PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Giampaolo Bovenzi

XXXIV Cycle

Training and Research Activities Report – Third Year

Tutor: Antonio Pescapè

Information

Giampaolo Bovenzi received in year 2018 the Master Science degree in Computer Engineering from the University of Napoli Federico II. He attended a curriculum in "Reti e Internet" within the PhD programme in Information Technology and Electrical Engineering at the University of Napoli Federico II, being tutored by the professor Antonio Pescapè. He received a grant from CINI.

Study and Training Activities

Courses

Module Title	Type	Credits	Lecturer	Organization
Digital Forensics	Ad hoc module	3	Dr. Giovani Cozzolino	ITEE
Data Management	MS Module	6	Prof. Flora Amato	University of Napoli Federico II

Seminars

Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
At the Nexus of Big Data, Machine Intelligence, and Human Cognition	0.2	Prof. George S. Djorgovski	University of Napoli Federico II	ITEE
Exploiting Deep Learning and Probabilistic Modeling for Behavior Analytics	0.2	Prof. Giuseppe Manco	University of Napoli Federico II	ITEE
Data Driven Transformation in WINDTRE through Managers voice	0.4	Marcello Savarese	University of Napoli Federico II	ITEE
Patent Searching Best Practices with IEEE Xplore	0.2	IEEE Xplore Webinar		IEEE
Robo Ludens: A game design taxonomy for human-robot interaction	0.2	Dr. John Edison Muñoz Cardona	University of Napoli Federico II	ITEE
Advances in Machine Learning for Modelling and	0.3	Prof. Gustau Camps-Valls	University of Napoli Federico II	ITEE

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Understanding in Earth Sciences				
Artificial Intelligence for notary's sector - a case study	0.2	Salvatore Palange	University of Napoli Federico II	ITEE
The era of Industry 4.0: new frontiers in business model innovation	0.2	Marco Balzano	University of Napoli Federico II	ITEE
Approaches to Graph Machine Learning	0.2	Miroslav Cepek	University of Napoli Federico II	ITEE
Big Data and Computational Linguistics	0.4	Francesco Cotugno	University of Napoli Federico II	ITEE
Cyber security in Akka Technologies	0.4	Dr. Luigi Villa, Sara Belluccini, Matteo Pracchia	University of Napoli Federico II	ITEE

Credits summary

	Credits year 1								Credits year 2								Credits year 3									
	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Total	Check
Modules	20	1.2	4.2	9	4.2	0	3.6	22.2	10	0	0	0	0	0	0	0	7	3	0	0	0	0	6	9	31.2	30-70
Seminars	5	0.8	0.6	0.9	2.4	0.2	1.6	6.5	5	0	0	0.4	0	0	0.2	0.6	5	1	0.9	0.6	0	0	0.4	2.9	10	10-30
Research	35	8	5.2	0.1	3.4	9.8	4.8	31.3	45	10	10	9.6	10	10	9.8	59.4	48	6	9.1	9.4	10	10	3.6	48.1	139	80-140
	60	10	10	10	10	10	10	60	60	10	10	10	10	10	10	60	60	10	10	10	10	10	10	60	180	180

Research activity

Giampaolo Bovenzi was involved in the design, implementation, and validation of advanced modelling techniques for network traffic, with the goal of obtain significant improvements in applications like traffic prediction and (incremental) traffic classification.

Deep Learning-based fine-grain prediction of mobile traffic

The fine-grain (viz. packet-level) modelling of traffic generated by mobile applications with deep-learning techniques has the purpose of forecast future behavior of the mobile traffic. We evaluated several state-of-the-art Deep Learning (DL) approaches for time-series forecasting, in order to model the mobile application traffic packet-level features, like Payload Length (PL) Inter-Arrival-Time (IAT), and Direction (DIR). Moreover, we evaluated the impact of the addition of exogenous inputs (viz. not predicted) like the TCP flags, the TCP receive window, and the bytes of the L4 (transport) payload.

Deep Learning-based class incremental learning for mobile traffic

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The adaptation (from computer vision) of incremental learning techniques (viz. class incremental learning) for the traffic generated by mobile applications, with the objective of extending the actual knowledge of an already trained model by preserving the already acquired knowledge. In detail, we design a revised version of iCaRL (incremental class and representation learning) by adapting its component to the network traffic via various optimizations which result in iCaRL+. We positively assessed the superiority of iCaRL+ w.r.t. iCaRL in its original formulation. However, despite the performance drop w.r.t. a model trained from the scratch (upperbound) is huge, the strong reduction of the update time is enough to further investigate the classification performance improvements.

This track of research is explored in collaboration with Huawei Paris, during the attended internship period.

Deep Learning-based global classifier hierarchical approaches for mobile traffic

The fine-grain modelling of traffic generated by mobile applications via hierarchical learning approaches based on global classifiers, which exploit the (hierarchical) relations among network traffic classes with the aim at obtaining performance gain in terms of classification accuracy. In detail, we designed 7 global classifier approaches to enforce hierarchical dependencies among classes during the training phase of DL-based models, capitalizing advancements in AI learning paradigms, like multitask learning, task-incremental learning.

Products

Publications

International journal papers

Montieri, A., **Bovenzi, G.**, Aceto, G., Ciuonzo, D., Persico, V., & Pescapè, A. (2021). Packet-level prediction of mobile-app traffic using multitask deep learning. *Computer Networks*, *200*, 108529.

Chapter in Books

Bollino, R., **Bovenzi, G.**, Cipolletta, F., Docimo, L., Gravina, M., Marrone, S., Parmeggiani, D., & Sansone, C. (2022). Synergy-Net: Artificial Intelligence at the Service of Oncological Prevention. In Handbook of Artificial Intelligence in Healthcare (pp. 389-424). Springer, Cham.

International Conference papers

Bovenzi, G., Yang, L., Finamore, A., Aceto, G., Ciuonzo, D., Pescape, A., & Rossi, D. (2021). A First Look at Class Incremental Learning in Deep Learning Mobile Traffic Classification. In *Network Traffic Measurement and Analysis Conference (IFIP TMA 2021)*.

Bovenzi, G., Foggia, A., Santella, S., Testa, A., Persico, V., & Pescapè, A. (2022). Data Poisoning Attacks against Autoencoder-based Anomaly Detection Models: a Robustness Analysis. In *ICC 2022-2022 IEEE International Conference on Communications*. IEEE.

Conferences and Seminars

Details

Network Traffic Measurement and Analysis Conference, Virtual, 14-15 September 2021, 1 paper

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Presentations made

Seminar entitled "Hierarchical Learning Approaches" during the Internet Data Analysis course, 2020/21.

End of internship presentation on final submitted research and results, internal at Huawei, Virtual.

Presentation of Class Incremental Learning techniques for Mobile Traffic, INW22, Courmayeur.

Activity Abroad

Year	Institution	Responsible for the foreign institution	Dates	Performed activities
3	Huawei R&D center Paris, France	Alessandro Finamore, Principal Engineering at Huawei R&D Center	17/11/2020-16/05/2021	Research on advanced machine- and deeplearning techniques for identification and analysis of network traffic. From this period a conference paper has been carried out, named "A First Look at Class Incremental Learning in Deep Learning Mobile Traffic Classification."

During this period carried out the abroad activities reported below.
State of the art on Class Incremental Learning, research proposal.
Study of state of the art regarding open issues in traffic classification: data and model obsolescence and class incremental learning; definition of a methodology / systematic approach for testing and evaluation of incremental learning approaches; discussion about available datasets.
Design, Implementation, and validation of the proposal.
Preliminary prototyping and evaluation of promising models in a class incremental scenario based on literature review; preliminary implementation of iCarl+ proposal, an enhanced version of iCaRL; evaluation of performing multiple incremental updates; deeper inspection of iCaRL+ failure modes and trying improvements; tuning of iCarl+ hyperparameters and evaluation of impact on incremental learning performance; manuscript writing and editing.
Submission of the Conference Paper "A First Look at Class Incremental Learning in Deep Learning Mobile Traffic Classification" to TMA 2021.
Seminar provided by Giampaolo Bovenzi on final submitted research and results.

Tutorship

Giampaolo Bovenzi has actively collaborated in teaching, carrying out support and control actions during exams for the Computer Networks course.
In addition, he held a seminar entitled "Hierarchical Learning Approaches" during the Internet Data Analysis course, 2020/21.
Noteworthy, he participated as co-supervisor to several B.Sc. and M.Sc. thesis.

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