# Emanuele Nardone

Software Engineer - PhD in Artificial Intelligence

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## Professional Profile

I am a PhD student focused on developing AI-driven medical diagnostic tools through machine learning and artificial intelligence applications. I analyze multiple data sources - handwriting dynamics, neuroimaging, and biological markers - to create early detection methods for Neurodegenerative Diseases (ND) and Specific Learning Disorders (SLD). I use deep learning architectures, specifically Transformers and CNNs, to build diagnostic frameworks that show promising results in the early detection of conditions like Alzheimer's disease using offline handwriting images. In my research, I also applied data augmentation techniques, Bayesian networks, feature selection optimization through evolutionary computation algorithms and a genetic programming approach for classification. I implement explainability tools such as SHAP values and attention visualisation to ensure that AI-driven diagnoses provide clear insights for healthcare practitioners.

## Education

**PhD - University of Cassino and Southern Lazio:** *PhD*
Department of Electrical and Information Engineering (DIEI)
**Supervisors**: Prof. Francesco Fontanella, Claudio De Stefano, Leonardo Vanneschi
**Thesis project**: Digital handwriting analysis using Machine and Deep Learning techniques for early diagnosis of DSA in children.
**Other**:
1. Develop C# WPF application for data acquisition for the PRIN2022 project on Alzheimer's disease through voice and handwriting.
2. Develop AI and Acquisition system for Parkinson's disease through handwriting for San Raffaele Cassino.
3. Develop a AI pipeline for handwriting analysis.

**PhD Period Abroad - University of NOVA IMS - Lisbon:**
Develop a Genetic Programming approach for a Multi-modal classification system.

**Master's Degree:** *Software Engineering*
*University of Cassino and Southern Lazio*
**Thesis topic**: "A stroke-based Machine Learning approach for early diagnosis of neurodegenerative diseases."
**Final degree mark**: 110/110 summa cum laude

**Erasmus+ Period:** *Erasmus+ Student Grant*
*Faculdade de Engenharia da Universidade do Porto* (Portugal)
**Program**: European Student exchange program

## Work Experience

**Fellowship - University of Cassino and Southern Lazio:** *Researcher*
Department of Electrical and Information Engineering (DIEI)
1. Prof. Claudio De Stefano
2. Prof. Francesco Fontanella
Developing an application for handwriting data acquisition from Wacom devices using C# language and WPF library.

**Fellowship - University of Cassino and Southern Lazio:** *Researcher*
Department of Electrical and Information Engineering (DIEI)
1. Prof. Claudio De Stefano
2. Prof. Francesco Fontanella
Machine Learning techniques for predicting cognitive deficits through handwriting analysis using Python programming language and scikit-learn/pandas/numpy libraries.

## Certifications

- Professional Qualification to Practice Software Engineering - 12/2021
- Microsoft Certified: Azure AI Fundamentals - 06/2022
- ESB LEVEL 1 Certificate in ESOL International All Modes - (B2)

## Technical Skills

- Software Development
- Python, C++, C#, Java
- Machine Learning
- Deep Learning
- Data Analysis
- Database: SQL, MongoDB
- Operating Systems
- Kubernetes, Docker
- Basic Agentic AI Development: smolagents, LangChain, LangGraph

## Publications

- Emanuele Nardone, Tiziana D'Alessandro, Claudio De Stefano, Francesco Fontanella, Alessandra Scotto di Freca (2025). "How Data Augmentation Affects Evolutionary Algorithms in Feature Selection: An Experimental Study". In: *Springer Nature Computer Science, vol. 6, p.536, 2025.*
- Emanuele Nardone, Claudio De Stefano, Nicole Dalia Cilia, Francesco Fontanella (2025). "Handwriting strokes as biomarkers for Alzheimer's disease prediction: A novel machine learning approach". In: *Computers in Biology and Medicine, vol. 190, p.110039, 2025.*
- Emanuele Nardone, Tiziana D'Alessandro, Claudio De Stefano, Francesco Fontanella, Alessandra Scotto di Freca (2025). "A Bayesian network combiner for multimodal handwriting analysis in Alzheimer's disease detection". In: *Pattern Recognition Letters, vol. 190, p.177-184, 2025.*
- Gabriele Lozupone, Emanuele Nardone, Cesare D. Pace, Tiziana D'Alessandro (2025). "Transformers and CNNs in Neurodiagnostics: Handwriting Analysis for Alzheimer's Diagnosis". In: *International Conference on Pattern Recognition, p.447-463, 2025.*
- Tiziana D'Alessandro, Claudio De Stefano, Francesco Fontanella, Emanuele Nardone, Cesare D. Pace (2024). "From Handwriting Analysis to Alzheimer's Disease Prediction: An Experimental Comparison of Classifier Combination Methods". In: *International Conference on Document Analysis and Recognition, p.334-351, 2024.*
- Tiziana D'Alessandro, Claudio De Stefano, Francesco Fontanella, Emanuele Nardone (2024). "Integrating Data Augmentation in Evolutionary Algorithms for Feature Selection: A Preliminary Study". In: *International Conference on the Applications of Evolutionary Computation, 2024.*
- Marco Cantone, Svonko Galasso, Gabriele Lozupone, Emanuele Nardone, Cesare D. Pace, Ciro Russo *et al.* (2024). "UniCas for Medicine and Healthcare". In: *Ital-IA, 2024.*
- Tiziana D'Alessandro, Claudio De Stefano, Francesco Fontanella, Emanuele Nardone, Alessandra Scotto di Freca (2023). "Feature Evaluation in Handwriting Analysis for Alzheimer's Disease Using Bayesian Network". In: *International Graphonomics Conference, p.122-135, 2023.*

- Tiziana D'Alessandro, Claudio De Stefano, Francesco Fontanella, Emanuele Nardone (2023). "A Genetic Algorithm for Feature Selection for Alzheimer's Disease Detection Using a Deep Transfer Learning Approach". In: *Italian Workshop on Artificial Life and Evolutionary Computation, p.309-323, 2023.*
- Nicole Dalia Cilia, Tiziana D'Alessandro, Claudio De Stefano, Francesco Fontanella, Emanuele Nardone (2022). "Predicting Alzheimer's Disease: A Stroke-Based Handwriting Analysis Approach Based on Machine Learning". In: *International Conference on Pattern Recognition, p.632-643, 2022.*
- Emanuele Nardone, Francesco Fontanella, Claudio De Stefano (2021). "Machine Learning for Early Diagnosis of Neurodegenerative Diseases Through Handwriting Analysis". In: *1st INTERNATIONAL PhD SYMPOSIUM ON ENGINEERING AND SPORT SCIENCE, p.219, 2021.*
- Ciro Russo, Tobias Grossauer, Emanuele Nardone, Zafeiris Kokkinogenis, Rosaldo J. F. Rossetti (2020). "How Smart and Green? A Simulation Model of Demand Cost Perception in the Electricity Market". In: *IEEE International Smart Cities Conference (ISC2), p.1-8, 2020.*

## Languages

- Italian - Native
- English - B2 level

## Achievements

**Corso di Alta Formazione** **02/2025-06/2025: Tutor**
**University of Cassino and Southern Lazio**
Delivered frontal lessons and exercises on LLM tools and their application for industrial workflow optimization. Supervised students throughout the program and provided guidance for their final projects.

**University of Cassino and Southern Lazio** **Fall 2024: Adjunct Instructor Computer Engineering Department - LM-32 Master's Degree Program**
Delivered practical instruction in artificial intelligence as part of the Master's degree program in Computer Engineering (LM-32). Focused on developing students' hands-on capabilities through interactive learning sessions and practical exercises. Created and implemented learning materials to improve students' understanding of AI concepts and applications.

**ISESS 2023** **10/2023: Oral Session Chairman**
**University of Cassino and Southern Lazio**
Member of the Organization Committee of the $1^{st}$ *International PhD Symposium on Engineering and Sport Sciences* and Oral session Chairman.

**CyberChallenge.IT 2023** **06/2023: Instructor**
**Cybersecurity National Lab, CINI - University of Cassino and Southern Lazio**
Played a pivotal role at the University of Cassino and Southern Lazio location, facilitating hands-on learning and skill development in cybersecurity for participants. Engaged in delivering cybersecurity exercises, creating a dynamic and interactive learning environment.