# Joint design of new and traditional mobility services

MSc. Project Proposal at the Autonomous Multi-Robots Lab, Cognitive Robotics, TU Delft

New transport technologies enable elaborating bus transit services that do not longer depend (exclusively) on traditional fixed routes, i.e., those who always follow the same path that is known by the users; instead, flexible routes that operate on-demand with users sharing the vehicles might be used as well, by developing efficient algorithms to assign vehicles to users' trips. Combining both ways of operation is a challenging task, that could lead to public transport systems that are able to move massive numbers of passengers (as traditional ones), approximating door-to-door services (as the on-demand ones).

The design of traditional public transport lines is highly complex: on the one hand, designing the routes, overlooking at the frequencies, is already an NP-Hard problem (Borndörfer et al, 2007); on the other hand, calculating optimal frequencies for a fixed set of routes, is also complex, as they must fit how users choice their routes, which in turn depend on the frequencies. This is why this problem has been studied during decades, using heuristics and comparing different pre-defined generic sets of routes over simple networks (Fielbaum et al, 2016). The analysis of on-demand ridesharing systems has been increasing during the last years, due to the appearance of new technologies that enable massive coordination between requests and vehicles, and it still presents many open problems. The very question of how to assign efficiently for large-scale instances is quite complex, and current models have already shown the high potential of these systems (Alonso-Mora et al, 2017).

Considering the high complexity of both types of systems, combining them efficiently requires different approaches and the use of heuristic methods. So far, some specific ideas have been studied, such as using the on-demand system as a feeder for the traditional one (Chen and Nie, 2017, Shen et al, 2018, and Fielbaum, 2019), but there is still huge room for improvement. In particular, understanding how the traditional system should be adapted, possibly including some infrastructure constraints (e.g. rail-based systems), is a complete open problem.

In this thesis, we aim to propose a methodology to design both systems to operate in a simultaneous and collaborative way. This design should include routes, frequencies and fleet sizes for the traditional system, an assignment algorithm for the on-demand system, and rules that explain how are these systems combined; different types of rules could be explored to search for the best one. The student should be able to manage some mathematical optimization models, as well as having some programming skills.


**Desired qualities:**

- Motivated and independent
- Good problem solving skills
- Experience/interest in constrained optimization, discrete mathematics or combinatorial optimization

**For further questions or to apply,** please contact Dr. A. Fielbaum (A.S.FielbaumSchnitzler@tudelft.nl) or Ass. Prof. Dr. J. Alonso-Mora (j.alonsomora@tudelft.nl). When applying, please provide a short motivation, up to date CV, a transcript of your current degree program and intended start date.

**Group information:** www.autonomousrobots.nl

## References:


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