Andrea Terlizzi

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📍 **Work:** Via Giovanni Paolo II 132, 84084 Fisciano (Italy)

ABOUT ME

Ph.D. student at the intersection of deep learning and computational neuroscience, or NeuroAI, with a research focus on biologically and connectome-constrained neural architectures and reservoir computing. My work at NeuRoNe Lab aims to align modern AI more closely with principles of neural organization and dynamics. I maintain a long-term research collaboration with the University of Cambridge. Strong background in computer science, mathematics, and AI, supported by MSc and BSc degrees with honors from the University of Salerno.

Experienced in a multiple applied deep learning topics such as image captioning for remote sensing images, brain damage segmentation on MRI images, text-independent speaker identification, protein-ligand bound prediction, and label-free cell classification. Active reviewer for international journals and conferences (e.g. International Journal of Computational Intelligence Systems, IEEE SMC, IJCNN).

WORK EXPERIENCE

🏛 *Università degli Studi di Salerno* – Fisciano, Italy

Address: Via Giovanni Paolo II, 132, 84084 Fisciano (Italy) | **Website:** https://web.unisa.it/en/university | **Email address:** urp@unisa.it | **Name of unit or department:** Department of Management & Innovation Systems (DISA-MIS) - **Business or sector:** Professional, scientific and technical activities

Research Assistant

[08/05/2023 – 08/10/2023]

Grant Winner, "Remote Senting Image Captioning"
Research assistant focusing on developing and enhancing multimodal deep learning models for satellite image analysis.

Main activities:
- **Developed Enhanced Multimodal Deep Learning Models:** Engineering advanced models for zero-shot classification and automatic description of satellite images using state-of-the-art image-text architectures such as CLIP, SigLIP, and CLIPCap, employing techniques like self-distillation to improve their accuracy and correctness in the application domain.
- **Extensive Sperimentation**: Performance assessing by extensive sperimentation, ablation studies, and comparison with state-of-the-art methods.
- **Collaboration with NAIS Solutions:** Working closely with the NAIS Solutions, a leading tech company in the satellite imagery field, to refine and deploy these models in real-world applications.

Required Skills*:
Deep Learning, Multimodal Models, Zero-Shot Classification, Image-Text Architectures, Self-Distillation, Satellite Image Analysis

🏛 *Rigenera S.R.L.* – Rome, Italy

City: Rome | **Country:** Italy | **Website:** https://www.rigenerasrl.eu/ | **Email address:** info@rigenerasrl.eu | **Name of unit or department:** Rigenera S.R.L. Research - **Business or sector:** Professional, scientific and technical activities

Guest Researcher

[01/11/2021 – 01/06/2022]

Researcher developing innovative blockchain solutions for academic and industrial purposes, specifically efficient consensus algorithms and post-quantum blockchain-based signature schemes.

Main required skills included mathematical modeling, consensus algorithms, blockchain technologies, Web3, and smart contracts.

🏛 *Università degli Studi di Salerno* – Fisciano, Italy

Address: Via Giovanni Paolo II, 132, 84084 Fisciano (Italy) | **Website:** https://www.unisa.it/ | **Email address:** urp@unisa.it | **Name of unit or department:** DinfUnisa - Computer Science Department of Università degli Studi di Salerno - **Business or sector:** Professional, scientific and technical activities

Internal Internship

[22/02/2021 – 30/08/2021]

Design and implementation of a negotiation algorithm, in order to create an innovative, quantum-safe consensus mechanism for blockchains.

🏢 *Freelancing activity* – Caserta, Italy

Address: 81100 Caserta (Italy) | **Business or sector:** Professional, scientific and technical activities

Software designer and developer

[15/01/2020 – 23/12/2020]

Design and implementation of an e-commerce website, with particular focus on the algorithmic and high-level problem-solving side.

🏢 *Liceo Statale Alessandro Manzoni* – Caserta, Italy

Address: Via A. De Gasperi , 46, 81100 Caserta (Italy) | **Website:** https://www.liceomanzonicaserta.edu.it/ | **Email address:** cepm010008@istruzione.it | **Name of unit or department:** Linux User Group Manzoni (LUG Manzoni) - **Business or sector:** Professional, scientific and technical activities

Computer Science School Internship

[01/10/2016 – 30/05/2018]

Technical advising about the use of the Linux operating system, in order to improve the skills of the institute's Linux User Group (LUG).

EDUCATION AND TRAINING

Ph.D. in Data Science & Artificial Intelligence
Università degli Studi di Salerno [01/11/2024 – Current]

City: Fisciano | **Country:** Italy | **Website:** https://web.unisa.it/en/university | **Field(s) of study:** Computational Neuroscience and Bio-Inspired AI | **Level in EQF:** EQF level 8 | **NQF Level:** 8

- **Research Focus**: Bio-inspired and connectome-constrained deep learning with a focus on building neural network models that mimics principles of organization, connectivity and dynamics of biological neural networks. These include applying principles from computational neuroscience to create adaptive, energy-efficient deep learning systems.

- **Technical Skills**: Advanced data analysis, neural network design, and statistical modeling using Python, MATLAB, and deep learning frameworks (TensorFlow, PyTorch).

- **Research Competencies**: Strong foundation in experimental design, data-driven model development, and scientific writing. Experienced in end-to-end project management, from literature review to data analysis and publication.

- **Collaboration & Communication**: Interdisciplinary research experience; skilled in presenting findings and contributing to academic discussions.

Computer Science Master Degree
Università degli Studi di Salerno [01/10/2021 – 13/06/2024]

Address: Via Giovanni Paolo II, 132, 84084 Fisciano (Italy) | **Website:** https://web.unisa.it/en/university | **Field(s) of study:** Data Science & Machine Learning | **Final grade:** 110 Cum Laude with Highest Honors (4.0 G.P.A) | **Level in EQF:** EQF level 7 | **NQF Level:** 7 | **Type of credits:** ECTS | **Number of credits:** 117 | **Thesis:** Re-Imagining Bio-Inspired Neuromorphic Systems as Deep Neural Networks

Main advanced topics cover various types of neural networks (transformers, CNNs, RNNs, ...), computer vision and image processing, biometry, data analysis, inferential statistics, graph neural networks, advanced algorithms and optimization, learning methods, geometric topology and dimensionality reduction, multi-modal machine learning. Additionally, the program covers natural language processing techniques including language modeling, sentiment analysis, named entity recognition, and text classification, as well as reinforcement learning techniques such as Q-learning, policy gradients, and actor-critic methods. These skills encompass a range of abilities such as deep learning model design and training, feature extraction, transfer learning, data preprocessing, hyperparameter tuning, model evaluation, and ensemble learning techniques.
Number of ECTS Obtained: 117/117; **Grade Average**: 30/30; **Graduation Date**: 13 June 2024; **Final Grade**: 110 Cum Laude with Highest Honors (4.0 G.P.A.)

Computer Science Degree
Università degli Studi di Salerno [16/09/2018 – 30/09/2021]

Address: Via Giovanni Paolo II, 132, 84084 Fisciano (Italy) | **Website:** https://web.unisa.it/en/university | **Field(s) of study:** Computer Science | **Final grade:** 110 Cum Laude (4.0 G.P.A.) | **Level in EQF:** EQF level 6 | **NQF Level:** 6 | **Type of credits:** ECTS | **Number of credits:** 180 | **Thesis:** Blockchain with Negotiation-Based Consensus

Main topics and acquired skills include: proficiency in programming at both low and high levels, problem-solving abilities, implementation and usage of data structures, object-oriented programming, enterprise programming, and database design and implementation. The individual should also possess theoretical and practical knowledge in data structures and algorithm design and analysis, operating systems, web design, networking protocols, software engineering, discrete and continuum mathematics, artificial intelligence, operational research, numerical calculation, and theoretical computer science. These skills encompass a range of abilities such as computational complexity analysis, proofs of correctness, memory management, process management, file systems, use of E-R and relational models, SQL, front-end/back-end technologies, and understanding of various learning models, optimization algorithms, and formal languages.
Number of ECTS Obtained: 180/180; **Grade Average**: 30/30; **Graduation Date**: 30/09/2021; **Final Grade**: 110/110 Cum Laude (4.0 G.P.A.)

High School Leaving Qualification in Scientific Studies
Liceo Statale Alessandro Manzoni

Address: Via A. De Gasperi, 46, 81100 Caserta (Italy) | **Website:** https://www.liceomanzonicaserta.edu.it/ | **Final grade:** 96/100 | **Level in EQF:** EQF level 4

LANGUAGE SKILLS

Mother tongue(s): Italian

Other language(s):

English

LISTENING C1 **READING** C1 **WRITING** C1

SPOKEN PRODUCTION C1 **SPOKEN INTERACTION** C1

Levels: A1 and A2: Basic user; B1 and B2: Independent user; C1 and C2: Proficient user

SKILLS

Programming Languages, Frameworks, APIs and Technologies

Python (Excellent) / C (Excellent) / JAVA (Java SE, Java EE, EJB, JSP, Servlets, JDBC) (Excellent) / Scikit-Learn (Excellent) / Design Patterns (Good) / NumPy (Excellent) / Pandas (Good) / Graphein (Good) / NetworkX (Good) / NLTK (Good) / OpenCV (Good) / iGraph (Good) / Gymnasium (Good) / LaTeX (Good) / Weights & Biases (Excellent) / GitHub (Good) / R (Good) / SQL (Excellent) / MySQL (Excellent) / Matlab (Good) / JUnit (Good) / JavaScript (Good) / PHP (Good) / Flask (Good) / JEP (Java Embedded Python) (Good) / HTML5 (Good)

Deep Learning Frameworks

PyTorch (Excellent) / PyTorch Lightning (Excellent) / TorchVision (Excellent) / PyTorch Geometric (Excellent) / TorchText (Good) / HuggingFace Transformers (Excellent) / Sentence Transformers (Excellent) / TensorFlow (Excellent) / Keras (Excellent)

Tools and Software

PyCharm IDE (Excellent) / IntelliJ IDEA (Excellent) / Eclipse IDE (Good) / CLion IDE (Good) / Dev C++ IDE (Good) / Lightning Studio (Good) / Jupyter Notebooks (Good) / Linux OS (Good) / TeX Studio (Good) / Overleaf (Excellent) / Sublime Text Editor (Excellent) / Draw.io (Good) / Microsoft Office (Excellent)

PUBLICATIONS

[2024]
Elegans-AI: How the Connectome of a Living Organism Could Model Artificial Neural Networks **Authors:** Francesco Bardozzo, Andrea Terlizzi, Claudio Simoncini, Pietro Lió, Roberto Tagliaferri**Journal:** Neurocomputing, Volume 584, 1 June 2024, 127598**DOI:** 10.1016/j.neucom.2024.127598**License:** Creative Commons Open Access
Description:The paper introduced Elegans-AI models, which use the connectome topology of Caenorhabditis elegans worm to design neural network architectures. By transforming natural connectomes into artificial neural networks, we embedded their

intricate circuitry, including neural paths and cycles, into deep learning and reservoir models. Our approach enhances neural-dynamic memory and learning capabilities and the expressiveness of the models, while providing structural explainability by examining connectome properties.The Elegans-AI models achieved remarkable accuracy rates of 99.99% on CIFAR-10 and CIFAR-100, and 99.84% on MNIST-Unsup benchmarks, with fewer learning parameters than state-of-the-art methods, especially in reservoir configurations. These results underscore the effectiveness of evolutionary optimization in developing efficient, high-performing neural networks.

Keywords*: Connectome Topology, Deep Learning, Reservoir Networks, Evolutionary Optimization, Bio-plausible Networks, Neural-Dynamic Memory, Structural Explainability, Small-World Networks, Connectome-Constrained Deep Learning, Neuromorphic Deep Learning.

[2025]
Advancing label-free cell classification with connectome-inspired explainable models and a novel LIVECell-CLS dataset **Authors:** Andrea Terlizzi, Pierpaolo Fiore, Francesco Bardozzo, Pietro Lió, Roberto Tagliaferri**Journal:** Computers in Biology and Medicine, Volume 192, Part B, June 2025, 110274**DOI:** 10.1016/j.compbiomed.2025.110274**License:** Creative Commons Open Access

Description: This work introduced LIVECell-CLS, a new benchmark dataset of over 1.6 million label-free single-cell images drawn from eight distinct cell lines, aimed at enabling more realistic and scalable training and evaluation of deep learning models. We evaluated sixteen state-of-the-art model architecture, from convolutional networks to Vision Transformers and MLP-Mixers, finding that models with strong locality inductive biases (such as CNNs and Swin-Transformers) tend to outperform patch-based models in balanced accuracy and F1 in this kind of biological datasets. To further push performance, we designed variants of the baseline backbones that integrate a connectome-inspired Tensor Network module (modeled after *C. elegans*) into the latent space just before classification; these variants delivered consistent improvements (up to ~4 percentage points) in test accuracy with modest parameter increases. The best model, Elegans-EfficientNetV2-M, achieved ~ 90.35 % accuracy and ~ 94.82 % F1-score. Finally, through explainable-AI tools and dimensionality reduction visualizations (UMAP), we showed that these performance gains correspond to better feature separability and more precise decision boundaries, especially when discriminating among cell lines with very similar morphology.

Keywords*: Deep learning, Microscopy imaging, Explainable AI, Label-free cell classification, Connectome-constrained deep learning

PROJECTS

[28/03/2022 – 25/07/2023]
DNN-HMM Hybrid deep learning system for speaker identification, combining an LSTM-CNN neural network and Hidden-Markov-Models (HMMs) to empower the recognition capabilities compared to state-of-the-art methods on the TIMIT dataset (GitHub [link](#)).

[15/04/2023 – 31/07/2024]
Quadruplet Sentence Transformers A variant of the Sentence-BERT model based on the y-quadruplet loss, a novel loss function designed to enhance semantic embedding models by capturing nuanced sentence-level relationships and improving performance in tasks such as space coherence, separability, and information retrieval, outperforming the baseline Sentence-BERT model (GitHub [link](#)).

[30/10/2022 – 07/01/2023]
Protein-Rearrangement-Prediction A Graph Neural Network (GNN)-based system for protein structural rearrangement classification trained with a large database consisting in AlphaFold-generated protein 3D structures (GitHub [link](#)).

[14/02/2022 – 03/08/2022]
De-Trains A NoSQL and blockchain-based application for solding train tickets using Solidity smart contracts (GitHub [link](#)).

[30/11/2020 – 03/02/2021]
GameHub An videogame e-commerce webapp featuring a machine learning-based recommendation system perfectly integrated in the Java environment through several design patterns (GitHub [link](#)).

MACHINE & DEEP LEARNING SKILLS

Methods and theoretical skills

- **Machine Learning**: optimization algorithms, learning methods, dimensionality reduction, and ensemble learning techniques, model evaluation, regularization theory;
- **Deep Learning**: artificial neural networks, CNNs, RNNs, transformers, graph neural networks, LLMs, VLMs, state-space models, diffusion models, neural ODEs, capsule networks, deep learning model design and training, feature extraction, transfer learning, data preprocessing, hyperparameter tuning;
- **Computational Neuroscience and Neuromorphic Deep Learnning**: neuronal models, SNNs, SNN-deep learning methods, neural circuit policies, reservoir computing and echo-state networks, connectome-constrained deep learning;
- **Computer Vision and Image Analysis**: spectral image analysis, image filtering, image denoising, biometry.
- **Natural Language Processing**: language modeling, sentiment analysis, and text classification;
- **Reinforcement Learning**: model-free on-policy/off-policy methods (e.g. SARSA, Q-Learning, DQN, SPR, BBF), policy gradients methods (e.g. Reinforce, PPO, SAC, TD3), and model-based methods (e.g. AlphaGo, MuZero, EfficientZero, Dreamer).

OTHER SCIENTIFIC EXPERIENCES

Review Activities

International Journals:

- International Journal of Computational Intelligence Systems
- IEEE Transactions on Cybernetics
- Applied Optics

International Conferences:

- IJCNN
- IEEE SMC
- CIBB

COMMUNICATION AND INTERPERSONAL SKILLS

Soft Skills

In addition to my technical skills, I possess several valuable soft skills that enable me to contribute effectively to a team. I prioritize teamwork and am capable of critical thinking and decision-making. My strong analytical skills give me the ability to learn, listen, and decipher intricate information, while still being able to communicate effectively and convey technical concepts clearly and concisely. Furthermore, I am highly motivated and enthusiastic, always looking for opportunities to learn and grow.

Caserta, CE, Italy, 11/11/2024

Andrea Terlizzi