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**PhD in Information Technology and Electrical Engineering**  
**Università degli Studi di Napoli Federico II**

**PhD Student: Francesco Crescenzo Grasso**

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**Cycle: XXXIX**

**Training and Research Activities Report**

**Year: First**

**Tutor: prof. Domenico Cotroneo**

**Date: October 31, 2024**

# Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXIX

Author: Francesco Crescenzo Grasso

## 1. Information:

- **PhD student:** Francesco Crescenzo Grasso
- **DR number:** DR997195
- **Date of birth:** 06/08/1998
- **Master Science degree:** Computer Engineering
- **University:** Università degli Studi di Napoli Federico II
- **Doctoral Cycle:** XXXIX
- **Scholarship type:** PNRR - DM 118/2023
- **Tutor:** Domenico Cotroneo

## 2. Study and training activities:

| Activity                                                                      | Type <sup>1</sup> | Hours | Credits | Dates                         | Organizer                             | Certificate <sup>2</sup> |
|-------------------------------------------------------------------------------|-------------------|-------|---------|-------------------------------|---------------------------------------|--------------------------|
| Ensuring Electronic Reliability Against CERN's Radiation Environment          | Seminar           | 1     | 0.2     | 01/12/2023                    | Prof. Francesco Fienga                | Y                        |
| Energy-Efficient Data Science                                                 | Seminar           | 1     | 0.2     | 13/12/2023                    | Prof. Elio Masciari                   | Y                        |
| Robotics meets AI and 5G: il futuro è adesso                                  | Seminar           | 2     | 0.4     | 14/12/2023                    | Prof. Paolo Massarotti                | Y                        |
| Strategic Orientation For STEM Research & Writing                             | Course            | 18    | 5       | 07/12/2023<br>-<br>23/02/2024 | Chie Shin Fraser                      | Y                        |
| Virtualization technologies and their applications                            | Course            | 18    | 5       | 11/01/2024<br>-<br>07/02/2024 | Prof. Luigi De Simone                 | Y                        |
| Using Deep Learning properly                                                  | Course            | 12    |         | 23/01/2024<br>-<br>06/02/2024 | Prof. Andrea Apicella                 | Y                        |
| IoT Data Analysis                                                             | Course            | 12    | 4       | 08/02/2024<br>-<br>22/02/2024 | Prof. Raffaele Della Corte            | Y                        |
| Statistical Data Analysis for Science and Engine                              | Course            | 12    | 4       | 15/02/2024<br>-<br>29/02/2024 | Prof. Roberto Pietrantuono            | Y                        |
| HOMINIS                                                                       | Seminar           | 5     | 1       | 21/02/2024                    | Proff. Carlo Sansone, Stefano Marrone | Y                        |
| Analytic center selection of optimization-based controllers for robot ecology | Seminar           | 1     | 0.2     | 09/04/2024                    | Prof. Bruno Siciliano                 | Y                        |
| Exploring the Frontiers of Modern Cryptography                                | Seminar           | 1:30  | 0.3     | 12/04/2024                    | Prof. Simon Pietro Romano             | Y                        |

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|--------------------------------------------------------------------------------------------------------|---------|------|-----|------------|--------------------------------------------------------|---|
| IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE Editors  | Seminar | 1:30 | 0.3 | 07/05/2024 | The IEEE Xplore Team                                   | Y |
| Sustainable IT: Strategic and Best Practices for a Green Engineering Future                            | Seminar | 5    | 1   | 27/05/2024 | Prof.ssa Tulino                                        | Y |
| Generative AI for Software Engineering: Strategies, Impact, and Practical Applications                 | Seminar | 5    | 1   | 30/05/2024 | Prof.ssa Tulino                                        | Y |
| Social Network Analysis: Methods and Applications                                                      | Seminar | 2    | 0.4 | 07/06/2024 | Prof. Giancarlo Sperli                                 | Y |
| Introduction to Large Language Models: Evolution and the current state                                 | Seminar | 2    | 0.4 | 10/06/2024 | Prof. Giancarlo Sperli                                 | Y |
| On the Single Allocation hub location problems: New formulations and Solving Methods                   | Seminar | 1    | 0.2 | 26/06/2024 | Proff. Claudio Sterle, Maurizio Boccia, Adriano Masone | Y |
| Using support vector machines for feature selection and outlier detection                              | Seminar | 1    | 0.2 | 26/06/2024 | Proff. Claudio Sterle, Maurizio Boccia, Adriano Masone | Y |
| Real-time Resource Management for Adaptive Embedded Systems and Applications                           | Seminar | 1    | 0.2 | 26/06/2024 | Prof. Marcello Cinque                                  | Y |
| Resource management and orchestration for mixed-criticality cloud/distributed systems                  | Seminar | 1    | 0.2 | 27/06/2024 | Prof. Marcello Cinque                                  | Y |
| From ACE Technologies to Sustainable, Accessible and Equitable Urban Mobility: An Optimization Journey | Seminar | 2    | 0.4 | 16/09/2024 | Prof. Stefania Santini                                 | Y |

- 1) Courses, Seminar, Doctoral School, Research, Tutorship
- 2) Choose: Y or N

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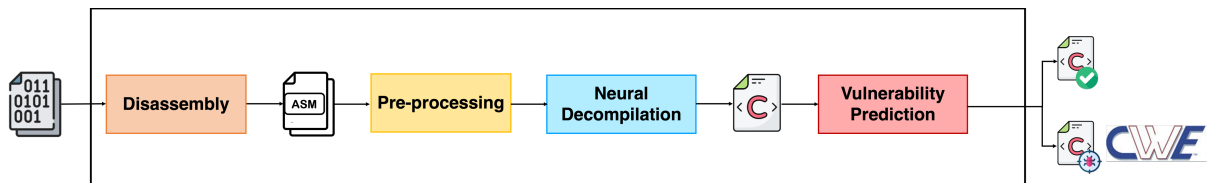
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## 2.1. Study and training activities - credits earned

|                 | Courses | Seminars | Research | Tutorship | Total |
|-----------------|---------|----------|----------|-----------|-------|
| Bimonth 1       |         | 1        | 9        |           | 10    |
| Bimonth 2       | 10      | 1        | 2        |           | 13    |
| Bimonth 3       | 8       | 0.5      | 2.5      |           | 11    |
| Bimonth 4       | 4       | 3.9      | 5        |           | 12.9  |
| Bimonth 5       |         |          | 9        |           | 9     |
| Bimonth 6       |         | 0.4      | 10       |           | 10.4  |
| <b>Total</b>    | 22      | 6.8      | 37.5     |           | 66.3  |
| <b>Expected</b> | 30 - 70 | 10 - 30  | 80 - 140 | 0 - 4.8   |       |

## 3. Research activity:

My research focuses on *binary vulnerability detection* via *neural decompilation* without the need for source code. Addressing this challenge involves coming across different fields of computer engineering in a transversal way, since the aim is to fulfill **security objectives** through new innovations in **machine learning**. I aim to explore the feasibility of developing a system capable of decompiling binary executables into a higher-level representation and classifying them based on the presence and types of vulnerabilities. The classification of vulnerabilities follows an established taxonomy, the *Common Weakness Enumeration (CWE)*. Although the complexities involved in this work are numerous and there are no works in the state of the art adopting my same approach to solve this problem, I find this direction promising and interesting since the first experiments in thesis.



In the early months, I focused on the comprehension of the encoder-decoder architectures, and concepts such as attention, behind *transformers* and modern *LLMs*. I concentrated on how to exploit these architectures in training models for neural decompilation and vulnerability prediction tasks. Furthermore, I investigated the pretraining technique, in particular the impact of pretraining in code generation and code translation tasks. In the next months, I trained transformers for both tasks, achieving results that in both cases overcome the state of the art. After the experimental phase, I submitted this work to the *DSN 2024 conference*, however it was rejected because a relevant problem concerned the synthetic data used to train the models, as they are not representative of the real data.

Since deep learning approaches are *data-driven*, another purpose of my first PhD year was to identify the best dataset for the neural decompilation work. I carefully analyzed data from several related works and concluded that I had to retrieve the dataset autonomously since no state-of-the-art dataset meeting all the requirements could be found. Following laboratory activities, I came to the generation of a new

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*real-world dataset* characterized by code taken from well-known open-source projects for this task for decompilation using Debian source packages. The created dataset has not yet been used in the work submitted to *EuroSys Fall '25*.

In the last few months, my main research topic branched into two possible directions. The first concerns neural decompilation, which could be studied by varying the architecture used, the level of optimization, and the training data. The second concerns vulnerability prediction, and understanding what the best representation (i.e., AST, CFG) of the code could be used to maximize the possibilities of predicting vulnerabilities. One outcome of this work is that some code representations are better at detecting some types of vulnerabilities than others. Therefore, a possible solution to improve vulnerability prediction could be to exploit different representations in conjunction to achieve higher performance in prediction.

## 4. Research products:

V. Orbinato, **F. Grasso**, R. Natella, D. Cotroneo. “Vulnerability Prediction on Binaries via Neural Decompilation”, *ACM European Conference on Computer Systems (EuroSys '25)*, 2025.  
Status: under 1st stage of review.

## 5. Conferences and seminars attended

None.

## 6. Activity abroad:

None.

## 7. Activity in partner companies:

None.

## 8. Tutorship

Supplementary teaching activities for the course of Laboratorio di Programmazione, Prof. Pietro Liguori. I provided lectures on Python, Data Science, Machine Learning, Neural Network.