Dynamic Carpooling with Transshipments, Maximal Number of Modality Reports, 4-values role, and retrieval of vehicule

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Mots-clés *: Carpooling, Dynamic Carpooling, Incremental Carpooling, Complex itineraries generation, Dynamic Programming Algorithm.*

Expansion of carpooling to better integrate the sharing of individual vehicule in our day-of-life displacements.

This work focuses on the utilisation of dynamic carpooling services to meet the expanding mobility needs of modern society whilst being more environmentally responsible by taking accountability for the use of exhaustible resources and the emission of greenhouse gases. A solution with new innovative features, compared to the current state-of-the-art carpooling services, has been proposed for the area of Belfort - Montbéliard, with the possibility of future expansion. New features like multi-modality, transshipment, role flexibility and return trip distinguish this system from the traditional ride-sharing approaches. A system modeling and formalisation of a multi-objective and multi-constraint dynamic algorithm will be presented. Various tests are run to prove the possibility of an exact solving problem based on dynamic programming approach in a reasonable time.

Placement of our approach in relation to literature

Our new carpooling approach introduces the concept of 4-term dynamic time-window (earliest arrival time, latest arrival time, earliest departure time and latest departure time). This type of dynamism is made possible using time-window normalization and propagation with the aim to generate and adaptable and satisfactory route for all the participants of the itinerary. Such a concept gives birth to another concept, which is the processing time in a position. So, we will have a possibility to propose a return trip for a driver or a passenger.
Also, our approach allows inter-modal vias, which means that drivers and passengers can change vehicles at via points. This allows us to carry out modal transfers within a route. This aspect is absent from most of the works dealing with carpooling. To achieve modal shifts, we also introduce a 4-valued flexibility of roles. Subsequently, we allow a passenger to be a driver and vice-versa.
We also propose car retrieval for a driver who has left his car at a certain stop during his itinerary. A car retrieval itinerary will be proposed which will take the driver to the place or parking where his car is currently parked. As for the formalization, we use a multi-constraint and multi-objective formalization

and based on an origin-destination matrix. For the solving method, we propose an exact solving algorithm, a dynamic cut-and-share algorithm which addressed PDP/DARP/VRP/TSP problems.
Also, we present several instances and nominal scenarios to validate the functionality, scalability, and originality of our approach.
For technical tools, we use C++ programming language to implement the algorithm and OpenStreetMap to plot the generated routes on a map.

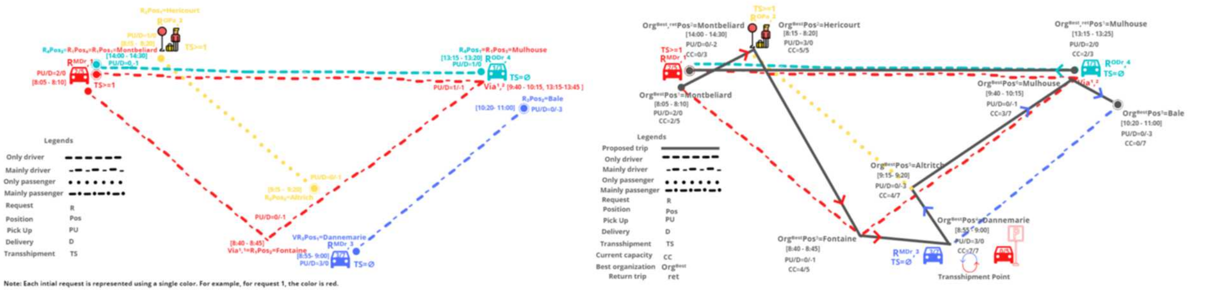

FIG. 1 – Initial request and outcome of the incremental dynamic programming algorithm

The job of the system was to propose itineraries that satisfy all the constraints and maximize the fulfilment of the objectives at the same time. In the best organization that we expected the system to predict, the following itinerary was proposed. A car [color: red, capacity: 5] will leave Montbeliard with 2 people. The car will then pick up 3 passengers at Hericourt. At this point, the car will be fully occupied. The car will drop one of its passengers at Fontaine. The car will reach Dannemarie. It will be parked at the parking space. And all the passengers will be transshipped to another car [color:blue, capacity:7]. The car will drop 3 passengers from Hericourt at Altrich. The car will drop 1 remaining passenger from Montbeliard at Mulhouse. The car will end its journey at Bale where it will drop the 3 passengers from Dannemarie. For the return trip, a car [color: green, capacity:3] will leave from Mulhouse. The car will end its journey at Montbeliard dropping the 2 passengers.

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