

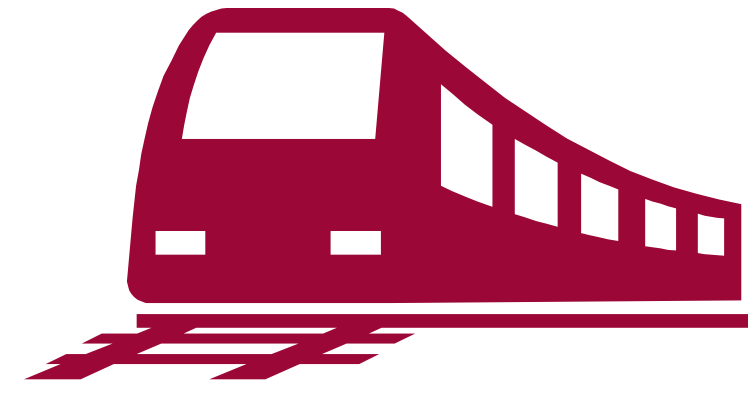
# PROTOTYPE FOR RELIABLE TRAVEL PLANNING

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## Introduction

Current setting: **Reliability** of planned journeys varies, and its distinguishing is important from customer as well as operational point of view.

Reliability in transport is influenced by **delays and cancelled connections**. A connection is considered reliable if it ensures an on-time probability of arrival given a time budget, **Bi Yu Chen et al. (2013)**.



According to **Börjesson et al. (2011)** travelers modify their choice of connection according to its reliability.

Given current network, travelers have multiple possible tours to get from origin to destination and **can decide on the fastest way weighted in its reliability**.

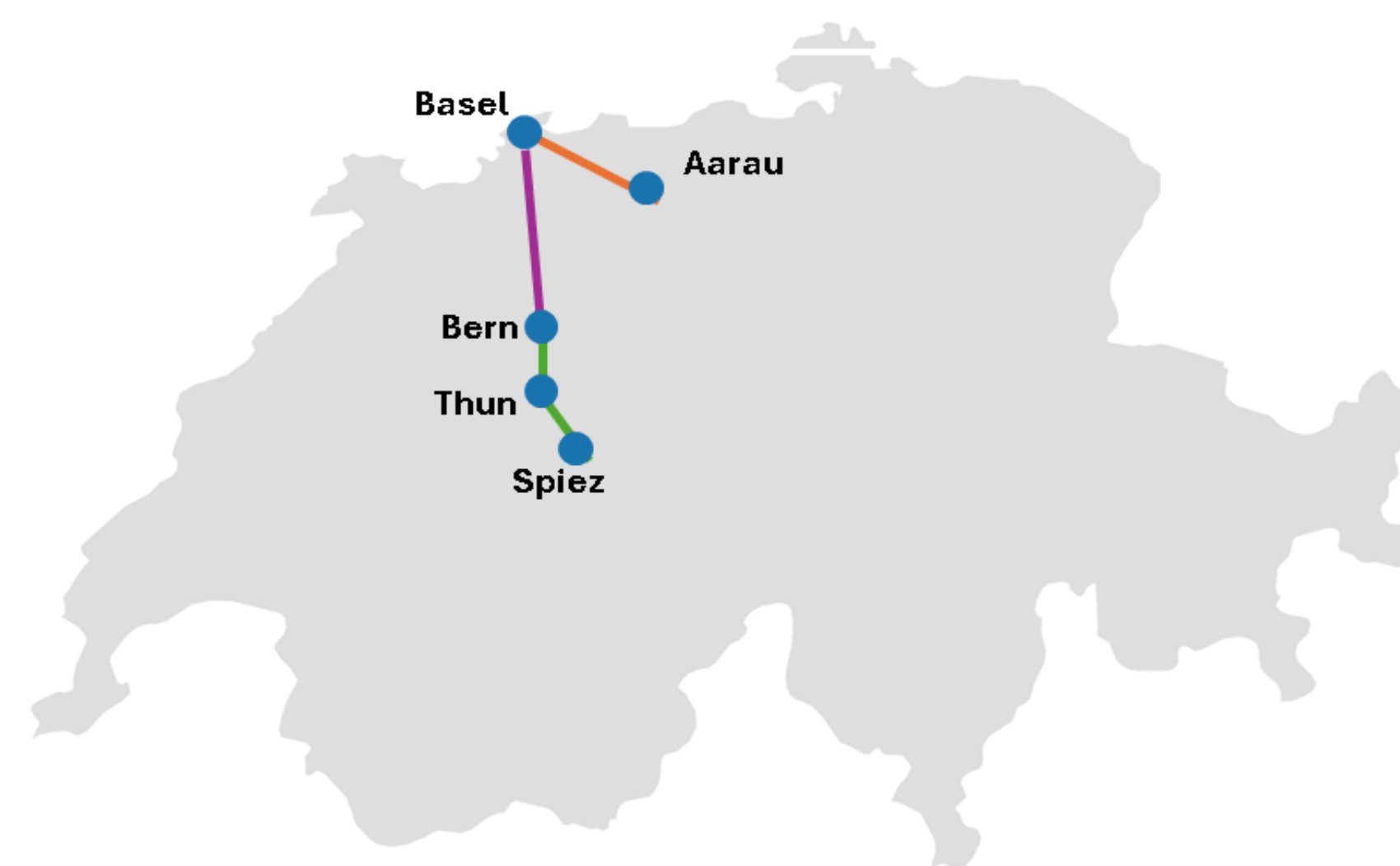
## Goal of the Project

Create a network search algorithm to determine journey **reliability** on real transportation data, using a pseudo code and reference paper from **Redmond et al. (2018)**.

## Results

**Shortest Path Reliability:** Example Spiez to Aarau at 8 PM (Oct 2, 2024)

**Train 1:** Spiez to Thun (20:22 – 20:32)  
**Train 2:** Bern to Basel SBB (21:04 – 21:30)  
**Train 3:** Basel SBB to Aarau (21:49 – 21:57)  
Thun to Bern (20:33 – 20:52)



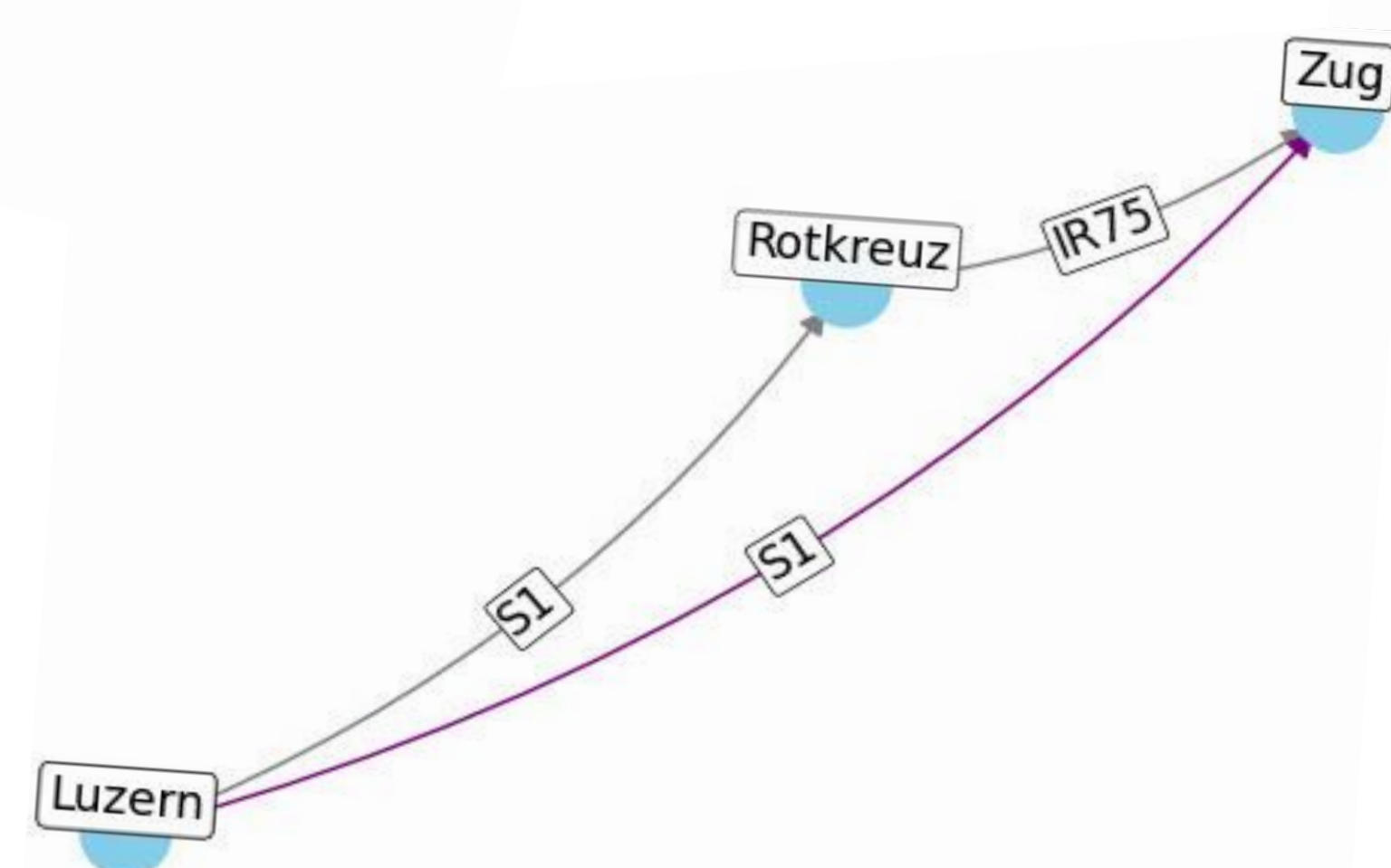
This path is reliable on 58%.  
**There is 58% chance that the connection arrives to Aarau at 21:57 or earlier.**

**Finding the Most Reliable Path:** Example Luzern to Zug at 10 AM (Oct 2, 2024)

**Shortest path arrival:** 10:57 -> reliability: 78%  
**Most reliable path arrival:** 11:05 -> reliability: 100%  
**Time budget:** 86 mins

Two interesting observations around this "small" example Luzern-Zug:

- Increasing the time budget of 5 minutes for the shortest path, increases the reliability from 78% to 90% (more realistic – arriving within 5 min. is acceptable).
- The run time of the network search is rather slow (~ 40 seconds). With efficiency improvements like pruning the intermediate itineraries, it can be drastically reduced (with our implemented improvements down to ~ 20 seconds).

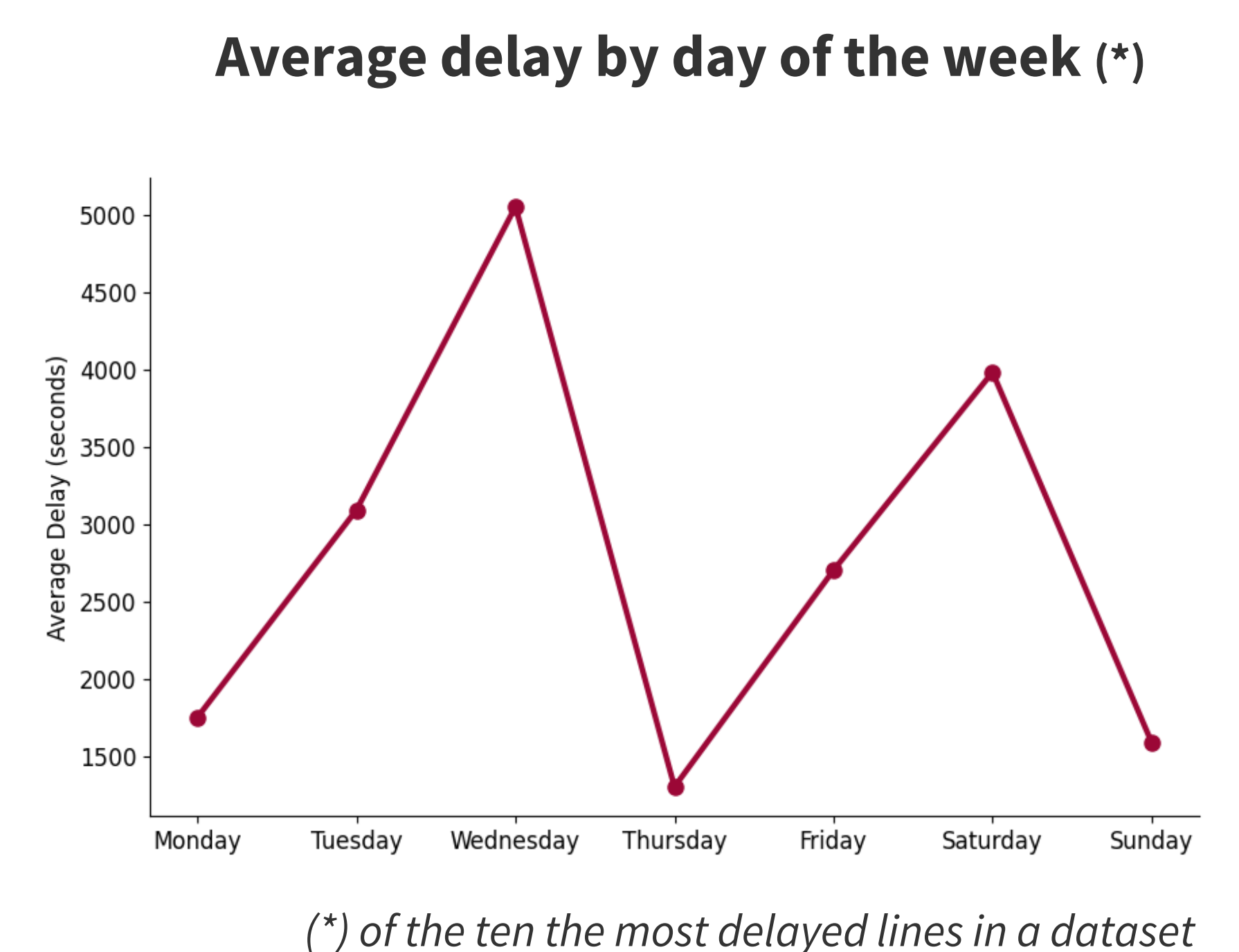


## Dataset

Swiss database of public transport., focusing on **train** connections.

**1.74%** of trains are delayed more than 5 minutes.

Delay data extracted for period 05-10/2024.



## Algorithm and Reliability Formula

Dijkstra algorithm for finding the shortest path from a source to a destination in a graph.

**Shortest path = earliest possible arrival given start time, origin and destination**

Setting **time budget** - a multiple of duration of the shortest path found using Dijkstra. Default: Transfer time between lines: 5 mins, time buffer: 1.5 times shortest path travel time.

## Reliability calculation process:

Three important parts

Probability of making the connection

Probability of arriving at or before the next departure (given previous connection made)

Reliability (probability of arrival within time budget times probability of all connections made)

**How probable is it that the fastest connection will arrive on time?  
What trip should be taken to maximize the chance we can arrive to the destination within our time budget?**

## Interface

Example: Train from Bern to Visp at 8 AM (Oct 2, 2024)

You searched for a journey from **Bern** to **Visp** departing at **08:00**.  
The difference between the shortest and most reliable path is **60 minutes**.

### Shortest Path

Departure Station	Departure Time	Arrival Station	Arrival Time
IC8 Bern	08:07	Thun	08:25
IC8 Thun	08:26	Spiez	08:36
IC8 Spiez	08:36	Visp	09:02

Projected reliability: 12.5%

### Most Reliable Path

Departure Station	Departure Time	Arrival Station	Arrival Time
IC8 Bern	08:07	Thun	08:25
IC8 Thun	08:26	Spiez	08:36
IC6 Spiez	09:36	Visp	10:02

Projected reliability: 75.0%

## References

Redmond, M., Campbell, A.M. and Ehmke, J.F. (2019) 'The most reliable flight itinerary problem', *Networks*, 73(3), pp. 325–343. Available at: <https://doi.org/10.1002/net.21866>.  
Börjesson, M. and Eliasson, J. (2011) 'On the use of "average delay" as a measure of train reliability', *Transportation research. Part A, Policy and practice*, 45(3), pp. 171–184. Available at: <https://doi.org/10.1016/j.tra.2010.12.002>.  
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