

MSc. Thesis Project Can Traffic Self-Organise? Decentralised Control with Intelligent Agents



Problem description

Most traffic systems are managed through centralised control, such as traffic signals or coordinated control strategies, where decisions are based on aggregated system information. However, such approaches can be difficult to scale and adapt, especially in highly dynamic or uncertain environments. At the same time, traffic is fundamentally a multi-agent system in which many independent actors interact locally. This raises an alternative perspective: instead of controlling traffic from the top down, can we design rules that allow traffic to organise itself from the bottom up?

Recent ideas from AI, such as **Active Inference**, provide tools to model agents that act based on local information, expectations, and adaptation—without requiring central coordination. This leads to a key question: **Under what conditions can decentralised decision-making lead to organised, efficient traffic, and when does it fail?**

Assignment

In this project, you will investigate **self-organisation in traffic systems** under decentralised control. You will use a simplified traffic simulation to explore how local decision rules lead to global system behaviour. Rather than focusing on a single driver model, you will:

- Define and test different local interaction rules between agents
- Explore how system performance changes when removing or relaxing central control
- Investigate how coordination (or lack thereof) emerges from local decisions

You are encouraged to **experiment with different system designs**, for example: purely local vs. partially coordinated behaviour, simple vs. adaptive decision rules, and different levels of information sharing between agents.

The focus is on understanding how traffic patterns emerge from local interactions and identifying when decentralised approaches lead to stable and efficient outcomes.

Candidate

- Experience with Python programming
- Interest in AI, complex systems, or traffic

Research group

AiMTT Project, DAIMoND Lab at TU Delft's Department of Transport & Planning

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