Sujets de thèses

PhD position: Cooperation, optimization and artificial intelligence for future communications

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Title: Cooperation, optimization and artificial intelligence for future communications: interplay between model-based and data-driven approaches

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- Collaborator: Romain Negrel, ESIEE, Noisy le Grand

Location: Lille (approximately 1h away from Paris by TGV) and Cergy (Paris area)

Summary

Future generations of wireless networks face great expectations regarding the increase in network capacity, system throughput, massive user density under a tight energy budget.

The goal of this PhD thesis is to design efficient resource allocation policies in cooperative networks composed of a cellular network and an opportunistic network of users. The latter can exploit several full-duplex operating relay nodes to communicate while ensuring a low impact, in terms of Shannon rates, on the cellular network performance; as well as energy harvesting in order to boost the opportunistic achievable rate. To the best of our knowledge, opportunistic rate maximization for a cognitive full-duplex relay aided multi-tier network, under a rate-based Quality of Service constraint has not been addressed in the literature. Furthermore, the simultaneous blend of full-duplexing, multi-tier networks, cooperative communications, enables us to optimize the global network while assessing the impact of each technique on the wireless network. This optimization problem will be tackled for several relaying schemes which will require various tools from multi-user information theory, to game theory, artificial intelligence and deep learning techniques.

Objectives

This PhD proposal aims at deriving efficient and optimal resource allocation policies for networks that exploit jointly cognitive radio, full-duplex nodes, cooperative communications and energy harvesting. This simultaneous blend of cutting-edge technologies enables us to optimize the global network while assessing the impact of each technique. We assume that the communication takes place in two phases: one dedicated to power transfer and one dedicated to data transmission. The considered network is composed by several cellular user/destination pairs and several opportunistic user/destination pairs communicating with the help of some energy-harvesting FD relay nodes. The resulting network optimization problems are complex and
non-convex and their solutions will require tools beyond classical optimization such as data-driven tools, deep networks and machine learning techniques, emerging as promising and necessary for the design of future 6G networks.

Within this PhD proposal, we intend to focus on the following objectives:

- Objective 1: Design of a joint relay selection and power allocation policy when transmitters exploit energy harvesting to boost their communication.
- Objective 2: Design of shared relay nodes capable of helping both the licensed and opportunistic transmissions.

**Additional information**


The successful candidate can start as early as September 2020.

Applications are sought from France, EU and international candidates with an outstanding academic background, especially in wireless communications, information theory, optimization theory, machine learning or related disciplines. Demonstrable mathematical skills will be essential and an interdisciplinary background (e.g. computer science, data science) will be an advantage. The candidate should be familiar with key engineering programming languages (Matlab, Python, …)

Applicants must have an Msc degree (M2, engineer degree or equivalent in France). A good and working knowledge of the English Language is required.

**How to apply**

Interested candidates have to send their detailed CV, academic records (from Bsc to Msc level), at least two academic referees and a short motivation letter via email to the contacts below. Applications will be received until the 15th of April 2020.

**Contacts**

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**References**


A. Savard, E.V. Belmega, "Optimal Power Allocation in a Relay-aided Cognitive Network", ACM
Failures of safety-critical embedded systems used in industries such as aeronautics, automotive, railway or nuclear can lead to catastrophic consequences. These more and more connected complex systems, also known as Cyber-Physical Systems (CPS), also have to face cyber-attacks, which most of time cause serious dysfunctions and undermine the security of such systems. For instance, in 2015, an attack via the SPRINT cellular network targeted a Jeep Cherokee. The vehicle happens to be fitted with a multimedia device named Uconnect, connected to a CAN bus using a Renesas V850 processor; at the software level, it also manages the cellular open TCP port 6667 to support a DBus service for interprocess communication (IPC) and remote procedure call (RPC). The security breach consisted in injecting a modified firmware into the V850 co-processor, exploiting a “buffer overflow” error. It became then possible, and actually tested in the field, to remotely, over-the-air, inject CAN packets into the TCP port, and thus taking the hand over the car's various controls, from the radio volume to the brakes: clearly a serious design flaw...

The relationships between security and safety are thus at the heart of the current concerns of specialists in the field of complex embedded systems. In fact, one can no longer consider designing safe systems without ensuring them to be also secured. For instance, a vulnerability may compromise the functional safety of an autonomous car, while, on the other hand, a safety constraint such as the introduction of redundant components or diagnostic ports can increase the attack surface of the system. The increasing complexity of software and hardware components used in complex embedded systems has thus motivated the adoption of new approaches to anticipate security and safety problems. In particular, system designers have been advised to adopt an early modeling and validation approach against potential threats during the design phase to reduce the costs of lately detected errors and correction time.
PhD position in Explainable Recommender Systems

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Context

A recommender aids the user explore the set of items in a system and find the most relevant items to him/her. The two basic recommender categories are the context- and score-based ones. The first category exploits the characteristics of users and items, while the latter depends on the item scores given by the users. Traditional implementations of recommenders are based on TF-IDF and nearest neighbors techniques, while more recent recommenders follow machine learning approaches, like matrix factorization and neural networks. A natural issue that comes along with recommendations is whether a user, or even the system designer understands the results of the recommender. This problem has given rise to the so-called explainable recommenders.

Subject

Explainable recommendation helps to improve the transparency, persuasiveness, effectiveness, trustworthiness, and satisfaction of recommendation systems. It also facilitates system designers for better system debugging. So far, the research in explainable recommendations is focused on the Why question: “Why is an item recommended?”. Solutions either consider the recommendation system as a black-box, and thus try to reveal relationships among users and items, the importance of different features with respect to the predicted value, or to dwell into the intrinsic characteristics of the recommendation system in order to truly explain the system. What has not yet been studied though, is the Why-Not aspect of a recommendation: “Why is not a specific item a recommendation?”. We argue that explaining why certain items or categories of items are not recommended can be as valuable as explaining why items are recommended. Why-Not questions have recently gained the attention of the research community in multiple settings, e.g., for relational databases. In machine learning, Why-Not questions are shown to improve the intelligibility of predictions but remain vastly unexplored.

In this thesis proposal we aim to explore Why-Not, machine learning based explainable recommenders. In a second phase, we aim to extend the recommenders so that they can leverage the Why-Not explanations for auto-tuning.
Candidate's profile

The candidate should hold a Msc Degree in fields related to Computer Science, Machine Learning, or Applied Mathematics/Statistics. She/He should have solid knowledge of data management, algorithms and programming. Knowledge and previous experience on machine learning, recommender systems, explainability are a plus. She/He should master the english language (oral and written); knowledge of the french language is not obligatory. She/He must have strong analytical skills, be proactive, self-driven and capable to collaborate with a group of international researchers.

Candidate's skills

The candidate should hold a Msc Degree in fields related to Computer Science, Machine Learning, or Applied Mathematics/Statistics.

Location

CY Cergy Paris Université
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Contact

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