Ph.D. in Information Technology: Final Dissertations

DEIB Beta Room

February 22nd, 2017

1.00 pm

First Ph.D. presentation and discussion:

Michele BUCCOLI – XXIX Cycle

"Linking Signal and Semantic Representations of Musical Content for Music Information Retrieval"

Advisor: Prof. **Augusto Sarti**

Abstract:

In recent years, the evolution of technology and connectivity has led to a major revolution in the music industry, which has led to novel content consumption scenarios. The design of tools and applications for such scenarios requires us to model and account for two different levels of abstraction in the musical content description: the signal-based and the semantic level. The former concerns the automatic extraction of the objective properties from the musical signals, while the latter involves the subjective perception and interpretation of such musical properties. These two description levels, however, are very separated from each other, which is why Music Information Retrieval (MIR) research today is focusing exactly on bridging this critical gap and linking the two representations of the musical content.

In this work we follow a schema that involves the formalization of the signal and the semantic domains, as well as the design of the related linking function. The signal domain is formalized by means of a feature representation, while the semantic domain is formalized by using high-level descriptors and metrics of semantic similarity among such descriptors. The linking function is modeled by means of rule-based or machine learning techniques. The definition and formalization of the different components is a challenging task that relies on and requires to expand the state of the art of MIR.

After the main components are defined and formalized, we apply the schema to a number of MIR-related application scenarios of gradually increasing complexity. The addressed application scenarios include the automatic analysis of the musical structure, the automatic annotation of musical items using classification and regression approaches, and the retrieval of musical content by means of a semantic model capable of handling the common ambiguities of natural language.

Second Ph.D. presentation and discussion:

Silvia LAMERI – XXIX Cycle

“Phylogenetic Analysis of Video Sequences”

Advisor: Prof. **Stefano Tubaro**

Abstract:

With the increasing popularity of the Internet and social media, we witness an exponential growth in the creation and redistribution of video content: once one video is posted online by a user, it can easily go viral, being republished by many others. Therefore, a significant fraction of video content available online consists in edited versions of already existing material, known as near-duplicate videos.
Video phylogeny is a new research field that aims to jointly analyze pools of near-duplicate videos, instead of single instances of the same video separately, in order to infer how these near-duplicates are related to each other and study their provenance. In this scenario, we develop a set of tools that enable the joint analysis of multiple related videos for phylogeny applications. We first focus on solving two primary yet paramount problems: detection of near-duplicate videos and their temporal synchronization. Then, we exploit these building blocks for more complex applications in the video phylogeny scenario. First, we propose a method that, starting from the analysis of a pool of near-duplicate videos, reconstructs an estimate of the original source video used to generate them. This approach allows us to study how content is reused and to recover original content when it is no longer available. The second developed application retrieves the causal relationships between video pairs within a pool of near-duplicate videos, and represents them by means of a phylogeny tree. This is done by taking inspiration from biology studies and assimilating the process of videos changing into different versions over time to the mutations of living organisms. This application allows us to assess the authenticity of a video content and identify its origin. This possibility plays an important role in the detection of copyright violations or in investigations regarding the diffusion of illegal material (such as child pornography, cyber bullying or terroristic propaganda).

Third Ph.D. presentation and discussion:

Gloria SOATTI – XXIX Cycle

“Consensus Methods for Distributed Inference in Dense Cooperative Wireless Networks”

Advisor: Prof. **Monica Barbara Nicoli**

Abstract:

With the development of large-scale networks, centralized algorithms revealed to be unfeasible for in-network data processing. In fact, their performance is penalized by communication/computational overhead

and latency required for data aggregation/processing at the fusion center, that badly scale with the network size. In recent years, distributed algorithms have become more attractive, as they enable the network to solve complex inference problems without the support of any central unit, facilitating energy-efficient, high-throughput and low-latency network communications.

In self-organizing networks, consensus algorithms play an important role. They are low-complexity iterative schemes, which perform distributed inference of some parameters by simple local processing and interactions with neighboring nodes. Consensus relies on successive refinements of local estimates computed at each nodes, till an agreement on the parameters' estimates is reached.

In this thesis, we provide two new consensus-based methodologies for in-network signal processing able to reduce the inter-node signalling and guarantee close convergence to the centralized solution, even when local measurements may be unreliable or incomplete. These algorithms are designed to improve the performance of conventional consensus approaches, as information exchanged between nodes is fused in such a way to account for the different reliabilities of the local estimate at each node. Fundamental limits and convergence properties are analytically evaluated for both the methods. In particular, one of the two proposed algorithms is shown to be more effective in boosting the convergence, allowing to closely attain the global estimate even in critical cases, such as with under-determined estimation scenarios and/or non-linear. The convergence analysis is extended to prove the attainment of the centralized estimation performance also in under-determined local settings.

Moreover, the proposed distributed algorithms are used as basis to develop distributed algorithms for self-organization of dense cooperative wireless networks, in different application scenarios. In particular, distributed inference is considered for the estimation of fundamental parameters needed for node cooperation, such as channel-state information, node locations, interference sensing, resource scheduling, and precise vehicle positioning. Furthermore, ad-hoc measurement campaigns, in indoor and/or outdoor industrial scenarios, have been carried out to highlight practical case studies of most of the considered inference problems.

PhD Committee:

Prof. **Monica Nicoli**, DEIB – Politecnico di Milano

Prof. **Andrea Cavallaro**, Queen Mary University of London

Prof. **Slim Essid**, Telecom ParisTech