



Pheromone Model: Application to Traffic Congestion Prediction

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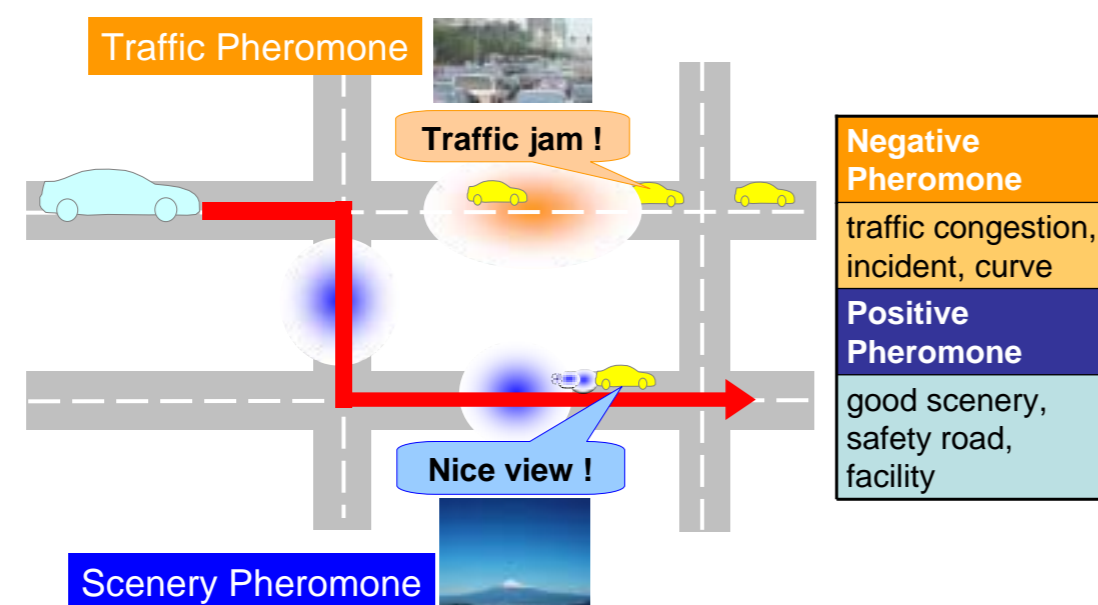
OVERVIEW

Concept

Multi purpose route guidance with virtual pheromone

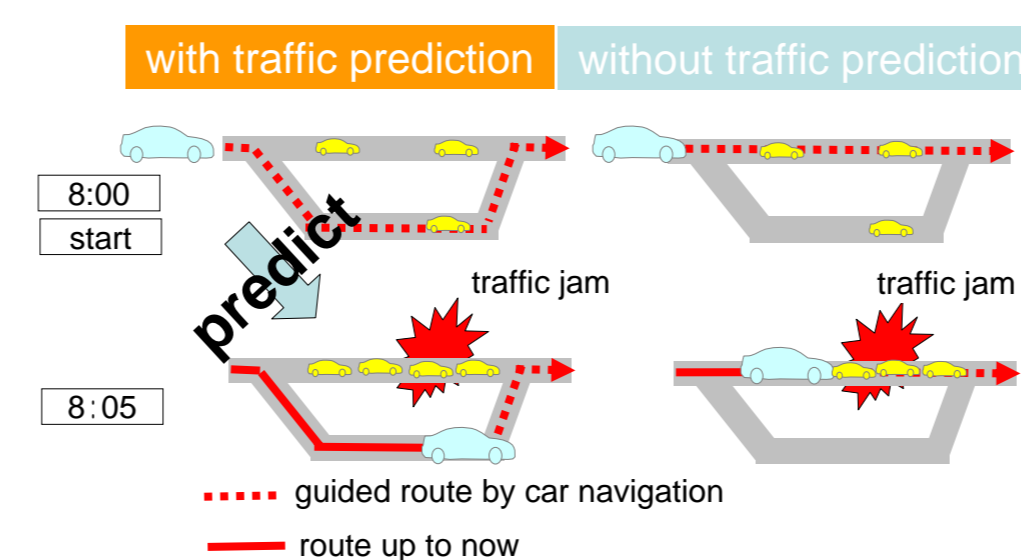
Route Guidance with Pheromone

- There are various reasons to choose route.
- Multiple semantics of pheromone for a route guidance.



Traffic Congestion Prediction

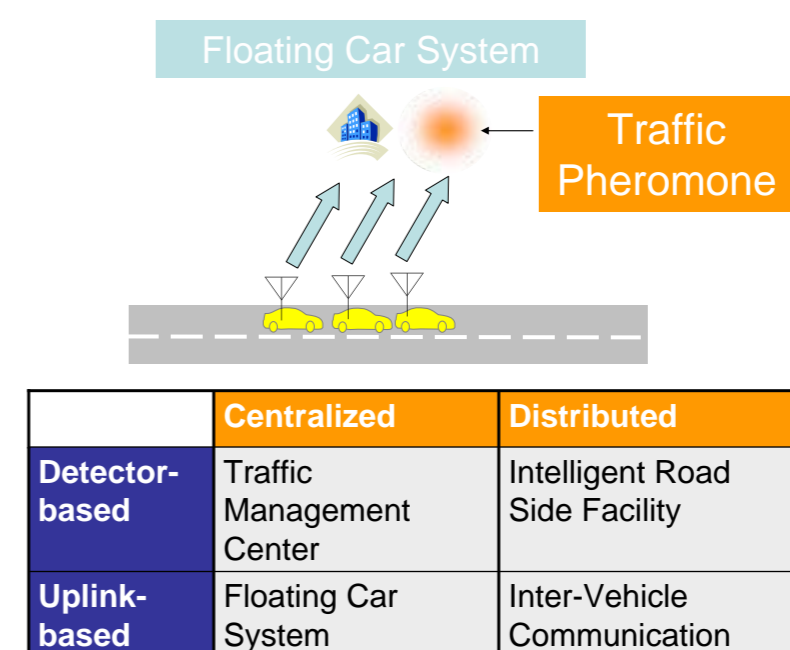
- Real time traffic information is inadequate for shortest time route guidance.



Feasibility

Implementation

- Who deal with the pheromone ?



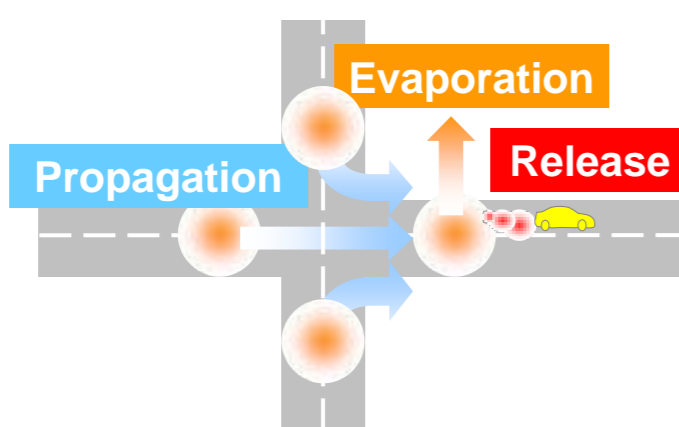
TRAFFIC PHEROMONE

Mechanism

Propagation process coordinated to traffic movement

Overview

- Car releases traffic pheromone.
- The pheromone evaporate and propagate over time.



Formulation

- Each car releases pheromone in proportion to the inverse of its speed.
- Propagation neighborhoods are upstreams of road links.

$$\text{Release } r(t, p) = \frac{1}{|C(t, p)|} \sum_{i \in C(t, p)} \frac{\alpha}{v_i(t, p)}$$

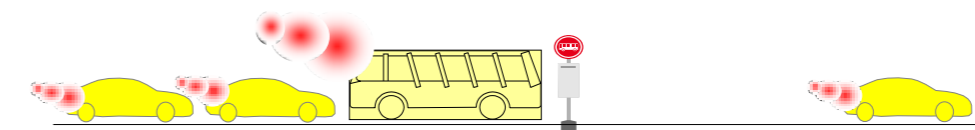
$$\text{Evaporation } s(t+1, p) = E \times s(t, p) + r(t, p) + q(t, p)$$

$$\text{Propagation } q(t+1, p) = \sum_{p' \in N(p)} \frac{F}{|N(p)|} (r(t, p') + q(t, p'))$$

s, r, q : current value, releasing value, propagating value at time t at place p
E, F : (release, evaporation, propagation) parameters (constants)
C(p, t) : set of car IDs at time t at place p
N(p) : neighborhoods of place p

Reflection of Real Traffic Phenomenon

- Public transportation (e.g. bus, taxi) should affect the traffic more than normal transportation.



- Release parameter of public traffic transportation should be bigger than normal transportation.

$$\alpha_{public} = k \alpha_{normal}$$

$$k \geq 1$$

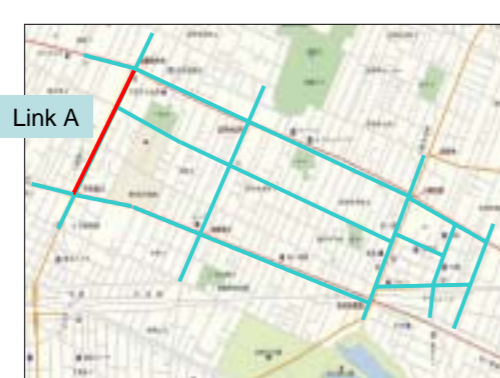
EVALUATION

Prediction Performance

Can pheromone be used for traffic prediction ?

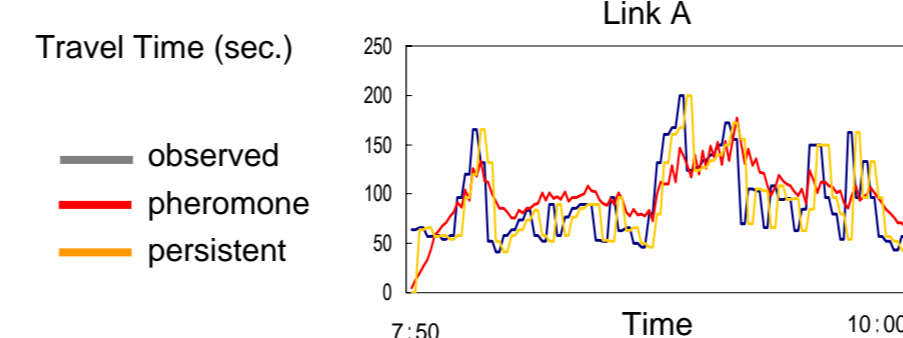
Specification

- 30 links of 2 * 2 km area in Tokyo.
- Detailed path observation of 15,000 cars.



Prediction Example

- Predict 1 minute later every minutes.
- Compared with 1 minute persistent prediction, that is, 1 minute delay.

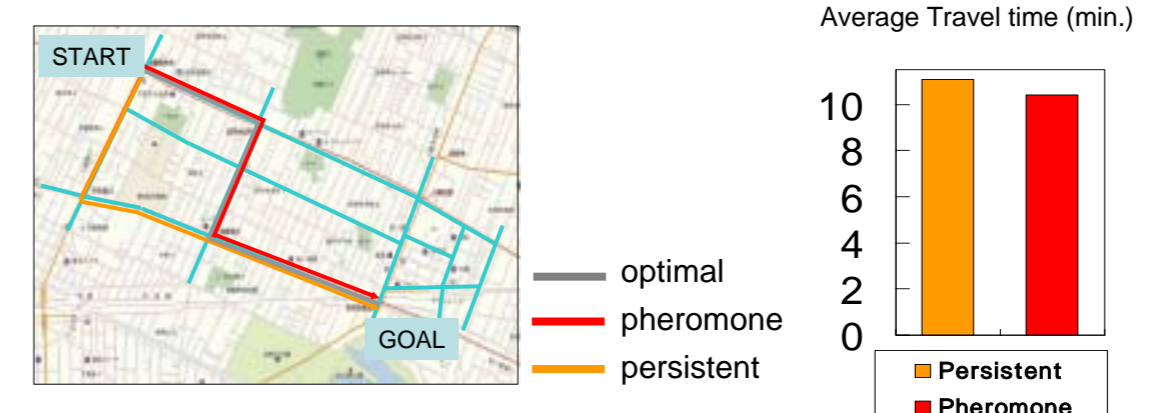


Application

How much the benefit of prediction?

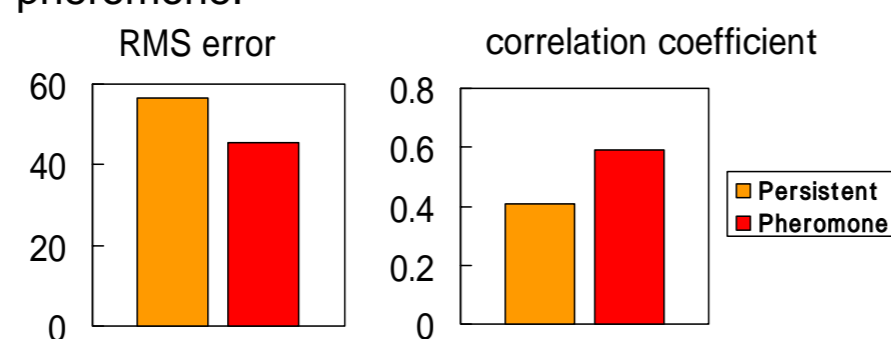
Route Guidance

- Route guidance according to predicted travel time of each link.



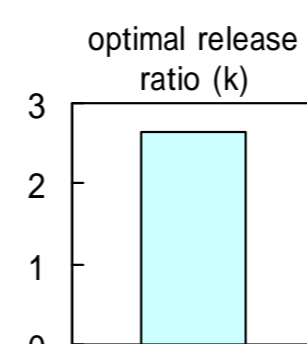
Overall Accuracy

- Both indexes indicate advantage of pheromone.



Releasing Rate

- Public transportation affects traffic more than normal one.



Future Work

Multiple semantics of pheromone for:

- Better performance of prediction.
- Multi purpose route guidance.
- Personalization.

