

Learning Drivers' Preferences: an Inverse Optimization Approach

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Delft University of Technology



Bilge Atasoy



Peyman Mohajerin Esfahani



Piet van Beek

Outline

Inverse Optimization

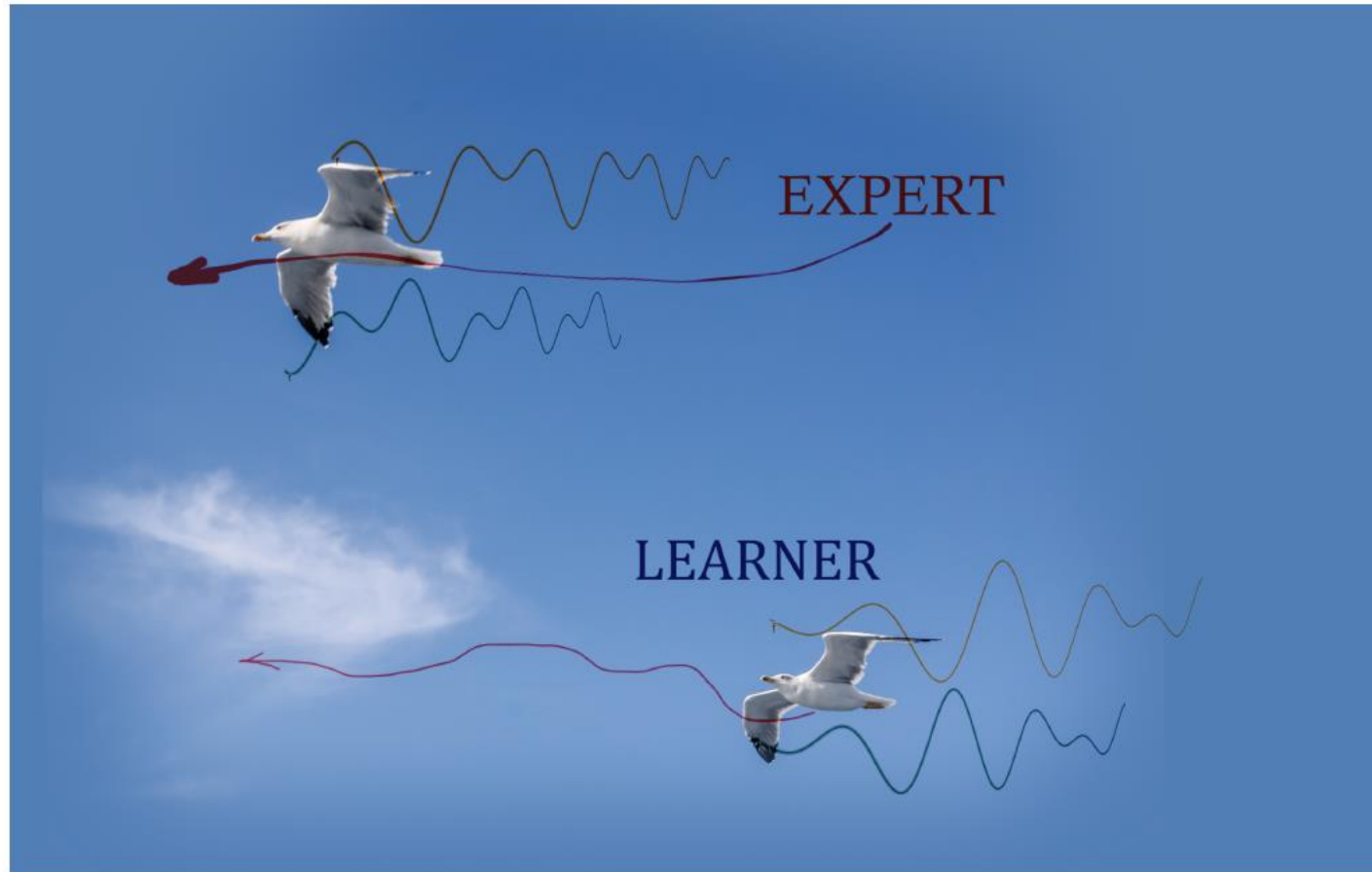
Amazon Challenge

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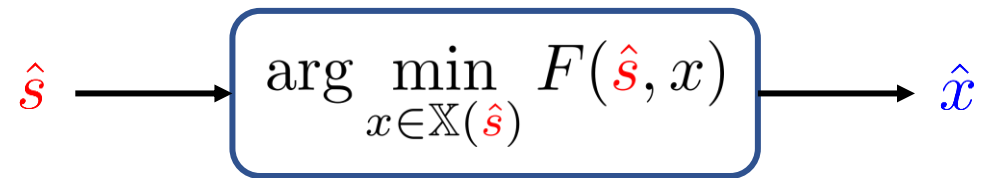


Underlying Assumption

Given a **signal** (**input**), the **expert** computes its **response** (**output**) by optimizing an unknown cost

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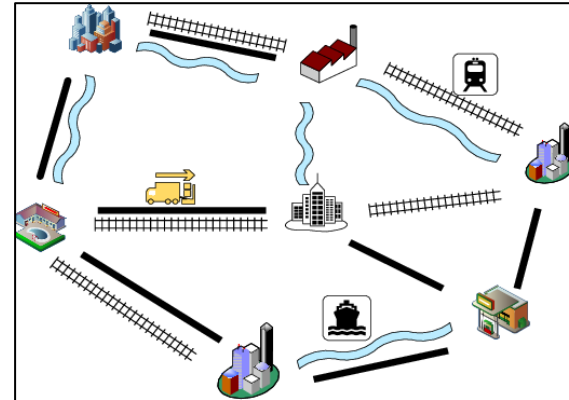
$$\hat{s} \longrightarrow \arg \min_{x \in \mathbb{X}(\hat{s})} F(\hat{s}, x) \longrightarrow \hat{x}$$



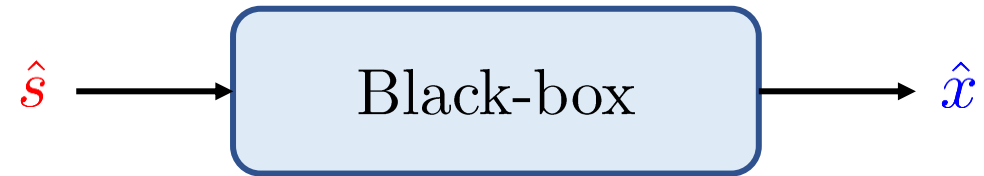
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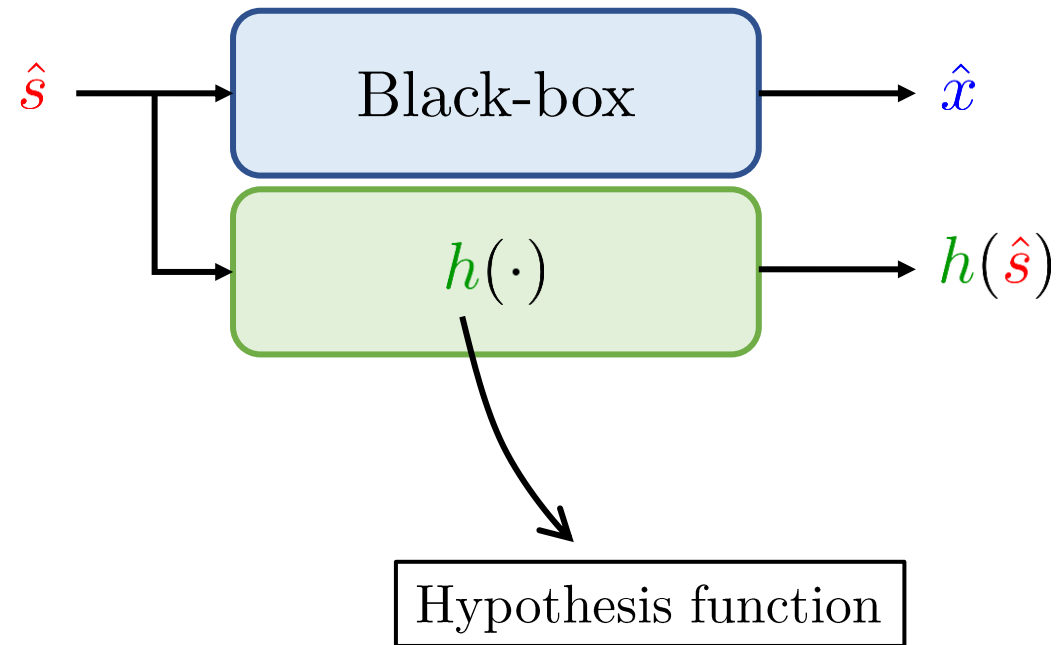
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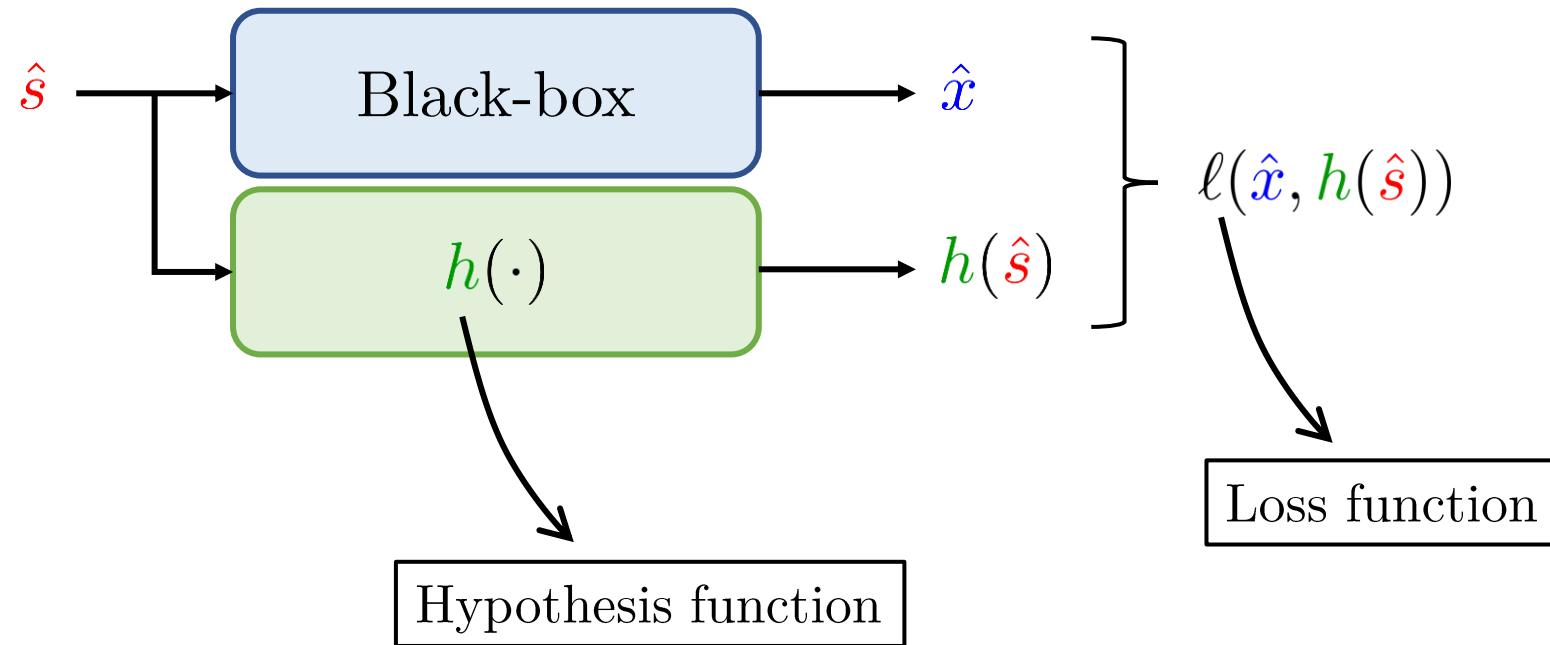
Supervised Learning Point of View



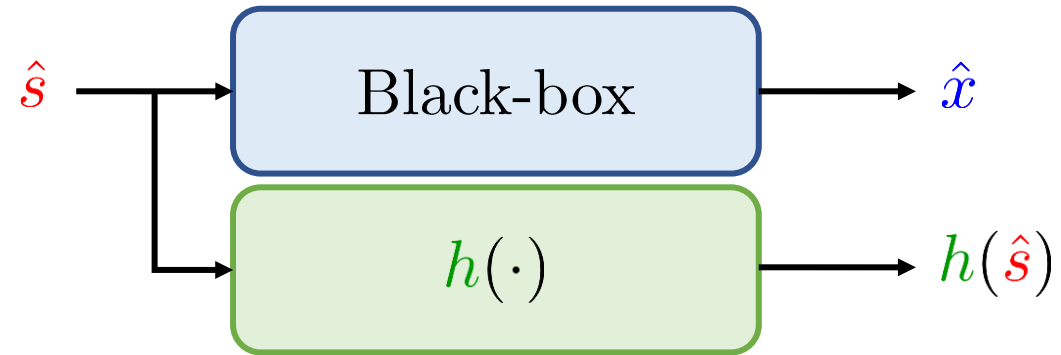
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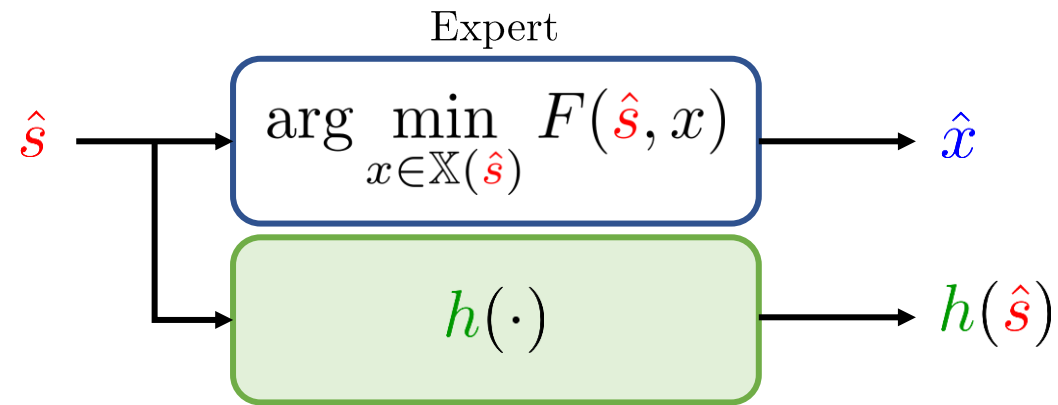
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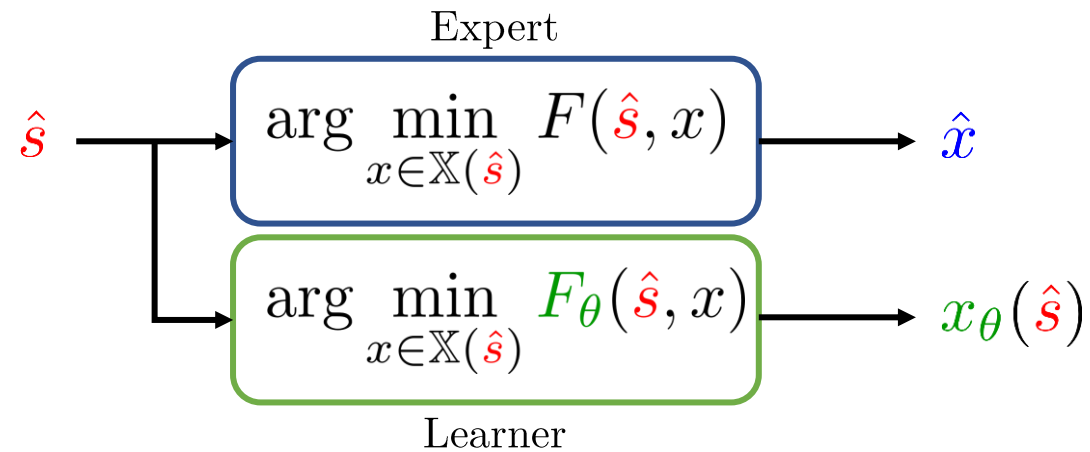


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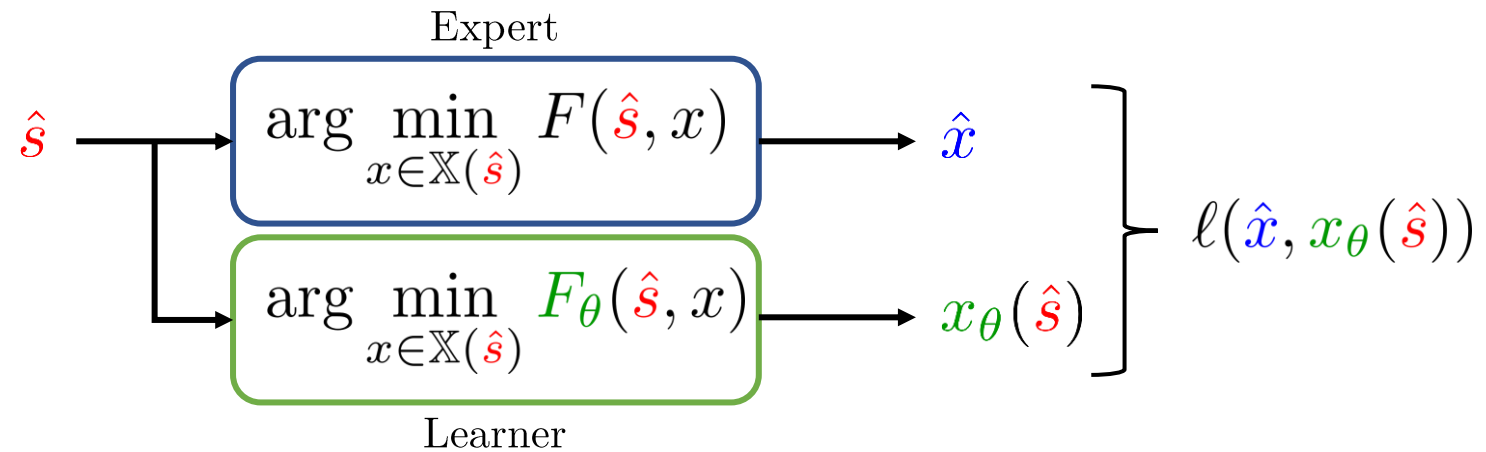
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- Optimize loss: $\min_{\theta \in \Theta} \frac{1}{N} \sum_{i=1}^N \ell(\hat{x}_i, x_\theta(\hat{s}_i))$

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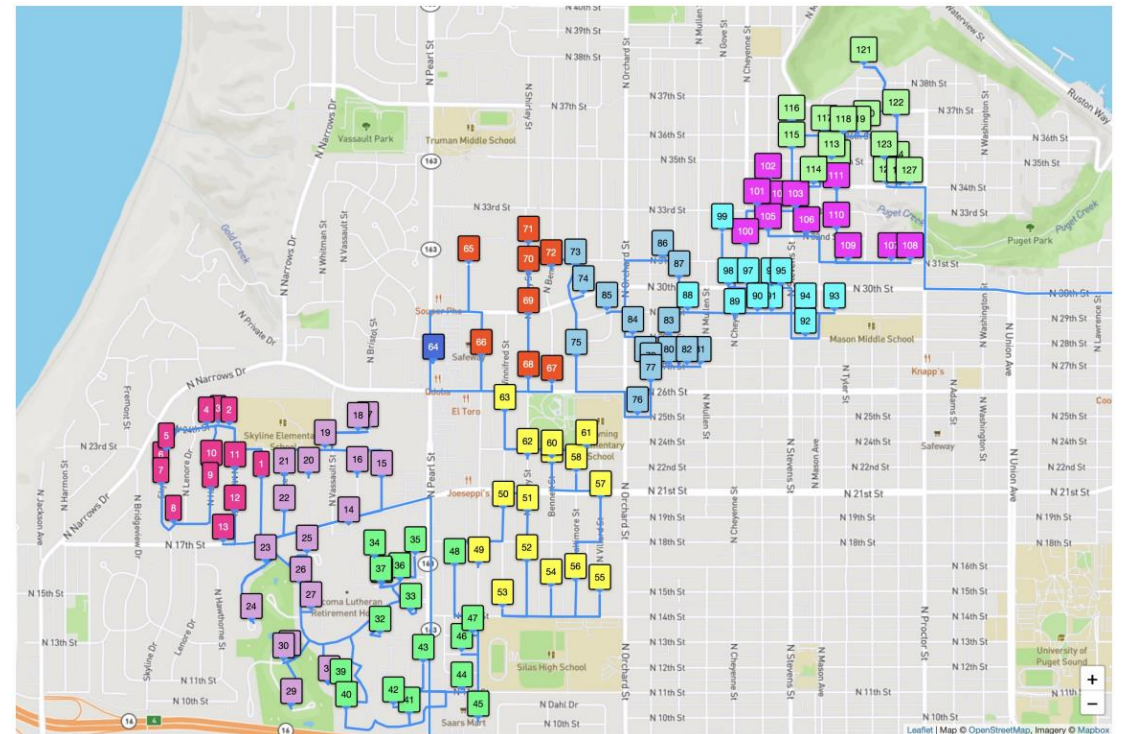
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amazon Last-Mile Routing Challenge (2021)

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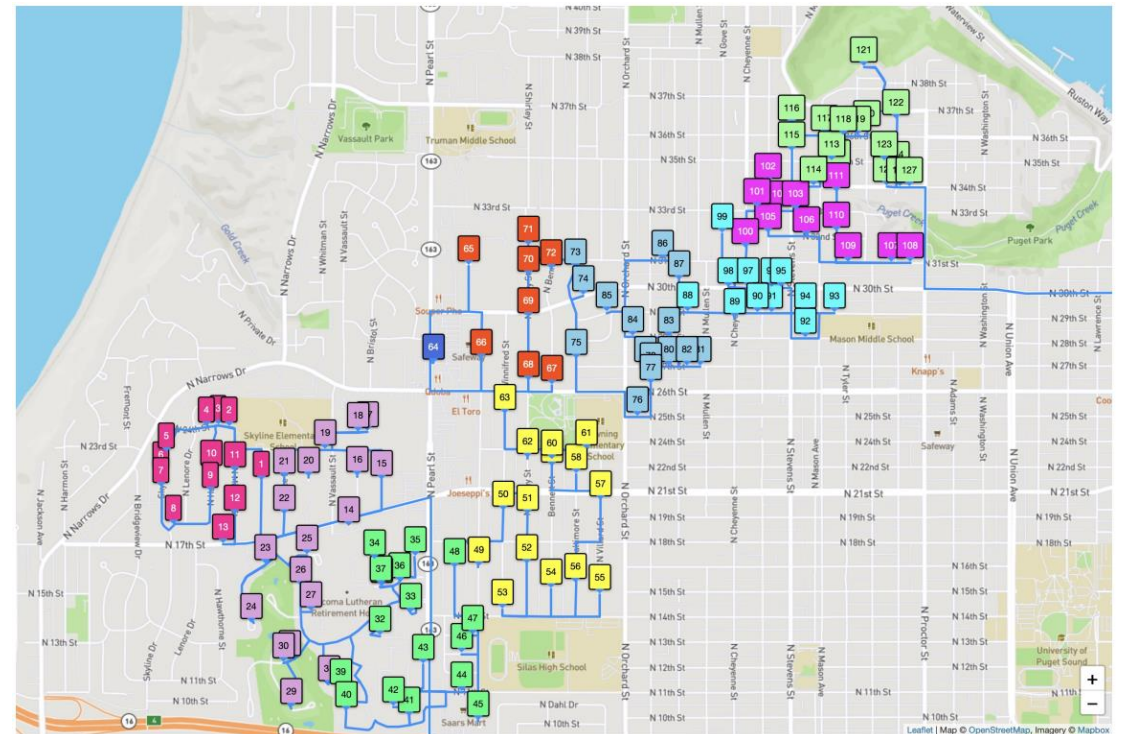
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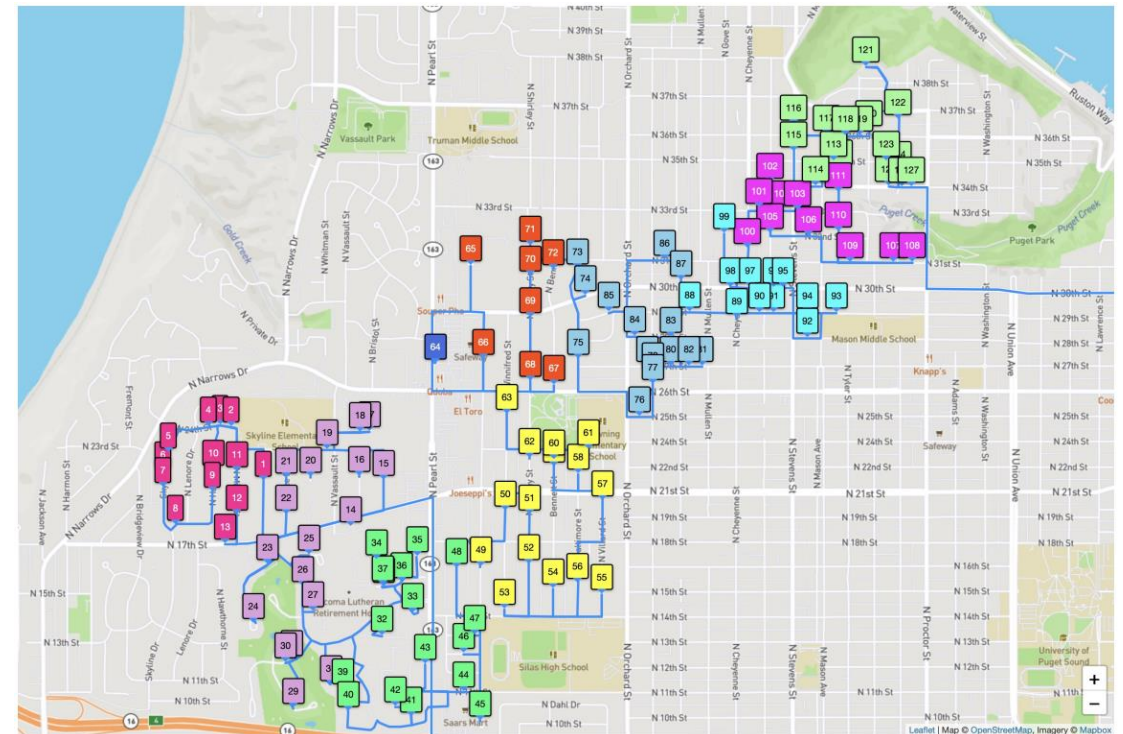
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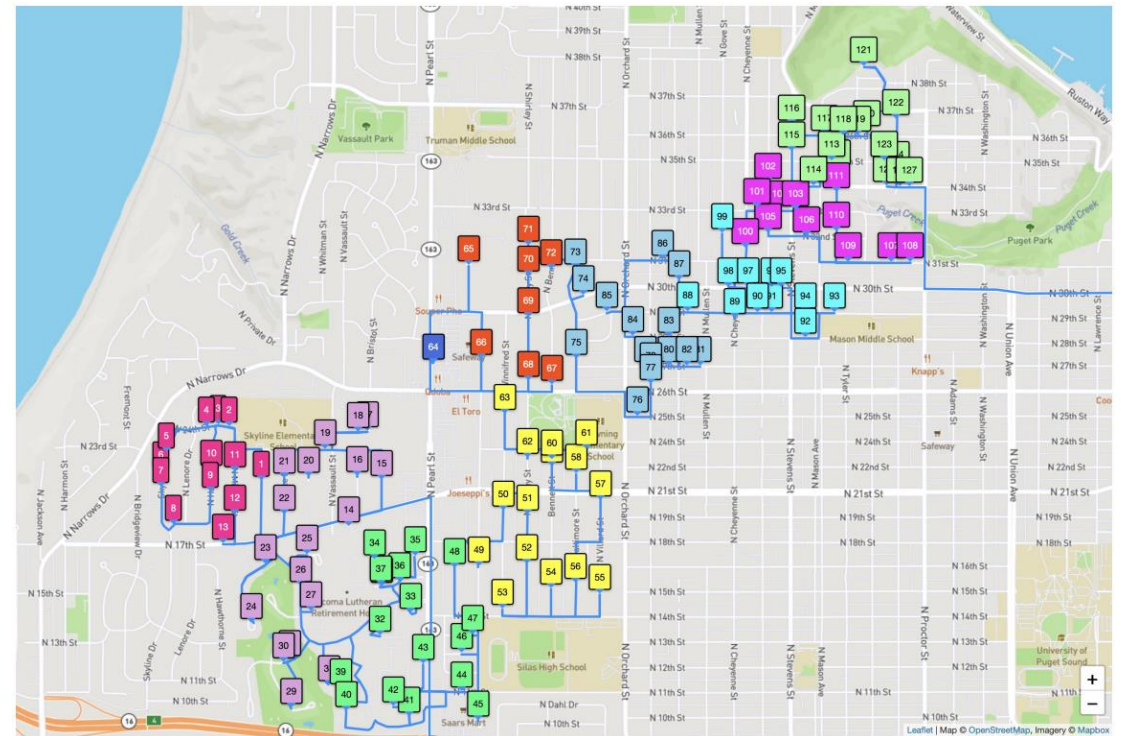
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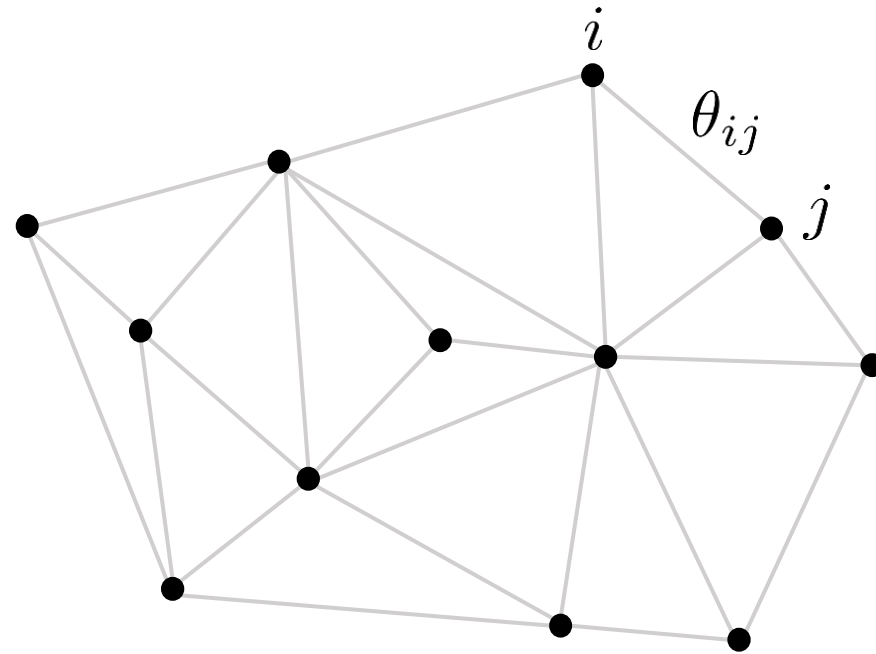


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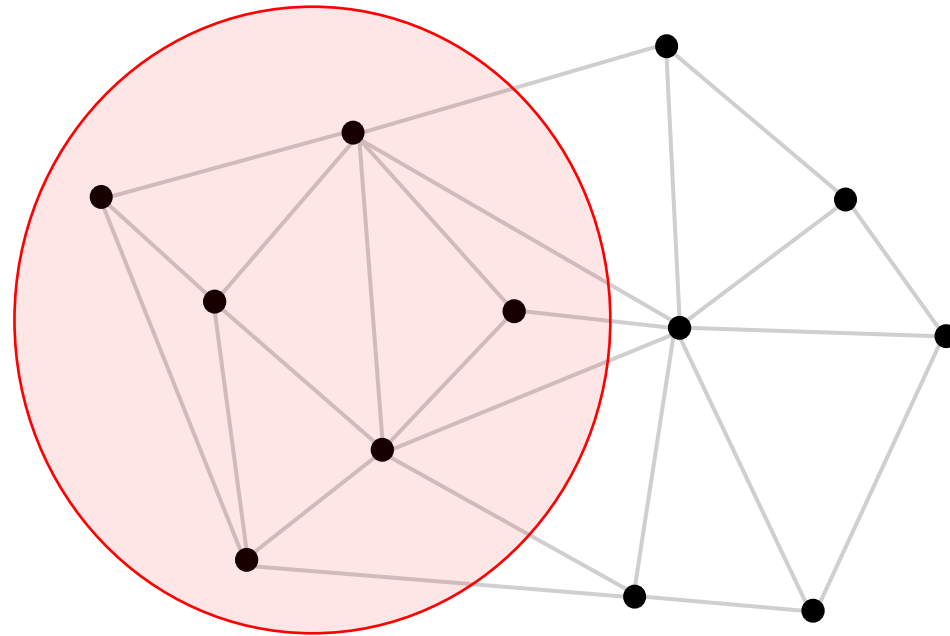
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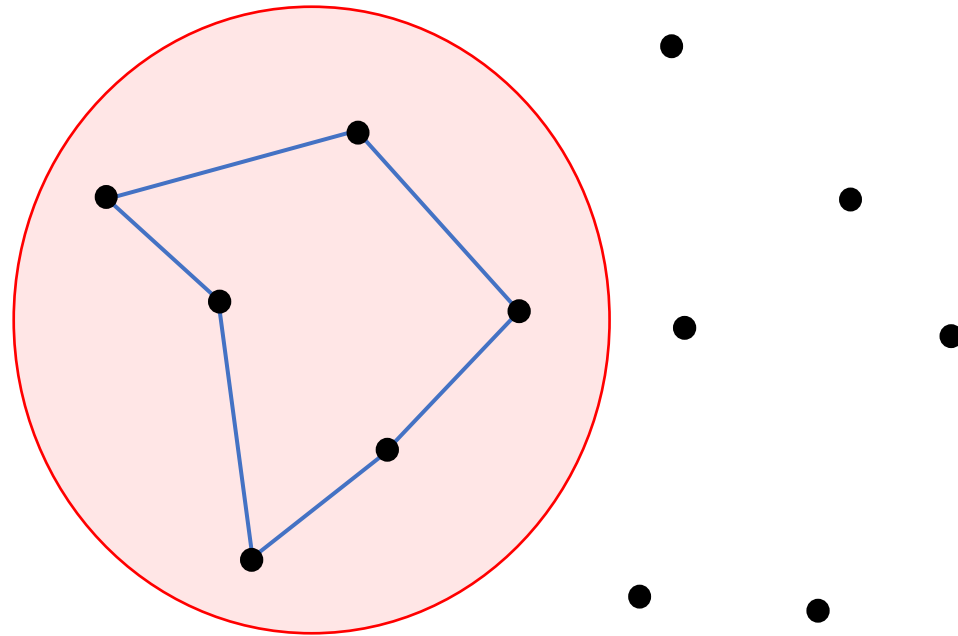
Traveling Salesperson Problem (TSP)



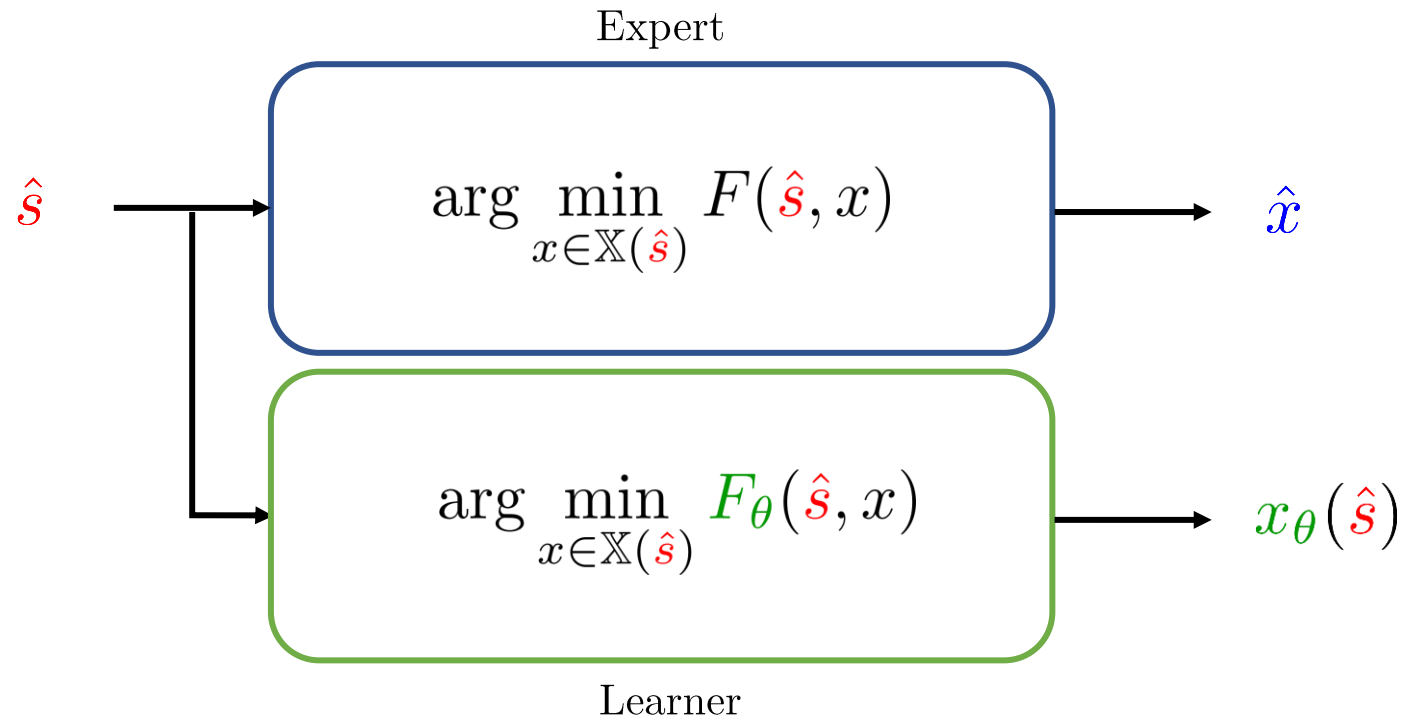
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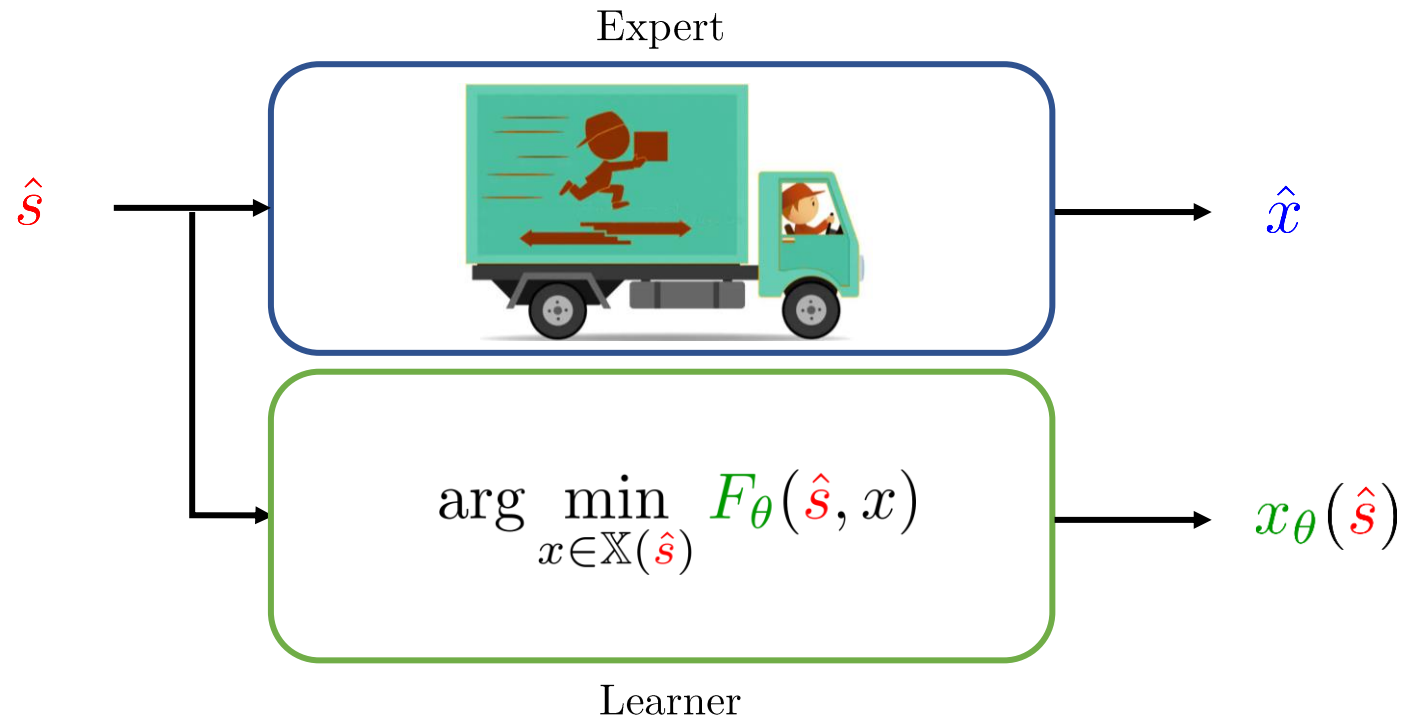
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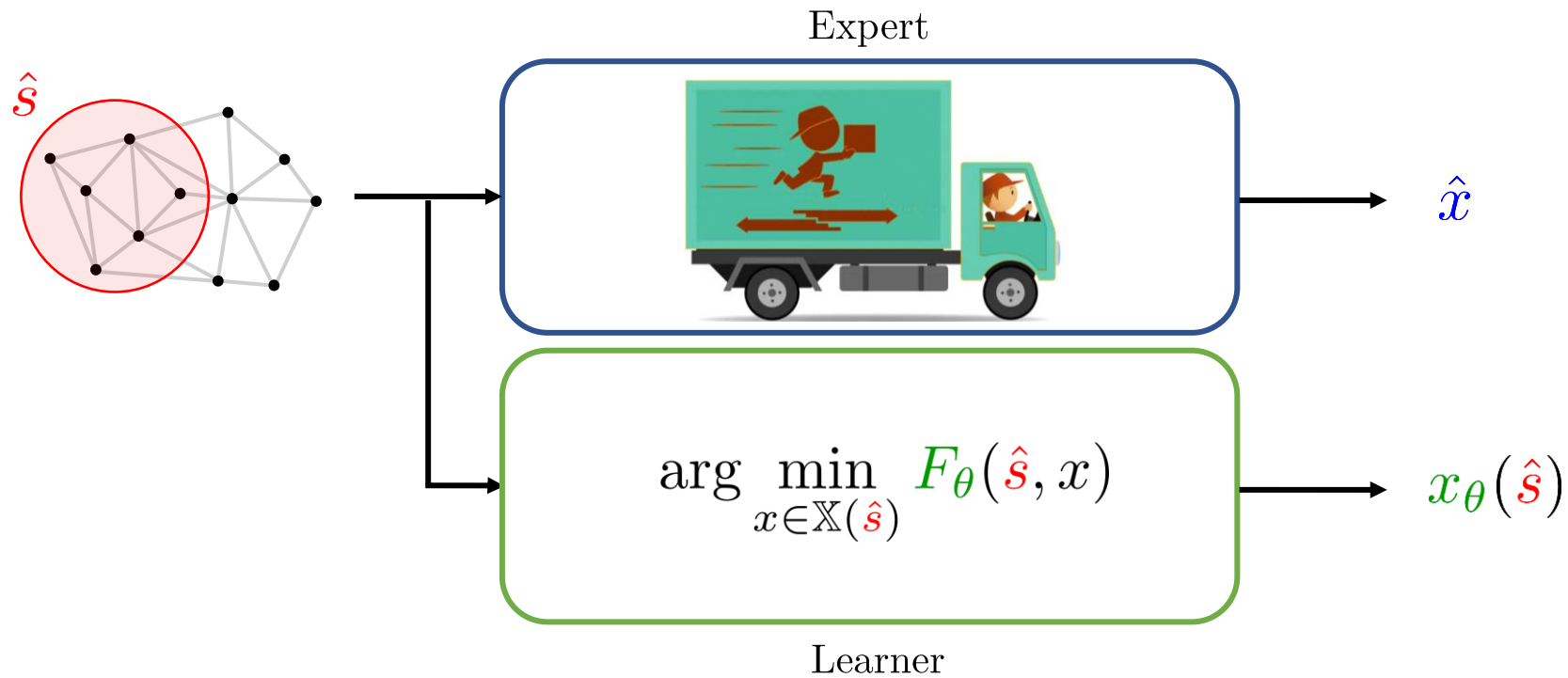
Inverse Optimization: Amazon Challenge



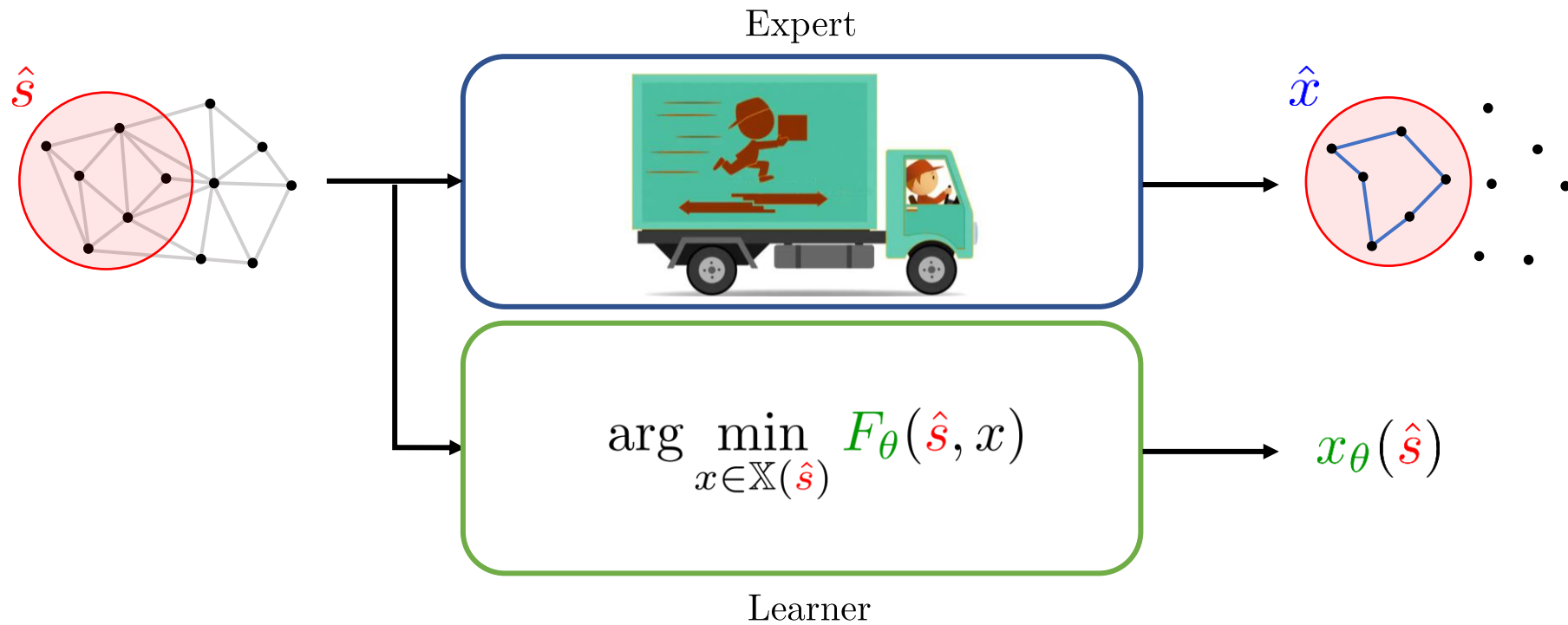
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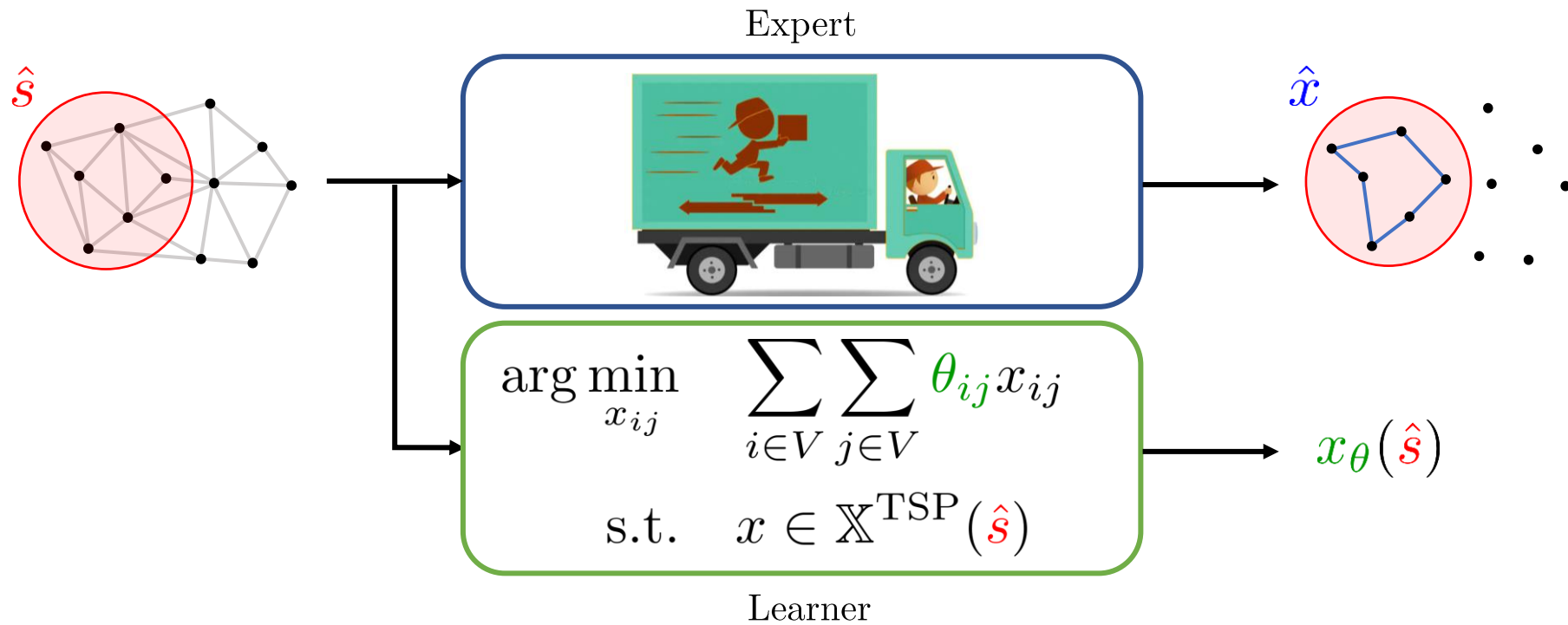
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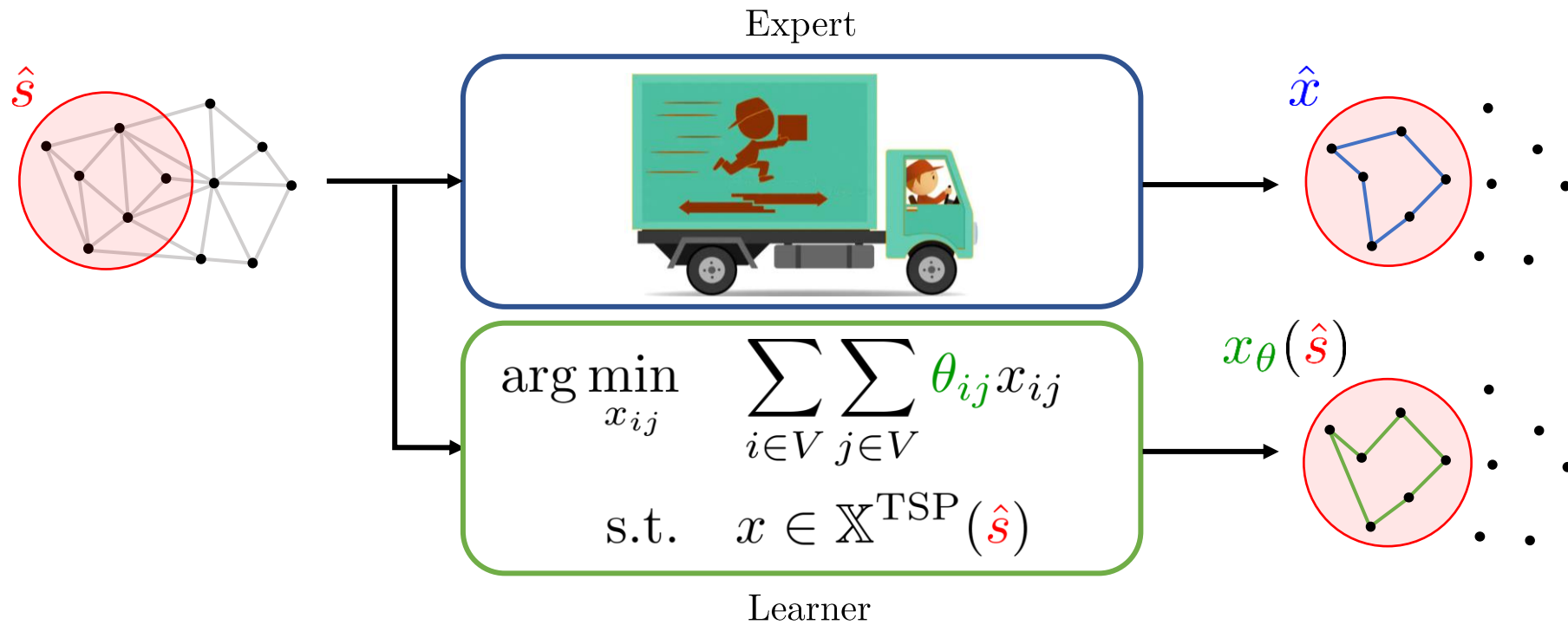
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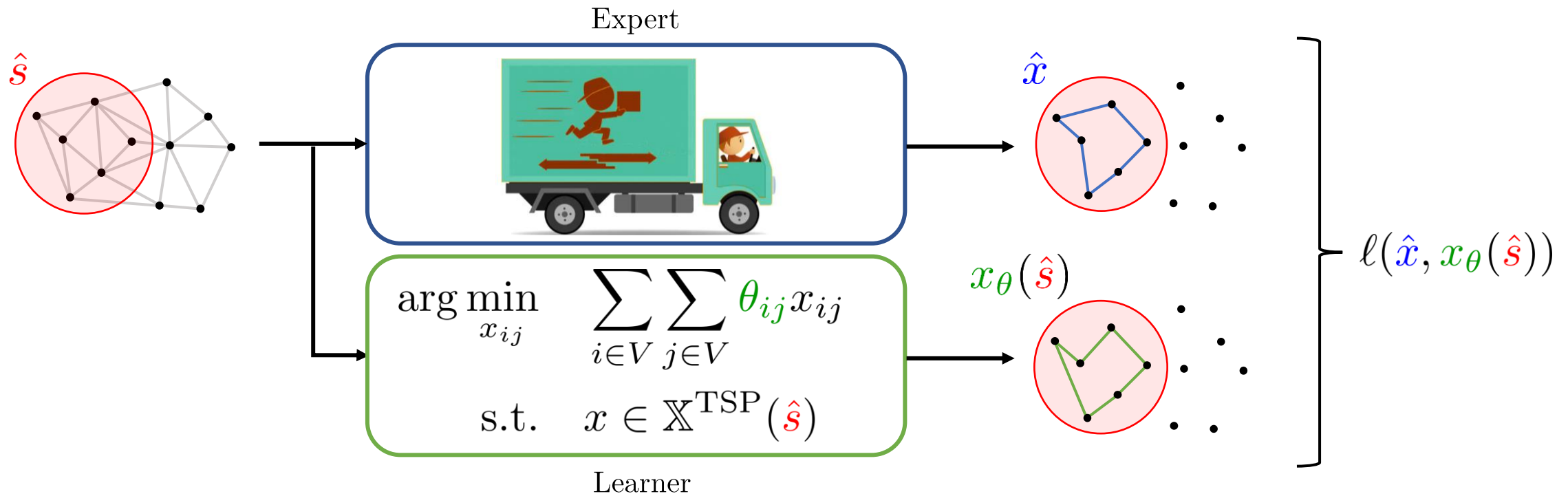
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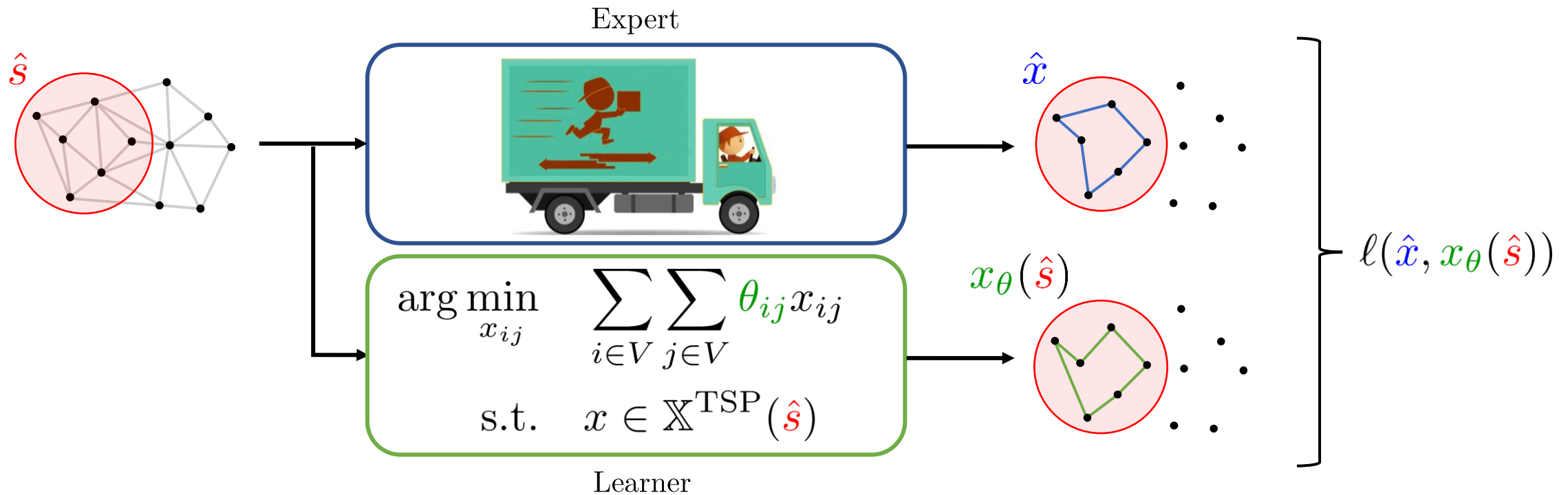
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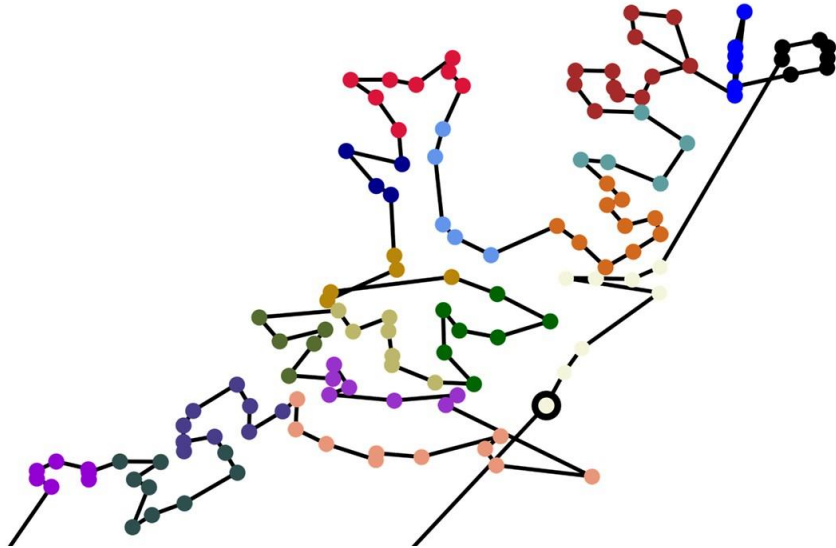


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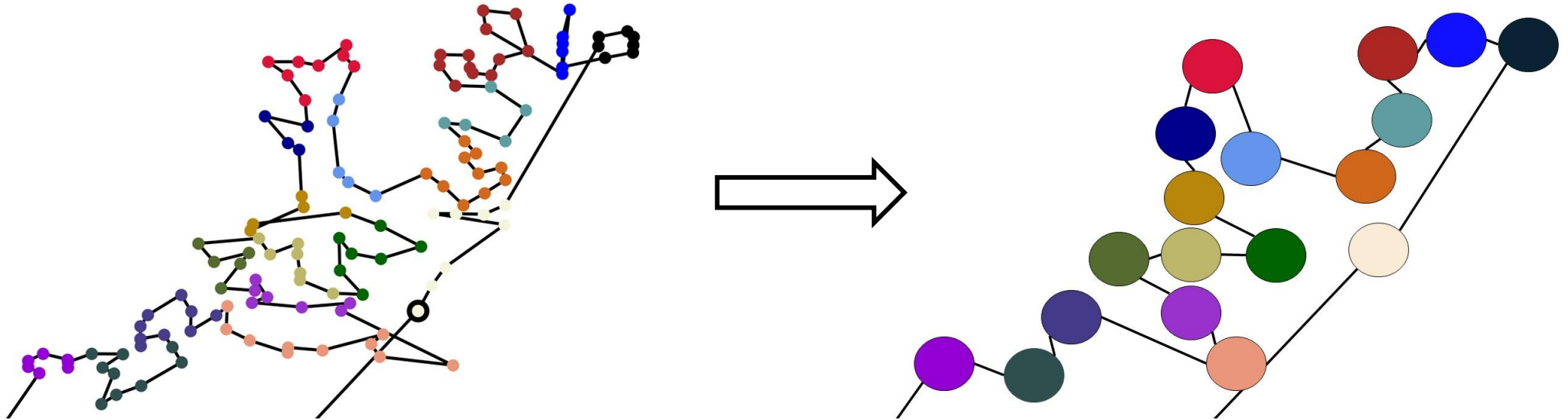


- Problem: the data is too sparse!

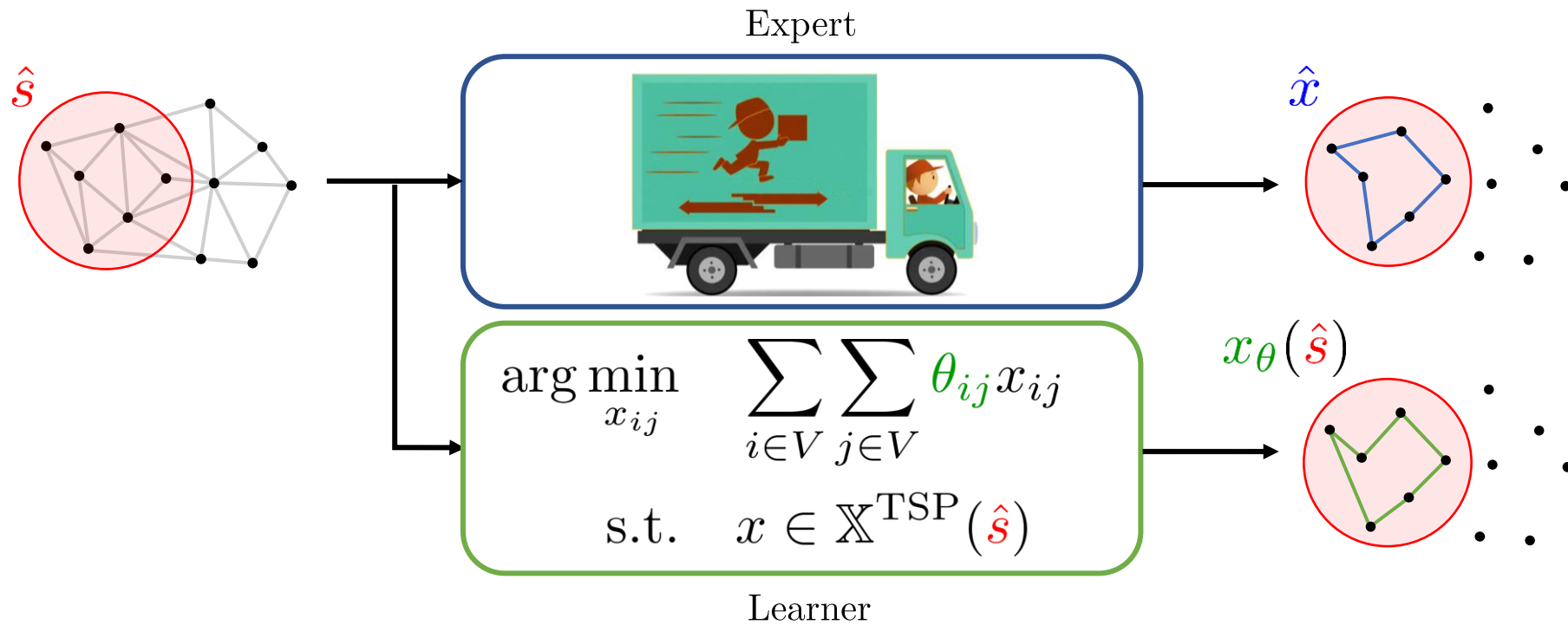
From Stop-level to Zone-level Learning



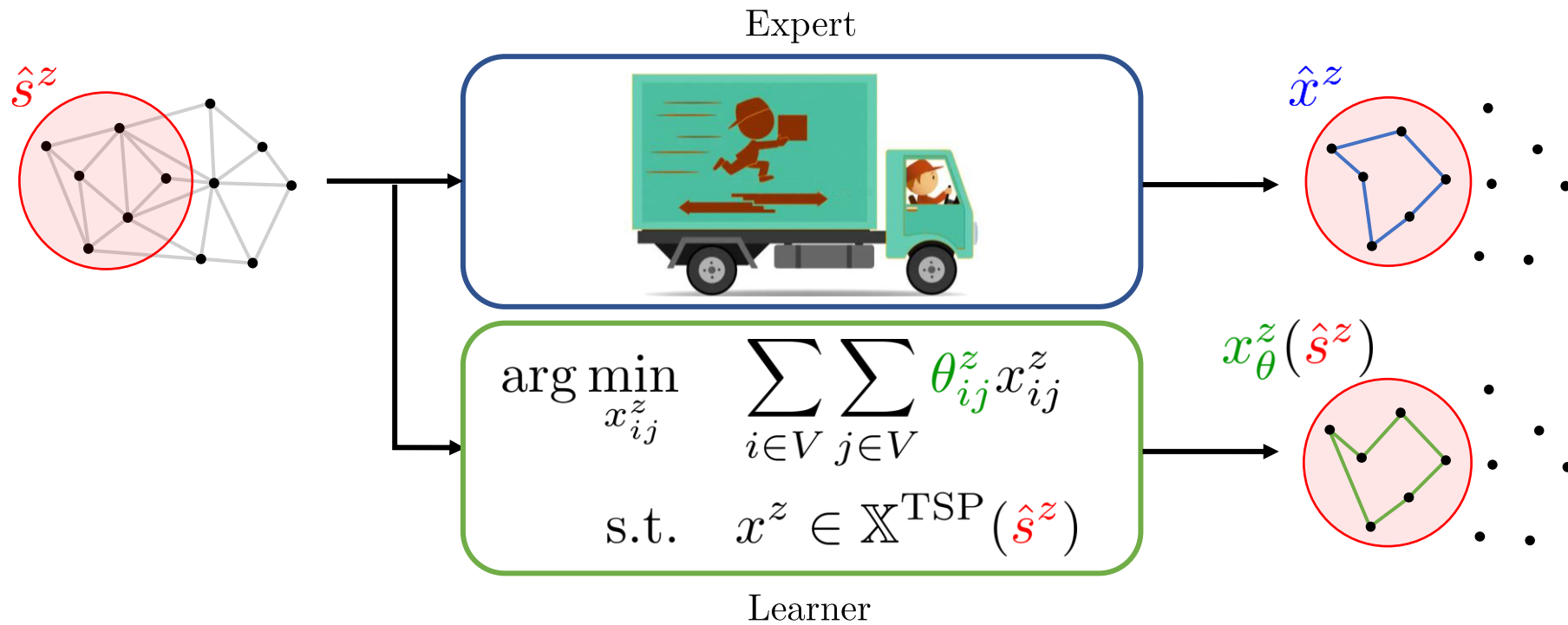
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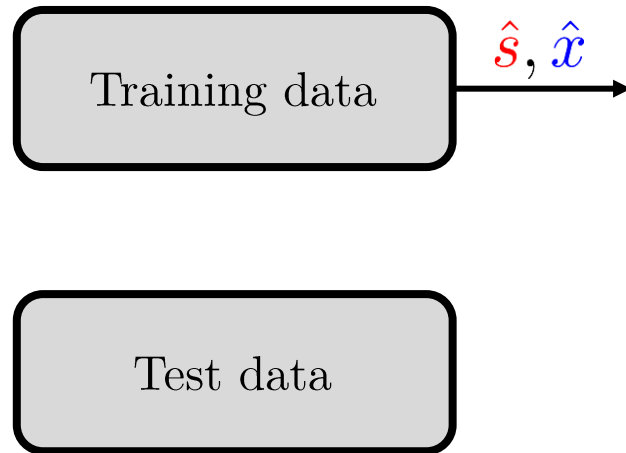
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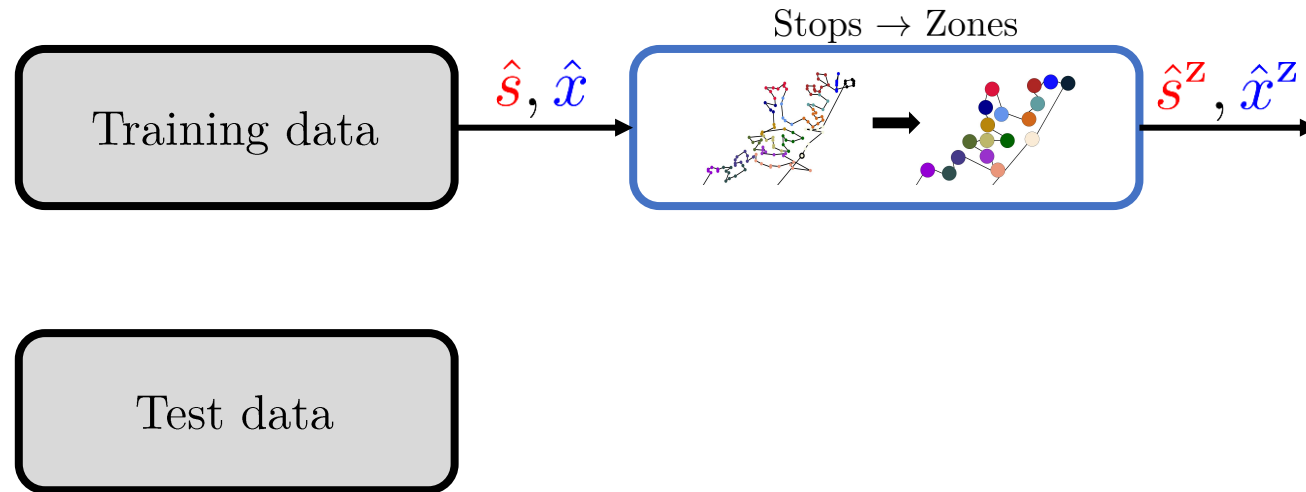
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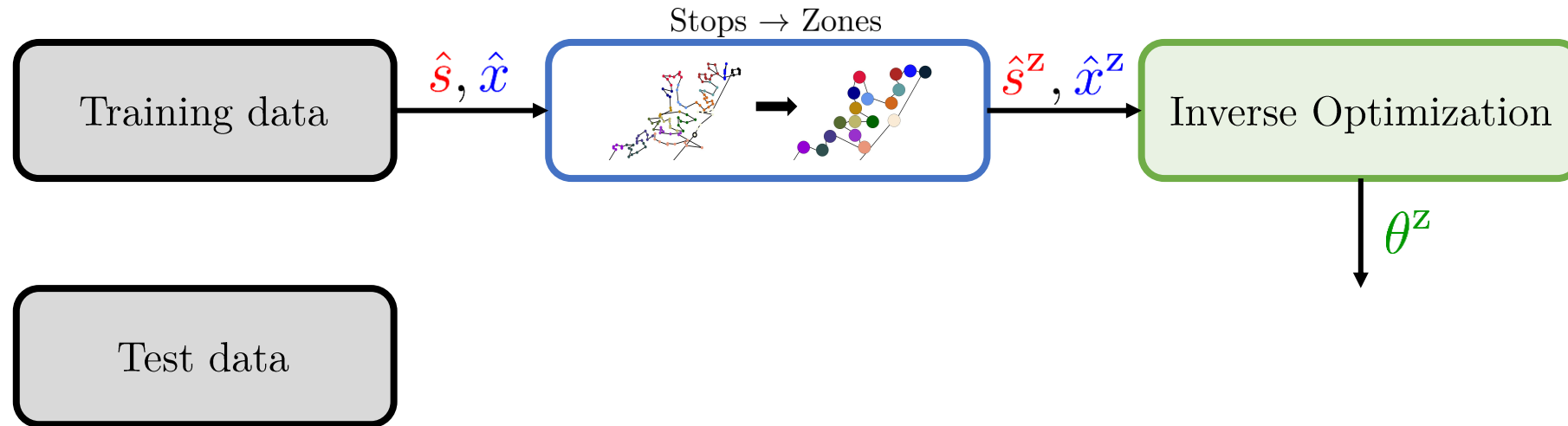
Complete Approach



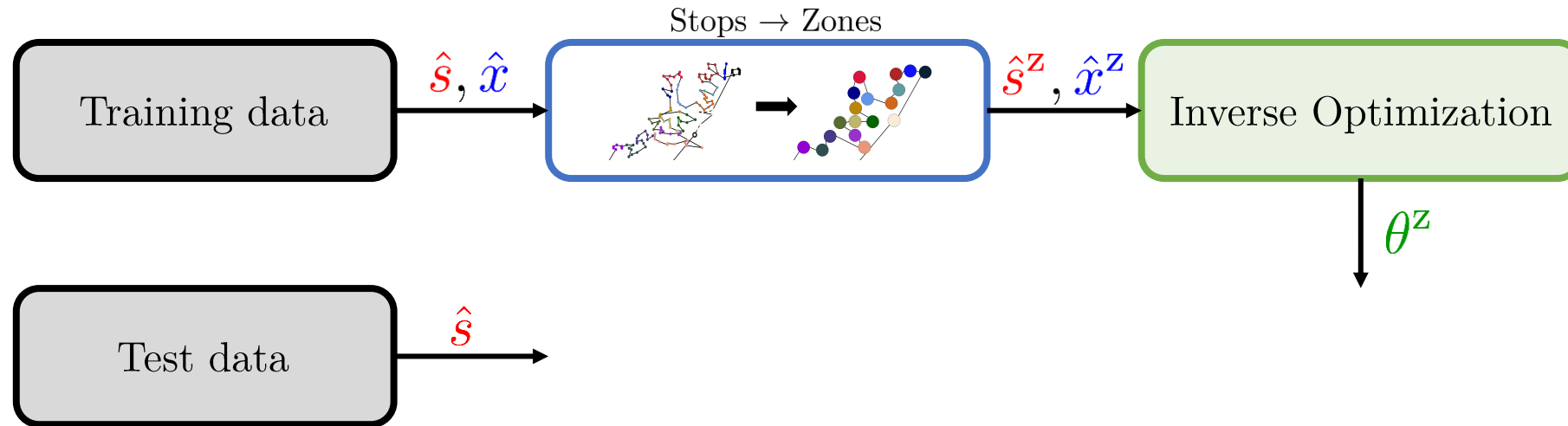
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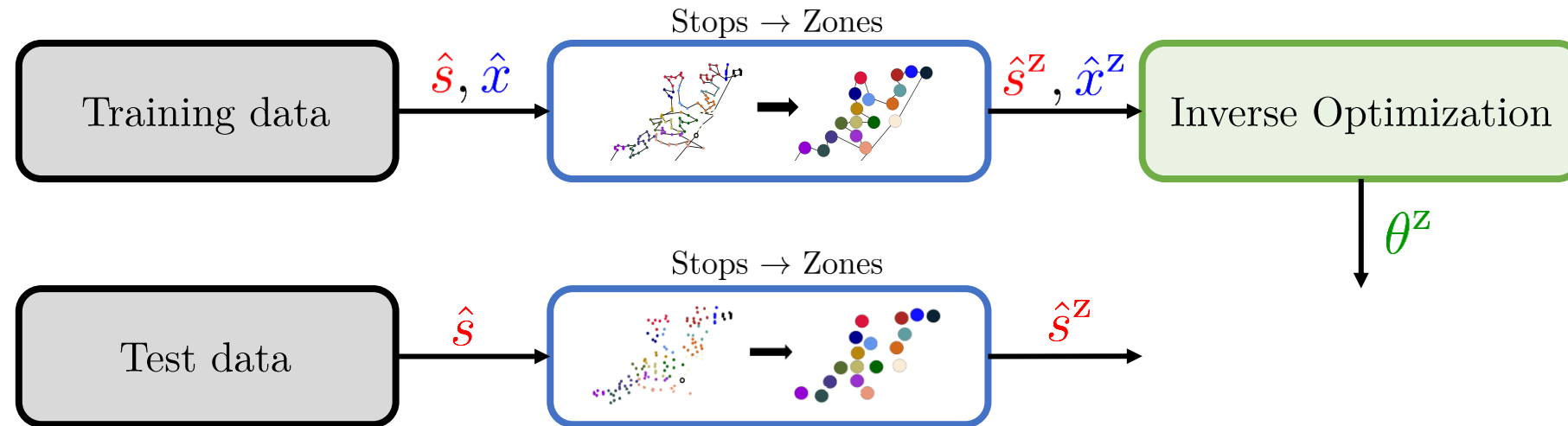
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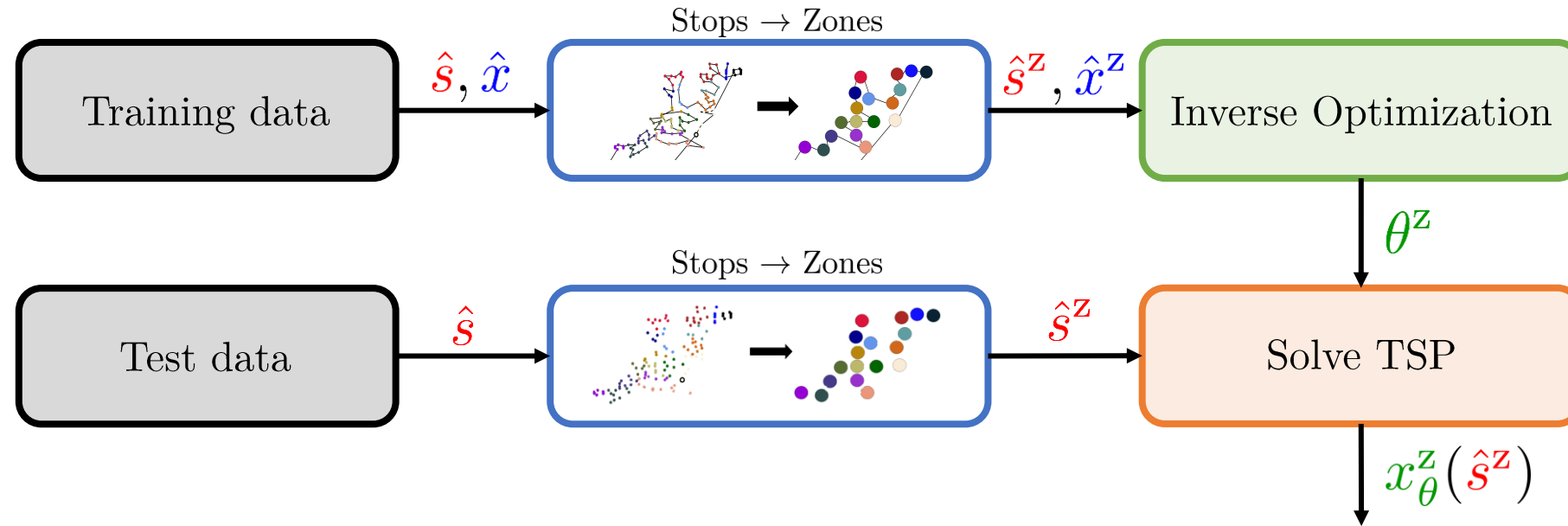
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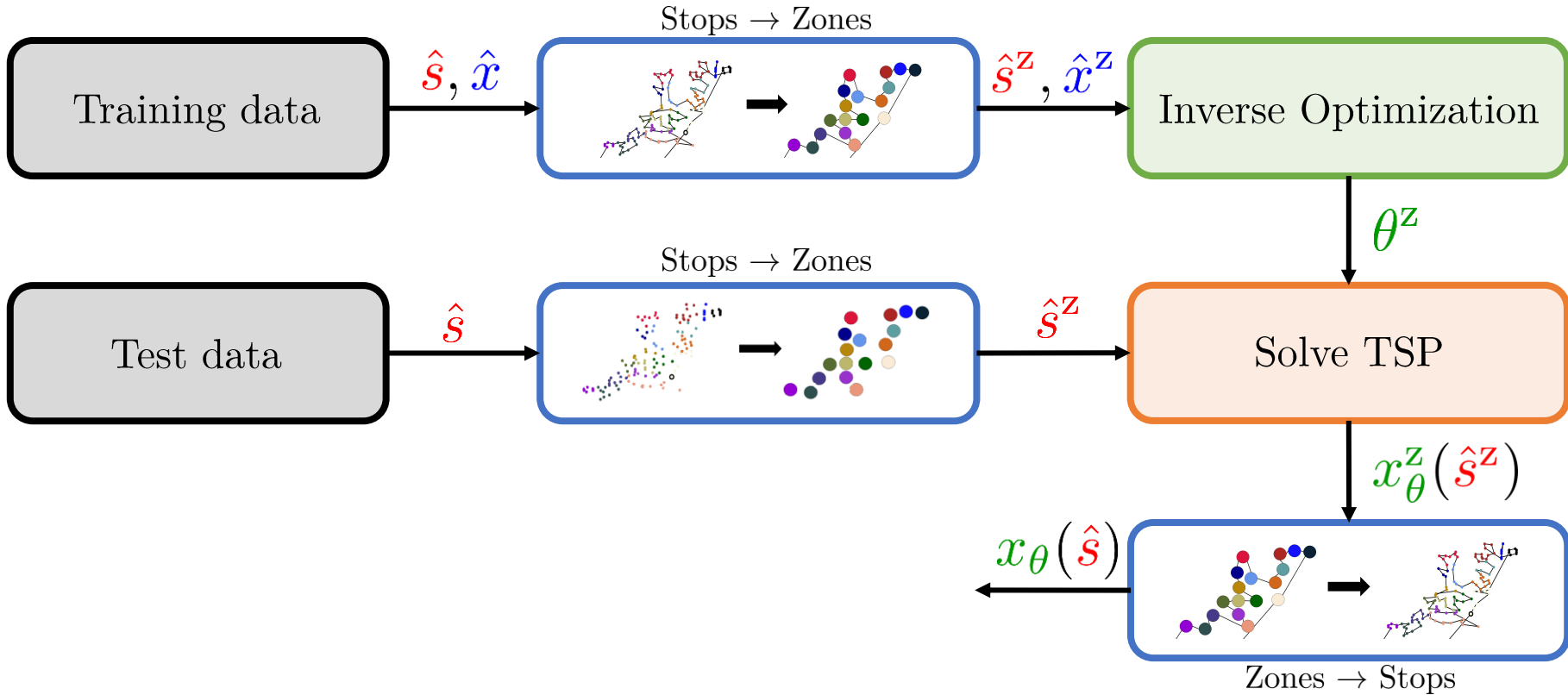
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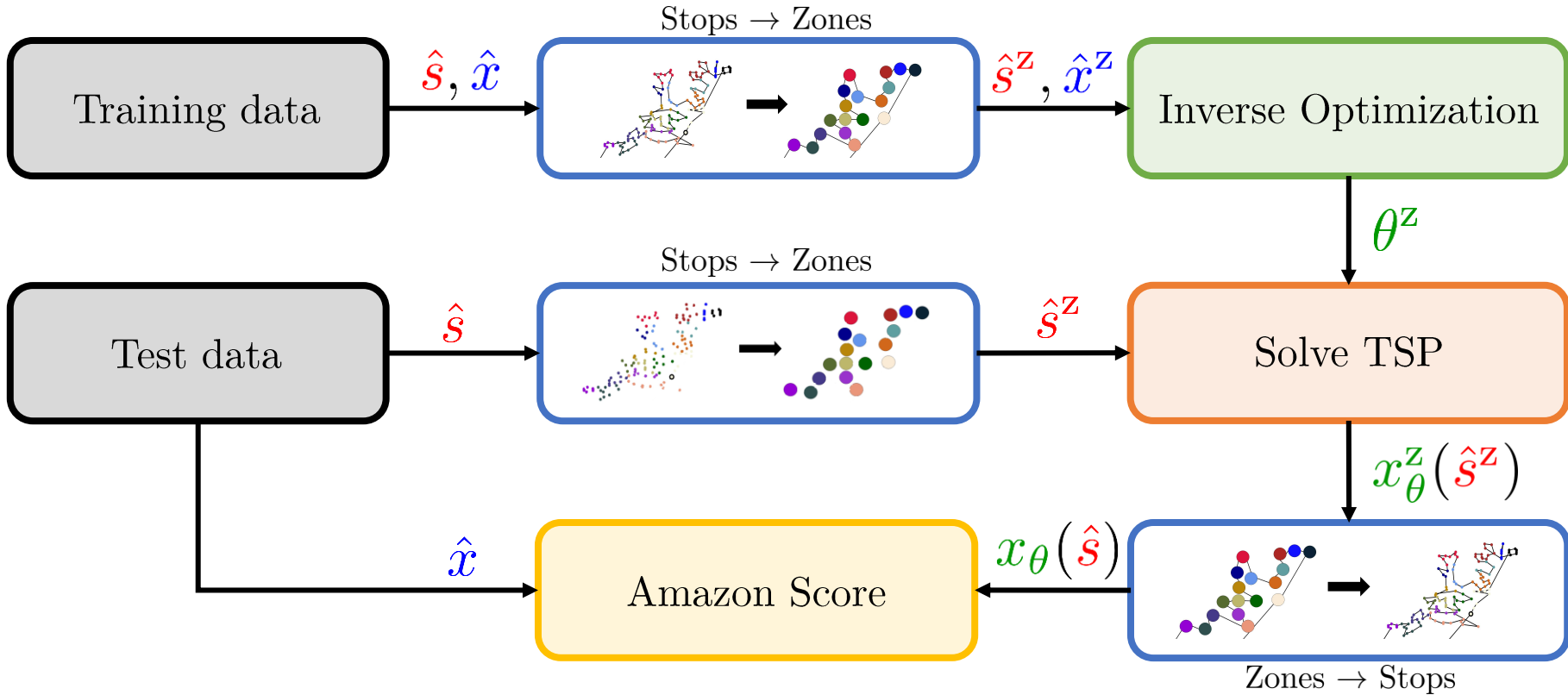
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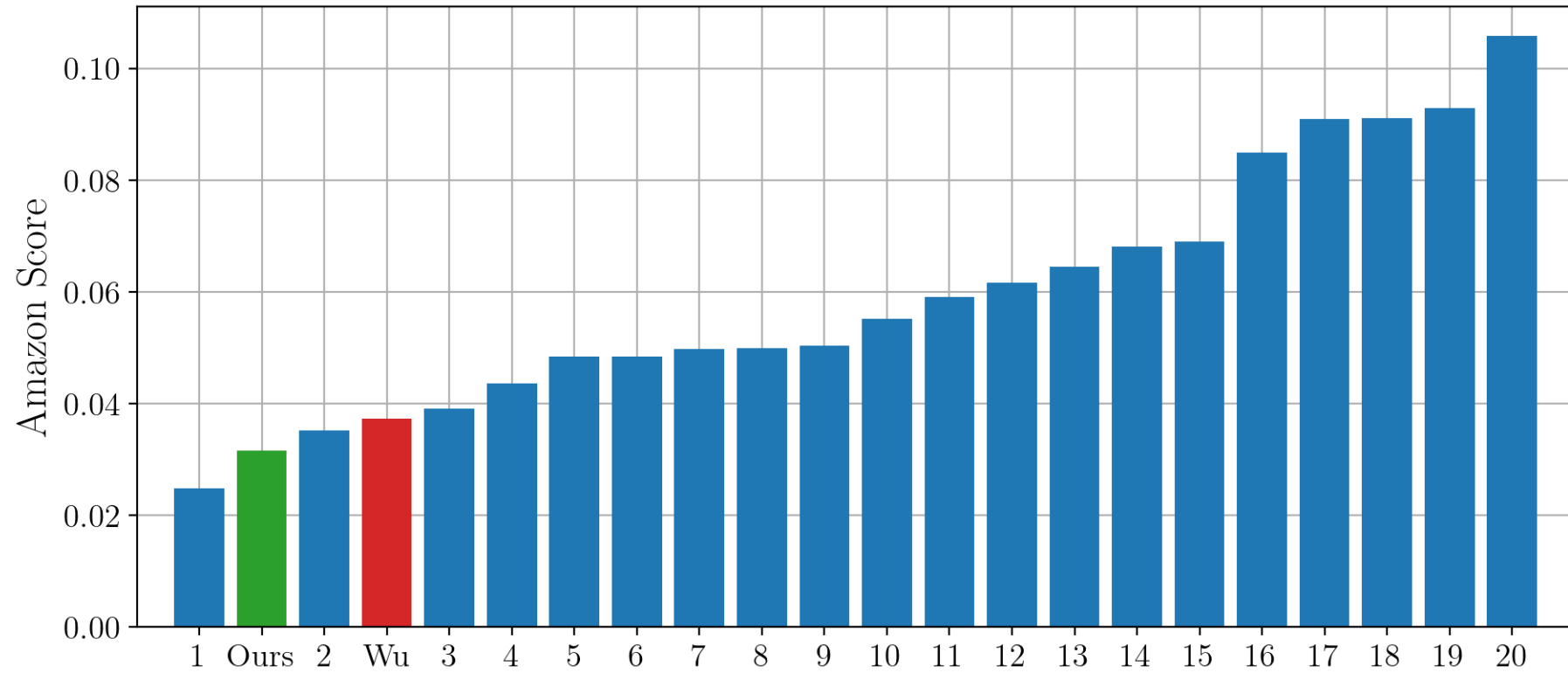
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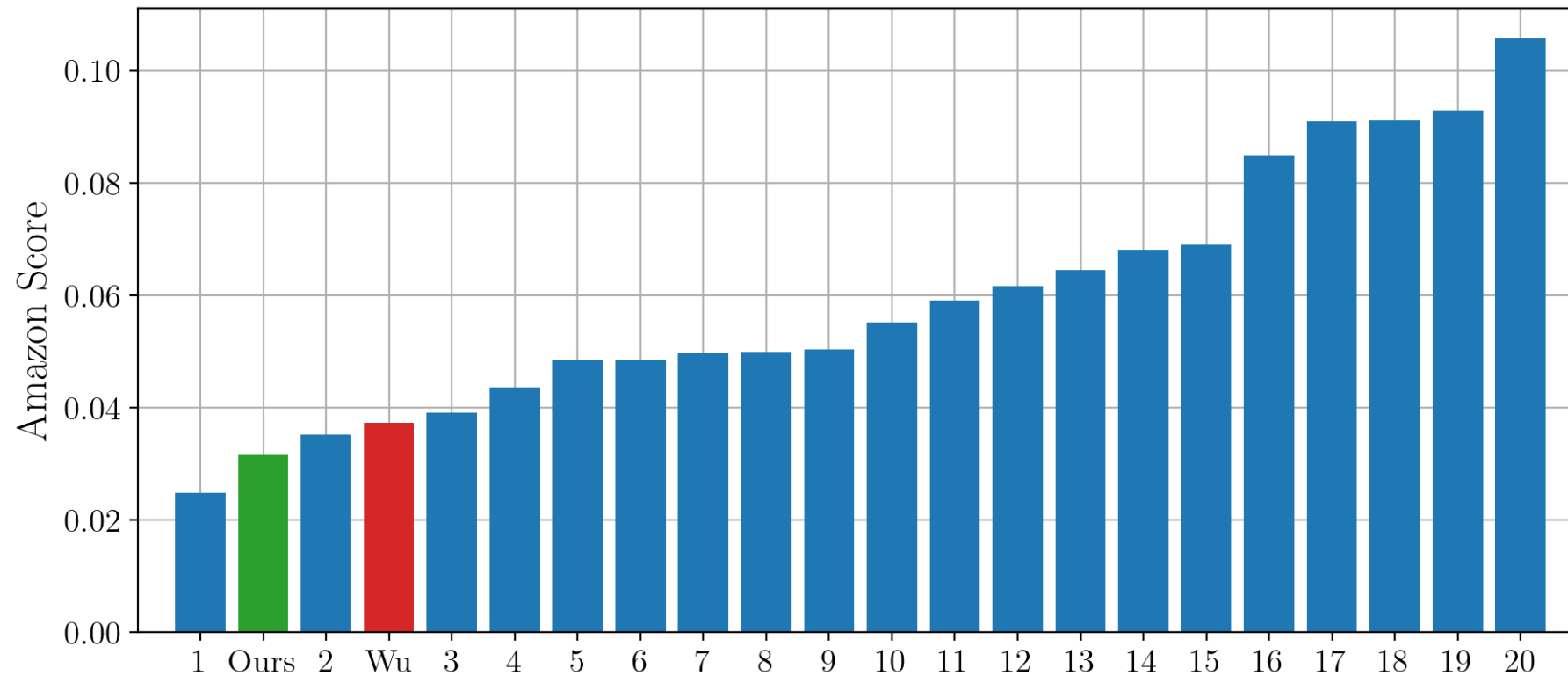
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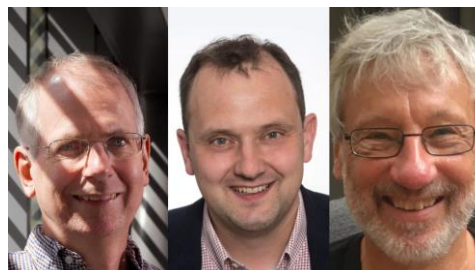
Results



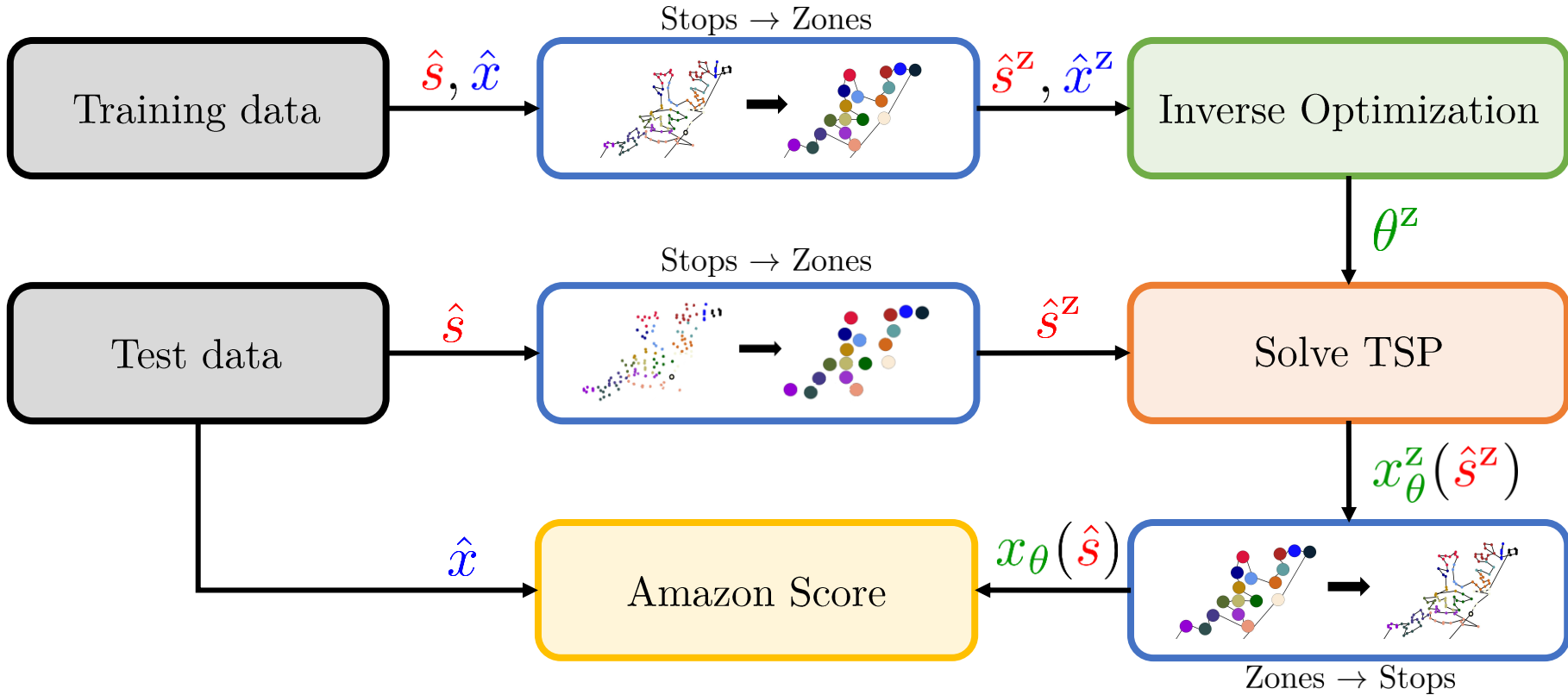
Results



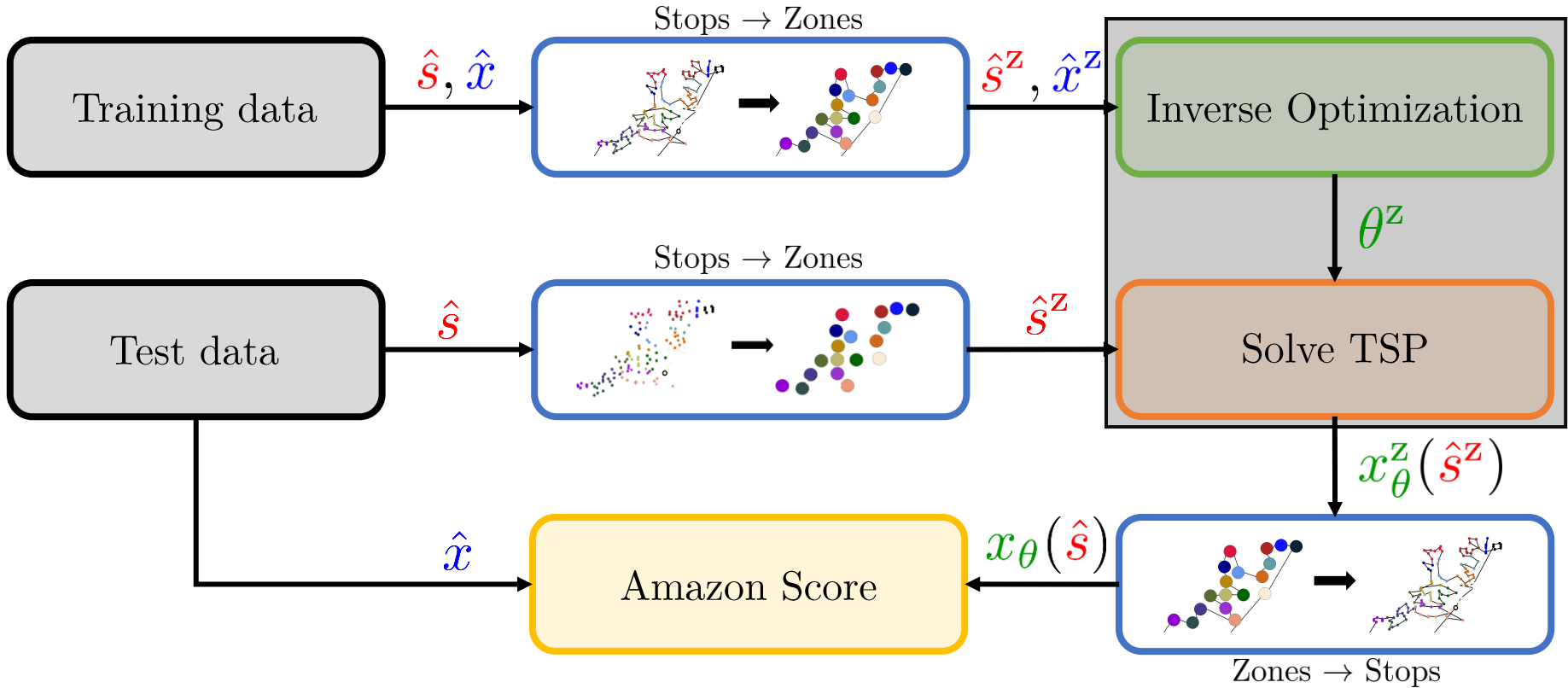
William Cook
Stephan Held
Keld Helsgaun



Complete Approach



Complete Approach



Python Package for IO

 pedroszattoni / [invopt](#)

An open-source Python package to solve Inverse Optimization problems.



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References

Theory

- Zattoni Scroccaro, Atasoy, and Mohajerin Esfahani, “Learning in Inverse Optimization: Incenter Cost, Augmented Suboptimality Loss, and Algorithms”, *arXiv:2305.07730*, 2023

Routing problems

- Zattoni Scroccaro, van Beek, Mohajerin Esfahani and Atasoy, “Inverse Optimization for Routing Problems”, *arXiv:2307.07357*, 2023

Code

- Zattoni Scroccaro, “InvOpt: Inverse Optimization with Python”, <https://github.com/pedroszattoni/invopt>, 2023

- Cook, Held, and Helsgaun, “Constrained Local Search for Last-Mile Routing”, *Transportation Science*, 2022.

Thank you!