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Nicola Di Cicco

PhD Student

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Skills

Programming Languages	Python, C, C++, Rust, MATLAB, AMPL, LaTeX
Software	PyTorch, JAX, Tensorflow, Gurobi, CPLEX, Docker, Kubernetes, Simulink, LabView, CST Studio Suite
Machine Learning	Reinforcement Learning, Graph Neural Networks, Probabilistic ML, Explainable AI
Operations Research	Advanced metaheuristics (Genetic Algorithms, Simulated Annealing, Variable Neighbourhood Search), exact and heuristic algorithms for Integer Linear Programming (Branch-and-Bound, Column Generation)

Education

PhD in Information Technology - Telecommunications, *Politecnico di Milano* 2021 - 2024 (expected)
- **Advisor**: Prof. Massimo Tornatore
- Co-author of 6 journal papers and several international conference proceedings (some at present under revision)

M.Sc. in Telecommunications engineering, cum Laude, *Università di Bologna.* GPA: 30/30 2019 - 2021
- "cum Laude" honors awarded in all exams
- **Research internship** on container orchestration and service function chaining. **Supervisor**: Prof. Walter Cerroni
- **Thesis**: "Scalable Algorithms for C-RAN Optimization". **Advisors**: Prof. Carla Raffaelli and Prof. Valentina Cacchiani

B.Sc. in Electronic and Telecommunications engineering, cum Laude, *Università di Bologna.* GPA: 29.3/30 2016 - 2019
- **Thesis**: "Theoretical and Experimental Modelling of Ring Resonators". **Advisors**: Prof. Paolo Bassi and Prof. Gaetano Bellanca

Selected Research Projects

Dynamic Reoptimization of Elastic Optical Networks with Deep Reinforcement Learning
- Real-time optimization of defragmentation in Elastic Optical Networks with dynamic traffic
- Goal: learn when to apply powerful (but expensive) heuristics to minimize OPEX and blocking rate
- Under active development. Preliminary results show 10%-30% w.r.t. static defragmentation scheduling

Deep Reinforcement Learning-based Local Search Algorithm for Network Optimization
- Implemented a state-dependant stochastic local search algorithm via Reinforcement Learning (DeepLS)
- Used a permutation-equivariant neural architecture for scaling on arbitrary-size instances
- Outperformed strong metaheuristics in the OSPF Weight Setting and Routing And Wavelength Assignment problems

Service Orchestration in Fog Computing Networks with Deep Reinforcement Learning
- Goal: learn fog orchestration policy leveraging telemetry data in the control plane
- Used a Deep Set network that generalizes zero-shot to arbitrary numbers of fog nodes
- Outperformed baseline heuristics on instances 10x-100x larger than training

Bayesian Active Learning for Failure Identification in Microwave Network
- Developed ensemble models for decomposing data and knowledge uncertainty in classification
- Implemented an Active Learning pipeline that autonomously selects samples providing the highest information gain
- Reducing labelling costs by 10x while maintaining 90%+ classification accuracy

Data Augmentation with Variational Autoencoders for Failure Identification in Microwave Networks
- Goal: mitigate data scarcity root-cause failure prediction in microwave networks with synthetic data
- Developed a Conditional Variational Autoencoder for efficient generation of per-class samples
- Improved recall on the least represented classes by 10%-30% compared to training on real data only

Static Routing and Wavelength Assignment with Deep Reinforcement Learning
- Goal: learn end-to-end a sequential routing heuristic based on Deep Reinforcement Learning
- Designed a shaped reward function and a Monte-Carlo multi-start algorithm for scaling to large networks
- Attained competitive results compared to a SotA Genetic Algorithm while being approximately 6x faster

Awards

Ph.D. Fellowship in Information Engineering (ranked 1st), Politecnico di Milano, 2021
Best Student Award in Telecommunications Engineering (ranked 1st), Università di Bologna 2021
Merit-based grant for students of Engineering and Architecture (ranked 2nd), Università di Bologna 2021

Personal Notes

- I am a fairly expert skier with more than 20 years of experience in the Dolomites, which are a big part of my life. Roberto Erlacher, former World Cup skier, and Heidi Schrott, National Instructor, were my first mentors. Franz Schrott was my latest mentor, to whom I owe
- I am a decent tennis player. I am also slightly better than my PhD advisor at playing padel
- My favorite song lately is "La Cura" by Franco Battiato

Publications

[1] F. Pasic*, N. Di Cicco*, M. Skocaj, M. Tornatore, S. Schwarz, C. F. Mecklenbräuker, and V. Degli-Esposti, "Multi-band high-mobility measurements for deep learning-based channel prediction and simulation," *IEEE Communications Magazine (under revision)*, 2023 (*equal contribution).

[2] M. Skocaj*, N. Di Cicco*, T. Zugno, M. Boban, J. Blumenstein, A. Prokes, T. Mikulasek, J. Vychodil, K. Mikhaylov, M. Tornatore, and V. Degli-Esposti, "Vehicle-to-everything (v2x) datasets for machine learning-based predictive quality of service," *IEEE Communications Magazine (under revision)*, 2023 (*equal contribution).

[3] N. Di Cicco, S. Del Prete, S. Kodra, M. Barbiroli, F. Fuschini, E. M. Vitucci, V. Degli-Esposti, and M. Tornatore, "Machine learning-based line-of-sight prediction in urban manhattan-like environments," in *17th European Conference on Antennas and Propagation (EuCAP 2023)*, 2023.

[4] N. Di Cicco, M. Ibrahimi, S. Troia, and M. Tornatore, "Lightweight deep reinforcement learning-based local search for network optimization," *IEEE Transactions on Network and Service Management (under revision)*, 2023.

[5] N. Di Cicco, G. F. Pittalà, G. Davoli, D. Borsatti, W. Cerroni, C. Raffaelli, and M. Tornatore, "Drl-forch: A scalable deep reinforcement learning-based fog computing orchestrator," in *9th IEEE International Conference on Network Softwarization (NetSoft 2023)*, 2023.

[6] G. S. Sticca, M. Ibrahimi, F. Musumeci, N. Di Cicco, A. Castoldi, R. Pastorelli, and M. Tornatore, "Selective hybrid edfa/raman amplifier placement to mitigate lightpath degradation in (c+l) networks," *IEEE/OSA Journal of Optical Communications and Networking (under revision)*, 2023.

[7] O. Ayoub, N. Di Cicco, F. Ezzedine, F. Bruschetta, R. Rubino, M. Nardecchia, M. Milano, F. Musumeci, C. Passera, and M. Tornatore, "Explainable artificial intelligence in communication networks: A use case for failure identification in microwave networks," *Computer Networks*, 2022.

[8] N. Di Cicco, V. Cacchiani, and C. Raffaelli, "Optimization over time of reliable 5G-RAN with network function migrations," *Computer Networks*, 2022.

[9] N. Di Cicco, M. Ibrahimi, and M. Tornatore, "Calibrated probabilistic QoT regression for unestablished lightpaths in optical networks," in *5th International Balkan Conference on Communications and Networking (BalkanCom)*, 2022.

[10] N. Di Cicco, E. F. Mercan, O. Karandin, O. Ayoub, S. Troia, F. Musumeci, and M. Tornatore, "On deep reinforcement learning for static routing and wavelength assignment," *IEEE Journal of Selected Topics in Quantum Electronics*, vol. 28, no. 4, 2022.

[11] A. Quran, S. Troia, O. Ayoub, N. Di Cicco, and M. Tornatore, "A reinforcement learning-based dynamic bandwidth allocation for XGS-PON networks," in *26th International Conference on Optical Network Design and Modeling (ONDM)*, 2022, pp. 1–3.

[12] N. Di Cicco, V. Cacchiani, and C. Raffaelli, "Scalable multi-objective optimization of reliable latency-constrained optical transport networks," in *2021 17th International Conference on the Design of Reliable Communication Networks (DRCN)*, 2021.