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Title: *Enhancing urban mobility with shared on-demand services*

Context: We are interested in enhancing the mobility of citizens in urban areas by providing them, through a unique interface enabling to express their preferences, the most convenient transportation means to reach their destinations. The proposed itinerary may combine several of the many available means of transportation (buses, tram, metro, shared bicycles, carpooling, etc.). The complexity of computing such multimodal itinerary comes from the variety of the possible modes of transportation that have to be combined. Moreover, we want to enable the design of a mobility companion (a mobile application) able not only to guide the user along her journey, including when and how to change of transportation mean, but also to propose itinerary changes when the current one exceeds a threshold delay.

To this end, we collaborate with SME Instant-System that designs, commercializes and operates a multimodal platform including: the traveler's real-time information on public transport; a multimodal trip planner; the integration of carpooling in metropolitan area, so for short trips; associated smartphone app and web sites. The real time trip planner is a very innovative technological brick. Indeed, even in major French networks where real-time data is available on all channels, trip calculations are always based on theoretical timetables (this is for instance the case in Paris). In fact, in a mobile situation, the proposed trip does not take into account the actual state of the network. To overcome this issue, Instant-System integrates and continuously refreshes the position of all bus, subway, streetcar on the network and uses them in the trip calculations.

In this context, we aim at studying and developing algorithms for a new form of shared on-demand services. With an Uber-like on-demand service, a user quickly gets a fast solution to reach her destination, but she has to pay a high price. With shared on-demand services, the system assigns several passengers to a vehicle to share expenses, and optimizes the routes of the vehicles so as to satisfy users constraints while optimizing operator's costs. The quality of service for passengers is lower (longer trips) but the price is reduced. This shared mode is different from carpooling since here the route of a vehicle is optimized for its passengers.

Objectives: We will investigate the algorithmic solutions enabling a city to operate such service as part of its PT offer. Questions of interest concern the fast computation of mix journey for the users combining on-demand service with regular transportation means (bus, metro, etc.), the design of flexible data structures enabling fast query and update times, the filling of vehicles, the optimization of the overall operation cost, the pre-positioning of vehicles, etc.

Duration: 6 months, starting October 2018, with possible continuation into PhD for mastering student. The internship student will be hosted at Inria with regular meetings with the SME.

Profil: Master 2 or PhD student

Required background: Good knowledge of graph algorithms and combinatorial optimization, programming languages Java, C/C++, Python.

About Inria and COATI.

Public science and technology institution established in 1967, Inria is the only public research body fully dedicated to computational sciences. The Inria Sophia Antipolis - Méditerranée research centre (`http://www.inria.fr/en/centre/sophia`), one of the 8 centers Inria, is localized in a pine tree forest inside Sophia-Antipolis (`http://www.sophia-antipolis.org/`) the first technopole in Europe. It has more than 500 scientists including 200 PhD belonging to 37 different teams. It has strong collaborations with Greece including an agreement with the University of Athens.

COATI (Combinatorics, Optimization, and Algorithms for Telecommunications, `https://team.inria.fr/coati/`) is a joint project-team between Inria Sophia Antipolis - Méditerranée and the I3S laboratory, which itself belongs to CNRS and University Nice - Sophia Antipolis (UNS). Its research fields cover Algorithms, Discrete Mathematics and Combinatorial Optimization with applications in various kinds of networks, including communication networks design and provisioning (optical WDM, MPLS, Backhaul, LTE, etc.), networks of proteins in bio-informatics, economics networks, as well as transportation networks. COATI has strong collaborations with industrial partners like Nokia bell-labs, Orange Labs, Amadeus and SMEs such as 3Roam and Instant-System.

About Instant-System.

Instant-System (`http://instant-system.com/`) is a SME based in Sophia-Antipolis, France, expert in smart-mobility. Its new-generation real-time mobility platform combines address locators and multimodal itinerary computations. Choose your destination and the app will display all available access modes in real time (personal car,

public transport, bicycles, on foot, car-sharing, etc.), including delays, disruptions, cancellations, civil works and obstacles. This step-by-step guide gives the best solution at all times and enables users to optimize their mobility.

The R&D team of Instant-System, leaded by Yann Hervouet (co-founder), gathers 17 experts working on the design and implementation of these solutions.