Chair of Transportation Systems Engineering
TUM School of Engineering and Design
Technische Universität München

Modelling Public Transport Crowding Effects in MATSim

Somakala Subbaraman, Filippos Adamidis, Arkadiusz Drabicki

MATSim User Meeting

Session 5: Policy and Scenario Analysis in MATSim

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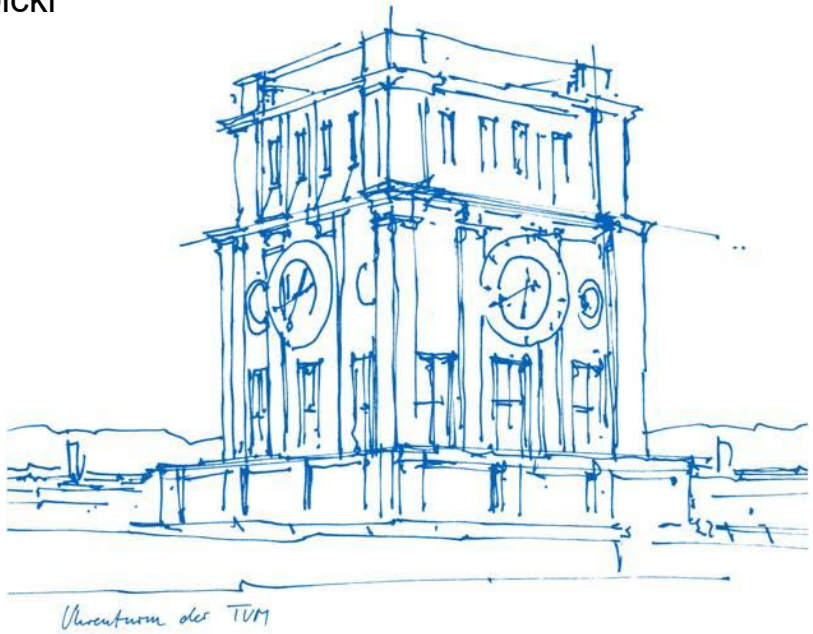


Content

Introduction

Motivation

Research Question:

How can passenger crowding effects can be accurately represented in MATSim?

Crowding Effects (Cats and Hartl, 2016)

Travel Discomfort

- No seats, physical closeness etc.
- Maximum Standing Multipliers: 2.5 – 6.0

(Wardman and Wheelan, 2011)
(Tirachini et al., 2013)
(Batarce et al., 2016)

Denied Boarding and Queuing Phenomena

- When demand exceeds service capacity
- Post-denial waiting time
- Amplified delays and queue build-up

(Gentile, 2016)

Demand-Supply Variations

- Flow dependant dwell time
- Bus Bunching
- Critical with short headways / close stops

Transport Models: State of the Art

Macroscopic Static Models:

e.g. VISUM

Aggregated load distribution, fixed PT schedules

Limited sensitivity to crowding effects

Agent-Based Models:

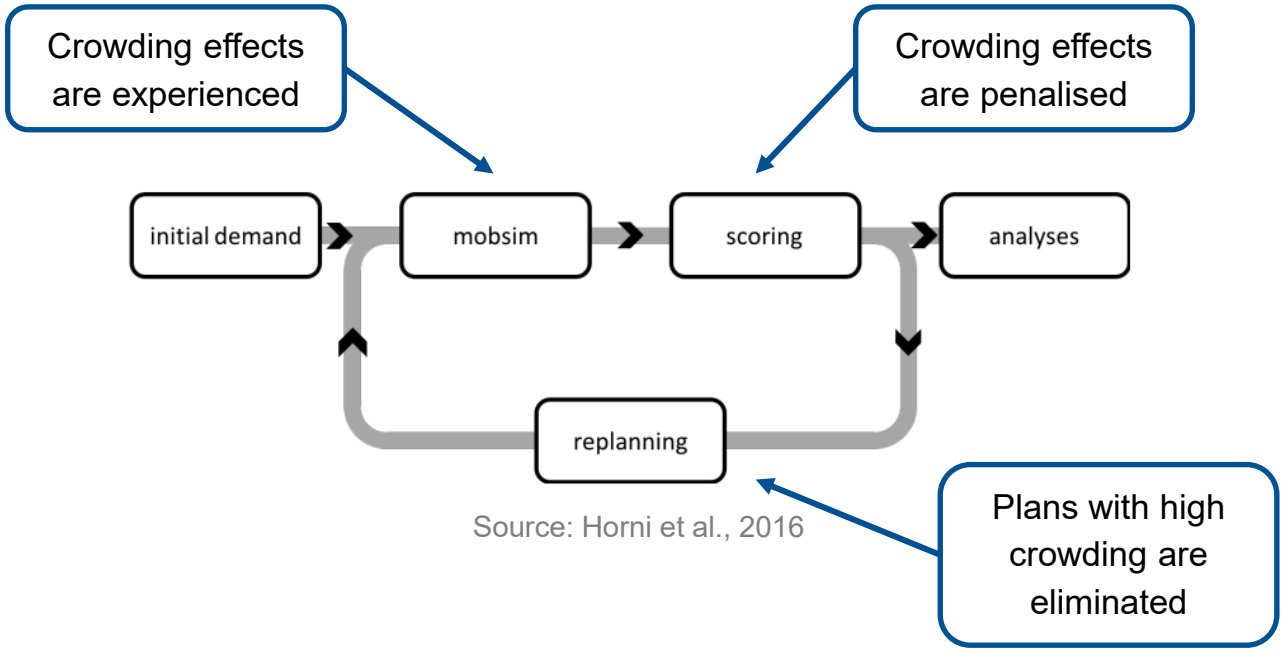
e.g. BusMezzo, MATSim

Dynamic rerouting, consideration of waiting times

Higher sensitivity to crowding effects

Methodology

Overview of MATSim

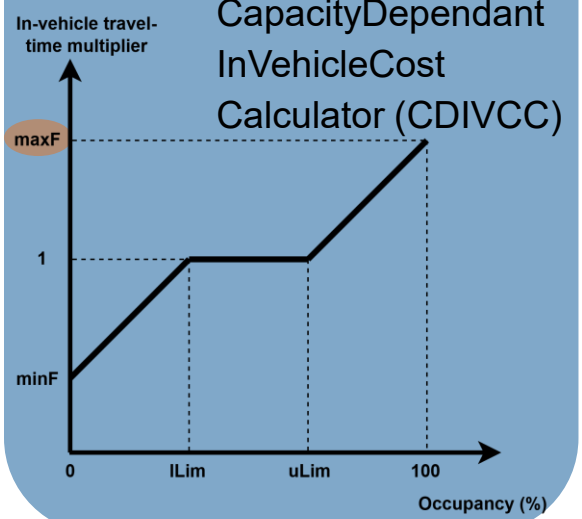


Source: Horni et al., 2016

Crowding Effects in MATSim

Travel Discomfort

CapacityDependant InVehicleCost Calculator (CDIVCC)



Denied Boarding and Queuing Phenomena

- Strict and explicit capacity constraints

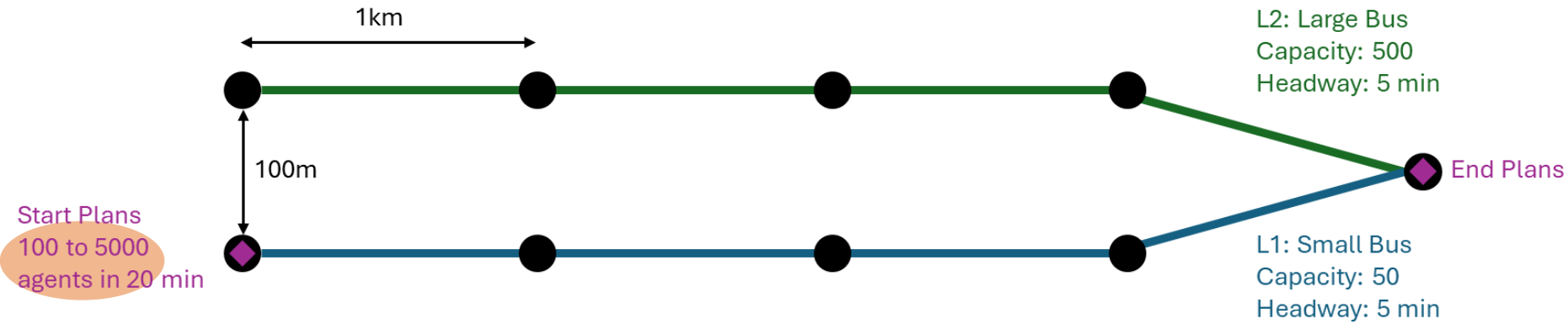
Demand-Supply Variations

- Linear Dwell Time Increment: 2.0s / pax
- Methods: setAccessTime & setEgressTime

Analytical Set-up

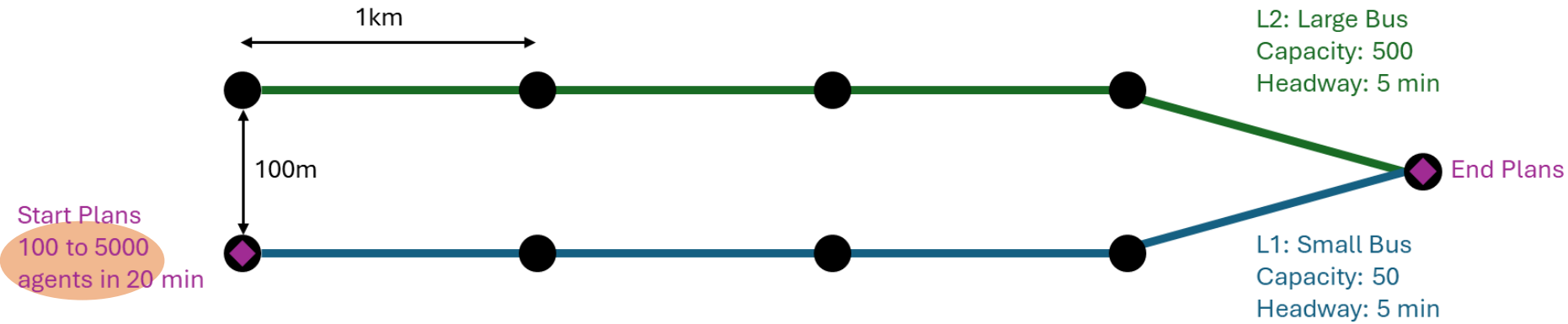
Toy Network

maxF = 1 to 15
boardingTime = 0 s/ pax
alightingTime = 0 s/pax



Toy Network

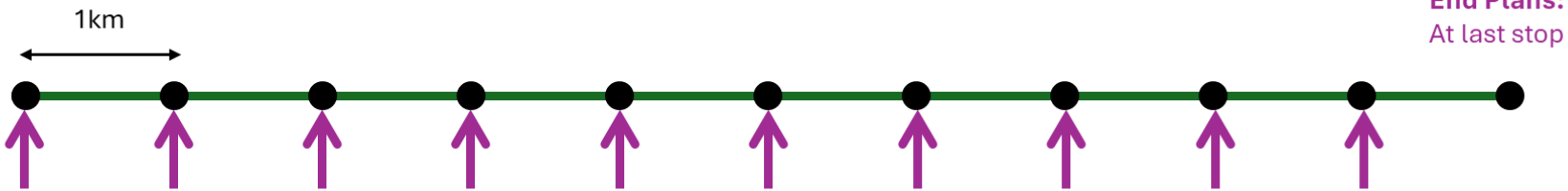
maxF = 1
boardingTime = 0 s/ pax
alightingTime = 0 s/pax



Toy Network

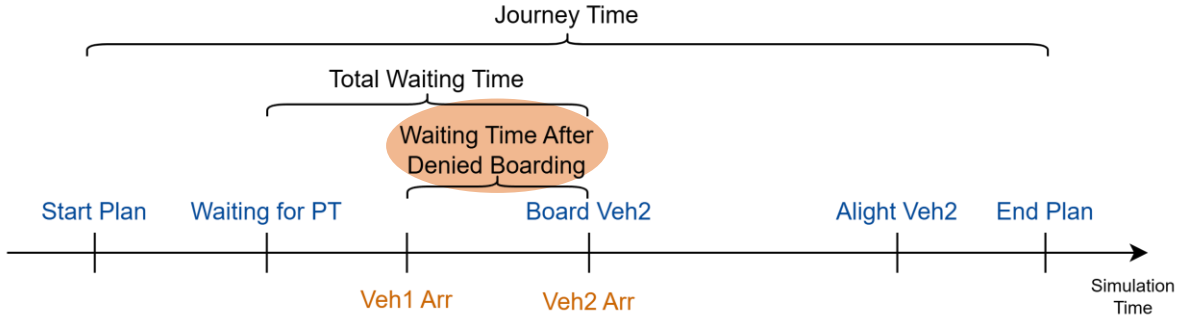
maxF = 1
boardingTime = 0 or 2 s/ pax
alightingTime = 0 or 2 s/pax

PT Line Info
Headway: 1 min
Capacity: 10000 pax



Output Parameters

Trip Parameters



Service Failures

- Number / Frequency of Denied Boarding
- Number / Frequency of Uncompleted Trips

Route Choice

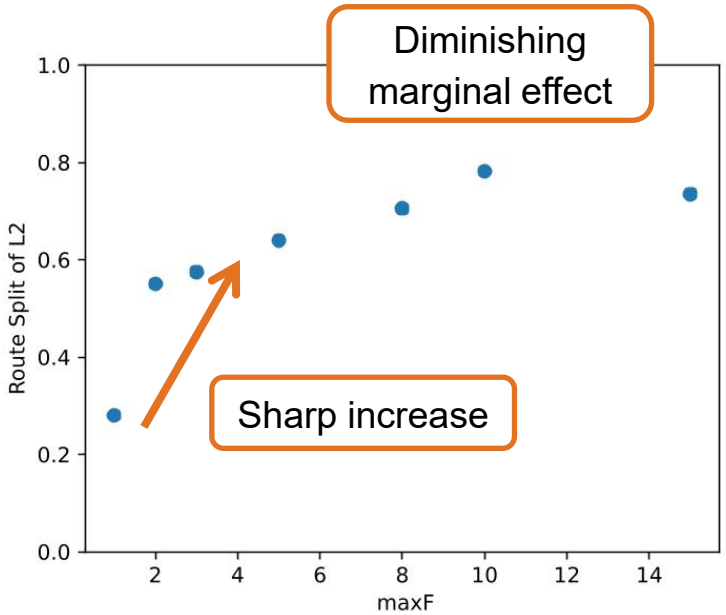
- Ratio of passengers in competing routes

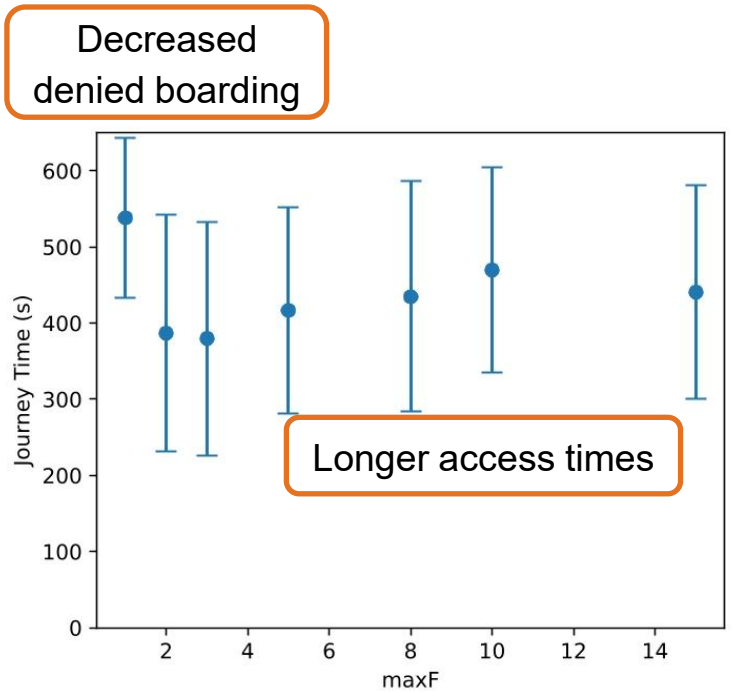
Bus Trajectories

- Space-time trajectories of buses

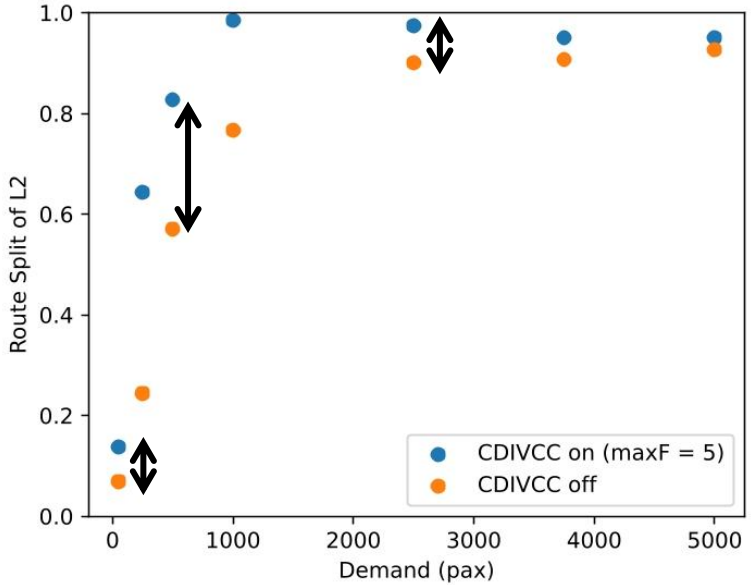
Results

Increasing maxF





Increasing Demand

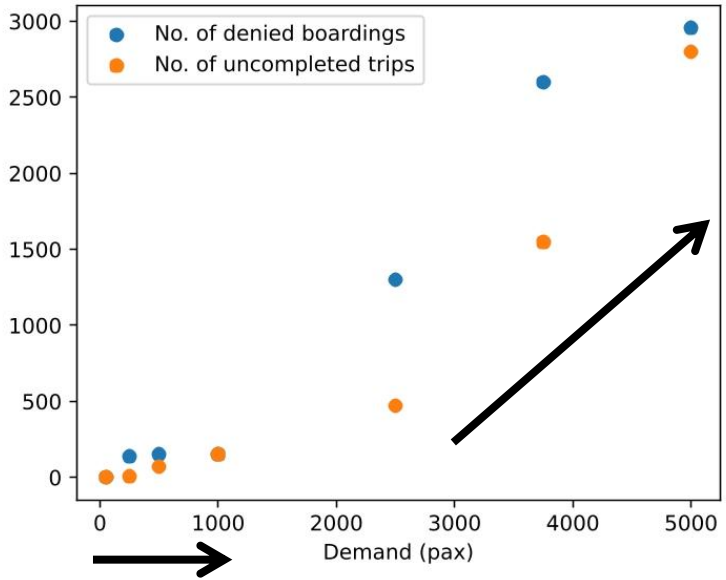


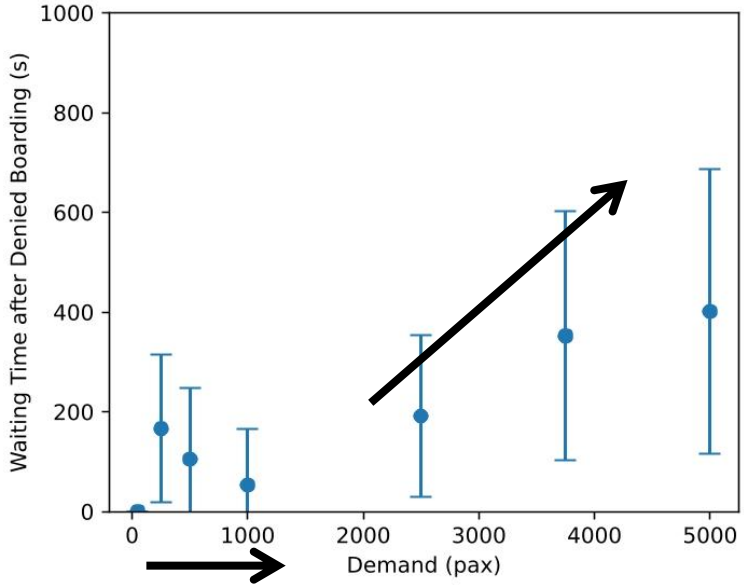
Low crowding
Low denied boarding

High crowding
Low denied boarding

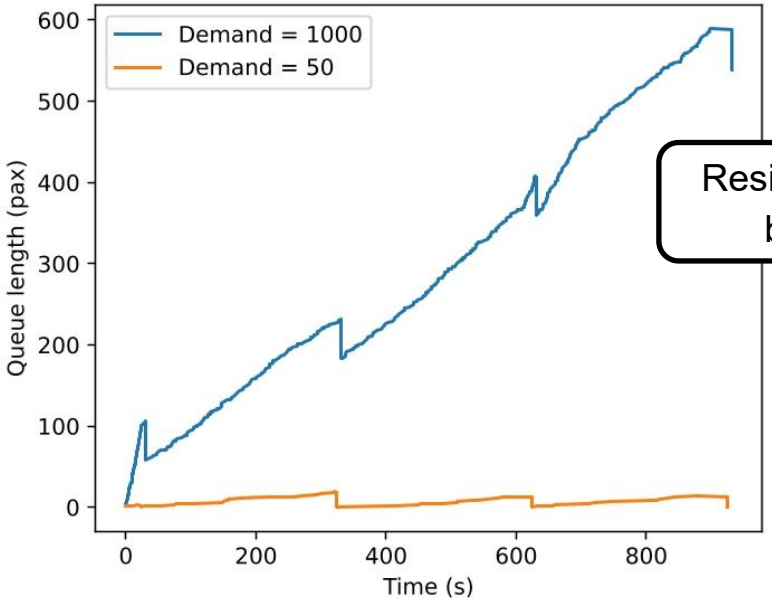
High crowding
High denied boarding

Denied Boarding & Waiting Times





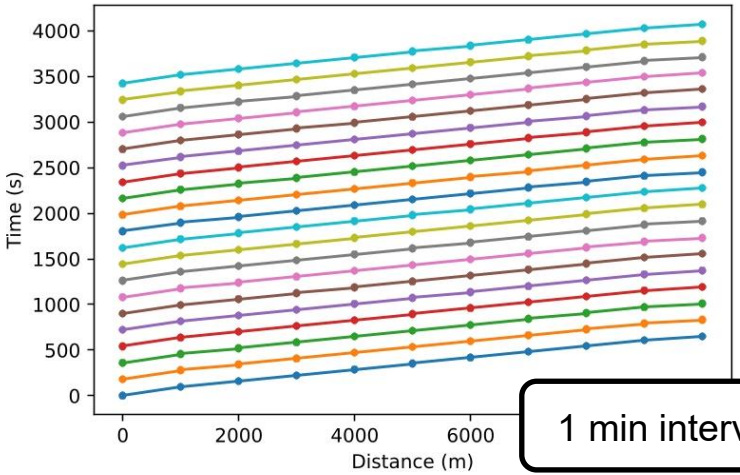
Queuing Phenomena



Residual queue build-up

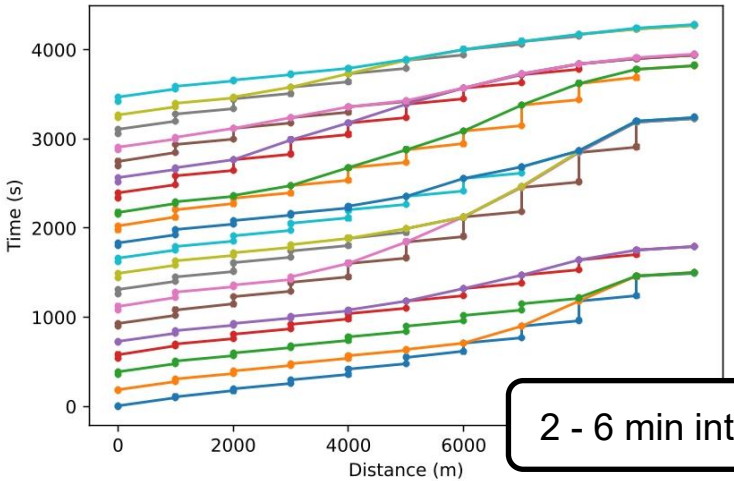
Space-Time Trajectories

Board & Alight Times = 0 s / pax



1 min interval

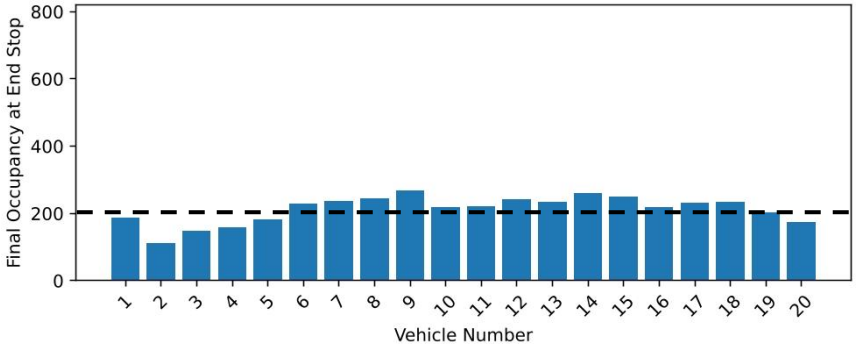
Board & Alight Times = 2 s / pax



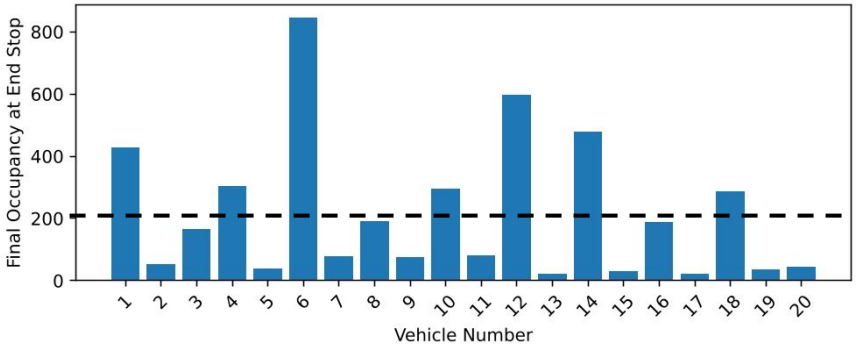
2 - 6 min interval

Vehicle Loading Pattern

Board & Alight Times = 0 s / pax



Board & Alight Times = 2 s / pax



Average vehicle occupancy: 200 pax

Conclusion

Summary of Results

Travel Discomfort

- ↑ maxF:
  - ↑ crowding sensitivity
  - ↑ ridership on high capacity lines
- ↑ Demand
  - ↑ Discomfort
  - ↑ Denied Boarding

Denied Boarding and Queuing Phenomena

- ↑ Demand:
  - ↑ Denied Boarding
  - ↑ Uncompleted Trips
  - ↑ Queue Length
  - ↑ Waiting Time

Demand-Supply Variations

- Dwell Time Increment:
  - Bus Bunching
  - Uneven Load Distribution (Passenger Bunching)

Outlook

- Agent Based Modelling suitable for crowding effects
- Examination of choice set necessary
- Sensitivity to parameters (e.g. maxF, demand)
- Future work: Real world case studies

Thank you! Any Questions?