Milan, Italy
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Nicola Di Cicco

PhD Student

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Skills

Programming Languages	Python, Julia, C++, Rust
Software	Deep Learning development (PyTorch, JAX), MILP solvers (Gurobi, SCIP, etc.), Docker
Machine Learning	Reinforcement Learning, Graph Neural Networks, Conformal Prediction, Explainable AI
Optimization	ILP modeling, metaheuristics (Genetic Algorithms, Variable Neighbourhood Search, Constraint-Based Local Search), stochastic and robust optimization, Constraint Programming

Education and Experience

Research Intern, *Internet Initiative Japan Research Lab, Tokyo, Japan* 2024

- **Advisor**: Jean-François Baffier
- **Research project**: Large Language Models for semi-automated Constraint Programming model formulation

NGI Enrichers Fellow, *Columbia University, New York, USA* 2023 - 2024

- **Advisor**: Prof. Gil Zussman
- **Research project**: Machine-Learning-based admission control and routing in mmWave backhaul networks

PhD in Information Technology - Telecommunications, *Politecnico di Milano, Italy* 2021 - 2024 (expected)

- **Advisor**: Prof. Massimo Tornatore
- **Research project**: Machine Learning for network optimization and control

M.Sc. in Telecommunications engineering, cum laude, *Università di Bologna, Italy.* GPA: 30/30 2019 - 2021

- Awarded “cum laude” honors in all class examinations
- **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, Italy.* 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

Language Models for Semi-Automated Constraint Programming (under development)

- Goal: translate natural-language descriptions into formal Constraint Programming models
- Developed a program search algorithm leveraging Large Language Models and Monte-Carlo Tree Search
- Preliminary qualitative results show high accuracy in mapping human intent to the appropriate XCSP3 core constraints

Local Search for Network Optimization via Deep Reinforcement Learning

- Goal: learn a stochastic local search algorithm via Reinforcement Learning (DeepLS)
- Proposed using permutation-equivariant neural networks for scaling on arbitrary-size instances
- Outperformed strong metaheuristics in the OSPF Weight Setting and Routing And Wavelength Assignment problems

Static Routing and Wavelength Assignment via 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 improving computational efficiency
- Attained competitive results compared to a SotA Genetic Algorithm while being approximately 6x faster

Reliable Machine Learning for Failure Classification in Microwave Networks

- Goal: learn a data-driven fault predictor with statistical guarantees
- Proposed using Conformal Prediction for post-training calibration of black-box ML models into rigorous probabilistic classifiers
- The model can satisfy strict user-specified constraints on its predictions (e.g., $P(\text{correct}) \geq 0.99$)

Active Learning for Failure Classification in Microwave Networks

- Goal: minimize costly and time-consuming data annotation of microwave network telemetry data
- Implemented an Active Learning pipeline that autonomously selects new data for augmenting the training set
- Reducing labelling costs by 10x while maintaining 90%+ failure classification accuracy

Awards and fellowships

NGI Enrichers fellowship for a 6-month research visit at Columbia University 2023
Ph.D. Fellowship in Information Engineering (ranked 1st), Politecnico di Milano 2021
Best Student Award in Telecommunications Engineering (ranked 1st), Università di Bologna 2021

Personal Notes

- I am a fairly expert skier. I spent many years having fun in the Dolomites. I actually bonked my head really hard as a kid once.
- My favorite piece of music as of late is “A Town with an Ocean View”.

Publications

[1] A. Attarpour, M. Ibrahimi, N. D. Cicco, F. Musumeci, A. Castoldi, M. Ragni, and M. Tornatore, "Joint qot-aware optimization of otn and wdm layers for low-cost optical metro networks," *ICC 2024 - IEEE International Conference on Communications*, 2024.

[2] N. D. Cicco, M. Ibrahimi, O. Ayoub, F. Bruschetta, M. Milano, C. Passera, and F. Musumeci, "Asap hardware failure-cause identification in microwave networks using venn-abers predictors," *IEEE Transactions on Network and Service Management*, 2024.

[3] N. Di Cicco, M. Ibrahimi, F. Musumeci, F. Bruschetta, M. Milano, C. Passera, and M. Tornatore, "Machine learning for failure management in microwave networks: A data-centric approach," *IEEE Transactions on Network and Service Management*, 2024.

[4] N. Di Cicco, M. Ibrahimi, S. Troia, F. Musumeci, and M. Tornatore, "Open implementation of a large language model pipeline for automated configuration of software-defined optical networks," in *ECOC 2024 - 50th European Conference on Optical Communications*, 2024.

[5] N. Di Cicco, G. F. Pittalà, G. Davoli, D. Borsatti, W. Cerroni, C. Raffaelli, and M. Tornatore, "Scalable and energy-efficient service orchestration in the edge-cloud continuum with multi-objective reinforcement learning," *under review*, 2024.

[6] N. Di Cicco, F. Poltronieri, J. Santos, M. Zaccarini, M. Tortonesi, C. Stefanelli, and F. De Turck, "Multi-objective scheduling and resource allocation of kubernetes replicas across the compute continuum," in *20th International Conference on Network and Service Management (CNSM)*, 2024.

[7] O. Karandin, A. Lahoz, N. Di Cicco, F. Musumeci, and M. Tornatore, "Resource-efficient implementation of multiple concurrent tree-based models in p4 switches using feature sharing," in *20th International Conference on Network and Service Management (CNSM)*, 2024.

[8] G. F. Pittalà, C. Zilli, N. Di Cicco, G. Davoli, and A. Sacco, "Recovering missing monitoring data to enhance service provisioning in the edge-to-cloud continuum," in *2024 IEEE 10th International Conference on Network Softwarization (NetSoft)*, 2024.

[9] J. Santos, M. Zaccarini, F. Poltronieri, M. Tortonesi, C. Stefanelli, N. Di Cicco, and F. De Turck, "Hephaestusforge: Optimal microservice deployment across the compute continuum via reinforcement learning," *under review*, 2024.

[10] J. Santos, M. Zaccarini, F. Poltronieri, M. Tortonesi, C. Stefanelli, N. Di Cicco, and F. de Turck, "Efficient microservice deployment in kubernetes multi-clusters through reinforcement learning," in *NOMS 2024 - IEEE/IFIP Network Operations and Management Symposium*, 2024.

[11] G. S. Sticca, M. Ibrahimi, N. Di Cicco, F. Musumeci, and M. Tornatore, "Hollow-core fibers for latency-constrained and low-cost edge data center networks," *under review*, 2024.

[12] G. S. Sticca, M. Ibrahimi, N. Di Cicco, F. Musumeci, and M. Tornatore, "On high-power optical amplification in hollow core fibers for energy efficiency and network throughput maximization," in *ECOC 2024 - 50th European Conference on Optical Communications*, 2024.

[13] G. S. Sticca, M. Ibrahimi, F. Musumeci, N. Di Cicco, and M. Tornatore, "Hollow-core-fiber placement in latency-constrained metro networks with edgedcs," *OFC 2024 - Optical Fiber Communication Conference*, 2024.

[14] A. Attarpour, M. Ibrahimi, N. D. Cicco, F. Musumeci, A. Castoldi, M. Ragni, and M. Tornatore, "Minimizing the cost of hierarchical optical transport network traffic grooming boards in metro networks," *IEEE/OSA Journal of Optical Communications and Networking*, 2023.

[15] N. Di Cicco, A. Al Sadi, C. Grasselli, A. Melis, G. Antichi, and M. Tornatore, "Poster: Continual network learning," in *Proceedings of the ACM SIGCOMM 2023 Conference*, 2023.

[16] 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.

[17] N. Di Cicco, M. Ibrahimi, S. Troia, and M. Tornatore, "DeepLS: Local search for network optimization based on lightweight deep reinforcement learning," *IEEE Transactions on Network and Service Management*, 2023.

[18] 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.

[19] N. Di Cicco, J. Talpini, M. Ibrahimi, M. Savi, and M. Tornatore, "Uncertainty-aware qot forecasting in optical networks with bayesian recurrent neural networks," in *ICC 2023 - IEEE International Conference on Communications*, 2023.

[20] F. Pasic, N. Di Cicco, M. Skocaj, M. Tornatore, S. Schwarz, C. F. Mecklenbräuker, and V. Oegli-Esposti, "Multi-band measurements for deep learning-based dynamic channel prediction and simulation," *IEEE Communications Magazine*, 2023.

[21] 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*, 2023.

[22] 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*, 2023.

[23] G. S. Sticca, M. Ibrahimi, F. Musumeci, N. Di Cicco, and M. Tornatore, "Throughput maximization in (c+l+s) networks with incremental deployment of hfas and 3rs," *ECOC 2023 - 49th European Conference on Optical Communications*, 2023.

[24] 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.

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

[26] 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.

[27] 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*, 2022.

[28] 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.

[29] 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.