Chalmers, Gothenburg
2020-10-21

Master thesis project proposal

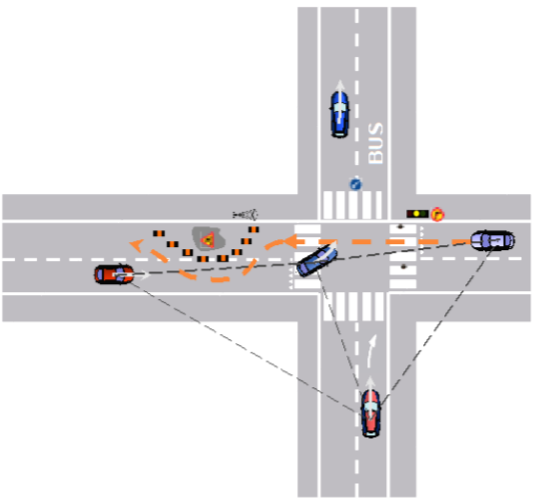
Solution methods for sequentially connected 2D assignment problems with application to multi-object tracking

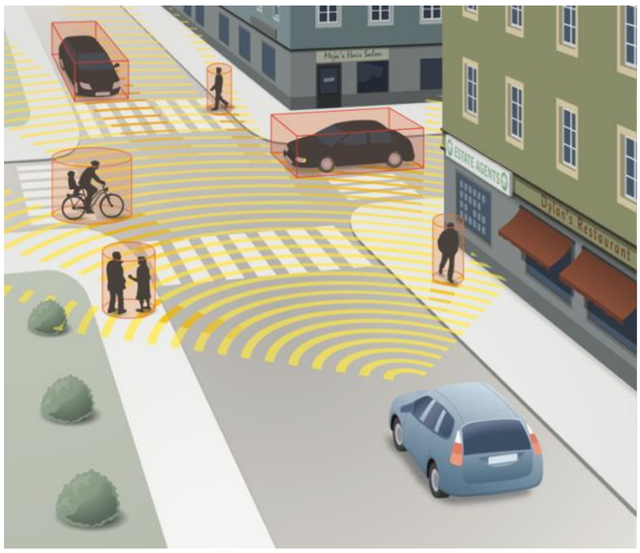
Motivation and background

Multi-object tracking (MOT) can be used to track pedestrians, cars, and bicycles in traffic. MOT is therefore an essential component in self-driving vehicles and is currently receiving a surge of interest.

Performance measures play a key role in the development of new algorithms and methods within MOT. First, because they enable us to construct benchmarks that researchers can use for comparing methods and evaluating progress. Second, as machine learning and deep learning become increasingly important, it is desirable to use end performance to select network parameters in an end–to–end fashion. However, the latter is only possible when we have access to reasonable performance measures that are fast to evaluate.

We have developed a new performance measure (strictly speaking, a metric between sets of trajectories) for multi-object tracking with several key advantages as compared to existing measures [1]. However, to evaluate this performance measure we need to solve an optimisation problem, and current implementations do not scale well with the problem size (even though it is a linear programming problem). The handling of large-scale problem instances is computationally expensive and memory consuming and it is therefore intractable to use the metric to train deep learning models.





Problem description

The goal of this project is to study a specific linear programming problem which is formulated in [1] and to develop efficient solution methods for this problem. Interestingly, the complete problem involves subproblems which are 2D assignment problems that can be solved efficiently using Lagrangian relaxation based algorithms, such as the auction algorithm [2] or the Hungarian algorithm. The subproblems are, however, connected via the objective function and it is not sufficient to solve them separately. It is still possible to leverage on the presence of such subproblems, and their solutions, to develop an efficient solution method for the problem of interest.

There is a rich family of important optimisation problems that contain tractable subproblems, connected in some manner. Consequently, there is also a rich literature to study and draw inspiration from, including [3], [4], and [5]. Apart from solving a problem of great practical importance, you will therefore learn about optimisation theory and techniques that are applicable much more widely.

We expect the students to

- perform a literature study on Lagrange relaxation based solution methods applied to assignment problems;
- propose solution methods to the problem at hand inspired by ideas from the literature;
- produce an efficient implementation of the proposed algorithms (preferably in Python);
- analyze the results and suggest additional improvements.

Applicant profile

Two (2) students with a strong background in mathematics, optimization, and programming.

Contacts/supervisors

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References

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