



## Passenger-oriented traffic control for rail networks:

considering crowding effects on passenger choices and train operations

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## **Outline**

- Introduction
- Problem statement
- Model formulation
- Case study
- Conclusions and future work



### Introduction

⇔ SBB CFF FFS Home Objective Projects Survey Long-term study SBB Service Scouts de fr it en



#### Objective

Making SBB better, together with our customers.

Your satisfaction is our foremost concern. Every day we set out to ensure you feel comfortable with us. Tell us your opinion and what we can improve. With your feedback we will achieve our objective:

We want to be become even friendlier, more reliable and needs-orientated. Together with our customers we want to make SBB even better and ensure that you feel at home on the move.

Gesamte Zufriedenheit



#### Statement



"Our customers' satisfaction is the benchmark for all we do - this includes our RailFit20/30 fitness programme.

With your help we want to make SBB even better. Get involved and tell us what you think here.

We are listening!"

Andreas Meyer, CEO





## Introduction

Supply (train schedule)

**Demand** (passenger wishes)

Vehicle capacity

Infrastructure capacity (macro/micro)

Quality (operations): delays

Quality (passengers): Travel time





# Vehicle capacity & crowding effects

- Assume to be sufficient
  - Passengers of a group follow exactly <u>one and the same</u> route, no split
- The fact:
  - Limited physical space in trains
  - Crowding issues:

affect passenger choices

affect train operations





### **Problem statement**

- Rescheduling trains and rerouting passengers
- Decisions to be optimized:
  - o train orders and departure and arrival times
  - passenger choices on their itineraries
- Goal:
  - Find the system optimum



## **Model formulation**

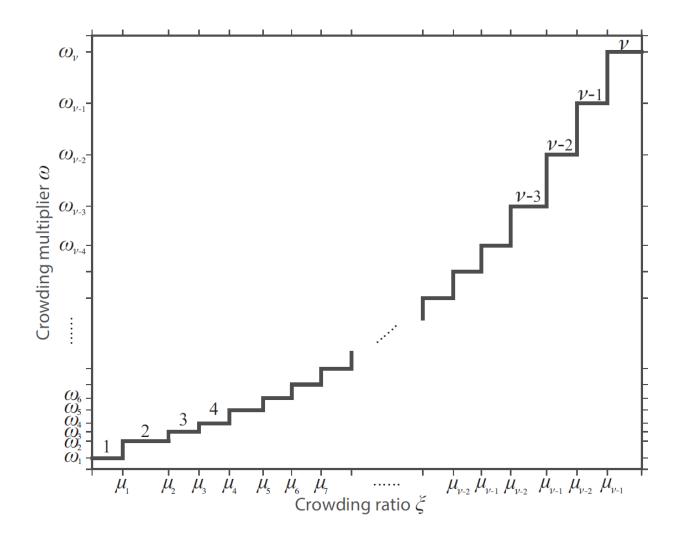
- Assumption
  - Rational passenger choices
  - Good information
- Objective: min weighted sum of
  - passenger disutility: passenger delay, travel time, additional travel time, stranded passenger
  - train delay

- Constraints:
  - train operation (micro)
  - passenger transition (macro)
- Variables:
  - train departure and arrival times, dwell time
  - passenger itinerary selection





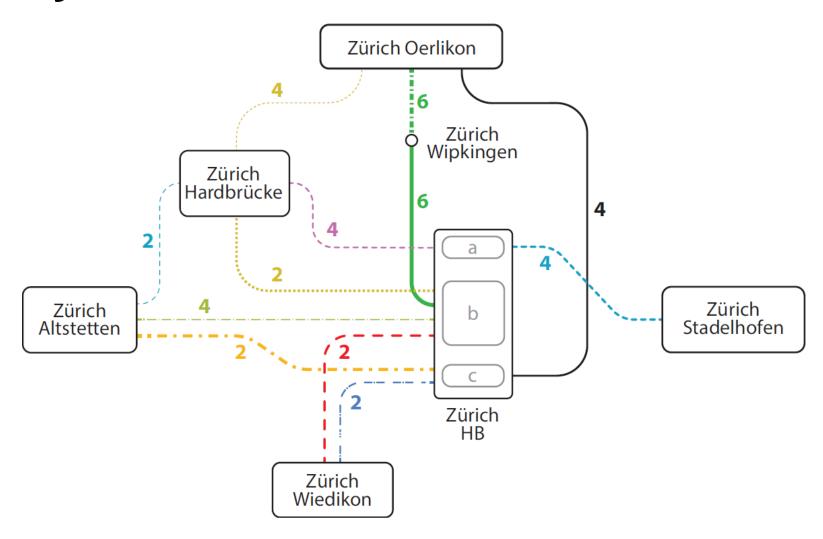
## **Model formulation**



exact method transformation properties











- Computation configuration:
  - Config\_1: no crowding effects
  - Config\_2: crowding effect on passenger choices
  - Config\_3: crowding effects on passengers and train traffic, no delay, allow stranded passengers
  - Config\_4: crowding effects on passengers and train traffic, allow delays, no stranded passenger
  - Config\_5: crowding effects on passengers and train traffic, allow delays and stranded passengers





	Train delay (s)	Prolongation of train dwell time (s)	Total passenger disutility	Passenger delay + travel time + penalty due to stranded passengers	Additional passenger travel time (crowding)
Config_1 (excl.)	0	142.88	499932 increase	499932	-
Config_1 (incl.)	0	142.88	553238 - Increase	499932	53306
Config_2	0	126.19	538962	506696	32266
Config_3	0	0	1061200	1039444	21756
Config_4	537	65.44	529902	506258	23107
Config_5	377	65.81	532257	507840	24041





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## **Conclusions**

- Improvement on the overall system performance by rerouting some passengers onto alternative routes
- If train dwell time is highly sensitive to the alighting and boarding passengers, the transport network will become vulnerable and less reliable
- Flexibility in the train decisions helps in providing better services to passengers





### **Future research**

- Solution approaches, decomposition and distributed approaches
- Passenger behavior model
- Social rerouting of passengers





# Thank you for your attention!

