm Behaviours with Graph Neural Networks: prototype and first experiments.

Master Thesis, Student: Filippo Vissani *2024*
Feasibility of Reactive Aggregate Programming via Kotlin Flows.

Master Thesis, Student: Luca Bazzocchi *2023*
Daily Medical Team Briefings in Ambiente Collaborativo con Schermi Multi-Touch.

Master Thesis, Student: Giacomo Cavalieri *2023*
Gestione degli effetti in linguaggi di programmazione funzionale: tecniche di modellazione e interpretazione.

Master Thesis, Student: Francesco Dente *2023*
A functional-reactive perspective on the Aggregate Computing paradigm.

Master Thesis, Student: Davide Domini *2023*
Aggregate Computing and Many-Agent Reinforcement Learning: Towards a Hybrid Toolchain.

Master Thesis, Student: Angelo Filaseta *2023*
Distributed monitoring and control with dynamic offloading: the case of the Alchemist Simulator.

Bachelor Thesis, Student: Simone Bollini *2025*
Integrazione di RAG e LLM nello Sviluppo del Software.

Bachelor Thesis, Student: Axel Arfelli *2024*
Utilizzo di ChatGPT come supporto nello Sviluppo Software: Un'Analisi Completa.

Bachelor Thesis, Student: Lorenzo Bacchini *2024*
Sviluppo di un sistema di visione artificiale per la rilevazione e localizzazione di marker ArUco in un contesto di aggregate computing.

Bachelor Thesis, Student: Giorgio Garofalo *2024*
Quarkdown - Typesetting versatile di documenti articolati.

Bachelor Thesis, Student: Elvis Perlika *2024*
Eterogeneità dei sistemi di Aggregate Programming: un caso studio con WaveRobot e ThymioRobot.

Bachelor Thesis, Student: Mirco Terenzi *2024*
Utilizzo di Neverlang per la modellazione di Domain Specific Languages.

Bachelor Thesis, Student: Lorenzo Tosi *2024*
Simulazione di fenomeni emergenti in Alchemist: il caso dell'aggregazione di "slime-mold".

Bachelor Thesis, Student: Federico Bonetti *2023*
Prototipazione di una applicazione collaborativa e distribuita per schermi multi-touch.

Bachelor Thesis, Student: Matteo Cerioni *2022*
Progettazione di un ambiente di programmazione visuale block-based per ScaFi.

Bachelor Thesis, Student: Daniela Chavez Rejas *2022*
Prototipazione di applicazioni collaborative e distribuite per schermi Touch.

Bachelor Thesis, Student: Kevin Mancini *2022*
ScaFi: Integration and Performance Analysis with Scala Native.

Bachelor Thesis, Student: Denys Grushchak *2021*
Piattaforma a Supporto del Monitoraggio di Sistemi di Computazione Aggregata: Caso di Studio ScaFi-Web.

Invited Talks

Autonomous Agents with Language Chains – 1 hour *2025*
Mini School Workshop on Object to Agents – WoA

Seminar: ***Introduction of LangChain – 1 hour*** *2025*
Deep Learning - University of Urbino

Oltre l'IA Individuale: Il Potenziale dell'Intelligenza Artificiale Collettiva *2024*
University of Urbino

Seminar: ***Deep Reinforcement Learning – Introduction – 1 hour*** *2024*
Fundamentals of Artifical Intellingence - University of Urbino

Mini School: ***Multi-Agent Reinforcement Learning, Unleashing Collective Intelligence – 3 hours*** *2023*
Advanced School in Artificial Intelligence Summer School

Seminar: ***Intro to Deep Reinforcement Learning – 2 hours*** *2023*
Fundamentals of Artificial Intelligence - University of Urbino

Talk: ***Engineering Cyber-Physical Swarm – 1 hours*** *2022*
DIGIT lunch meetings – Aarhus Universitat

Software Projects

Designer of Phyelds
It is a framework which implemented a "python" version of Aggregate computing. *2025 – today*
`https://github.com/phyelds/phyelds`

Designer of Macroswarm [9]
It is a field-based compositional framework for swarm programming. *2023 – today*
`https://github.com/scafi/macro-swarm`

CO-designer of FRASP [46]
It is a framework for reactive self-organizing programming *2023 – today*
`https://github.com/cric96/distributed-frp`

Designer of Scarlib [15]
It is a framework for cooperative many agent deep reinforcement learning in Scala *2023 – today*
`https://github.com/ScaRLib-group/ScaRLib`

Co-designer and main contributor of ScaFi-Web [53]
It is a web-based application allowing in-browser editing and execution of ScaFi programs. *2021 – today*
`https://github.com/scafi/scafi-web`

Designer of scalapy-gym
It is a Scala facade that enable the usage of open ai gyms in the JVM! *2021 – today*
`https://github.com/cric96/scalapy-gym`

Open Source Contributions

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

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

Professional Experience

Emilia-Romagna Region **Bologna, Italy**
Invited Lectures on AI-assisted coding *2025*
Specialized training on leveraging artificial intelligence for software development efficiency. 8 hours of lectures focused on practical applications of AI tools in coding, debugging, and software design.

SOILMEC S.p.A. **Cesena, Italy**
Software Engineering Consultant *2025 – Today*
Providing strategic technical consulting focused on legacy system modernization and architectural improvements to enhance code maintainability and development efficiency.

Flash Start **Cesena, Italy**
Software Engineering Consultant *2024 – Today*
Delivering specialized consulting services in software architecture redesign and implementation of modern development practices to optimize existing systems.

Technical Skills

Programming Languages

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

Other Languages

●●●●● **HTML** :	●●●●● **Markdown** :	●●●●● **SPARQL** :
●●●●● **XML** :	●●●●● **LaTeX** :	●●●●● **YAML** :
●●●●● **JSON** :	●●●●● **OWL** :	●●●●● **SQL** :
●●●●● **RDF** :		●●●●● **Typst** :

Libraries

●●●●● **Torch** :	●●●●● **VMAS** :	●●●●● **ScalaPy** :
●●●●● **Torch geometric** :	●●●●● **Monix** :	●●●●● **Cats** :
●●●●● **Torch_rl** :	●●●●● **Matplotlib** :	●●●●● **ZIO** :
●●●●● **Gym** :	●●●●● **Akka** :	●●●●● **Tensorflow** :
●●●●● **Pettingzoo** :	●●●●● **Scala.js** :	●●●●● **LangChain** :
		●●●●● **LangChain4j** :

Software Tools

●●●●● **Gimp** :	●●●●● **Inkscape** :	●●●●● **NPM** :
●●●●● **Git** :	●●●●● **Blender** :	●●●●● **SBT** :
●●●●● **GHA** :	●●●●● **OWL** :	●●●●● **Hugo** :
●●●●● **Docker** :	●●●●● **Kdenlive** :	●●●●● **Gradle** :
		●●●●● **Ollama** :

Miscellaneous

Presenting Project Emerge @ Researcher Night *2025*
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`

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

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

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

Student class representative @ Alma Mater Studiorum *2020*

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

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

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

May 8, 2026

Gianluca Aguzzi