



UNIVERSITÀ DI PISA
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

“Algorithmic Aspects of Distributed Systems”

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Short Abstract:

Today's Internet researcher must carry a large toolkit. Expertise in network measurement, network modeling, protocol design and systems engineering are perforce. But while many researchers bring these skills to the table, far fewer have deep insight when it comes to questions of algorithms and algorithmic analysis. This is all the more surprising given the wealth of elegant algorithmic constructs which have successfully been applied to a broad spectrum of problems in computer networking, distributed systems, and large-scale Internet infrastructures in recent years. This accelerated course is designed to strengthen and broaden a PhD student or postdoc background on a few algorithmic techniques that are broadly applicable to many networked and distributed systems, with the goal of applying at least one of these techniques towards a publication draft by the end of the course. In particular, I will first explain some of these techniques and algorithms, then give concrete examples on how my research group has applied them in multiple occasions, obtaining publications in reputable transactions or conference papers. Examples of topics covered will include (i) techniques on problems formulations, such as modeling multi-objective problems using (primal and dual) decomposition and network utility maximization, (ii) versatile solutions in distributed resource allocation such as consensus protocols and approximation algorithms, and (iii) probabilistic data structures such as Bloom Filters and Cuckoo filters for efficient implementations.

Hands-on Writing Activities: Students will be asked to apply these concepts in their own research, complete short technical writing exercises during the course, and will write a draft of a publication using one of the techniques presented during the course. We will dedicate part of the course reviewing also communication techniques that I found useful to write publications and grant proposals.

Course Contents in brief:

- Optimization and decomposition techniques for networking problems.
- Distributed algorithms for resource allocation and coordination.
- Probabilistic data structures for scalable systems.
- Algorithmic methods for networked and distributed systems.
- Research case studies and applications.

Total # of hours of lecture: 16

References:

L. Pappone; A. Sacco, F. Esposito, *“Mutant: Learning Congestion Control from Existing Protocols via Online Reinforcement Learning”*, NSDI’25.

--- <https://www.usenix.org/conference/nsdi25/presentation/pappone>

CV of the Teacher

Flavio Esposito is an Associate Professor in the Department of Computer Science at Saint Louis University (SLU), and a Fellow of the Research Institute at SLU. He received his Ph.D. in Computer Science at Boston University and his M.S. in Telecommunication Engineering from the University of Florence, Italy. His research interests intersect (wireless) network management, network virtualization, artificial intelligence, and cyber-physical systems. Before joining SLU, Flavio was a senior software engineer at a high-frequency trading company, building network protocols and firmware for FPGA. Flavio was also a visiting research scientist at Bell Laboratories, NJ, BBN Technologies, MA (the company that built ARPANET), at Eurecom, France, and at the Center for Wireless Communications, in Oulu, Finland. Flavio has received several research and service awards, including five best paper awards in IEEE conferences, the Comcast Innovation Award twice, and the Outstanding Graduate Mentoring Faculty Award from the School of Science and Engineering at SLU. Currently, Flavio is currently managing four National Science Foundation (NSF) grants and welcomes visiting scholar applications.

Final Exam: oral discussion

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell’Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

Mer 24 June 9.30 – 13.30

Gio 25 June 9.30 – 13.30

Ven 26 June 14.30 – 18.30