Self-Organization of Traffic Lights with Swarm Intelligence

Workshop on Transport and Self-Organization in Complex Systems (TSOCS 2004)

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Outline

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- What is Swarm Intelligence?
- Description of the Simulator
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- Model of task allocation in the traffic scenario
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Introduction

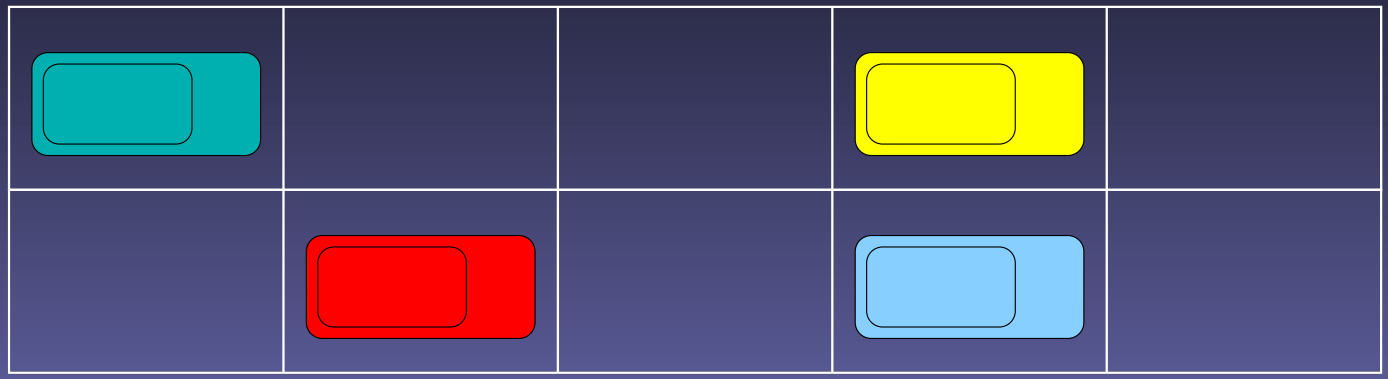
- Approaches to reduce traffic jams have been proposed in several disciplines.
- A classical one is to coordinate or synchronize traffic lights so that vehicles can traverse an arterial *in one direction*, with a specific speed, without stopping.
- In cities with complex urbanization, fixed synchronization can not be used.
- Intelligent systems offer more flexible and robust solutions.

What is Swarm Intelligence?

- "The collective behavior that emerges from a group of social insets is called *swarm intelligence*".
- Main characteristics
  - No central control
  - Partial model of the environment
  - Reaction and adaptation to the environment

Description of the Simulator

We use the Nagel–Schreckenberg model which is a microscopic model for traffic simulation originally based on cellular–automata (CA).



Synchronization of Traffic Lights

Appropriate signal plans are selected to run at the adjacent traffic lights, a “green wave” is built so that drivers do not have to stop at junctions.

Model of task allocation in the traffic scenario

Every signal plan possess associated stimuli according to the direction towards this signal plan is biased.

$$T_{\theta_{ij}}(s_j) = \frac{s_j^2}{s_j^2 + \theta_{ij}^2} \quad (1)$$

where:

- θ_{ij} is the response threshold for the individual *i* for executing the task *j*.
- s_j is the stimulus associated with the task *j*.

Model of task allocation in the traffic scenario

The stimulus of a plan is given by a weighted sum of accumulated pheromone in each phase of this plan.

$$s_j = \sum_{i=0}^{n} (d_{in_{i,t}}) \Delta t_i \qquad (2)$$

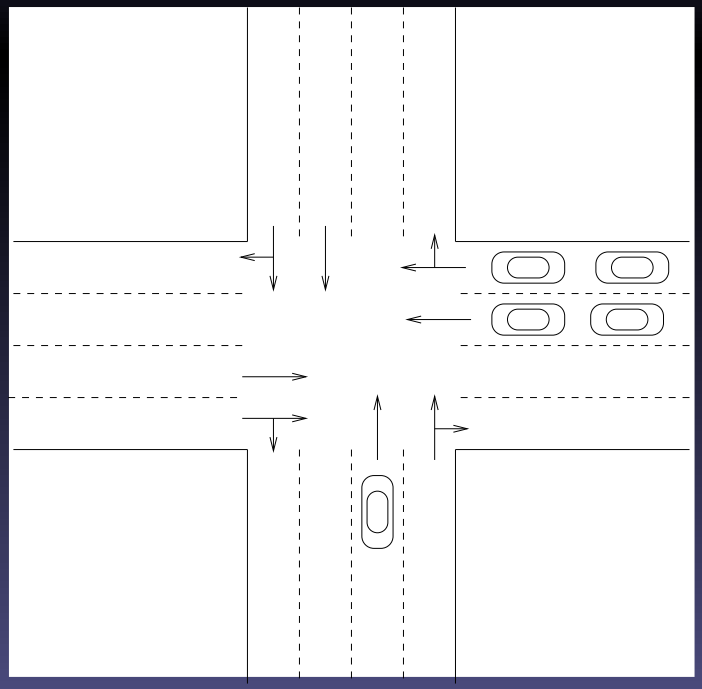
where:

n number of phases of the signal plan *j*

$d_{in_{i,t}}$ is the accumulated pheromone trail in the input lanes in phase *i* at time *t*

Δt_i is the time fraction of the phase *i*

Model of task allocation in the traffic scenario



Conclusions and Outlook

- The agents are free to decide coordinating according to the swarm approach the system behaves almost as if a central decision support was given
- Synchronization is achieved without any management, that indicates a successful swarm based application.

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