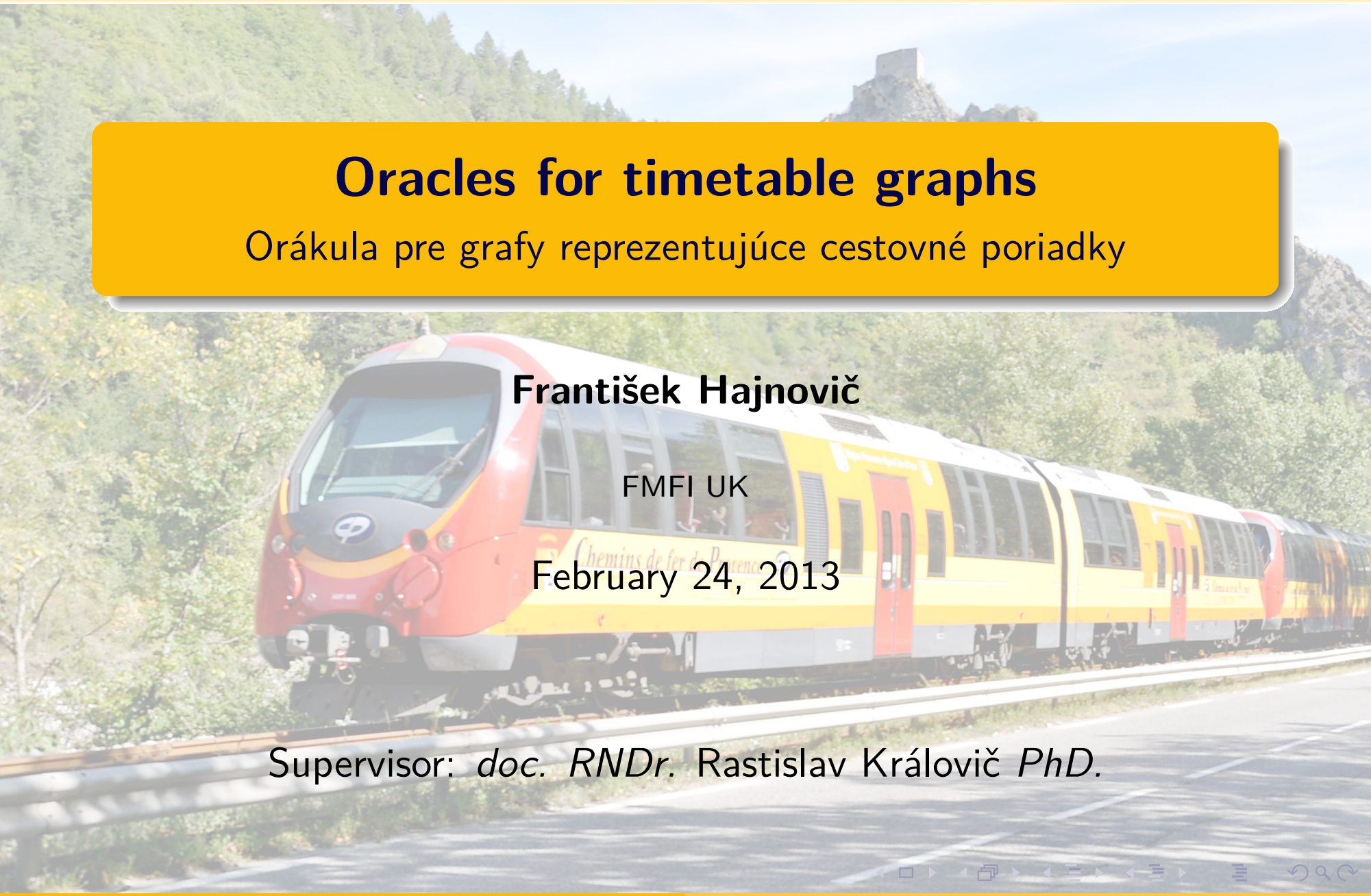

Oracles for timetable graphs

Orákula pre grafy reprezentujúce cestovné poriadky

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Introduction

- It is about: **Earliest arrival problem** (EAP) given a timetable

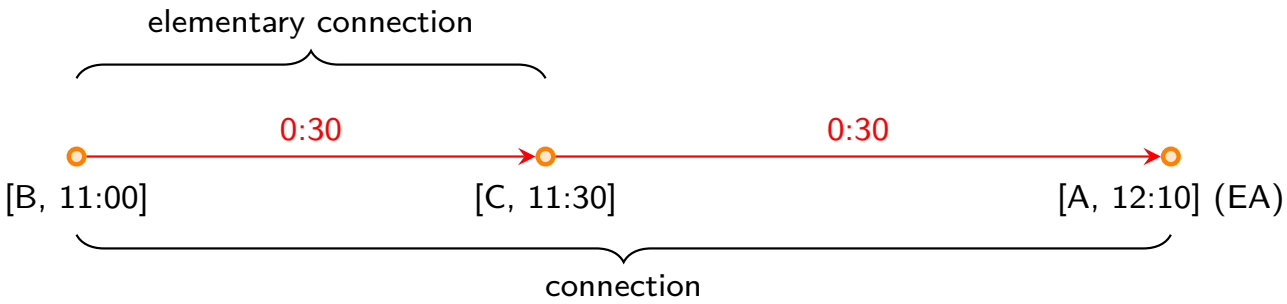

Figure : **Connection**, **elementary connection** and **earliest arrival**

- Motivation: large-scale timetable search engines (*cp.sk*, *imhd.sk*...)
- Approach: Oracle-based approach - pre-computation
- Goals:
  - Devise methods to tackle EAP
  - Analyse properties of timetables

USP-OR

- *"Usually we go through the same sequence of cities"*

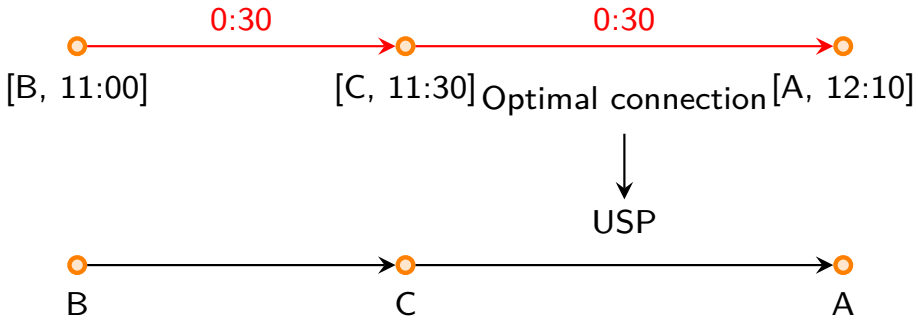

Figure : **Underlying shortest path**

- **USP-OR** pre-compute all underlying shortest paths
- space $\mathcal{O}(\tau\ n^3) \rightarrow$ too much!

USP-OR

- *"Usually we go through the same sequence of cities"*

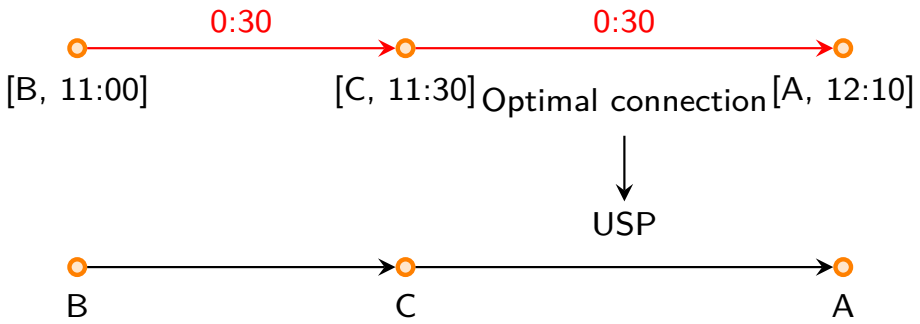

Figure : **Underlying shortest path**

Name	**avg** $\tau_{A,B}$	**max** $\tau_{A,B}$
air01	18.3	126
cpru	10.25	53
cpza	5.87	45
montr	4.09	30
zsr	8.9	85

Table : $\tau_{A,B}$ - number of USPs between A and B

- **USP-OR** pre-compute all underlying shortest paths
- space $\mathcal{O}(\tau\ n^3) \rightarrow$ too much!

- Pre-compute only some USPs?

USP-OR-A

- **Access nodes** - set A of cities in UG
  - Size $|Acc| = \mathcal{O}(\sqrt{n})$
  - Small node neighbourhoods $\forall v \ |neigh_{Acc}(v)| = \mathcal{O}(\sqrt{n})$
  - Few local access nodes $(\forall v \ |Acc_v| = \mathcal{O}(f(n)))$
- Space $\mathcal{O}(\tau \ n^2)$

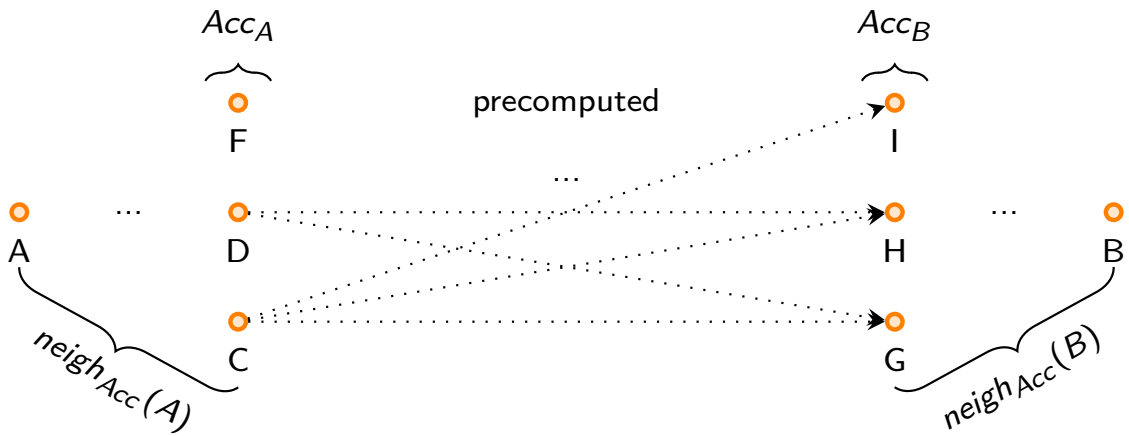

Figure : **Principle of access nodes**

Other contribution

- **Neural networks oracle** - problem too challenging for NN/try different types of network
- **Analysis** of various real-world timetables
- Useful and easily extendible **application** for analysis and oracle tests

Name	Description	El. conns.	Cities	Time range	Height (h)
air01	domestic flights (US)	592767	250	1 month	24374
cpru	regional bus (SVK)	10011	250	1 day	239
cpza	regional bus (SVK)	15776	250	1 day	370
montr	public transport (Montreal)	7118	211	1 day	363
zsr	country-wide rails (SVK)	931647	233	1 year	59928

Table : Data - timetable properties

Conclusion

- **Other techniques** [Del08], [BDSV09], [DPW09]
  - different ideas
  - meant for different scenarios
- Trying out novel approaches to solve EAP in timetables
- Better insight on properties of timetables
- **To-do**:
  - Find a good access node set
  - Train and test properly neural network oracles

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Thank you for the attention