

# **Is Travel Social?**

**shared mobility, human interaction and  
urban creativity**

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Why ants don't run into traffic jam,  
while people do?

# How is travel social?

1. Why ants don't get into traffic jam?
2. Doing good or doing well
3. Do we make our own decision?
4. Mingle while traveling

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# How is travel social?

- |   |                                     |
|---|-------------------------------------|
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| 2. Doing good or doing well             | Intrinsic and Extrinsic Motivations |
| 3. Do we make our own decision?         | Social Norm and Peer Pressure       |
| 4. Mingle while traveling               | Transportation as Social Space      |

# Shared Mobility



uberPOOL

**LYFT LINE**

Your daily ride



# space required to transport 60 people



car



bus



bicycle



# space required to transport 60 people

© Jon Orcutt, TransitCenter, NYC



car



uber

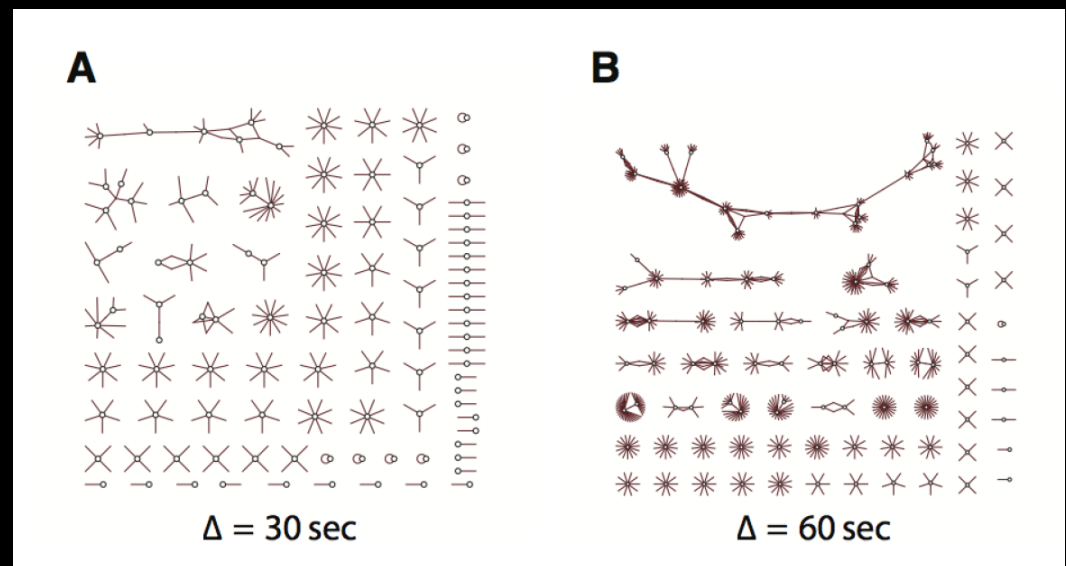
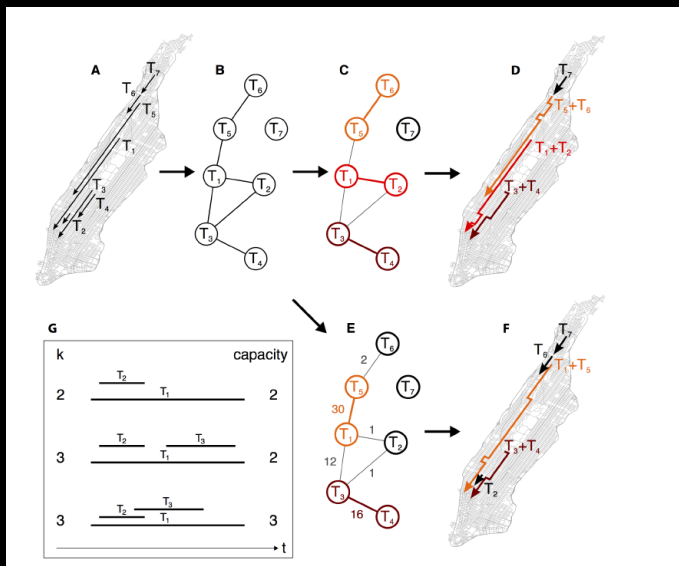


autonomous car

# Physics

Santi, Paolo, et al 2013, Taxi pooling in New York City: a network-based approach to social sharing problems

Santi, Paolo, et al 2014 Quantifying the benefits of vehicle pooling with share-ability networks.



# Psychology



two persons vs. two boxes

# modes of social interaction

Meeting room



**Intensity**

Bathroom



**Spontaneity**





Norman Foster + Steve Jobs, Apple Headquarter, 13,000 people

“serendipitous encounters”



# Meeting room



# Intensity

# Bathroom



# Spontaneity

Ride sharing

Impromptuness + Intensity









Ride sharing

Impromptuness

+

Intensity

+

Intimacy



a new mode of social interaction

# Q1: Matching Algorithm

Network Efficiency  
+  
Preference for Social Interaction

Hongmou Zhang and Jinhua Zhao (2017) Shared Mobility as a Preference Matching Problem

# Commodity markets

**Fruit market**



**NY Stock Exchange**



# In many markets prices can not / should not do all the work

- College admissions
- Kidney donation
- Courtship and marriage

*Two-sided matching market that involves  
searching and wooing on both sides*

# Shared Mobility

Commodity Market?

Matching Market?

# Matching Algorithm

# Matching theory

(Gale & Shapley 1962, Roth et al. 2005)

- **Bipartite matching**
  - Marriage
  - Kidney donation
  - Medical residency
- **Monopartite matching**
  - Roommates
  - *Ridesharing*

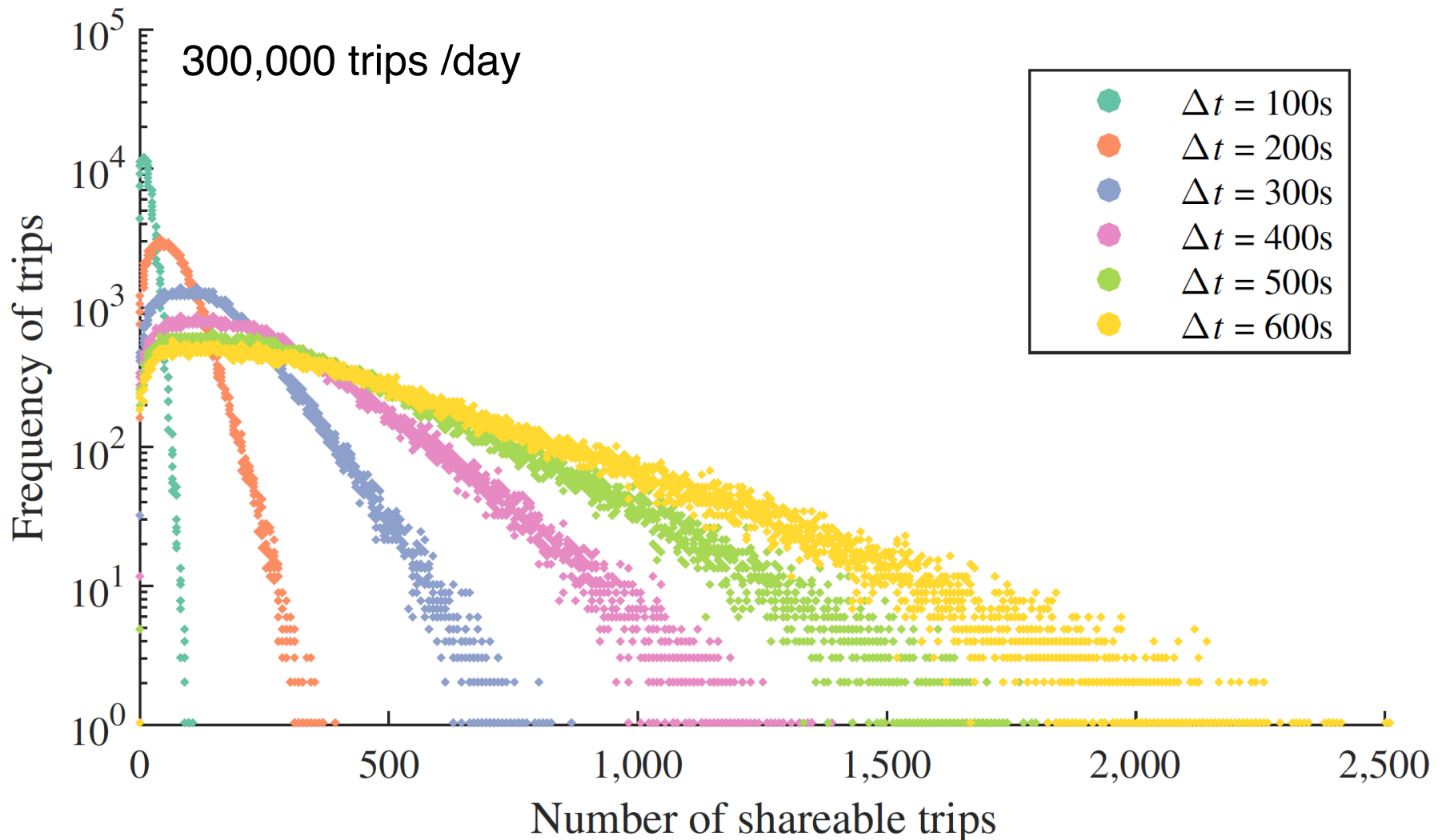




# Irving-Tan Algorithm

- **Maximum Stable Matching**
  - **Irving**, Robert W. 1985. “An Efficient Algorithm for the ‘stable Roommates’ Problem.” *Journal of Algorithms* 6(4): 577–95.
  - **Tan**, Jimmy J. M. 1990. “A Maximum Stable Matching for the Roommates Problem.” *BIT Numerical Mathematics* 29(4): 631–40.

# Taxi trips of a random day in Manhattan

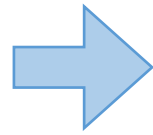


# Objectives ~ Methods

# of vehicles / parking

Maximum cardinality

# mile / time traveled



Maximum weights

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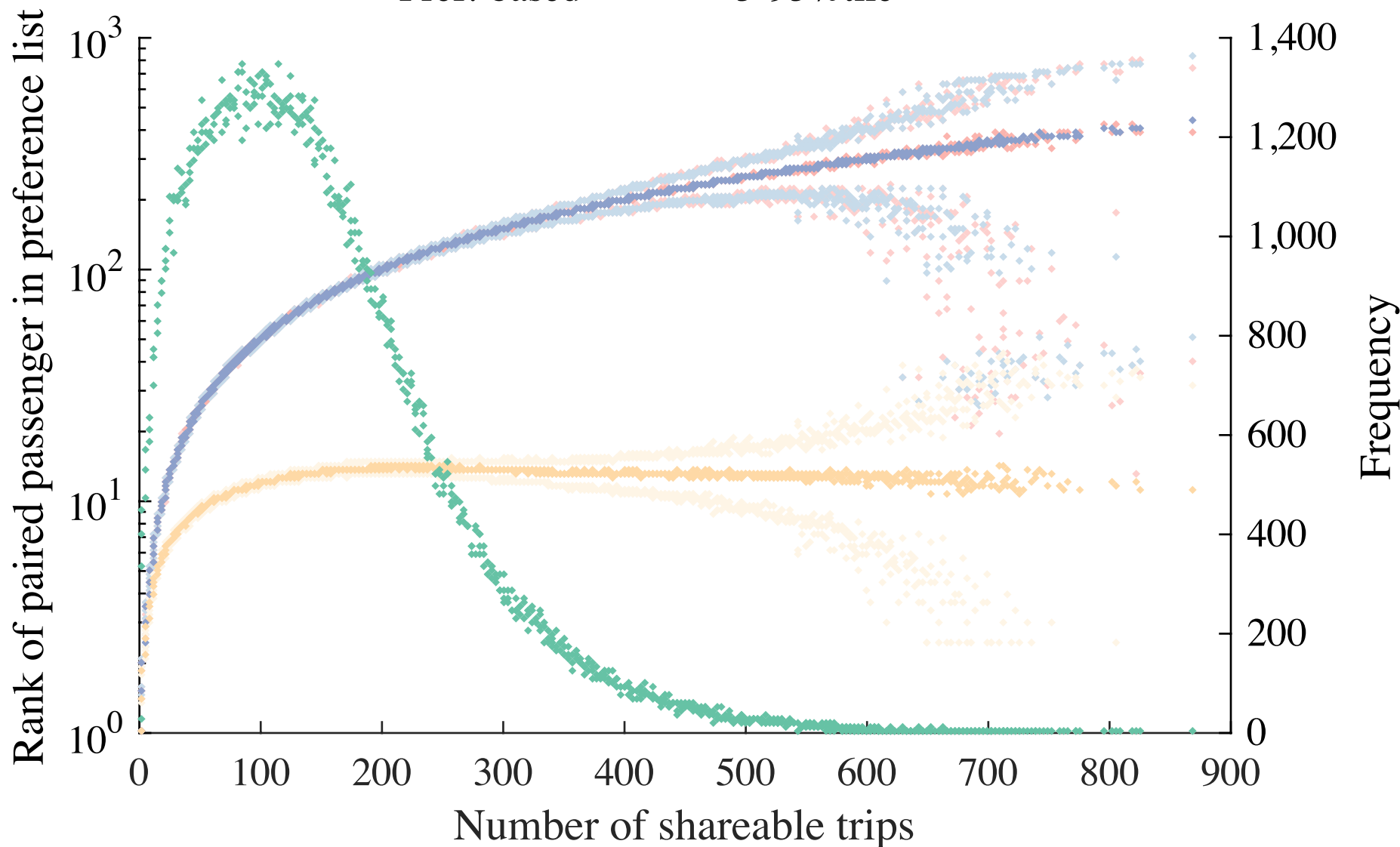
Social interaction

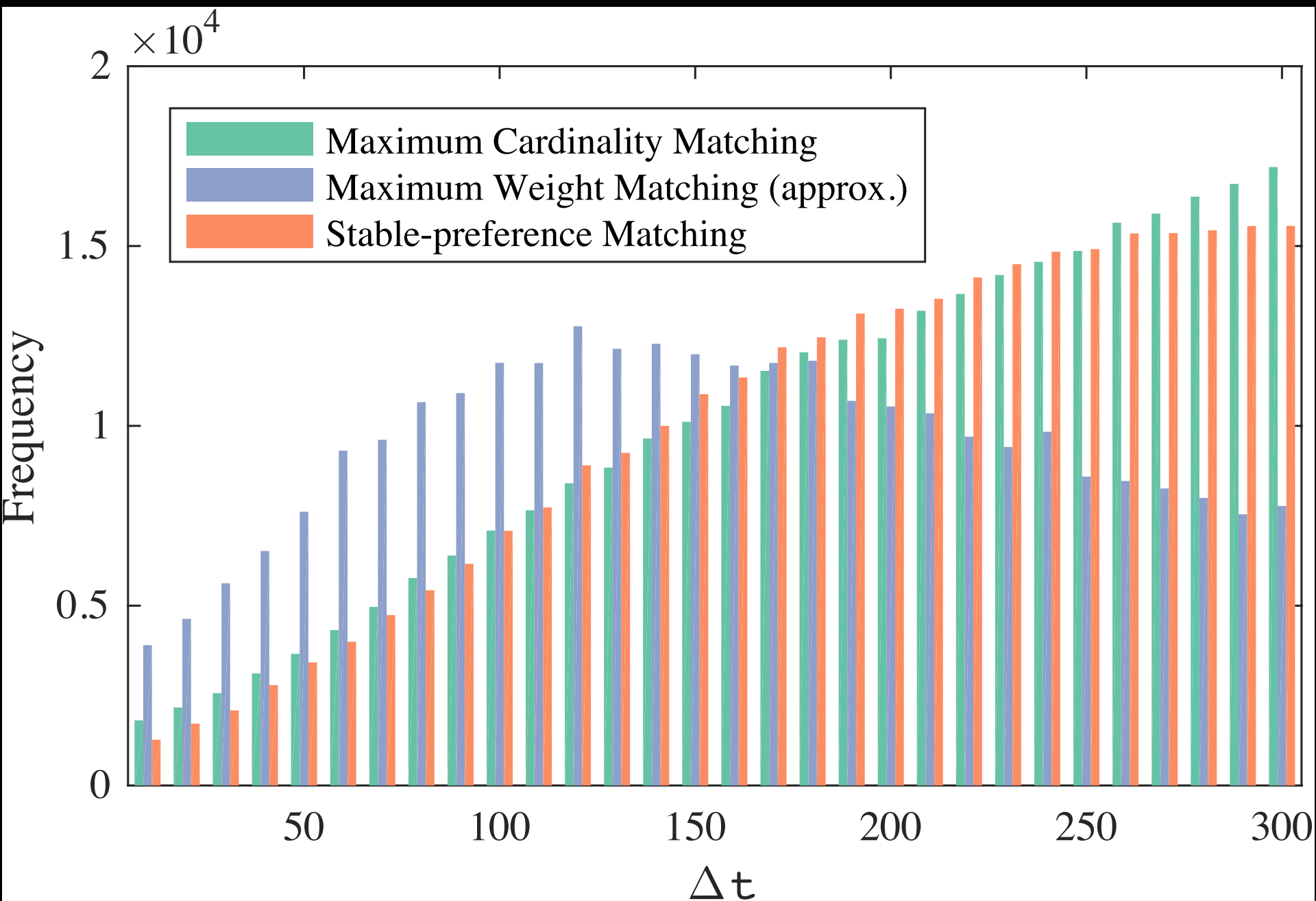
Maximum stable matching

(Assume a given preference rank order)

$\Delta t = 300s$

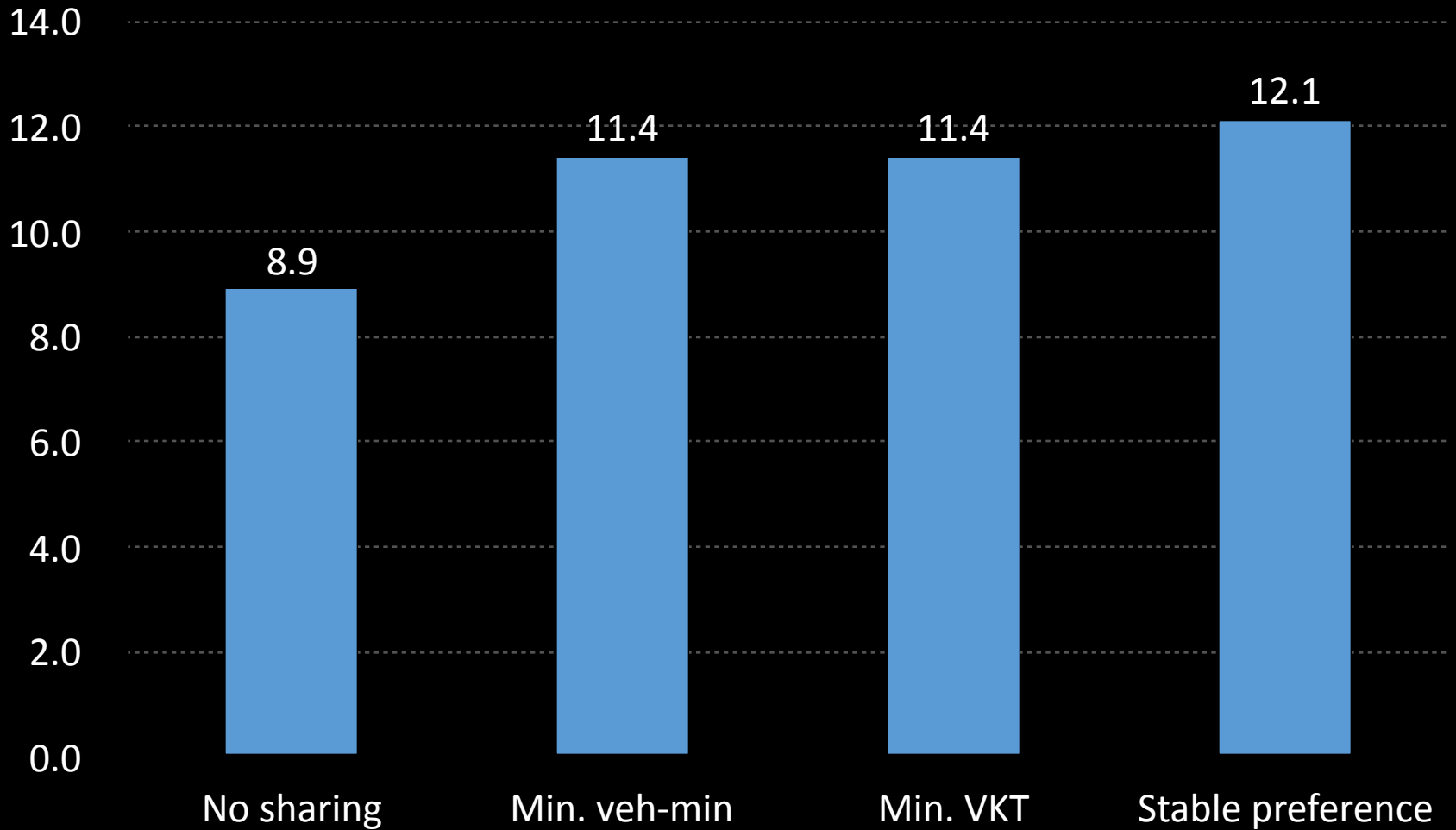
- Max. weight
- Max. card.
- Pref.-based
- 5-95%tile
- 5-95%tile
- 5-95%tile
- Degree dist.







# Passenger Travel Time Per Trip (min)



50 extra seconds for a better  
conversation?

# Q1: Matching Algorithm

Design a Human-Centric (**vs. Box-Centric**) Mobility Sharing System

# Q2: Urban Agglomeration: Interaction and Creativity



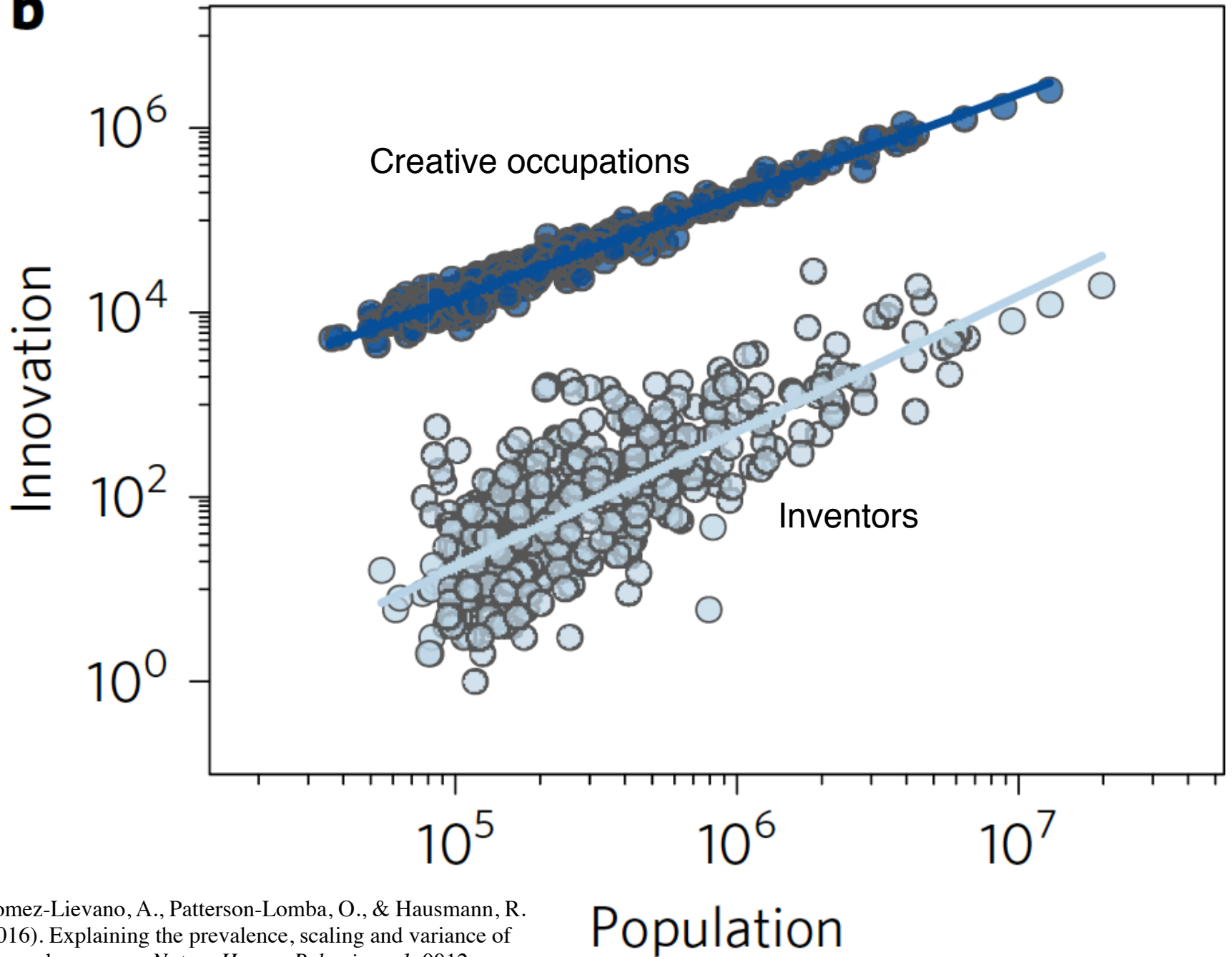
When cities grow, what happens?

# Whenever a city doubles in size...

Every measure of economic activity, from GDP to bank deposits to patents, increases by approximately 15% per capita.

—Geoffrey West

*It doesn't matter how big the city is; the law remains the same.*

**b**

Gomez-Lievano, A., Patterson-Lomba, O., & Hausmann, R. (2016). Explaining the prevalence, scaling and variance of urban phenomena. *Nature Human Behaviour*, 1, 0012.

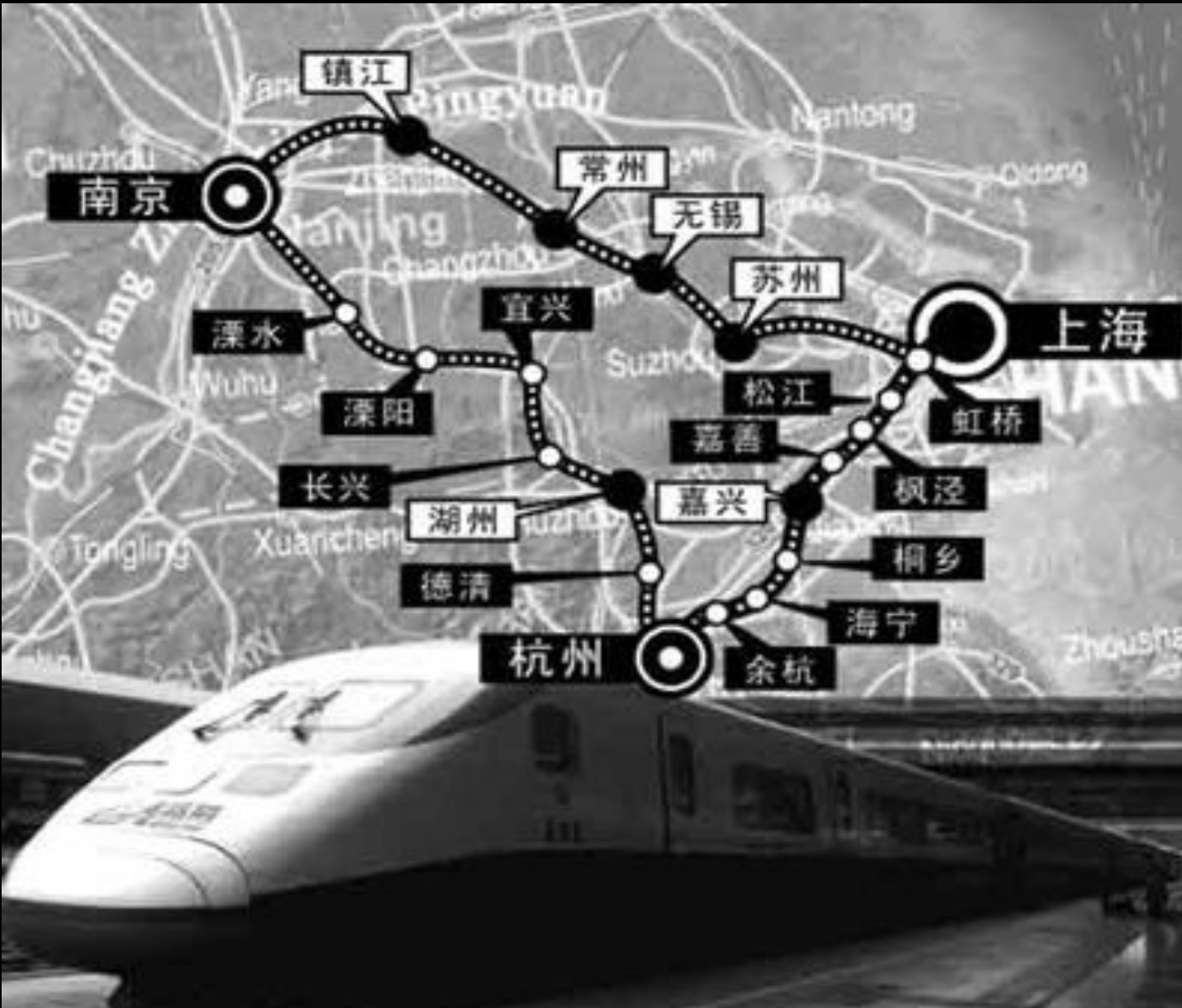
# Railway map of China

Colored lines showing CRH and other high speed rail services

Last update: 2016-01-06



# Yangtze River Delta High Speed Rail



300km

70-120 minutes

# Infrastructure and service

- Speed



A digital display showing train information in red text on a black background. The top row contains 'G7156', '19:39', and a train icon with the number '6'. The bottom row contains the Chinese characters '速度' (Speed) followed by '326km/h'.

G7156 19:39 6  
速度 326km/h

- Headways: 123 pairs of trains each day
  - Average: 7.5 minutes
  - Peak hours: 5.3 minutes



80m~100m people



*If infrastructure can effectively hold the region together, if Geoff West's law continues to hold, China could create marvel!*

# Shared Mobility at Scale

Design human-centric mobility sharing system

Intensify effective human interaction without  
growing the city physically

# Micro level behavioral foundation for urban agglomeration

- Sharing
- Matching
- Learning

**How are ideas born?**

How are new ideas born?

When ideas kiss each other...

# How are ideas born?

- Neurologically: when neurons connect
- Biologically: when genomes remix
- Sociologically: when people interact each other

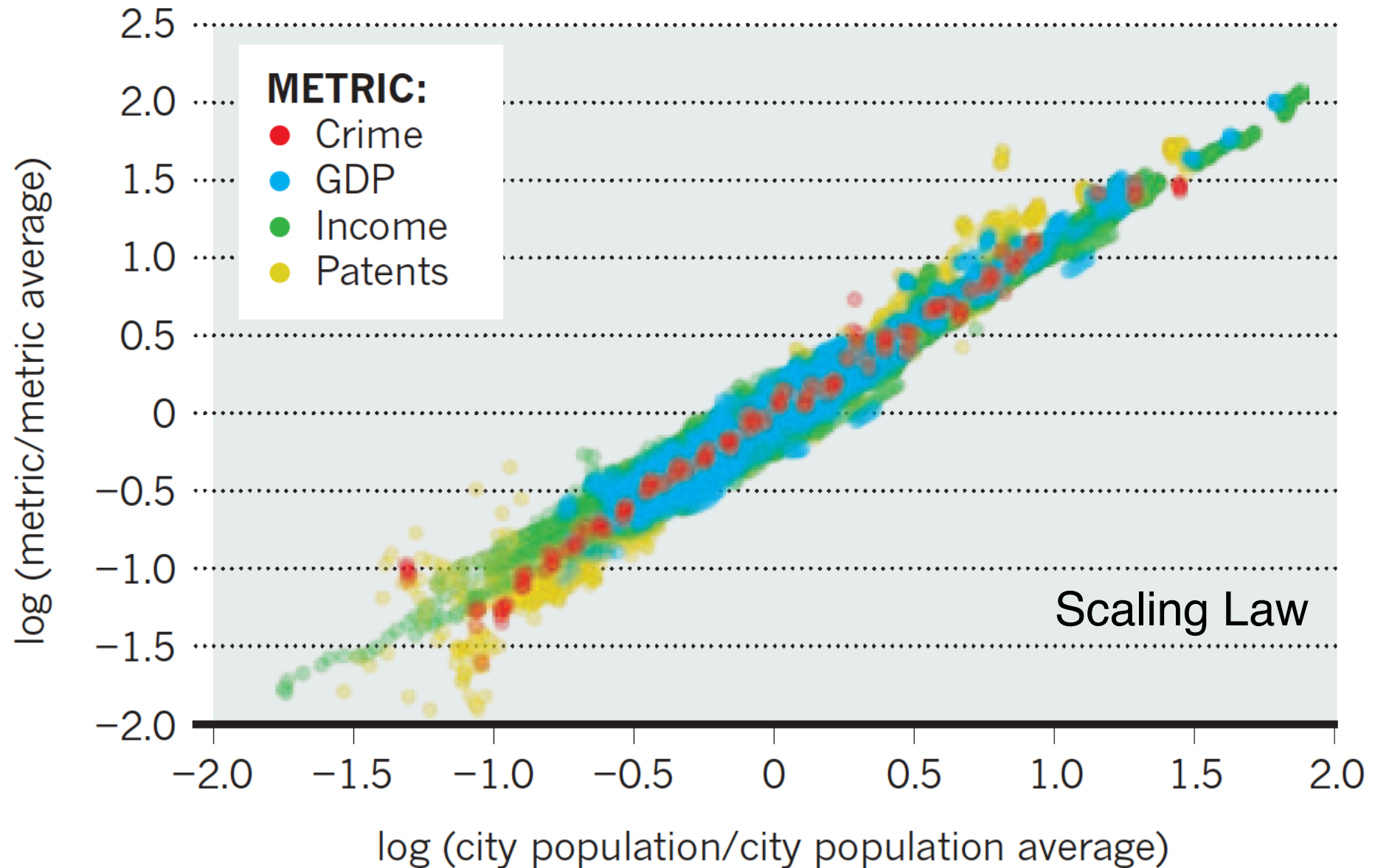


# Whenever a city doubles in size...

It also experiences a 15% per capita increase in violent crimes, traffic and AIDS cases.

# PREDICTABLE CITIES

Data from 360 US metropolitan areas show that metrics such as wages and crime scale in the same way with population size.

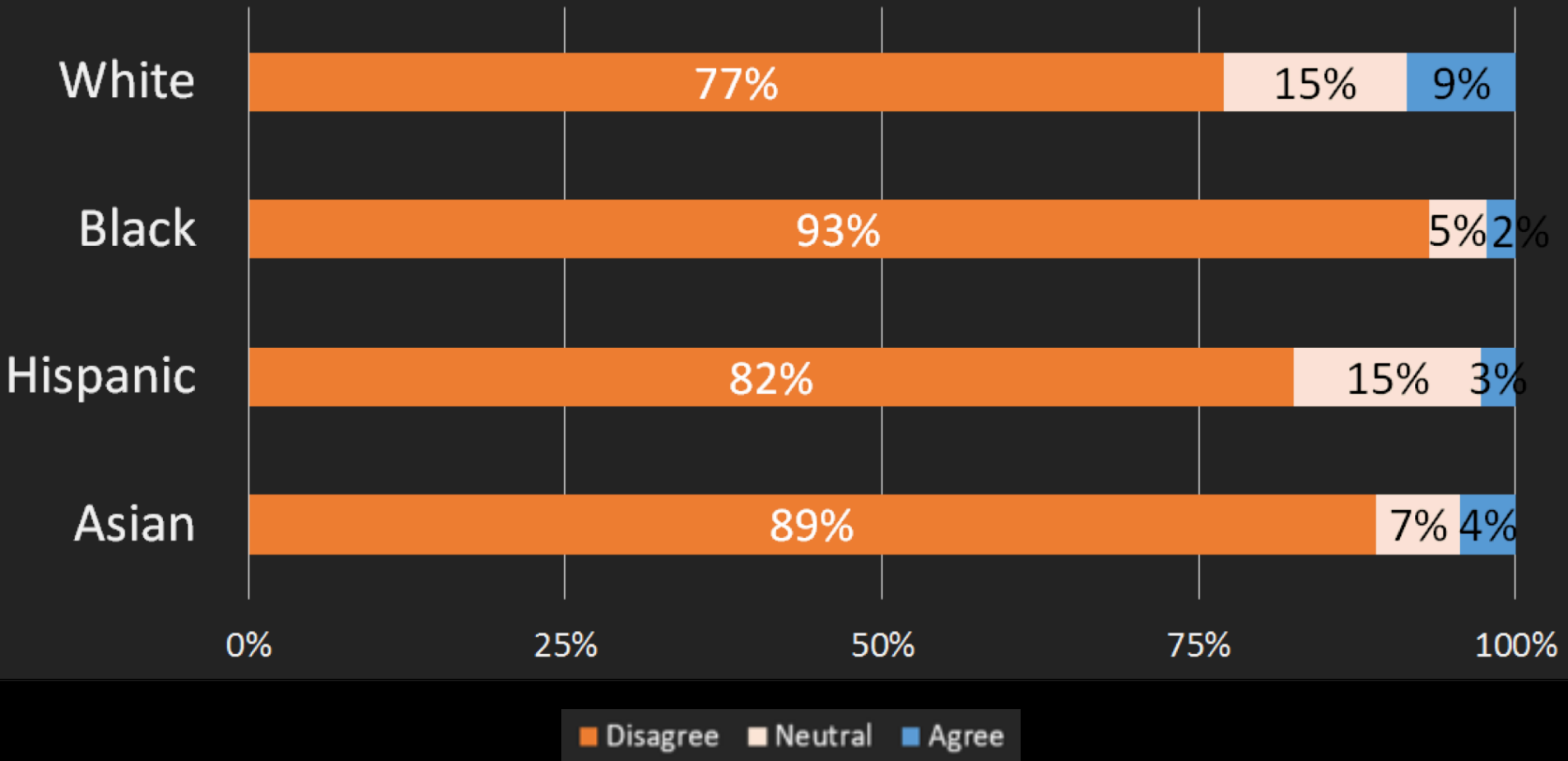


# Q3. Social Prejudice & Racial Biases

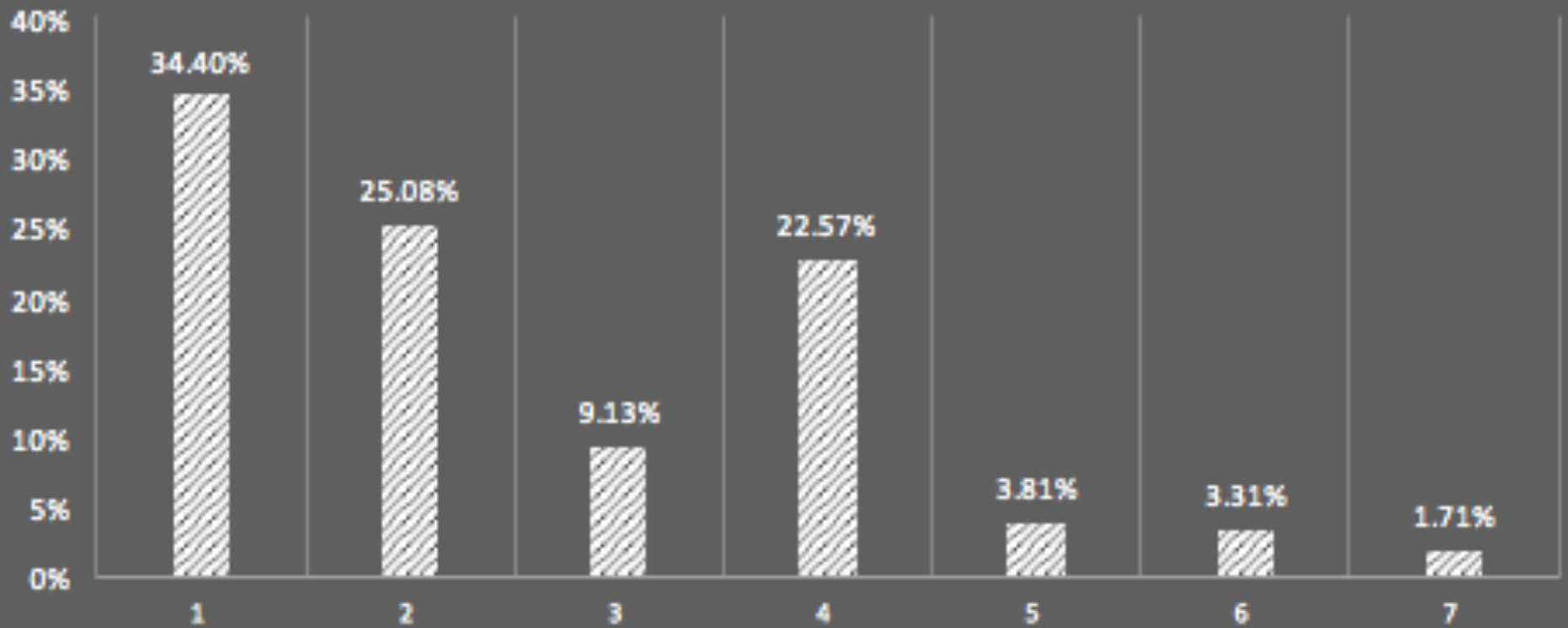
We develop algorithms to respect social preferences...

But NOT all preferences are respectable

# Sharing a ride with a passenger of a different ethnicity could make me uncomfortable



# I WOULD PREFER TO AVOID BEING PAIRED WITH A PASSENGER OF A LOWER SOCIAL CLASS IN SHARED RIDES

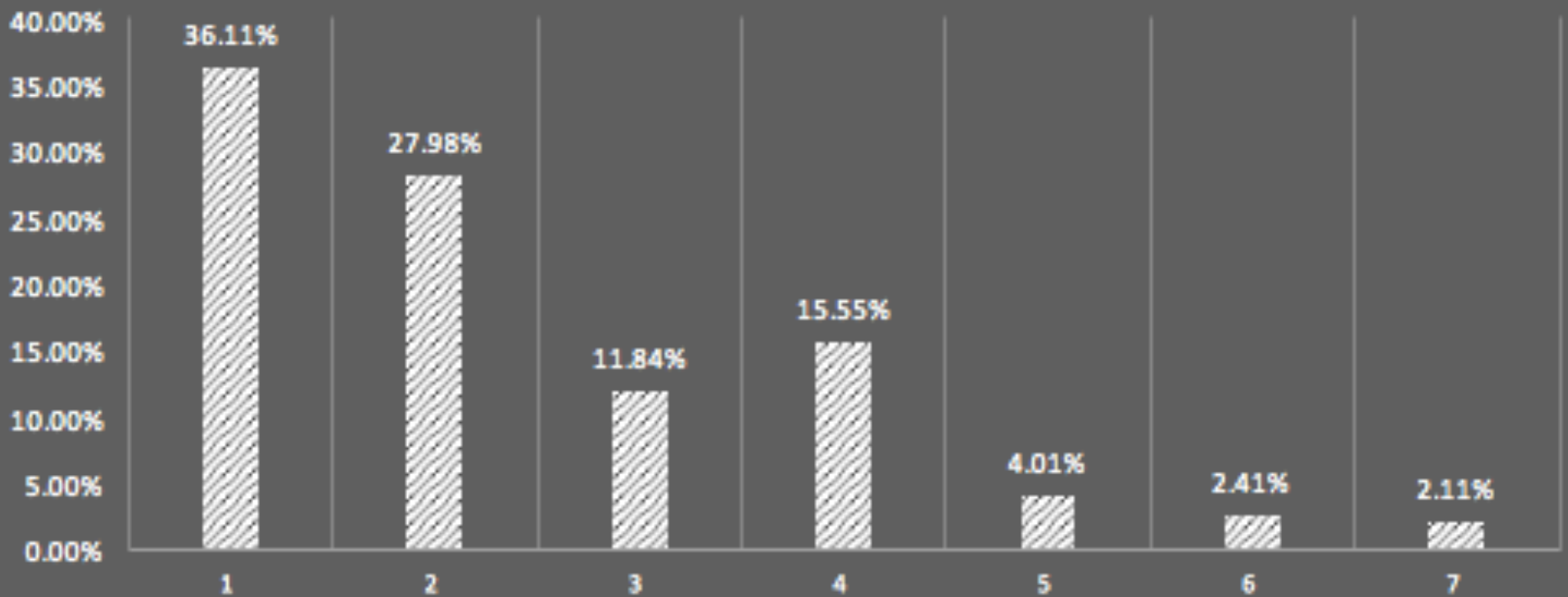


Strongly Disagree

Strongly Agree



## GROUPING PASSENGERS OF DIFFERENT RACES IN SHARED RIDES IS A RECIPE FOR TROUBLE



Strongly Disagree

Strongly Agree

# Substantial evidence of social prejudice in ridesharing

Ge, Y., Knittel, C. R., MacKenzie, D., & Zoepf, S. (2016). Racial and gender discrimination in transportation network companies (No. w22776). National Bureau of Economic Research.

# Regulating Shared Mobility

## Regulatory Asymmetry

- Supplier Discrimination
- Consumer Discrimination

## What about platforms

- Passenger vs. Driver
- Passenger vs. Passenger

# No-supervision of the drivers in autonomous vehicles

**Q4: Foster positive interaction  
(as a solution to social issues)**

	<b>Respondents indicating bias</b>	<b>Respondents who did NOT indicate bias</b>
Preference for seeing a photo	42%	22%
Preference to see name, age, gender	49%	29%
Preference to see ratings	43%	26%
Preference for clear norms and interaction	46%	29%

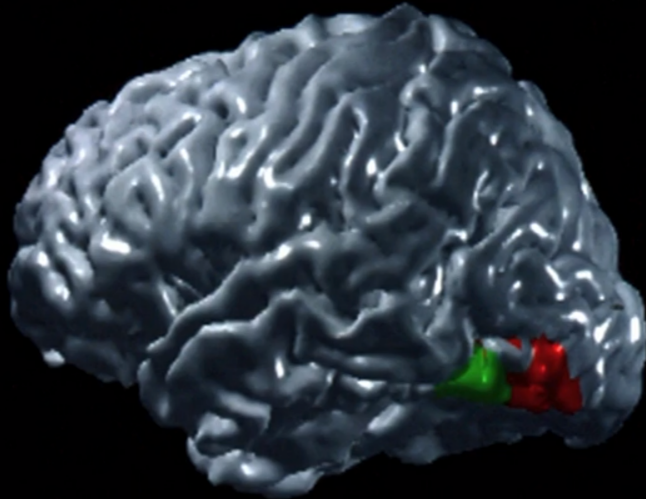


# Premise

When people interact face to face,  
they increase empathy of each other  
even when they disagree

# Neurological basis

# Mirror Neuron



Mirror neuron: a neuron that fires

- when one acts, and
- when one observes the same action performed by another

# Mirror Neurons

## Executed Reaching



## Observed Reaching



dorsal

posterior

lateral

medial

$p = 0.005$



They were discovered  
by Giacomo Rizzolatti  
and his group

Thanks to them  
we can learn

# MIRROR NEURONS

They develop  
with our  
motor system

Copy, mirror  
or imitation  
system

↳  
empathy

When they are  
damaged, people  
don't understand  
other people actions

↳  
Autism

↳  
Other brain  
damage disorder

The neurons that shaped civilization—Prof. Ramachandran

Increase social capital via shared mobility

# Traditional Metrics

## ***Maximum Cardinality***

- Maximize paired trips and minimize number of vehicles
- Reduce parking needs

## ***Maximum Saved Distance***

- Maximize shared mileage
- Reduce travel distance and travel time

# Social Metrics

## ***Maximum Mingling Time***

- Maximize the time travelers spend together
- Weight: shared trip time

## ***Maximum Social Mixing***

- Maximize the link mixing
- Higher weight for people belonging to different categories



# Pisa and MIT Proposal

## MobilitandoPisa - Italy

## MIT - Cambridge, US

“ A PISA PARTE IL QUESTIONARIO SULLA MOBILITÀ. SALTA SU! ”

**mobilitandopisa**

**Partecipa al questionario e vinci abbonamenti bus e bike sharing.**

È partito un questionario sul tema della mobilità, rivolto a tutti coloro che abitano o lavorano a Pisa. Finalmente puoi dare il tuo contributo attivo al miglioramento della qualità della vita della città di Pisa, offrendo le tue risposte ed i tuoi suggerimenti per costruire insieme il nuovo piano della mobilità. Il questionario ti richiederà solo pochi minuti. Inoltre, partecipando al questionario sulla mobilità puoi **vincere**:

- > 50 Abbonamenti CicloPi annuali di bike sharing
- > 5 Abbonamenti annuali trasporto pubblico cittadino
- > 10 Abbonamenti mensili trasporto pubblico cittadino

Puntiamo ad una città più sostenibile, pulita, vivibile a partire dall'impegno di tutti... a partire da te!

[Compila adesso il questionario](#)

**Commuting to MIT**

Welcome ,

The Parking and Transportation Office, the Environment, Health and Safety Office and the Office of the Provost are jointly sponsoring a survey on commuting to the MIT campus. The State of Massachusetts and the City of Cambridge require that MIT collect data related to how you get to MIT every day. This survey has multiple sections and should take about 10 minutes to complete. As an incentive to participate in this survey, we are offering several prizes. **MIT Community members who complete the survey will be entered into a lottery for a grand prize: \$500 Visa Gift Card OR TechCASH OR Bicycle from Cambridge Bicycle (your choice)**

Other prizes include:

- 25 TechCASH credits valued at \$100
- 50 TechCASH credits valued at \$50
- 325 TechCASH credits valued at \$25
- 10 \$50 Zipcar Gift Certificates
- 40 Lifetime annual memberships

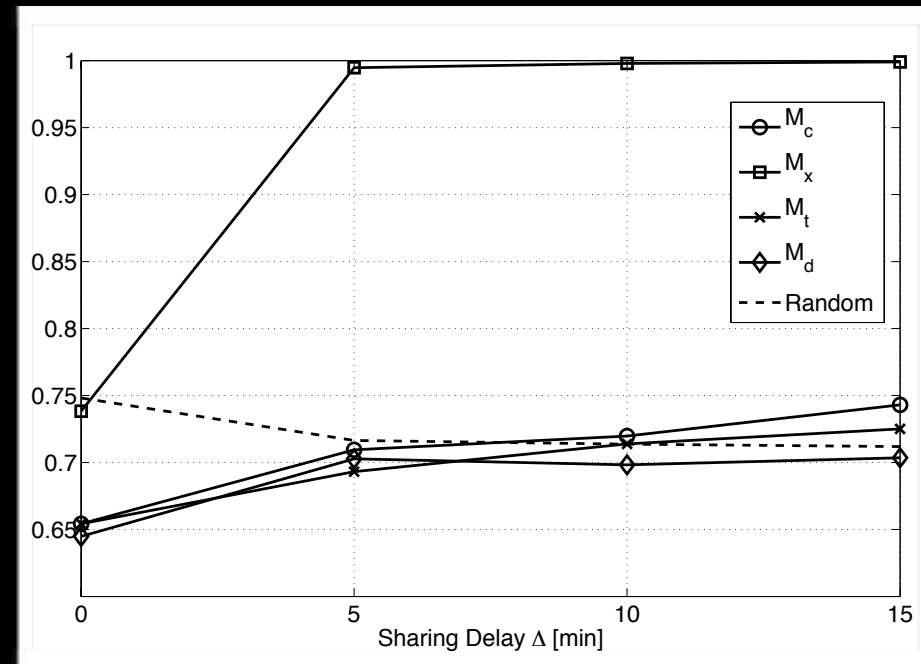
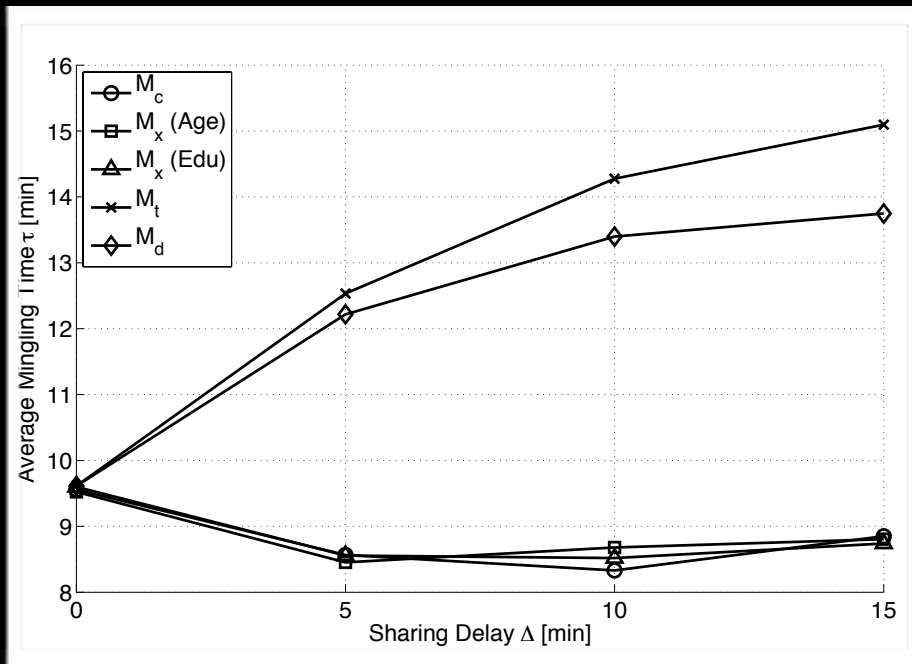
1,965 commuters who daily commute with the car with detailed addresses

1,968 commuters who daily commute with the car to/from the campus

# Pisa and MIT Proposal

## Average Mingling Time

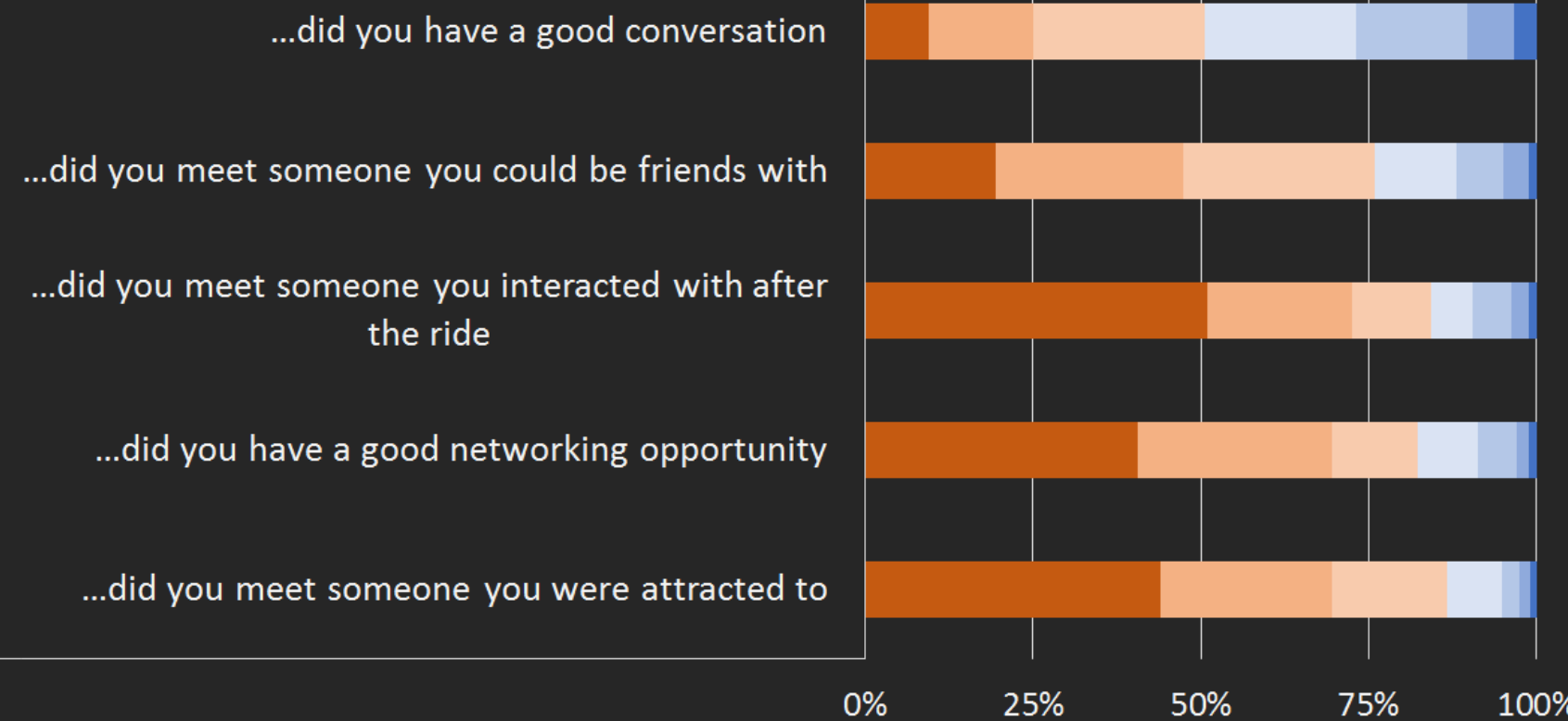
## % of Social Mixing



F. Librino, Fabio Duarte, M. Elena Renda, Giovanni Resta, Paolo Santi, Jinhua Zhao (2017) Social Dimension of Home-work Carpooling

$M_c$  Max Cardinality  
 $M_d$  Max Saved Distance  
 $M_t$  Max Mingling Time  
 $M_x$  Max Social Mixing

Among the experiences when you were paired with other passengers while using UberPool or Lyft Line, how often...



■ Strongly Disagree   
 ■ Disagree   
 ■ Somewhat Disagree   
 ■ Neutral   
 ■ Somewhat agree   
 ■ Agree   
 ■ Strongly Agree

# Shared mobility as a new mode of social interaction

Between

- job hunters and employers
- startup and venture capital
- students and faculties
- clients and professionals
- mathematicians and art historians
- ...

Can we mix republicans and democrats in a shared ride?

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