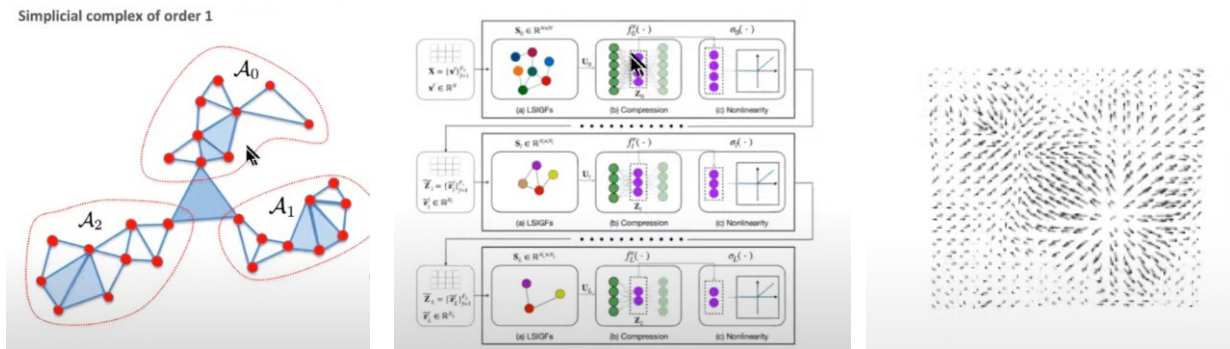


Lecture on Topological Signal Processing and Learning

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Perugia, Dipartimento di Ingegneria – Room 11

09 dicembre 2025 – 11.30 -13.30

Abstract:

The goal of this lecture is to introduce the basic tools for processing signals defined over a topological space, focusing on simplicial and cell complexes. Nowadays, processing signals defined over graphs has become a mature technology. Graphs are just an example of topological space, incorporating only pairwise relations. In this lecture, we will motivate the need to generalize the graph-based methodologies to higher order structures, such as simplicial and cell complexes as spaces able to incorporate higher order relations in the representation space, still possessing a rich algebraic structure that facilitates the extraction of information. We will motivate the introduction of a Fourier Transform over a cellular complex and recall the fundamentals of filtering and sampling of signals defined over such spaces. We will then show the impact of imperfect knowledge of the space on the tools used to extract information from data. Finally, we will present methods to infer the structure of the space from data and show how to exploit the above tools to design topological neural networks, operating over data defined over topological spaces of different order.

Short bio:



Sergio Barbarossa is a Full Professor at Sapienza University of Rome and a Senior Research Fellow of Sapienza School for Advanced Studies (SSAS). He is an IEEE Fellow and a EURASIP Fellow. He received the IEEE Best Paper Awards from the IEEE Signal Processing Society in the years 2000, 2014, and 2020, and the Technical Achievements Award from the European Association for Signal Processing (EURASIP) society in 2010. He served as an IEEE Distinguished Lecturer in 2013-2014. He has been the scientific coordinator of several European projects and he is now coordinating a national project on network intelligence. His main current research interests include topological signal processing and learning, semantic and goal-oriented communications, 6G networks and distributed edge machine learning.