



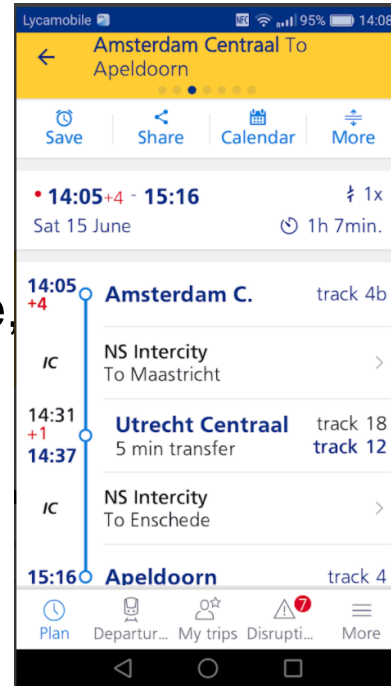
The role of incomplete information to passengers in railway delays

Nuannuan Leng, Francesco Corman

Introduction

■ Railway delays

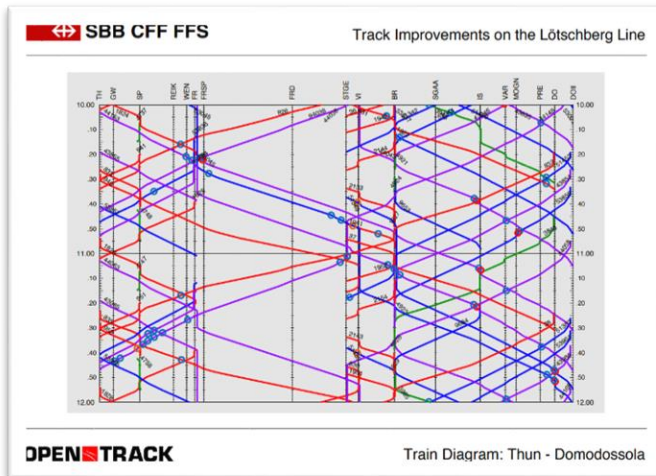
- Operational causes (infrastructure,
- Passenger traffic (huge)



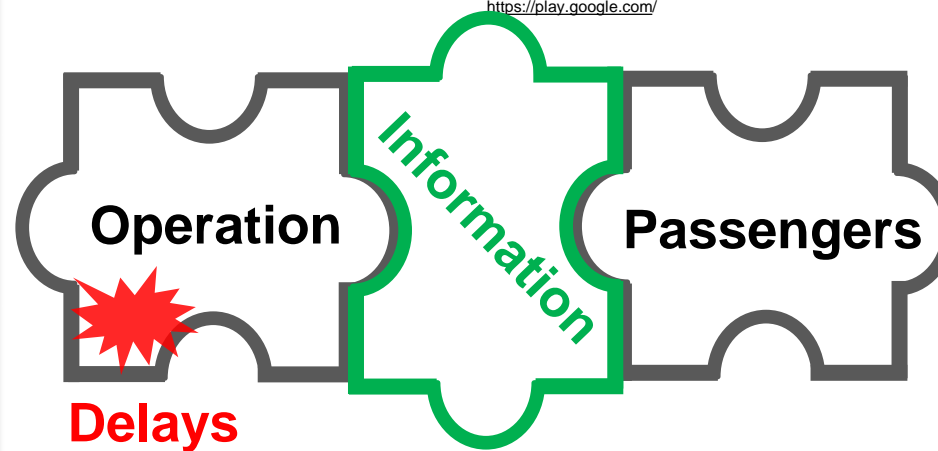
<https://play.google.com/>



<https://www.youtube.com/watch?v=tpR83cl044g>



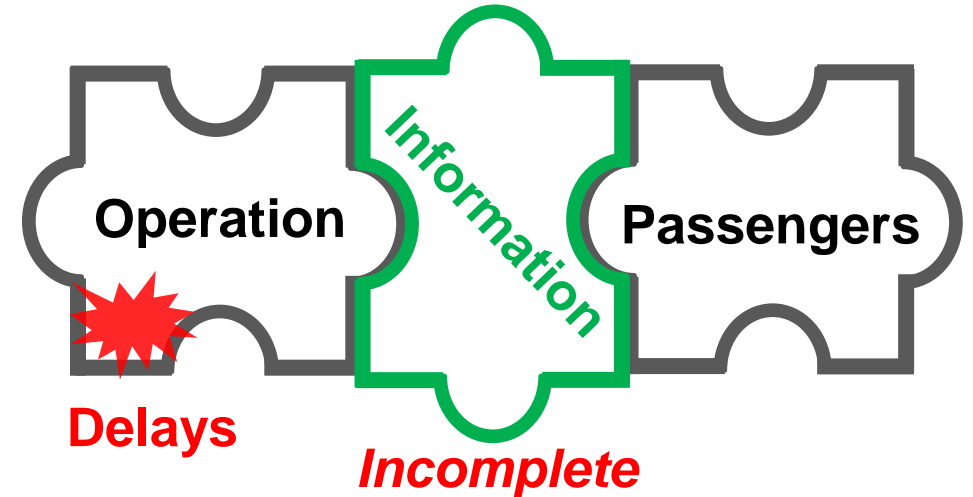
<http://www.opentrack.ch/>



<https://dribbble.com/>

Problem description






- **Incomplete information**
 - When and where start to know the information
 - What the information includes
 - *What if without information*
- **Passengers' belief**
 - Internal, own perspective of future operations
- **Goal**
 - To understand the effects of incomplete information to passengers in railway delays.



How to simulate which route choice passengers actually take in case of **incomplete information**?

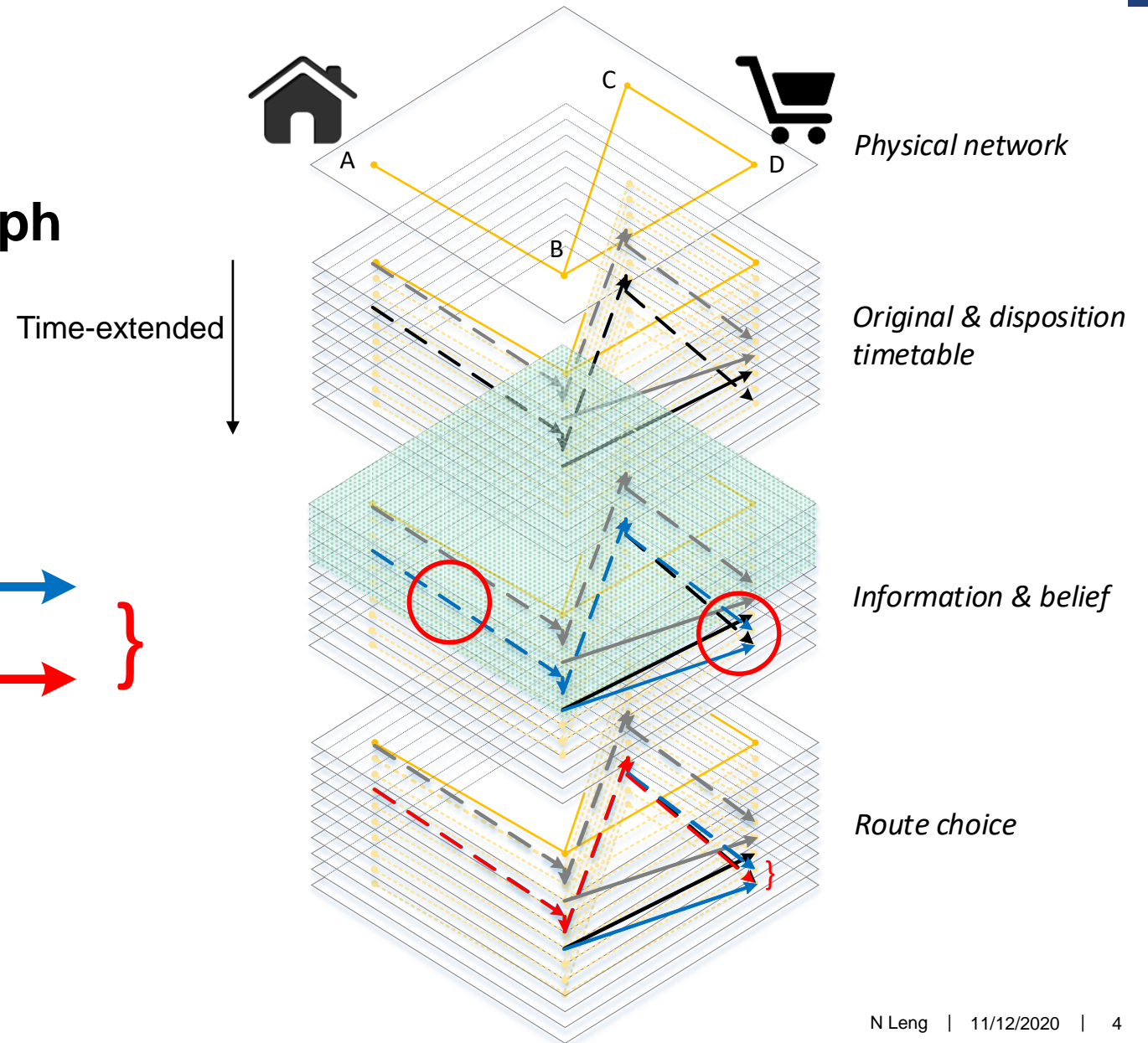
Approach

■ Multi-layer time-space-event graph

- Original timetable 
- Disposition timetable 
- Information 
- Passengers' thinking (info + belief) 
- Actual route choice 

Gap (thinking vs. reality)

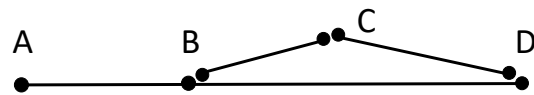
- *Optimality issue*: variation
- *Feasibility issue*: route doesn't exist



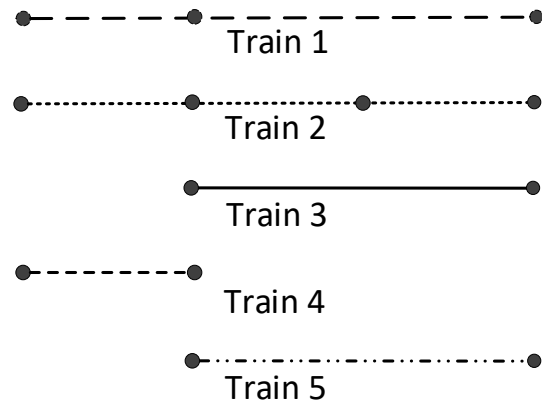
Example – Perfect vs. On-route information

Multi-layer time-space-event graph

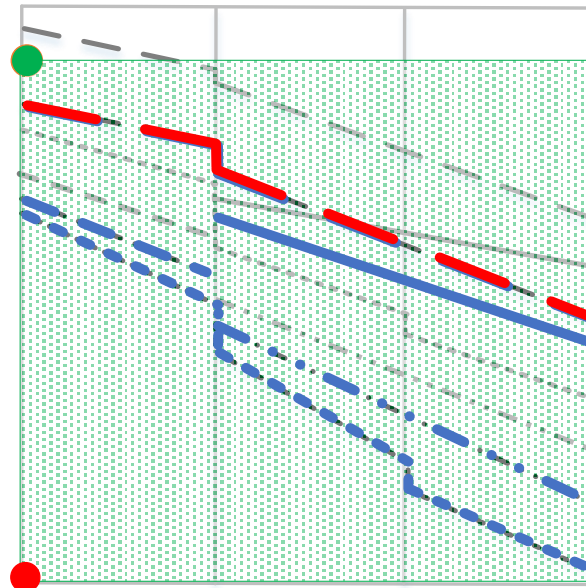
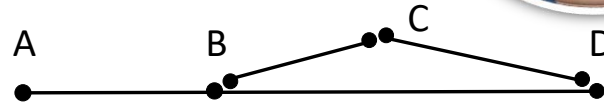
Physical network



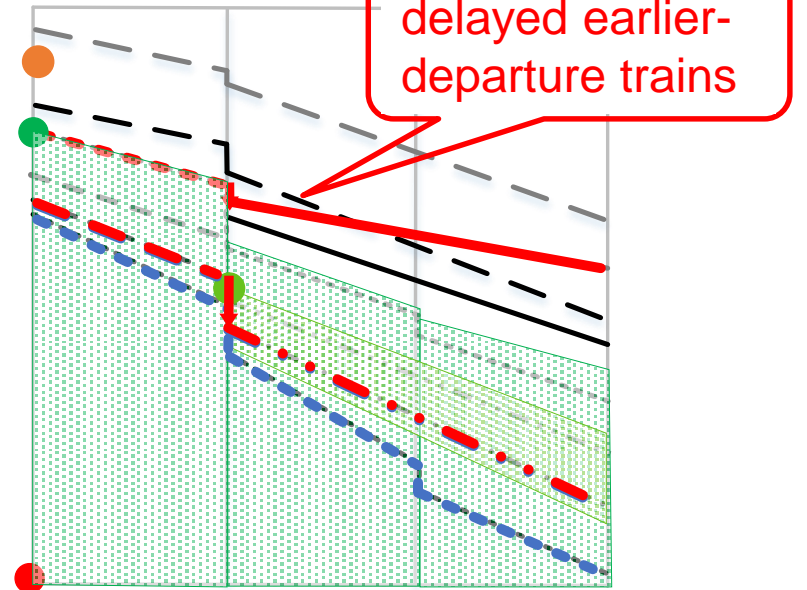
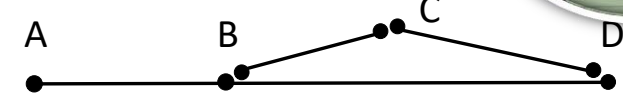
Trains



Perfect - infinite Information



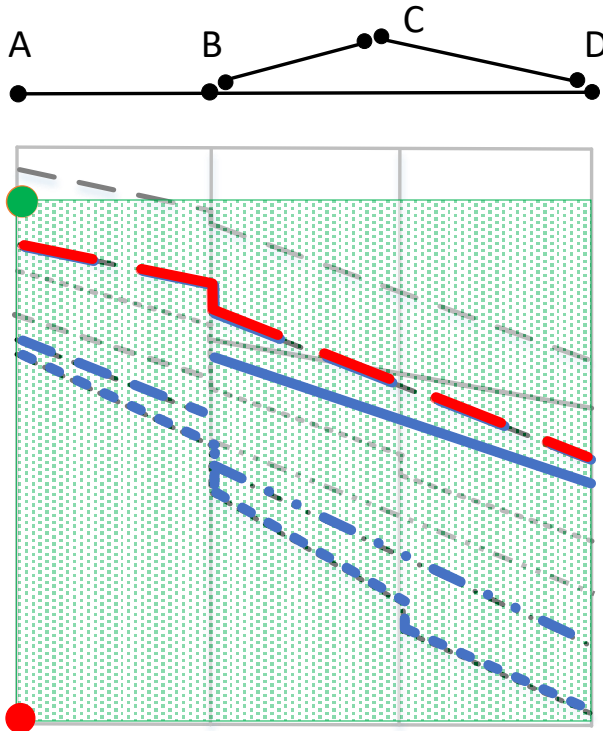
On-route – infinite Information



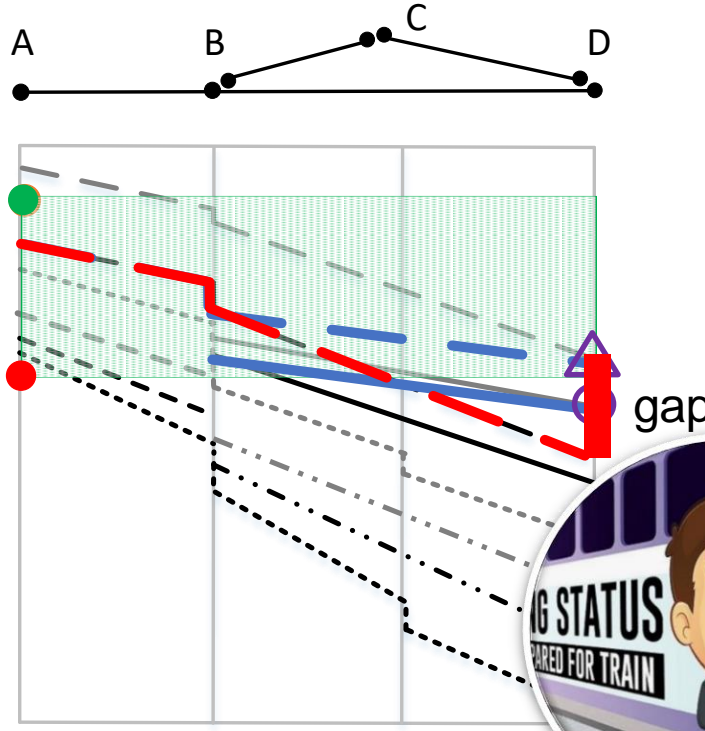
Example – Schedule vs. Delay belief

- Multi-layer time-space-event graph

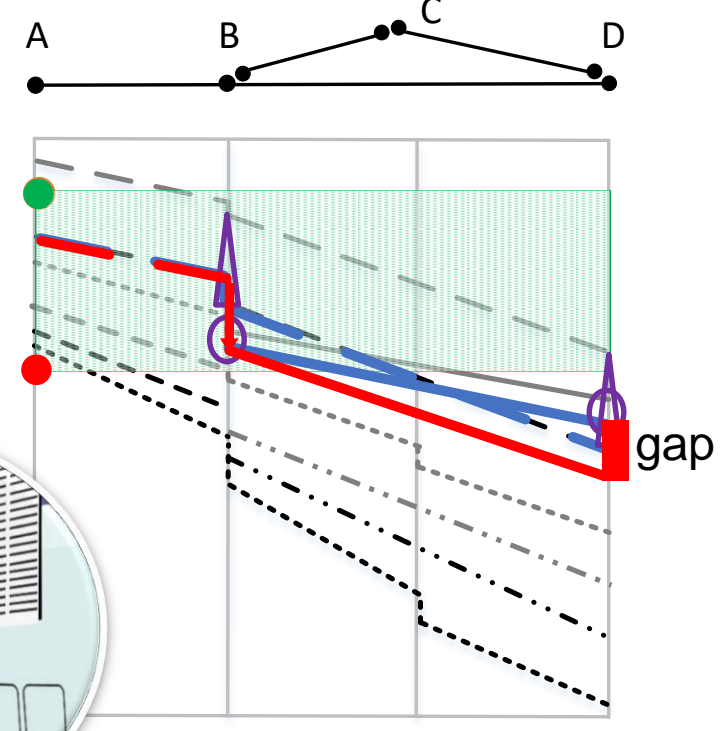
- Perfect - infinite Info



- Perfect Info +
Schedule- stubborn Belief



- Perfect Info +
Delay- extended Belief

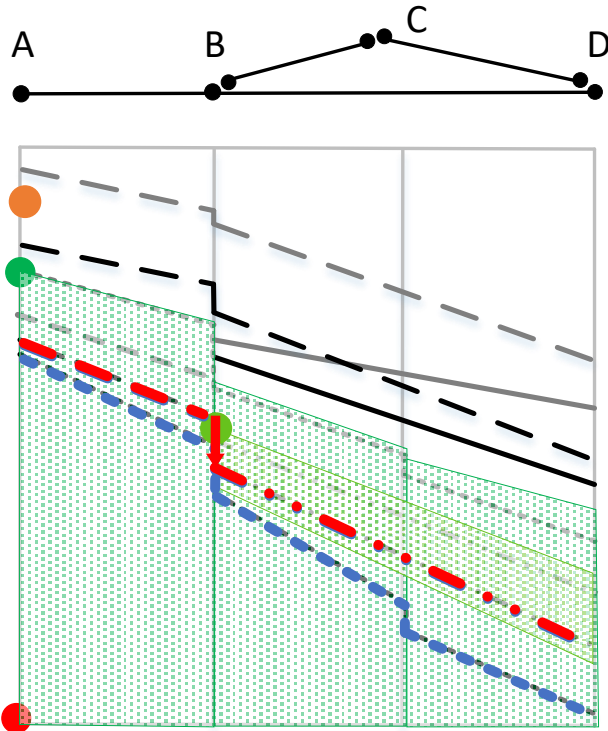


<https://www.pinterest.se/>

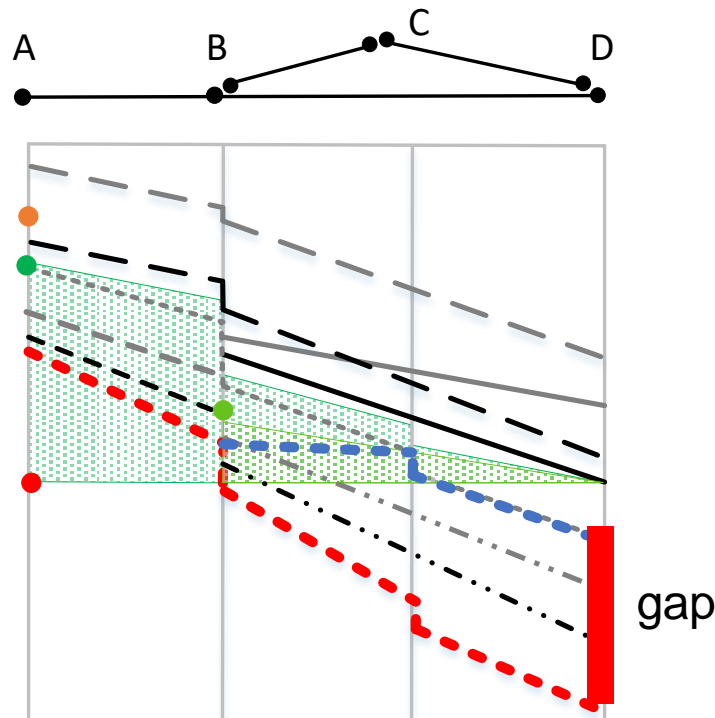
Example – Schedule vs. Delay belief

■ Multi-layer time-space-event graph

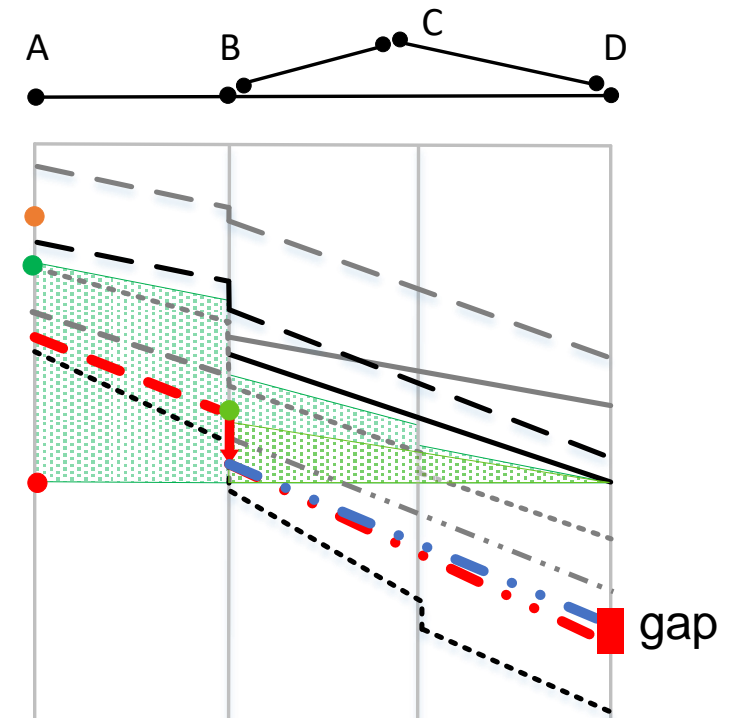
■ On-route - infinite Info



■ On-route Info + Schedule- stubborn Belief



■ On-route Info + Delay- extended Belief



IVT Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

-
- Figure 10 consists of four subplots arranged in a 2x2 grid, each showing the evolution of belief over time. The x-axis represents time, and the y-axis represents belief. The subplots are titled as follows:
- Top-left: "Perfect Information" & "Schedule-stubborn Belief"
 - Top-right: "Perfect Information" & "Delay-extended Belief"
 - Bottom-left: "On-route Information" & "Schedule-stubborn Belief"
 - Bottom-right: "On-route Information" & "Delay-extended Belief"
- Each plot displays multiple lines representing different belief states. The lines are color-coded and styled as follows:
- Red lines: Solid and dashed.
 - Blue lines: Solid and dashed.
 - Black lines: Solid, dashed, and dotted.
 - Grey lines: Dashed and dotted.
- Shaded regions are present in each plot, indicating specific belief intervals:
- Green shaded regions: Indicate belief intervals that are updated over time.
 - Blue shaded regions: Indicate belief intervals that are updated over time.
 - Light blue shaded regions: Indicate belief intervals that are updated over time.
- The plots illustrate how different information types (Perfect vs. On-route) and belief models (Schedule-stubborn vs. Delay-extended) affect the evolution of belief over time.

Results – Route feasibility

- **Thinking → Reality**

2% Infeasible route

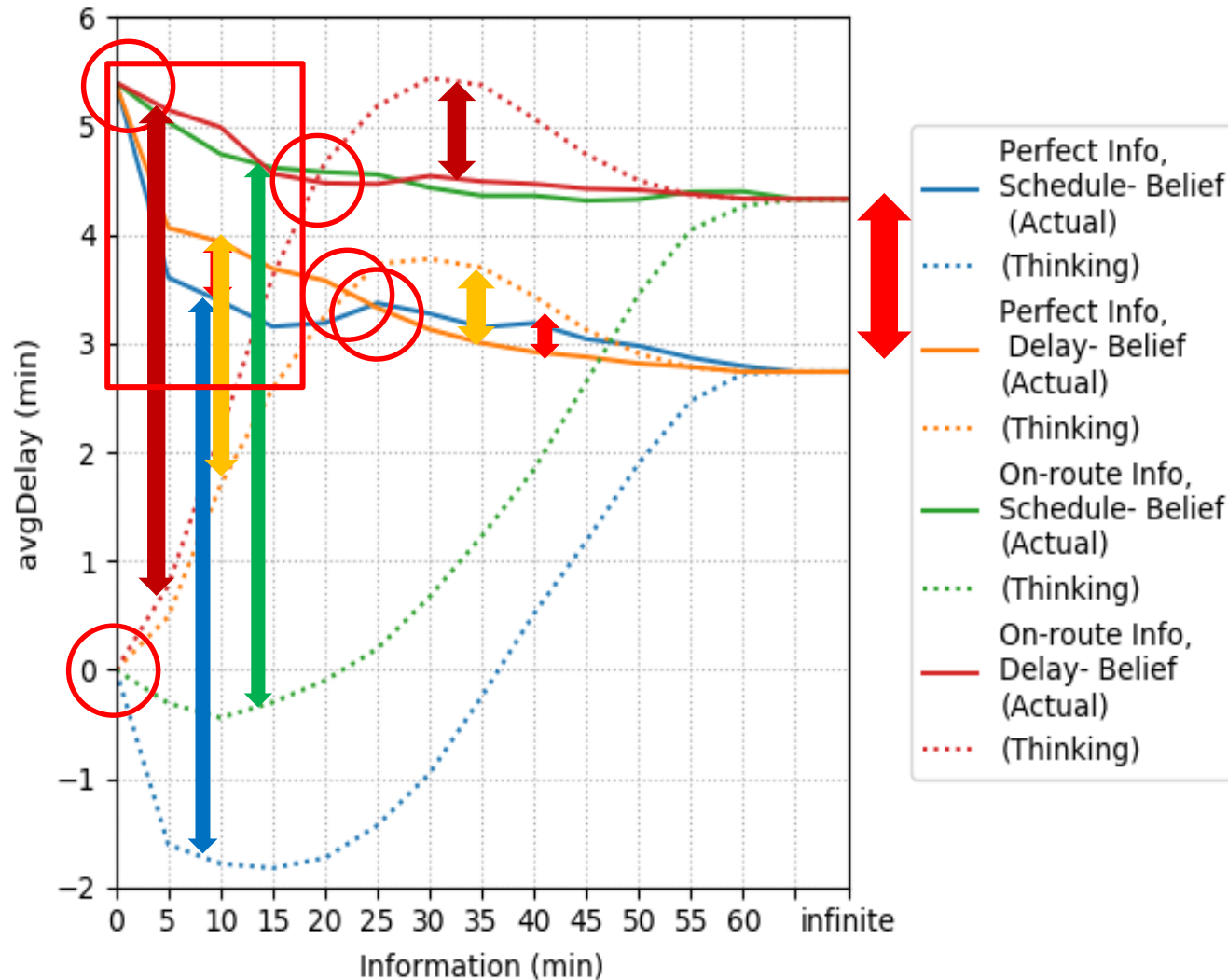
- **Information**

Perfect information (maximum 6.6%) more feasible routes

- **Belief**

Schedule belief (around 0.5%) more feasible routes

Results – Avg. delays (thinking vs. reality)



■ No information

- Thinking: zero delay
- Reality: the largest delay (5.4min)

■ Information affects reality

- Perfect info < On-route info
- Infinite info: the largest gap (1.6min)
- Quick decrease of delay (<15min info)

■ Info & belief (in reality)

- On-route info: belief (negligible effect)
- Perfect info:
 - Schedule belief (<25min info)
 - Delay belief (>25min info)

■ Thinking vs. reality

- Schedule belief:
 - thinking < reality
 - More info, smaller gap
- Delay belief: exists over thinking

Conclusions

- A novel multi-layer time-space-event graph model
 - Incomplete information/ passengers' belief (spatially & temporally).
- Perfect Information > On-route Information
 - More feasible routes.
 - Moreover decreased passengers' delays.
- Information & Belief
 - On-route Information: effects of belief are negligible.
 - Perfect Information: effects of belief depend on the length of provided information.
- Thinking VS. Reality
 - Belief matters (route infeasibility, delay underestimation/ overestimation).
 - The more information, the smaller the gaps.

Future research

- Railway disruptions
 - Infeasible route blockages.
 - Multiple train cancellations.
- Uncertain delays, disruptions
 - Information provided multiple times.
 - Unreliable information.
- Combination with timetable or rolling stock rescheduling
 - Trade off the benefits and costs of information and railway operations.

Thank you for your attention!