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An atomic routing game with hard vehicle capacities (aihe-esittely)

Martti Räsänen

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Ohjaaja: *Philine Schiewe*

Valvoja: *Philine Schiewe*

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Background information

- Event Activity Network (EAN)
  - Used for representation of transportation [1]
    - Forms directed graph structure with events as nodes and activities as edges
    - Events: arrival and departure from station/stops
    - Activities: transportation, wait and transfer
  - Allows dynamic route planning in static setting [1]
    - EAN and timetables are connected to each other

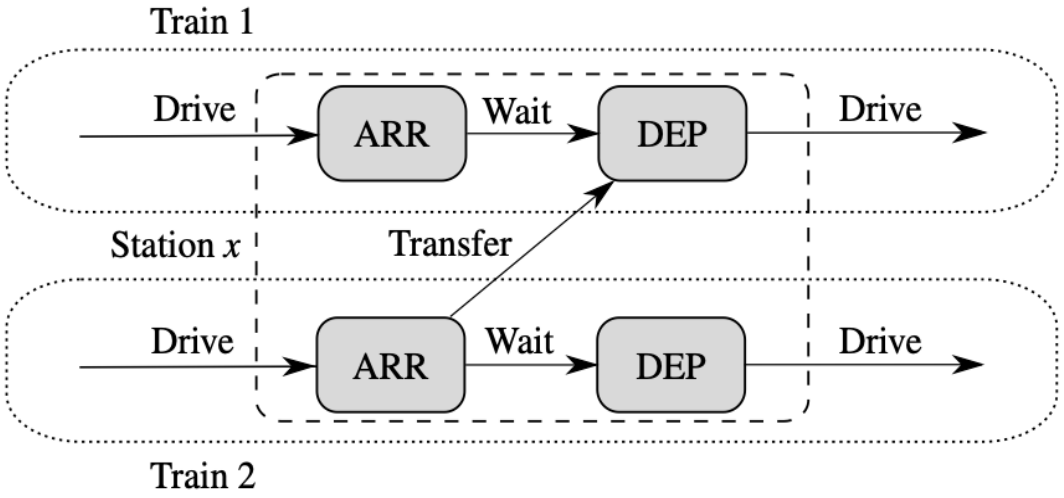

Figure: Event Activity Network

Small portion of an EAN illustrating how events and activities are structured.

Source [2]

Thesis objectives

- Create mathematical formulation of optimal path for EAN with hard capacity constraints and path replacement
  - Discovery of optimal path for individual
  - Experimental analysis of equilibrium states
    - Repeating optimal paths leads to equilibrium
  - How optimal routes and solutions change on depending to
    - Different starting solutions
    - Passenger order
    - Departure time

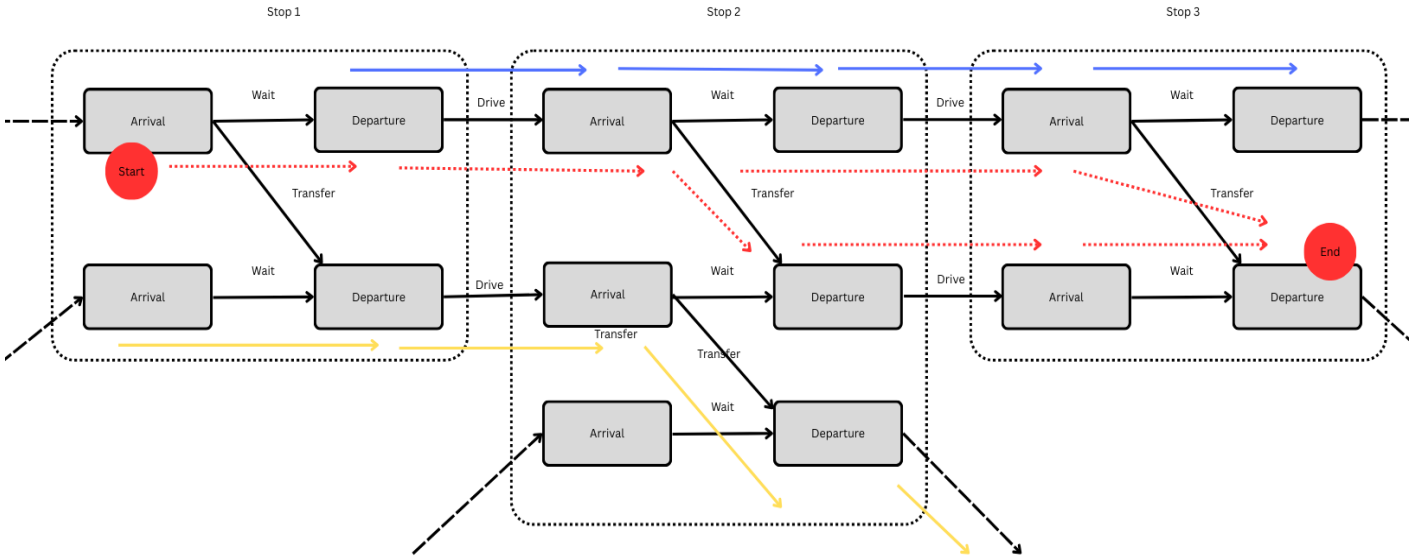

Figure: Example of a Selfish Routing Game

The figure illustrates a routing game based on an Event Activity Network (EAN) model without edge costs. It includes pre-assigned blue and yellow travelers as well as possible route options for a new red traveler with capacity of 1.

Scope of the thesis

- Mathematical modeling of the routing problem using the EAN framework
- Computational implementation of the model
  - Applications and analysis of large or real-world networks
- Analysis of the game-theoretic equilibrium formation
- Limited to static model without delays

Reference Materials

- EAN
  - Anita Schöbel, Integer Programming Approaches for Solving the Delay Management Problem [1]
  - Philine Schiewe, Optimization in Public Transport and Integrated Optimization in Public Transport [3]
- Equilibriums in transportation
  - Yosef Seffi, Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods [4]
  - Tim Roughgarden, algorithmic game theory lecture notes [5]

Methods for research

- Literature review
- Python implementation of optimal path
  - MIP solver
  - Graph structure
  - Example EAN models

Timing of the thesis

- Started in April
  - Backgroud research in April
- Creation and implementation of model in May
- Writing of the thesis June
- Finished in June

References

[1] A. Schöbel, “Integer Programming Approaches for Solving the Delay Management Problem”, in Algorithmic Methods for Railway Optimization, Springer, Berlin, Heidelberg, (2007), pp. 145-170. [Online]. Available https://doi.org/10.1007/978-3-540-74247-0_7

[2] M. Goerigk, M. Schmidt, A. Schöbel, M. Knoth, M. Müller-Hannemann “The Price of Strict and Light Robustness in Timetable Information” Transportation Science, vol. 48(2), pp. 225-242., (2014) Available: http://dx.doi.org/10.1287/trsc.2013.0470

[3] P. Schiewe, Integrated Optimization in Public Transport Planning, Springer Charm, 24 June 2020, Available: https://doi.org/10.1007/978-3-030-46270-3

[4] Y. Seffi, Urban Transportation Networks: Equilibrium Analysis With Mathematical Programming Methods, Prentice-Hall, January 1984, Available: ISBN: 0139397299

[5] Tim Roughgarden, algorithmic game theory lecture notes, [Online] Available: http://timroughgarden.org/notes.html