Piergiuseppe **Mallozzi**

Berkeley (CA), USA

 +1 (442) 877-2865 | piergiuseppe.mallozzi@gmail.com | pierg.github.io | pierg | piergiuseppe

Software Engineering | Formal Methods | AI/ML/DL | Blockchain and Zero-Knowledge Proof

Current Position

Postdoctoral Researcher in EECS   *Berkeley, USA*

UC BERKELEY   *Sept. 2021 - present*

- Architected and implemented a robust Zero-Knowledge Proof (ZKP) framework to verify statements on *sensitive real-world data*, utilizing blockchain technology as a publicly auditable infrastructure.
- Utilizing artificial intelligence to develop correct-by-construction designs, with focus on air vehicles (UAVs) and robotic missions.
- Contributing to the development of PACTI, a specification-based system analysis and design tool that is being tested by multiple organizations, including NASA.
- Contributed as a key member of the research and development team for the DARPA project "*Symbiotic Design for Cyber-Physical Systems*", where I developed AI-based approaches to facilitate the correct-by-construction design of Cyber-Physical Systems.

Education

PhD in Electrical Engineering and Computer Science   *Göteborg, Sweden*

CHALMERS UNIVERSITY OF TECHNOLOGY   *2016-2021*

Thesis: "Designing Trustworthy Autonomous Systems".

- Designed and implemented a novel framework for robotic mission design that uses contracts to model requirements, ensuring consistency and completeness in system specifications. Developed new algorithms to maximize reuse of existing components and efficiently realize robotic missions, reducing design complexity.
- Applied formal methods, including model checking, run-time monitoring and reactive synthesis, to ensure trustworthiness of autonomous systems in different contexts, such as vehicle platooning, *reward hacking* prevention, *safe reinforcement learning* and requirement engineering.

BSc, MSc in Computer Engineering Graduated with highest honors, full marks 110/110   *Pisa, Italy*

UNIVERSITY OF PISA   *2009-2016*

Thesis: "Design and development of a co-simulation library for the PVSio-web prototyping tool".

- Designed and developed a set of libraries for the *co-simulation* of Cyber-Physical Systems.
- Completed in collaboration with *NASA Langley Research Center*, Virginia, USA.
- Developed a library that forms a core part of the co-simulation engine. The library is responsible for coordinating and controlling different models, each developed in their own environment (e.g., Java, PVS, C, Matlab Simulink).

Awards

Zero-Knowledge Proof Hackathon 2023 - First Prize   *Berkeley, USA*

THREE MONTHS PROJECT WORLD-WIDE COMPETITION   *2019*

- Led the design and development of *Fact Fortress*, which was awarded the top prize in the self-selected Application Track at the UC Berkeley ZKP Hackathon 2023 (`https://zk-hacking.org`).
- Over the course of three months, 600 participants and 150 teams from around the world competed in five different tracks as part of the competition.

University of California, Berkeley   *Berkeley, USA*

FUNDED RESEARCH VISIT   *2019*

- Received Fellowship from Knut and Alice Wallenberg Foundation.
- Gained expertise in Deep Learning, Formal Methods and Contract-Based Design.

IDEA League   *Europe*

FUNDED A DOCTORAL SCHOOL ACROSS TOP EUROPEAN UNIVERSITIES   *2017 and 2018*

- Developed a strong network with ETH Zurich, TUDelft, Politecnico di Milano

WASEDA University   *Tokyo, Japan*

FUNDED RESEARCH VISIT   *2018*

- Collaborated with top Japanese research institutions as an awarded candidate among applicants from around the world.
- Received funding from JSPS (Japanese Society for Promoting Science) for the collaboration.

Wallenberg AI, Autonomous Systems and Software Program

Sweden

2016-2021

- Received full funding for doctoral program, international graduate school, and research visits through a prestigious fellowship program in Sweden.
- Awarded travel grants to present research at top academic and industry research centers worldwide, including Airbus (France), German Aerospace Center DLR (Germany), Stanford, UC Berkeley, Google, and Netflix (USA), and NTU, SUTD (Singapore).
- Engaged in high-level discussions with leading researchers in various fields, broadening my research expertise and network.

NASA Langley Research Center

Virginia, USA

FUNDED INTERNSHIP

2015

- Led the design and development of a flight simulator to demonstrate the NextGen collision avoidance system (DAIDALUS) developed at NASA Langley.
- Utilized the PVS verification system to execute mathematical models developed by the NASA team in a simulator.

Queen Mary University of London

London, UK

FUNDED TRAINEESHIP PROGRAM

2015

- Developed a communication middleware for co-simulation of device prototypes in the CHI+MED research team.
- Utilized the middleware to develop a demonstrative prototype of an Integrated Clinical Environment with interoperable medical devices.

Institut supérieur d'électronique de Paris

Paris, France

FUNDED SCHOLARSHIP FOR STUDY ABROAD SEMESTER

2014

Copenhagen University College of Engineering

Copenhagen, Denmark

SELECTED FOR INTERNATIONAL ENGINEERING PROJECT AND AWARDED SCHOLARSHIP

2012

Universidad Carlos III de Madrid

Madrid, Spain

FUNDED SCHOLARSHIP FOR STUDY ABROAD SEMESTER

2011

Some Open-Source Projects

Fact Fortress

Berkeley, USA

HTTPS://PIERG.GITHUB.IO/FACT-FORTRESS-WEB/

2023

- Leading and making significant contributions to the development of Fact Fortress, an on-chain Zero-Knowledge Proof framework.
- We use Zero-Knowledge Proofs (ZKP) for trustworthy and private fact-checking leveraging on proof of data provenance, auditable data-access policies and democratizing the construction of ZKP circuits.

PACTI

Berkeley, USA

HTTPS://WWW.PACTI.ORG

2021-2023

- Contributed to the developed and maintenance of PACTI, an open-source tool for scalable system analysis and design using an Assume-Guarantee contracts framework with support for polyhedral constraints, and ongoing support for Linear Temporal Logic.
- Developed a case study on UAV topology using contract-based design to enforce the rules of a context-free grammar that defines the feasible space of UAV topologies.

Berkeley CPS Symbiotic Design

Berkeley, USA

HTTPS://GITHUB.COM/BERKELEY-UAVS/BERKELEY-CPS-SYMBIOTIC-DESIGN

2021-2022

- Led the development of a comprehensive software pipeline for designing and evaluating unmanned aerial vehicles (UAVs) in the context of a DARPA challenge, contributing over 100,000 lines of code.
- Key features of the software pipeline include:
  - Context-sensitive grammar for generating abstract UAV topologies.
  - User-friendly JSON and GUI interfaces enabling designers to express preferences at multiple levels of abstraction.
  - Refinement from abstract topologies to graphs of UAV components and connectors, with optimization of component selection from a library of real UAV components.
  - Learning of common structures from existing UAV designs through graph isomorphism analysis.
  - Parameters and control optimization using Bayesian optimization techniques.

CROME - Contract-Based Goal Graph Analysis Tool *Berkeley, USA*
HTTPS://GITHUB.COM/PIERG/CROME-CGG *2019-2021*

- Contract-based goal graph analysis tool for modeling and deploying robotic missions in complex environments.
- Enabled designers to use Linear Temporal Logic (LTL) or Specification Patterns to model the environment and goals of robotic missions.
- Implemented efficient goal analysis via the construction of the CGG, a graph of contracts where each node is combined with algebraic operations.
- Enabled simulation of robotic missions through realization, execution, and orchestration of different controllers that guide the robot under varying environmental contexts.
- Implemented an LTL formulas manipulation library and parallel reactive synthesis controllers for more efficient realization of robotic missions.

Teaching Activity

Machine Learning and Software Engineering for AI Systems *Chalmers University of Technology*
MAIN COURSE DEVELOPER AND LECTURER *fall19, summer20, fall20*

- Created a course that provided a strong theoretical and mathematical foundation for Machine Learning and Deep Learning, while also offering practical applications and industry use cases.)
- Covered a wide range of topics including supervised learning (linear and polynomial regression, logistic regression, decision trees, gradient descent), unsupervised learning (clustering, K-means), reinforcement learning (MDP, value iteration, Q-learning), deep neural networks (convolutional neural networks, recurrent neural networks), and practical implementation using Python.

Advanced Software Architecture *Chalmers University of Technology*
TEACHING ASSISTANT AND LECTURER *spring16, spring17, spring18*

- Covered various topics, including Architectural Styles, Patterns, and Tactics, as well as Domain-Specific Software Architectures.
- Explored the phenomenon of Software Architecture Decay and its implications on large-scale software systems.

Model-Based Software Development *Chalmers University of Technology*
TEACHING ASSISTANT AND LECTURER *fall16, fall17, fall18*

- Covered topics including topics such as Domain Models, Use Case, Activity, Class, Component, Sequence, Deployment Diagrams, and State Machines, using modeling languages such as UML and SysML.
- Coordinated and supervised student groups working on a large-scale software development project for the course.

Skills

Languages Italian (Native), English (Full Professional Proficiency), French (Good), Spanish (Intermediate)

Programming Python, HTML/CSS/Javascript, Flask/React/NextJS, JAVA, C/C++, MySQL, Matlab, LaTeX, Docker, Git

Engineering **Cyber-Physical Systems and Embedded Systems**: Electronics, Logic Circuits, Computer Architecture, Concurrent and Distributed Systems. **Formal Methods**: Linear Temporal Logic, Model Checking, Reactive Synthesis, Runtime Verification. **Machine Learning and Deep Learning**: Supervised Learning, Unsupervised Learning, Reinforcement Learning, Neural Networks, Convolutional Neural Networks, Transformers, Natural Language Processing. **Theory of Computation**: Automata and Languages, Computability, Complexity. **Algorithms and Data Structures**: Operations Research, Graph Theory, Optimization. **Software Engineering**: Object-Oriented Programming, Design Patterns, Software Architecture, Agile Development, Testing, Debugging. **Security and Blockchain**: Advanced Networking, Internet Protocols, Cryptography, Network Security, Blockchain Technology and Zero-Knowledge Proof.

Publications

Pacti: Scaling Assume-Guarantee Reasoning for System Analysis and Design
Inigo Incer, Apurva Badithela, Josefine Graebener, **Piergiuseppe Mallozzi**, Ayush Pandey, Sheng-Jung Yu, Albert Benveniste, Benoit Caillaud, Richard Murray, Alberto Sangiovanni-Vincentelli, Sanjit Seshia
under submission, 2023

Deploying ZKP Frameworks with Real-World Data: Challenges and Proposed Solutions
Piergiuseppe Mallozzi
under review, 2023

Contract-Based Specification Refinement and Repair for Mission Planning
Piergiuseppe Mallozzi, Inigo Incer, Pierluigi Nuzzo, Alberto Sangiovanni-Vincentelli
International Conference of Formal Methods in Software Engineering (FORMALISE), 2023

A grammar for the representation of Unmanned Aerial Vehicles with 3D topologies
Piergiuseppe Mallozzi, Hussin Sibai, Inigo Pandey, Alberto Sangiovanni-Vincentelli, Sanjit Seshia
under review, 2023

A Framework for Specifying and Realizing Correct–by–Construction Contextual Robotic Missions Using Contracts
Piergiuseppe Mallozzi, Pierluigi Nuzzo, Nir Piterman, Patrizio Pelliccione, Gerardo Schneider
under review, 2022

Incremental Refinement of Goal Models with Contracts
Piergiuseppe Mallozzi, Pierluigi Nuzzo, Patrizio Pelliccione
Fundamentals of Software Engineering (FSEN), 2021

CROME: Contract-Based Robotic Mission Specification
Piergiuseppe Mallozzi, Pierluigi Nuzzo, Patrizio Pelliccione, Gerardo Schneider
International Conference on Formal Methods and Models for System Design (MEMOCODE), 2020

A Runtime Monitoring Framework to Enforce Invariants on Reinforcement Learning Agents Exploring Complex Environments
Piergiuseppe Mallozzi, Ezequiel Castellano, Patrizio Pelliccione, Gerardo Schneider, Kenji Tei
International Workshop on Robotics Software Engineering (RoSE), Co-located with ICSE, 2019

Autonomous Vehicles: State of the Art, Future Trends, and Challenges
Piergiuseppe Mallozzi, Patrizio Pelliccione, Alessia Knauss, Christian Berger, Nassar Mohammadiha
Book Chapter in Automotive Systems and Software Engineering, 2019

Engineering Trustworthy Self-Adaptive Autonomous Systems
Piergiuseppe Mallozzi
Licentiate Thesis. 2018

MoVEMo: a Structured Approach for Engineering Reward Functions
Piergiuseppe Mallozzi, Raúl Pardo, Vincent Duplessis, Patrizio Pelliccione, Gerardo Schneider
IEEE International Conference on Robotic Computing (IRC), 2018

Keeping Intelligence Under Control
Piergiuseppe Mallozzi, Patrizio Pelliccione, Claudio Menghi
International Workshop on Software Engineering for Cognitive Services (SE4COG), Co-located with ICSE, 2018

Combining Machine-learning with Invariants Assurance Techniques for Autonomous Systems
Piergiuseppe Mallozzi
Doctoral Symposium at International Conference on Software Engineering (ICSE), 2017

Automotive Architecture Framework: The Experience of Volvo Cars
Patrizio Pelliccione, Eric Knauss, Rogardt Heldal, S Magnus Ågren, **Piergiuseppe Mallozzi**, Anders Alminger, Daniel Borgentun
Journal of Systems Architecture. 2017

Formal Verification of the on-the-fly Vehicle Platooning Protocol
Piergiuseppe Mallozzi, Massimo Sciancalepore, Patrizio Pelliccione
International Workshop on Software Engineering for Resilient Systems (SERENE), 2016

A Proposal for an Automotive Architecture Framework for Volvo Cars
Patrizio Pelliccione, Eric Knauss, Rogardt Heldal, Magnus Ågren, **Piergiuseppe Mallozzi**, Anders Alminger, Daniel Borgentun
Workshop on Automotive Systems/Software Architectures (WASA), 2016

PVSio-web: Mathematically Based Tool Support for the Design of Interactive and Interoperable Medical Systems
Paul Curzon, Paolo Masci, Patrick Oladimeji, **Piergiuseppe Mallozzi**
EAI Endorsed Transactions on Collaborative Computing. ACM, 2015

Design and Development of a Co-simulation Library for the PVSio-web Prototyping Tool
Piergiuseppe Mallozzi
Master Thesis. 2015

Using PVSio-web and SAPERE for Rapid Prototyping of User Interfaces in Integrated Clinical Environments
Paolo Masci, **Piergiuseppe Mallozzi**, Francesco Luca De Angelis, G Di Marzo Serugendo, Paul Curzon
Verisure2015, Workshop on Verification and Assurance, Co-located with CAV, 2015

Invited Talks

2022	**DARPA PI Meeting**, Contract-Based Symbiotic Design for Cyber-Physical Systems	*Seattle, USA*
2019	**Nanyang Technological University (NTU),** Hierarchical Refinement of Goal Models using Contracts	*Singapore*
2019	**Singapore University of Technology and Design (SUTD),** Goal Models and Contract-Based Design	*Singapore*
2018	**Japanese Society for Promoting Scince (JSPS),** STINT Sweden Reppresentative Talk	*Tokyo, Japan*
2018	**Okinawa Institute of Science and Technology (OIST),** Safe Reinforcement Learning	*Okinawa, Japan*
2018	**Osaka University,** Run-time Monitoring and Reinforcement Learning	*Osaka, Japan*
2018	**Kyoto University,** Run-time Monitoring and Reinforcement Learning	*Kyoto, Japan*
2018	**Advanced Telecommunications Research Institute (ATR),** Safe Reinforcement Learning	*Kyoto, Japan*
2017	**Cruise**, Autonomous Driving and Reinforcement Learning	*San Francisco, USA*
2017	**Ericsson**, Thrustworthy Autonomous Systems	*Santa Clara, USA*
2017	**International Conference of Software Engineering (ICSE),** Self-Adaptive Systems	*Buenos Aires, ARG*
2015	**NASA Langley Research Center**, Flight Simulator Demonstration and Formal Verification	*Langley, USA*

References

Alberto Sangiovanni-Vincentelli   Supervisor at UC-Berkeley   **alberto@berkeley.edu**

Pierluigi Nuzzo   Assistant Professor at USC-Viterbi   **nuzzo@usc.edu**

Additional references available upon request.