# How much is trust: The cost and benefit of ridesharing with friends

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## 1. Introduction

Socio-psychological barriers such as trust are found to lead to low participation rate in ridesharing. In order to overcome such barriers, this work studies whether the additional detour costs of limiting shared rides to, or giving priority to contacts in social networks would be prohibitive.

This work builds a ridesharing model that compares the successful matching rate and detour cost of ridesharing with three types of social connections (i.e., friends) in a small-world network: direct friends, direct or indirect friends, and anyone.

## 2. Hypotheses

- ✓ Ridesharing with social contacts does not significantly increase detour cost.
- ✓ A matching algorithm giving priority to friends can significantly increase the ratio of matching between friends

## 3. Implementation

- ✓ Agents are distributed on a 100-by-100 gridline network.
- ✓ Agents have **small-world** social network connections: direct (first degree) friends, indirect (second degree) friends, and strangers .
- ✓ Detour cost is calculated in travel time.
- ✓ **Spatial distribution** of friendship has significant influence on matching result.

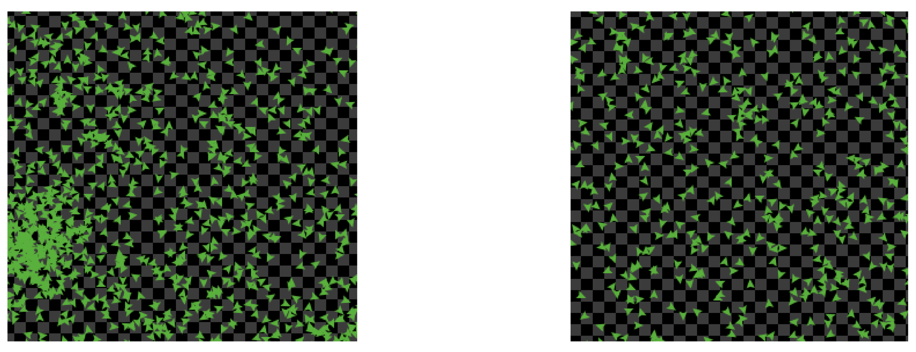

**Fig. 1** Screenshots from NetLogo of spatial distribution of friends: clustered (left figure) vs. random (right figure).

- ✓ **Detour tolerance and uptaking willingness** are influenced by social connection types
  - Heterogeneous: considering social network
    - Direct: 30% detour, 100% willingness
    - Indirect: 25% detour, 80% willingness
    - Stranger: 7% detour, 10% willingness
  - Uniform: regardless of social network
    - 30% detour, 100% willingness
- ✓ Three **matching patterns**:
  MP1: matching direct friends only;
  MP2: matching direct and indirect friends;
  MP3: matching anyone.

## MAJOR FINDINGS

1. When people have clustered friendship, even if with uniform tolerance and willingness for different types of social connections, matching only with friends does not necessarily lead to higher detour cost than matching with anyone. **This is the benefit of having friends nearby.**
2. Allowing for matches between anyone, our algorithm that gives priority to friends (i.e., heterogeneous tolerance and willingness) **drastically increases matches between friends** compared with existing algorithms that ignores social network. With clustered friendship, our algorithm matches about 14% of the total population with a friend, while existing algorithms only 3%. **It significantly reduces socio-psychological cost of ridesharing.**
3. Given clustered friendship, the uptake rate of 2000 agents increases from 27% when everyone is equally treated in matching, to 35% after prioritising friends. The numbers for 5000 agents are 24% and 38%. **The algorithm prioritising friends is effective with clustered friendship.**

**References**
[1] Chaube, V., Kavanaugh, A.L., Pérez-Quiñones, M.A., 2010. Leveraging social networks to embed trust in rideshare programs. In: Proceedings of the 43rd Hawaii International Conference on System Sciences (HICSS). Honolulu, HI.
[2] Wessels, R., 2009. Combining ridesharing & social networks.
[3] Agatz, N., Erera, A.L., Savelsbergh, M.W.P., Wang, X., 2011. Dynamic Ride-Sharing: a Simulation Study in Metro Atlanta. Procedia Soc. Behav. Sci. 17, 532–550.

## 4. Matching strategy

**Objective**: to maximise the total amount of matched people subject to space-time budget and socio-psychological constraints.

**Constraints**:

**a. Space-time budget** $EST(dr) + TTC(n(0), n(i)) \le T(n(i)) \le LET(dr)$

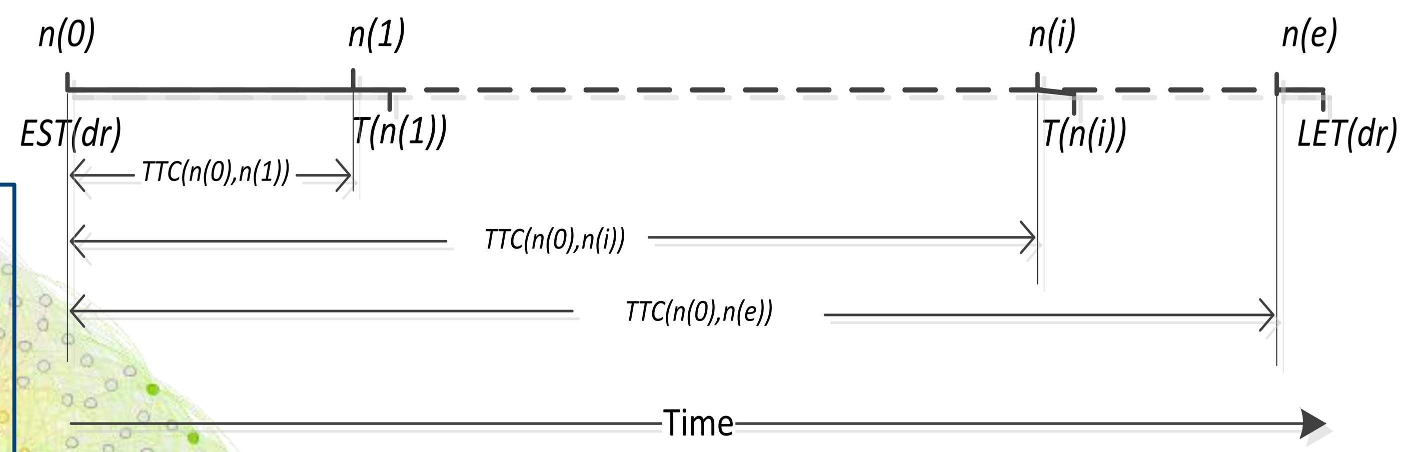


**Fig. 2**. Space-time constraint of a match requires that from the starting point to any of the intermediate stops must satisfy the corresponding arrival time limit. EST – earliest starting time; LET – latest ending time; T – required time limit; TTC(a, b) – total travel time from point a to b; n(i) – stops along the merged route; n(e) – ending point of the trip; dr – driver.

**b. Socio-psychological constraints:**

Detour cost = real travel time in a shared ride – shortest individual travel time;
Detour cost ≤ Detour tolerance (social type).

**c. Feasibility of matching:**

The merged travel must be shorter than travel individually [3]:
$TTC(p1) + TTC(p2) > TTC(p1 + p2)$

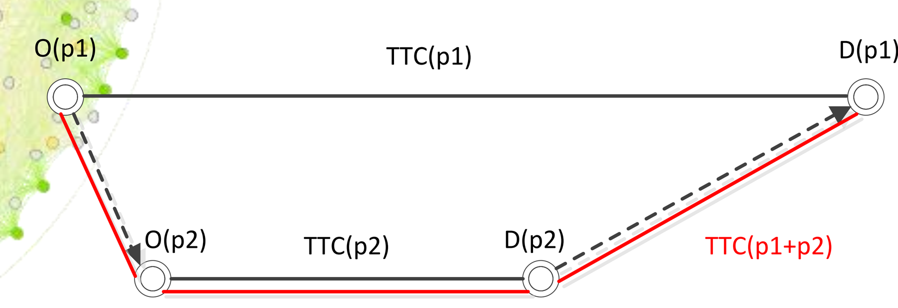


**Fig. 3**. Feasibility of matching requires that the sum of the two solid black lines should be greater than the total of the red lines. O(), D() means origin and destination; TTC(p1) and TTC(p2) are the two persons original shortest travel time, while TTC(p1 + p2) is the merged route travel time.

**Decision-making**:

In lieu of global optima, **egoistic** agents are assumed to achieve their instant best choice by trial-and-error.

a. In latest starting time sequence, each agent asks their current potential best choice.
b. The role to be a driver or passenger is not fixed until initially making a decision. It is based on the instant utility of a person.
c. Former decisions have influence on later ones, since multiple people may have the same best choice.

## 5. Future work

- ✓ Dynamic model for demand-responsive transport
- ✓ Autonomous vehicles with decreased amount of traffic
- ✓ Dynamic social network equilibrium for optimal collaboration

**Notes**
Background image in the centre is the small-world social network generated by Gephi's *Watts-Strogatz Small World* model *beta,* with 2,000 nodes, the average degree equal to 50, and beta equal to 0.01.

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## Research partners

vicroads yarra trams PUBLIC TRANSPORT VICTORIA PT RACV we're there for you Haasz Technology Pty. Ltd.

## Research team

Intelligent Mobility on Demand (**iMoD**)
http://imod-au.info/