The FLATLAND Framework

Enabling Machine Learning Research for Railway Re-scheduling and Beyond

FOSDEM, 02/02/2025, Manuel Schneider, Flatland Association

Swiss railway network

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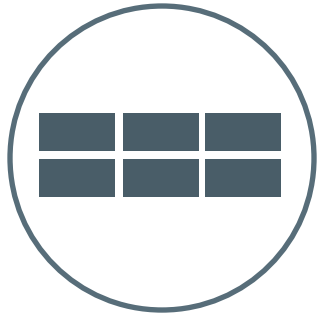
3.3kkm

11.4k

1.3M



175kT

92.5%

Railway dispatching (re-scheduling)

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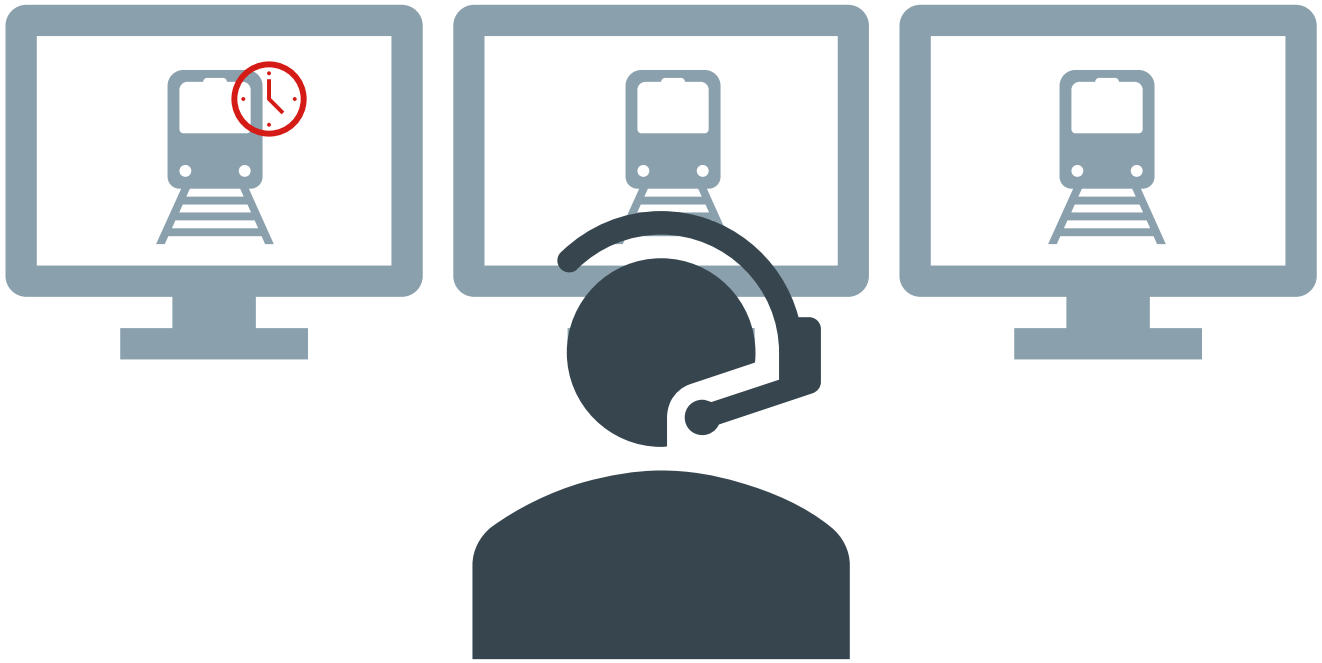

Multi-agent reinforcement learning (MARL)

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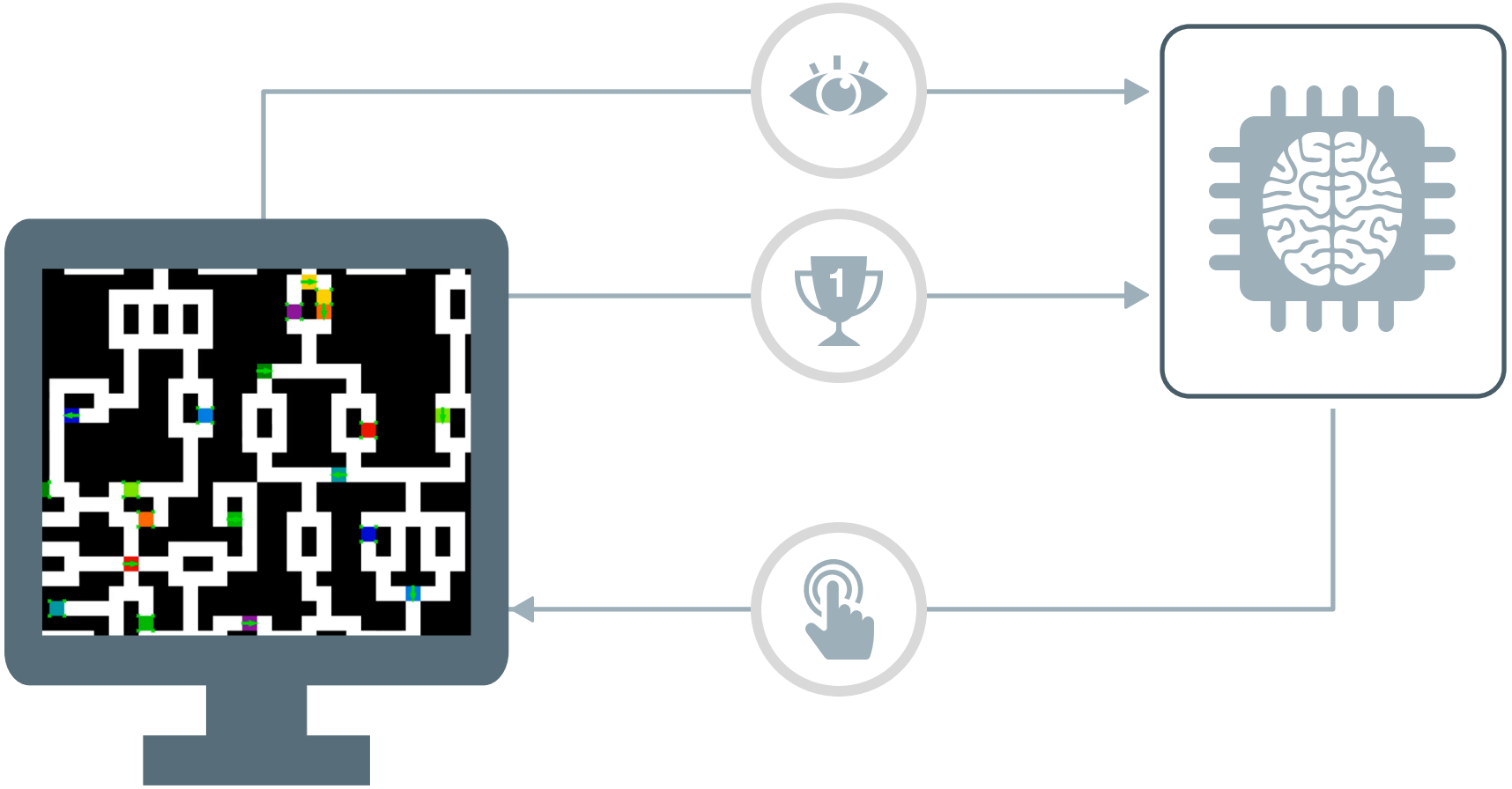
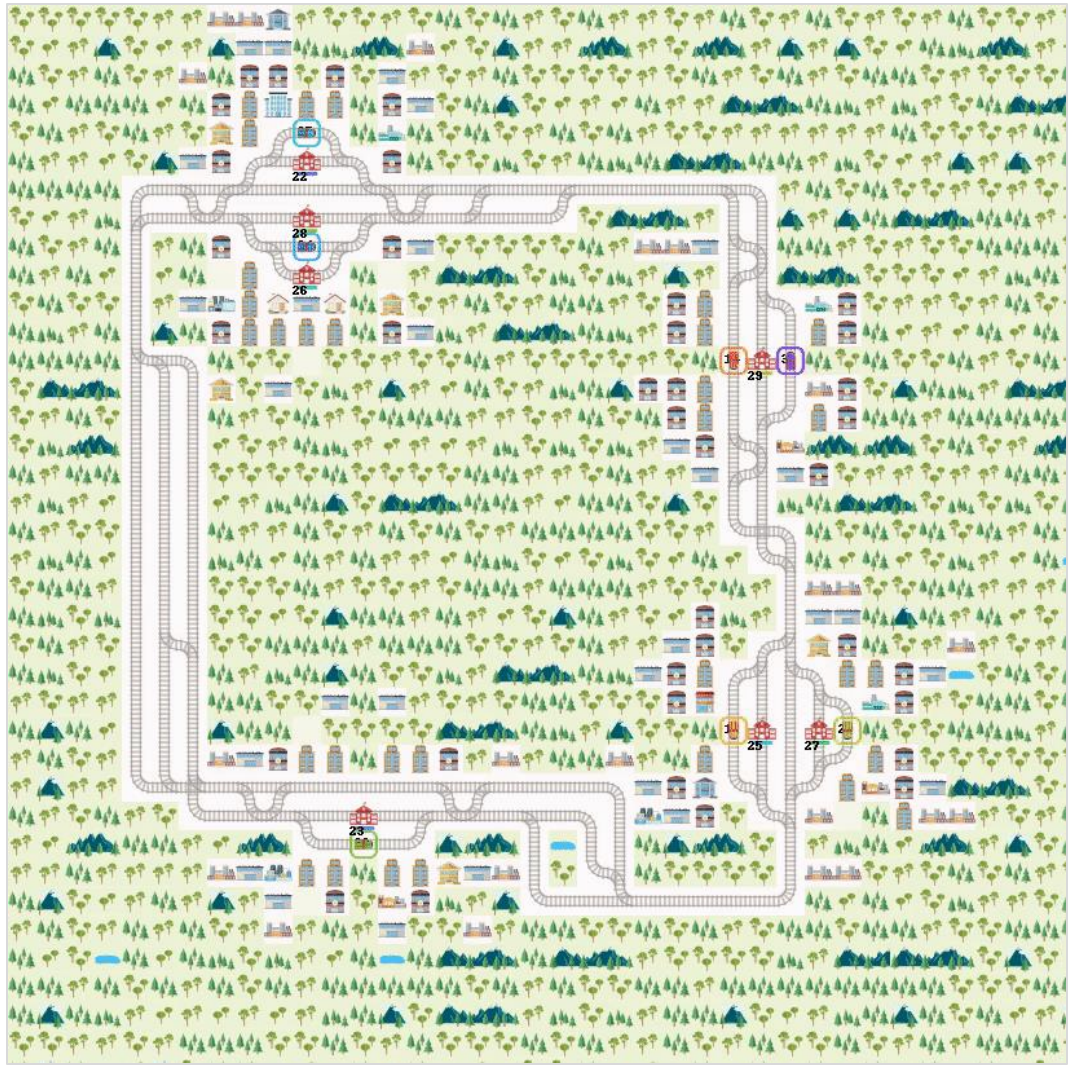
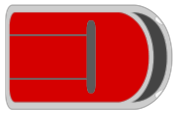


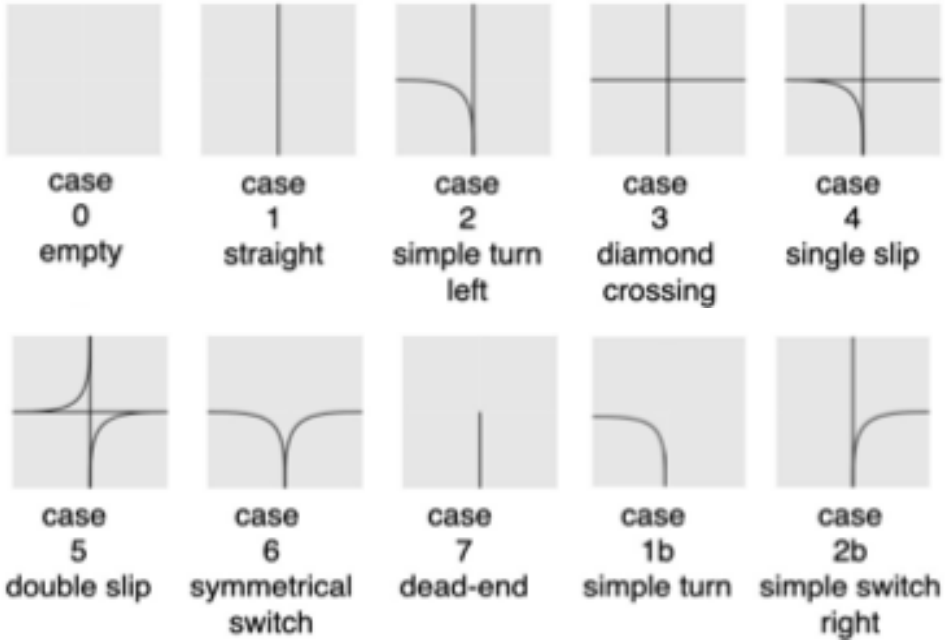
FLATLAND **framework**





Train (agent)

Station (target)



Cell types (2D-grid, transition maps)

Observations and reward

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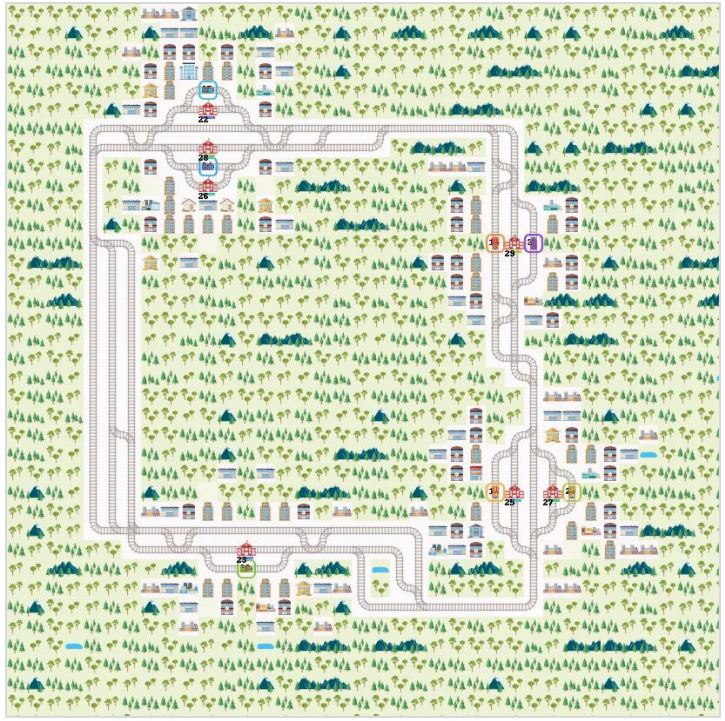
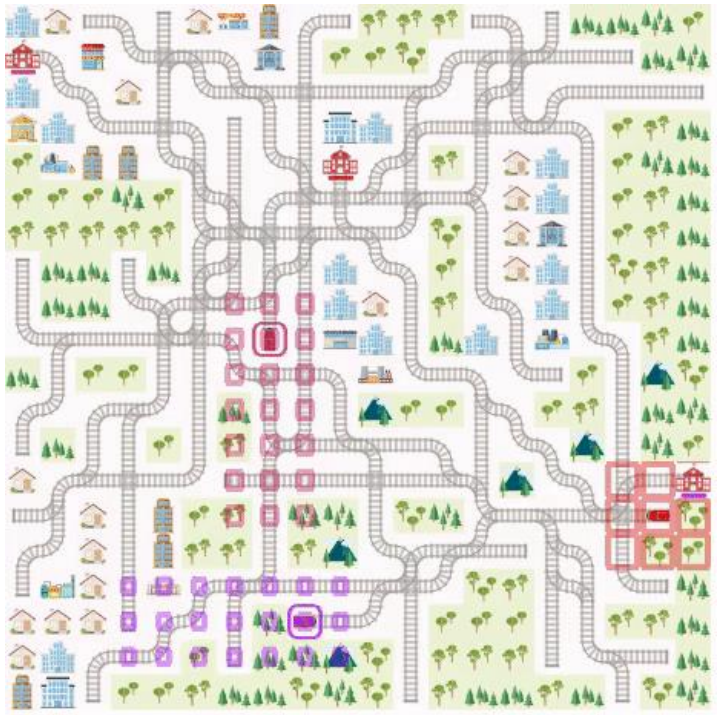
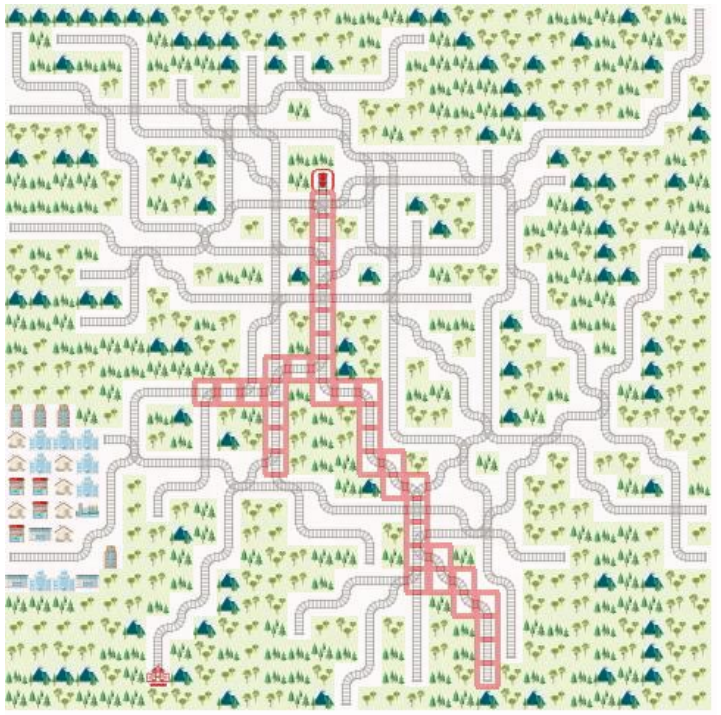


Global grid view



Local grid view



Local tree view

Community approach

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FLATLAND Challenges

Open source and open research

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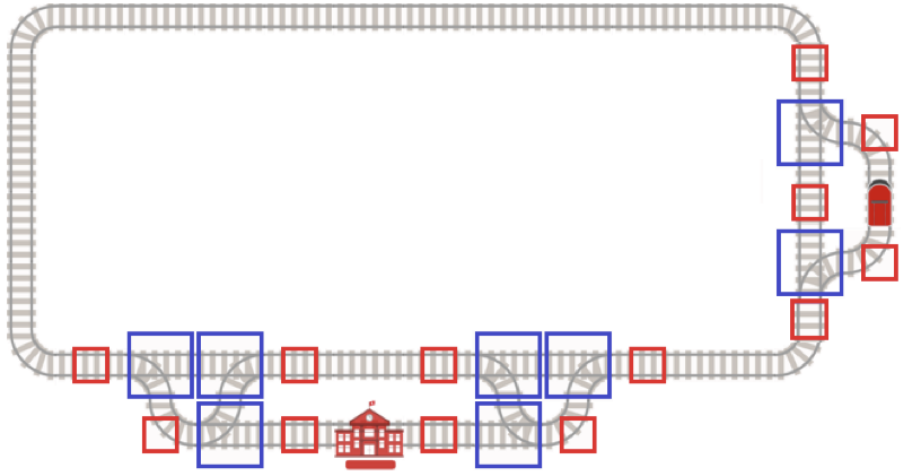
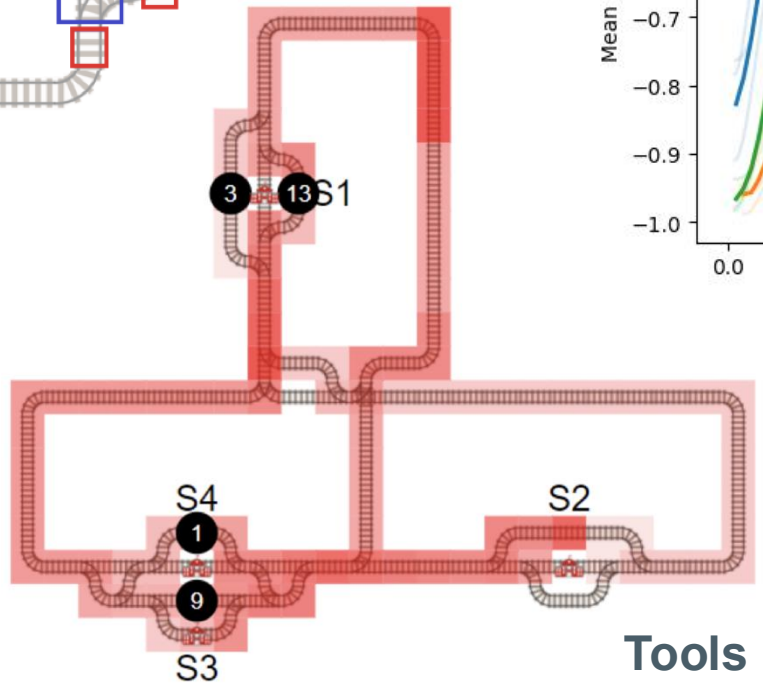
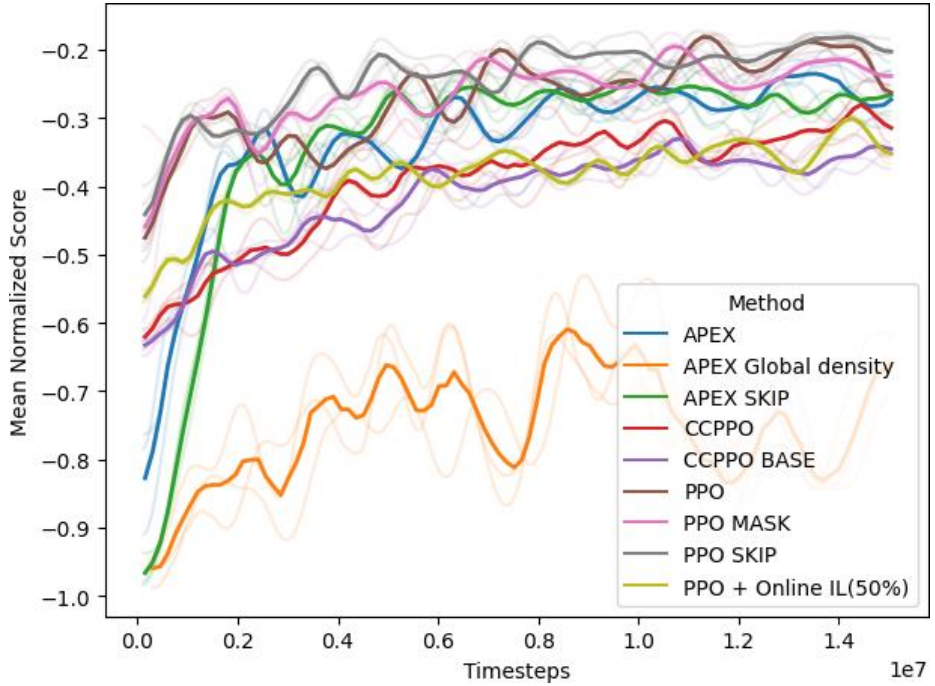


Extensions

Laurent, F., Schneider, M., Scheller, C., Watson, J., Li, J., Chen, Z., ... & Mohanty, S. (2021, August). Flatland competition 2020: MAPF and MARL for efficient train coordination on a grid world. In *Proceedings of the NeurIPS 2020 Competition and Demonstration Track*, PMLR 133:275-301, 2021



Tools



Baselines

Mohanty, S., Nygren, E., Laurent, F., Schneider, M., Scheller, C., Bhattacharya, N., ... & Spigler, G. (2020). Flatland-rl: Multi-agent reinforcement learning on trains. arXiv preprint arXiv:2012.05893

MARL is catching up

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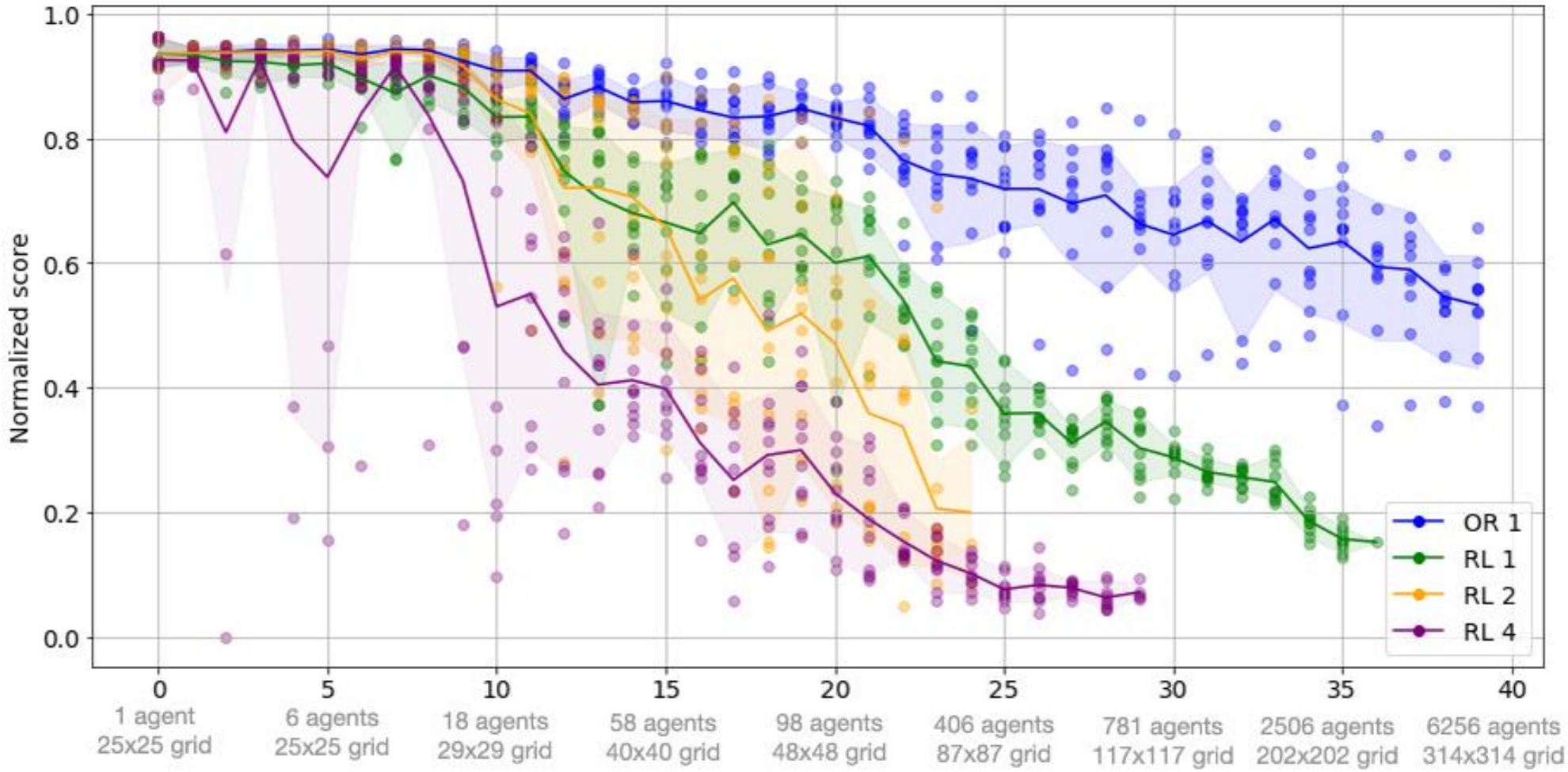

Laurent, F., Schneider, M., Scheller, C., Watson, J., Li, J., Chen, Z., ... & Mohanty, S. (2021, August). Flatland competition 2020: MAPF and MARL for efficient train coordination on a grid world. In *Proceedings of the NeurIPS 2020 Competition and Demonstration Track*, PMLR 133:275-301, 2021

Railway research and beyond

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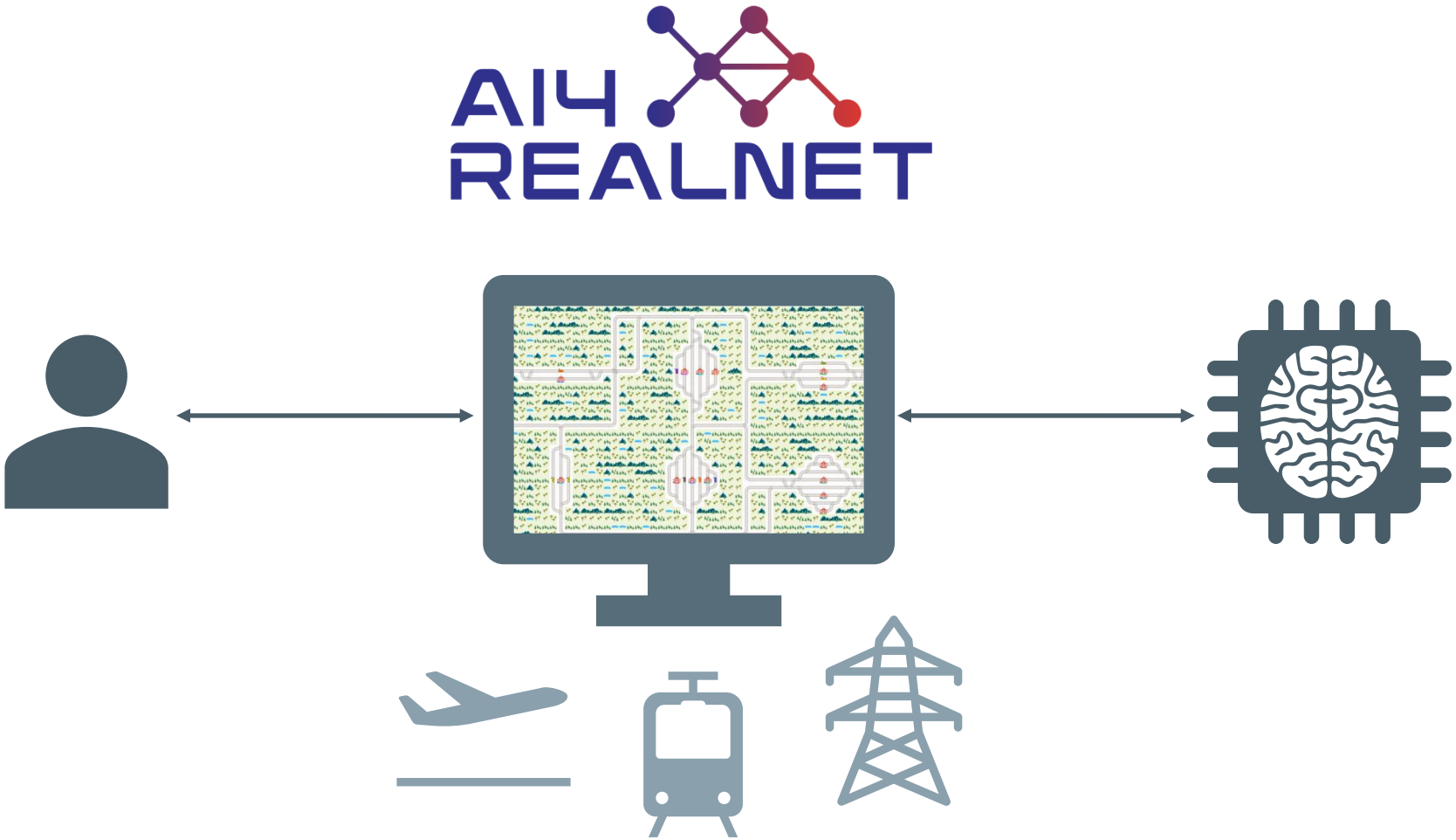


Open source inspires

Flatland Competition 2020: MAPF and MARL for Efficient Train Coordination on a Grid World

Florian Laurent, Manuel Schneider, Christian Scheller, Jeremy Watson, Jiaoyang Li, Zhe Chen, Yi Zheng, Shao-Hung Chan, Konstantin Makhnev, Oleg Svidchenko, Vladimir Egorov, Dmitry Ivanov, Aleksei Shpilman, Evgenija Spirovska, Oliver Tanevski, Aleksandar Nikov, Ramon Grunder, David Galevski, Jakov Mitrovski, Guillaume Sartoretti, Zhiyao Luo, Mehul Damani, Nilabha Bhattacharya, Shivam Agarwal, Adrian Egli, Erik Nygren, Sharada Mohanty *Proceedings of the NeurIPS 2020 Competition and Demonstration Track*, PMLR 133:275-301, 2021.

Abstract

The Flatland competition aimed at finding novel approaches to solve the ve
problem (VRSP). The VRSP is concerned with scheduling trips in traffic n
scheduling of vehicles when disruptions occur, for example the breakdo
the VRSP in various settings has been an active area in operations resea
ever-growing complexity of modern railway networks makes dynamic re
virtually impossible. Recently, multi-agent reinforcement learning (MARL
challenging tasks where many agents need to be coordinated, such as m
However, the coordination of hundreds of agents in a real-life setting like
challenging and the Flatland environment used for the competition models
in a simplified manner. Submissions had to bring as many trains (agents) to th
little time as possible. While the best submissions were in the OR category, partic
promising MARL approaches. Using both centralized and decentralized learning base
top submissions used graph representations of the environment to construct tree-based
observations. Further, different coordination mechanisms were implemented, such as communication
and prioritization between agents. This paper presents the competition setup, four outstanding
solutions to the competition, and a cross-comparison between them.

100+
Papers

🚂 Thank you for travelling with us today!

FLATLAND

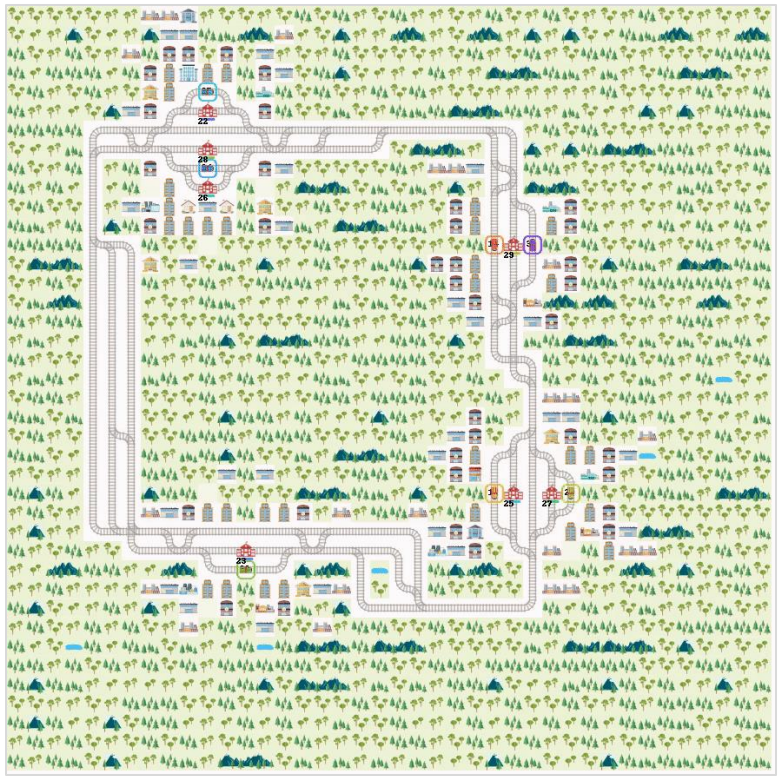
FLATLAND **Framework**

github.com/flatland-association/flatland-rl

flatland-association.github.io/flatland-book

FLATLAND **Association**

www.flatland-association.org



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