Internship at Laboratoire Informatique d'Avignon (LIA), France

Cognitive management of mobile network resources

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Future networks becoming a very dynamic and flexible environment consisting of virtual resources that can be instantiated and released on demand to timely meet customers' demands and to optimize operator's internal processes. As an example, cognitive mobile networks are evolving towards running big data analytics on traffic measurements carried out by in-network monitoring probes, to extract important knowledge about the current status of the system. This knowledge will be a fundamental input for automatic network functions to engineer traffic and allocate resources in concertation with the needs of the end users. This aspect is very well presented in the pre-structuring model of the EC H2020 5GPPP that indicates the integration of cognitive mechanisms as a major breakthrough for the management of 5G mobile networks [1]. However, this would come at the cost of higher computation complexity and power consumption. To alleviate the burden from the eNodeB, we propose to leverage on the introduction of network virtualisation which allows for more complex approaches.

In this internship, we will consider a large mobile phone datasets. The datasets are based on Call Detail Records (CDR) of phone calls and text exchanges between more than 9 million of Orange's customers in Senegal between January 1, 2013 to December 31, 2013. Then, we will propose novel RNN-based architectures for mobility prediction. Results of mobility prediction will be then used to help address society development questions in novel ways, e.g., for mobility management, traffic scheduling, resource optimization, infrastructure management.

Concerning precisely urban mobility management, mobility prediction plays an important role for generating reliable and regularly updated informations about the movements of million of individuals which are challenging, and not desirable, to follow individually (confidentiality). Up to now, household surveys allowed to estimate it. But their heaviness and cost make them unsuitable to follow the transportation demand variations. Actually, they are about to be replaced by the data provided by the mobile phone industry which knew a great technological

evolution, and a massive adoption by the populations. The researches on the subject led to the development of two collecting systems : the CDR (Call Detail Records) and GPS (Global Positioning System) data. GPS localization, thanks to applications downloaded on mobile phones, allows a very fine computation of road traffic data (a mobility component) : average speeds, densities, flows on roads. But, for users for which confidentiality is mandatory, they do not inform either about the origins and destinations, nor about activities performed. On contrary, the CDR have the capacity to estimate Origin-Destination traveler trips between activity areas, around relay antennas, but they are unsuitable to properly follow the traffic in real-time. We think that a mixed approach, combining CDR and traffic data provided by GPS based algorithms, may be of help to have a complete overview of the numerous facets of urban mobility: origin-destination of the users, user paths, estimation of the transportation mode used, traffic conditions, activities performed. During this internship, we will propose methods and algorithms, using these data, to estimate these facets. Our approach is tested with multi-agents simulation. Such an information system would open the door to several operational applications such as : improving activity locations to decrease travel times and to make car usage less necessary, analyzing how to improve the transportation network, studying the adequation between the public transport lines and the observed traveler paths, opening new public lines to catch transportation demand following this observation.

The recent emergence of artificial intelligence [2,3,4,5,6,7] technology has been shown to be a highly effective tool and has demonstrated significant performance in various domains (e.g., speech [2,5], image [7] and text [3,5,6] processing). These approaches mostly based on Recurrent Neural Networks (RNN), address the main issues related to the difficulty to learn from long sequences (words that appear few in a large corpus of document, large scale images, etc.) inter-dependencies between features in a latent space. In the context of phone calls, the model has to ‘’understand’’ alongside to code inter-dependencies between basic features depicting the mobility of the customer in a large set of text exchanges. The main challenge is to find out approaches between hitherto proposed models, algorithms that exhibit these dependencies in sequences of words to predict the customer mobility. Therefore, the aim of the internship is to:

- Study and understand main algorithms and models from state-of-the-art for user’s mobility prediction,
- Propose a novel RNN-based architecture to build a mobility prediction system,
- Use the proposed solution for operational applications.

Keywords: Cognitive mobile networks, network virtualization, data analytics, CDR, urban mobility, artificial intelligence, operational applications.

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