

# Quantum Programming for Software Engineering

## Teacher

Vita Santa Barletta (<https://serlab.di.uniba.it/>)

## Course Website (optional)

Code: To be defined

## Course description (min 150, max 300 words)

Quantum programming is an emerging area developed from the multidisciplinary research on quantum computing and combines the idea of Quantum Mechanics, Mathematics and Computer Science. The goal is to solve computational-hard problems in a reasonable amount of time, and this new technology has a very wide space for application in Software Engineering. Several are Software Engineering problems that require significant computational effort to be solved or to find a sub-optimal solution. Just think to all the proposed automatic techniques aiming to detect quality issues or to the entire area of Search-based Software Engineering.

Therefore, the course will cover the main topics concerning Quantum Programming for Software Engineering. Basics concepts of Quantum Computing will initially be provided, and then the different types of Quantum Programming Languages will be analyzed. This is essential to be able to discuss during the course of the main existing programming infrastructure for developing quantum software; the differences of developing conventional and quantum software regarding the development phases; and which are the domain in which quantum software is more aligned to.

The theoretical lectures will be supported by practical cases to directly apply the theory in a quantum software development in the context of software engineering domain but also in a variety of application domains.

## Course period

February - March 2024

## SSD

ING-INF/05

## Course References

[1] Manuel A. Serrano, Ricardo Pérez-Castillo, Mario Piattini. Quantum Software Engineering. Springer Cham. e-Book ISBN: 978-3-031-05324-5 Published: 12 October 2022. <https://doi.org/10.1007/978-3-031-05324-5>

## Credits and Hours

2 lectures credits, (8 hours per credit), for a total of 16 hours.

## Exam Modality

Two alternatives are available to the student to pass this exam:

- 1) Oral presentation. Students deepen and present a topic on quantum programming for software Engineering discussed during the course.
- 2) Project. Students will implement and experimentally validate a Quantum Programming technique for software development. Projects can be done in groups of 1-3 students, depending on the complexity of the technique.

### Teacher CV

Attach or link a max 3 pages CV. - **attachment**

### Teacher Main Publications

List 10 main publications in the last 15 years.

1. Barletta V.S., Caivano D., Vincentiis M.D., Ragone A., Scalera M., Martín M.Á.S., *V-SOC4AS: A Vehicle-SOC for Improving Automotive Security*, (2023) *Algorithms*, 16 (2), DOI: 10.3390/a16020112
2. Barletta V.S., Caivano D., Colizzi L., Dimauro G., Piattini M., *Clinical-chatbot AHP evaluation based on "quality in use" of ISO/IEC 25010*, (2023) *International Journal of Medical Informatics*, 170, art. no. 104951, DOI: 10.1016/j.ijmedinf.2022.104951
3. Barletta V.S., Caivano D., De Vincentiis M., Magri A., Piccinno A., *Quantum Optimization for IoT Security Detection*, (2023) *Lecture Notes in Networks and Systems*, 603 LNNS, pp. 187 - 196, DOI: 10.1007/978-3-031-22356-3\_18
4. Pecorelli F., Barletta V.S., Serrano M.A., QP4SE Welcome from the chairs (2022) *QP4SE 2022 - Proceedings of the 1st International Workshop on Quantum Programming for Software Engineering*, co-located with ESEC/FSE 2022, pp. III - IV
5. Dimauro G., Barletta V.S., Catacchio C.R., Colizzi L., Maglietta R., Ventura M., *A systematic mapping study on machine learning techniques for the prediction of CRISPR/Cas9 sgRNA target cleavage*, (2022) *Computational and Structural Biotechnology Journal*, 20, pp. 5813 - 5823, DOI: 10.1016/j.csbj.2022.10.013
6. Baldassarre M.T., Barletta V.S., Caivano D., Piccinno A., Scalera M., *Privacy Knowledge Base for Supporting Decision-Making in Software Development*, (2022) *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 13198 LNCS, pp. 147 - 157, DOI: 10.1007/978-3-030-98388-8\_14
7. Baldassarre M.T., Barletta V.S., Caivano D., Piccinno A., *Integrating security and privacy in HCD-scrum*, (2021) *ACM International Conference Proceeding Series*, DOI: 10.1145/3464385.3464746
8. Baldassarre M.T., Barletta V.S., Caivano D., Scalera M., *Integrating security and privacy in software development*, (2020) *Software Quality Journal*, 28 (3), pp. 987 - 1018, DOI: 10.1007/s11219-020-09501-6
9. Barletta V.S., Caivano D., Nannavecchia A., Scalera M., *Intrusion detection for in-vehicle communication networks: An unsupervised kohonen SOM approach* (2020) *Future Internet*, 12 (7), art. no. 119, DOI: 10.3390/FI12070119
10. Barletta V.S., Caivano D., Dimauro G., Nannavecchia A., Scalera M., *Managing a smart city integrated model through smart program management*, (2020) *Applied Sciences (Switzerland)*, 10 (2), art. no. 714, DOI: 10.3390/app10020714

## Barletta Vita Santa

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Via E. Orabona, 4, 70125 Bari – Italy

### Current Position

Assistant Professor (RTD-A) researcher at the Department of Computer Science, University of Bari Aldo Moro, with the research project “Quantum Software Engineering”.

### Research Area

Vita Santa Barletta is a member of SERLAB research laboratory (serlab.di.uniba.it) at the Department of Computer Science, University of Bari Aldo Moro. Her research interests include quantum computing, quantum software engineering, secure software engineering, secure project management and cyber security.

She starts her research in November 2017 with the Ph.D in Computer Science, investigating tools, methods and techniques for secure software project management along three dimensions: (i) *Organizational*, definition of new organizational models and structures that contribute to the development of "secure systems"; (ii) *Process groups and knowledge areas*, definition of new processes or knowledge areas for secure project management; (iii) *Tools and techniques*, definition of tools and techniques for secure project management and best practices for the design, development and deployment of secure services. The research produces several papers enabling scientific and industrial collaborations, such as the IBM Security internship. In addition, the results of this period in the industry are presented at International Conference “Cybertech 2019” in Tel Aviv, and in the Report CLUSIT (Associazione Italiana per la Sicurezza Informatica).

Moreover, the security factor is also being investigated on quantum technologies, leading to the initiation of further research activities on Quantum Software Security with the Alarcos research group at the University of Castilla La-Mancha. The goal is to define methods, tools and techniques to be able to fully exploit the potential of Quantum Computing in software development, also in accordance with the principles of the “Talavera Manifesto for Quantum Software Engineering and Programming” and in particular to “Security and Privacy by Design”. It is necessary to investigate the evolution of major software development methods and the impact that software development techniques based on Quantum Computing will have on different domains.

For this reason, currently, her research aims to investigate the effectiveness of quantum programming in improving security in the automotive domain. To this aim, several initiatives have been established including a doctoral project in which Vita Santa Barletta is a co-tutor. The research goals are to analyze the attacks that can be conducted on in-vehicle and out-vehicle with the purpose to evaluate the security of critical components; to investigate, implement, and evaluate new methodologies to increase the security and robustness of vehicles.

### Education

- February 2021 - Ph.D in Computer Science at the Department of Computer Science, University of Bari Aldo Moro. Title: “Secure Project Management”. Advisor: Prof. Danilo Caivano.
- July 2017 - MSc in Computer Science, University of Bari Aldo Moro with full marks and honors.
- July 2017 - Short master in Cybersecurity, University of Bari Aldo Moro.
- March 2014 - BSc in “Informatica e Comunicazione Digitale”, University of Bari Aldo Moro with full marks and honors.

## Professional Experience

July 2021 – January 2022 Post-Doctoral Research at the Department of Computer Science, University of Bari Aldo (Assegno di ricerca – ING-INF/05). Project title: “Quantum Software Security”. Advisor: Prof. Danilo Caivano.

A.A. 2019-2020 / 2020-2021 Contract Professor at the Department of Computer Science, University of Bari Aldo. Course: “Organizzazione Aziendale”, Master degree in “Sicurezza Informatica”.

## Organizing committee

- CSE4IA 2023 – Co-organizer of the *1<sup>st</sup> International Workshop on Cyber Security Education for Industry and Academia*, co-located in IS-EUD 2023
- QP4SE 2022 – Co-organizer of the *1<sup>st</sup> International Workshop on Quantum Programming for Software Engineering*, co-located with ESEC/FSE 2022
- INTERACT 2021 - Student Volunteer Co-Chairs of the *18<sup>th</sup> International Conference on Human-Computer Interaction*
- ESEM 2021 - Virtualization Co-Chair of the *15<sup>th</sup> Empirical Software Engineering and Measurement*
- ESEM 2020 - Website Co-Chairs of the *14<sup>th</sup> Empirical Software Engineering and Measurement*

## Program committee

- INTERACT 2023, International Conference on Human-Computer Interaction
- SEKE 2023 – 2022 – 2021 - 2020, International Conference on Software Engineering & Knowledge Engineering
- MUM 2021 - 2022, International Conference on Mobile and Ubiquitous Multimedia
- PROFES 2019, International Conference on Product-Focused Software Process Improvement

## Teaching

- Organizzazione Aziendale - Master Degree in “Sicurezza Informatica”, Department of Computer Science, University of Bari Aldo Moro
  - Academic years 2022/2023 - 2021/2022 – 2020/2021 – 2019/2020
- Ingegneria del Software, A-L (2 CFU) – Bachelor Degree in “Informatica e Tecnologie per la Produzione del Software”, Department of Computer Science, University of Bari Aldo Moro
  - Academic year 2022/2023
- Ingegneria del Software, M-Z (2 CFU) – Bachelor Degree in “Informatica e Tecnologie per la Produzione del Software”, Department of Computer Science, University of Bari Aldo Moro
  - Academic year 2022/2023
- Secure Software Engineering (2CFU) – Master Degree in Computer Science – Curriculum Security Engineering, Department of Computer Science, University of Bari Aldo Moro
  - Academic year 2022/2023
- Cyberchallenge.IT – organized by the CINI Cybersecurity National Laboratory – University of Bari Aldo Moro.
  - Academic years 2022/2023 - 2021/2022

## Reviewer

- IEEE Transactions on Knowledge and Data Engineering (Journal)
- Behavior & Information Technology (Journal)
- Springer - Software Quality Journal
- MDPI Applied Sciences – Open Access Journal

- Advances in Human-Computer Interaction (Journal)
- INTERACT 2021: International Conference on Human-Computer Interaction
- HEALTHINF 2021: International Conference on Health Informatics
- NordiCHI 2020: Nordic Conference on Human-Computer Interaction
- ECIS 2020: European Conference on Information Systems
- HCSE 2020: International Conference on Human-Centered Software Engineering
- AVI 2020: International Conference on Advanced Visual Interfaces
- INTERACT 2019: International Conference on Human-Computer Interaction
- Project Management: Driving Complexity 3rd PMI® Italian Academic Workshop

## Publications

List of main publications in the secure software engineering and quantum security software.

1. Barletta V.S., Caivano D., Vincentiis M.D., Ragone A., Scalera M., Martín M.Á.S., *V-SOC4AS: A Vehicle-SOC for Improving Automotive Security*, (2023) Algorithms, 16 (2), art. no. 112, DOI: 10.3390/a16020112
2. Barletta V.S., Caivano D., De Vincentiis M., Magri A., Piccinno A., *Quantum Optimization for IoT Security Detection*, (2023) Lecture Notes in Networks and Systems, 603 LNNS, pp. 187 - 196, DOI: 10.1007/978-3-031-22356-3\_18
3. Pecorelli F., Barletta V.S., Serrano M.A., QP4SE Welcome from the chairs, QP4SE 2022 - Proceedings of the *1st International Workshop on Quantum Programming for Software Engineering*, co-located with ESEC/FSE 2022, pp. III - IV
4. Baldassarre, M.T., Barletta, V.S., Caivano, D., and Piccinno, A., 2021. *Integrating Security and Privacy in HCD-Scrum*. In CHIItaly 2021: 14th Biannual Conference of the Italian SIGCHI Chapter (CHIItaly '21). Association for Computing Machinery, New York, NY, USA, Article 37, 1–5. <https://doi.org/10.1145/3464385.3464746>
5. Barletta, V.S., Buono, P., Caivano, D., Dimauro, G., and Pontrelli A., *An overview on the security technological levels in the Italian Smart Cities*. ITASEC. 2021. <http://ceur-ws.org/Vol-2940/paper42.pdf>
6. Barletta, V.S.; Caivano, D.; Nannavecchia, A.; Scalera, M. *Intrusion Detection for in-Vehicle Communication Networks: An Unsupervised Kohonen SOM Approach*. Future Internet 2020, 12, 119. <https://doi.org/10.3390/fi12070119>
7. Barletta, V.S.; Caivano, D.; Nannavecchia, A.; Scalera, M. *A Kohonen SOM Architecture for Intrusion Detection on In-Vehicle Communication Networks*. Appl. Sci. 2020, 10, 5062. <https://doi.org/10.3390/app10155062>
8. Baldassarre, M.T., Barletta, V.S., Caivano, D., Piccinno, A., “*A Visual Tool for Supporting Decision-Making in Privacy Oriented Software Development*”. AVI '20, September 28-October 2, 2020, Salerno, Italy.
9. Baldassarre, M.T., Barletta, V.S., Caivano, D., Scalera, M., *Integrating security and privacy in software development*. In Software Quality Journal, 2020. DOI: 10.1007/s11219-020-09501-6
10. Barletta, V.S.; Caivano, D.; Dimauro, G.; Nannavecchia, A.; Scalera, M. *Managing a Smart City Integrated Model through Smart Program Management*. Appl. Sci. 2020, 10, 714.
11. Baldassarre M.T., Barletta V.S., Caivano D., Scalera M. (2019) *Privacy Oriented Software Development*. QUATIC 2019. Communications in Computer and Information Science, vol 1010. Springer, Cham. [https://doi.org/10.1007/978-3-030-29238-6\\_2](https://doi.org/10.1007/978-3-030-29238-6_2)
12. Baldassarre, M.T., V. Santa Barletta, D. Caivano, D. Raguseo, and M. Scalera. *Teaching Cyber Security: The HACK-SPACE Integrated Model*. ITASEC. 2019. <http://ceur-ws.org/Vol-2315/paper06.pdf>

The list of all publications is available at the following links:

- <https://www.scopus.com/authid/detail.uri?authorId=57205505690>
- <https://orcid.org/0000-0002-0163-6786>