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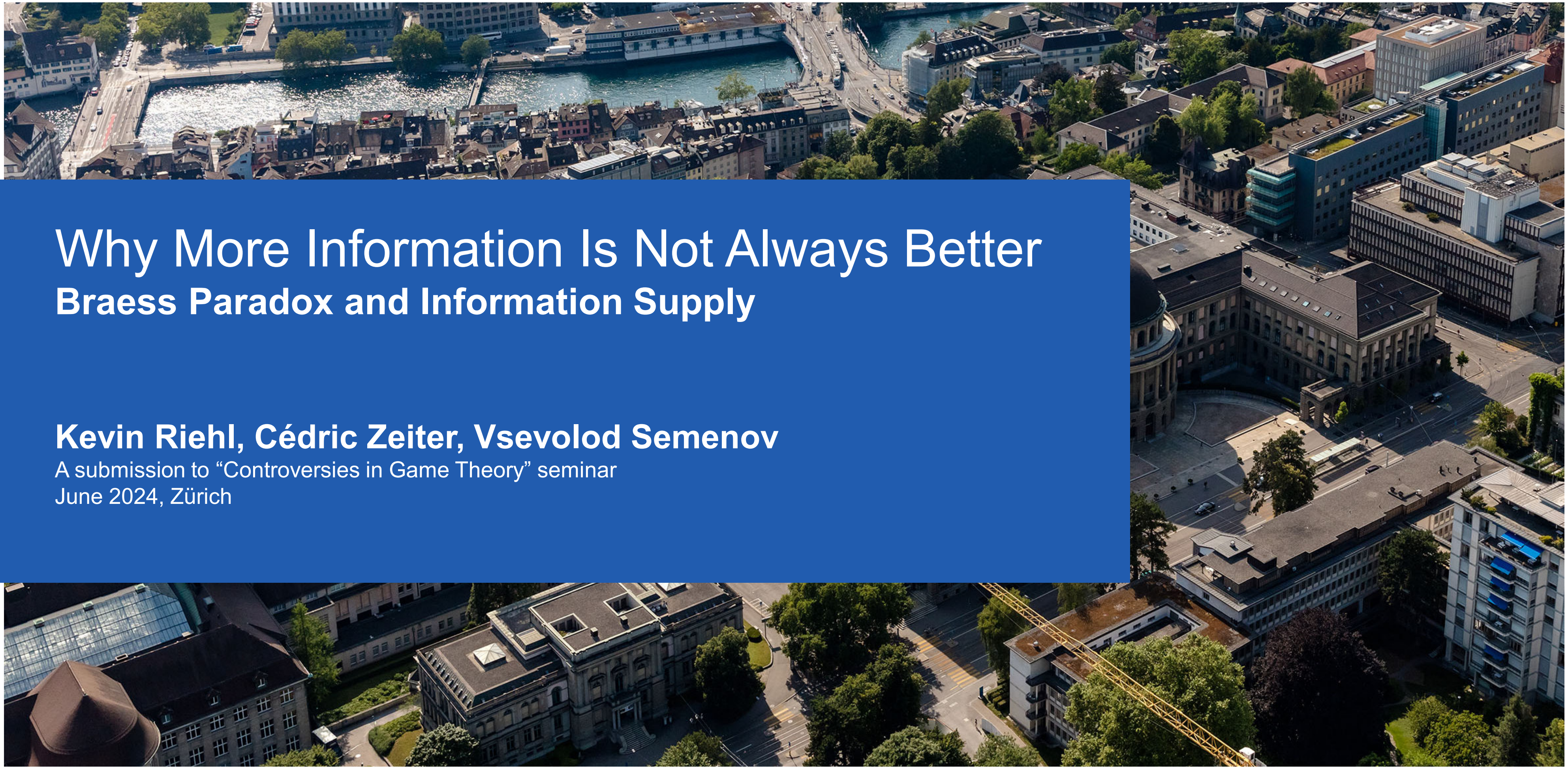

Why More Information Is Not Always Better

Braess Paradox and Information Supply

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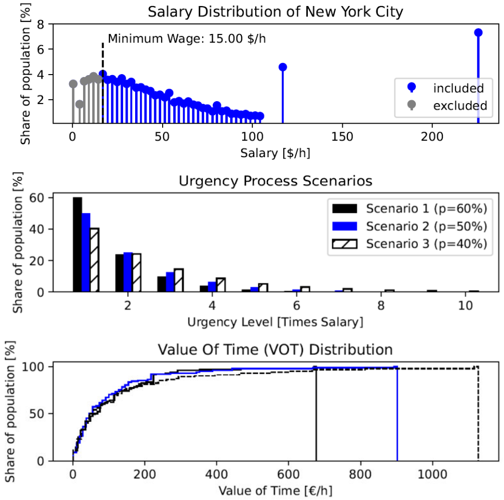
Introduction

- **Braess Paradox**
  - More options (road infrastructure) can lead to worse societal outcomes (congestion)
- **Research Question**
  - Does Braess Paradox also happen for more information?
  - **More Information = Better Outcomes?**
- **Background**
  - More available real-time traffic information in the advent of internet
  - Does this lead to better traffic situations?
  - Should rational drivers consider external information?

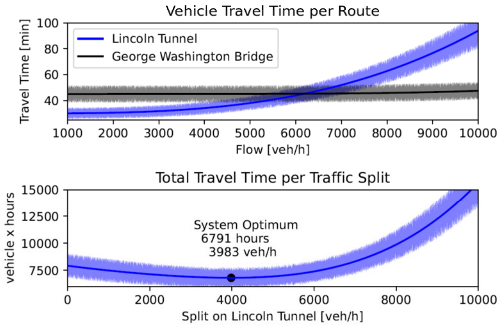
Case Study: Route Choice Behaviour in New York (1/2)

- New York and New Jersey are connected via two routes
- The route via Lincoln Tunnel is shorter and faster
- But if too many drivers use it, it gets congested, thus travel time increases

- Nash-equilibrium = Wardrop's equilibrium
  - **Behaviour: Rational drivers choose routes that minimize their own costs**
  - Leads to: Drivers choose Lincoln Tunnel until both routes similar travel times/costs
  - Chasing similar travel times gives worse average than what the system optimum would be



(A) Population Model



(B) Travel Time Model

Case Study: Route Choice Behaviour in New York (2/2)

Our algorithm that models route choice behaviour of rational driver population

Algorithm 1 Simulation of Drivers' Daily Route Choice

for each *day* **do**
    for each *driver* **do**
        $\hat{T}_A, \hat{T}_B \leftarrow EstimationScheme(\mathcal{I}_A^P, \mathcal{I}_A^R, \mathcal{I}_B^P, \mathcal{I}_B^R, w^P, w^R)$
        $\hat{C}_A, \hat{C}_B \leftarrow Cost(\hat{T}_A, \hat{T}_B)$
        if $\hat{C}_A < \hat{C}_B$ **then**
            $Choice \leftarrow A$
        else if $\hat{C}_B < \hat{C}_A$ **then**
            $Choice \leftarrow B$
        else
            $Choice \leftarrow random(A, B)$
        end if
        if $random(0, 1) \leq \gamma$ **then**
            if $Choice = A$ **then**
                $Choice \leftarrow B$
            else if $Choice = B$ **then**
                $Choice \leftarrow A$
            end if
        end if
        Driver Takes Route: *Choice*
    end for
    Update Information Sets: $\mathcal{I}_A^P, \mathcal{I}_A^R, \mathcal{I}_B^P, \mathcal{I}_B^R$
end for

We supply drivers with different amounts of information

- Travel times based on personal experiences
- Historical travel times reported by authority
- Different time horizons

Four different travel time estimation schemes

Scheme	Formula
Plain Average	$\hat{T}_r^{\mathcal{I}} = \frac{1}{h} \sum_{v \in \mathcal{I}} v$
Geometric Weights	$\hat{T}_r^{\mathcal{I}} = \frac{1}{h} \sum_{v \in \mathcal{I}} (v \times w_v)$ with $w_v = \frac{1}{v_j}$
Exponential Weights	$\hat{T}_r^{\mathcal{I}} = \frac{1}{h} \sum_{v \in \mathcal{I}} (v \times w_v)$ with $w_v = exp(v_j)$
Maximum Scheme	$\hat{T}_r^{\mathcal{I}} = max_{v \in \mathcal{I}}(v)$

Results

Depending on how much information gets processed, different convergence schemes

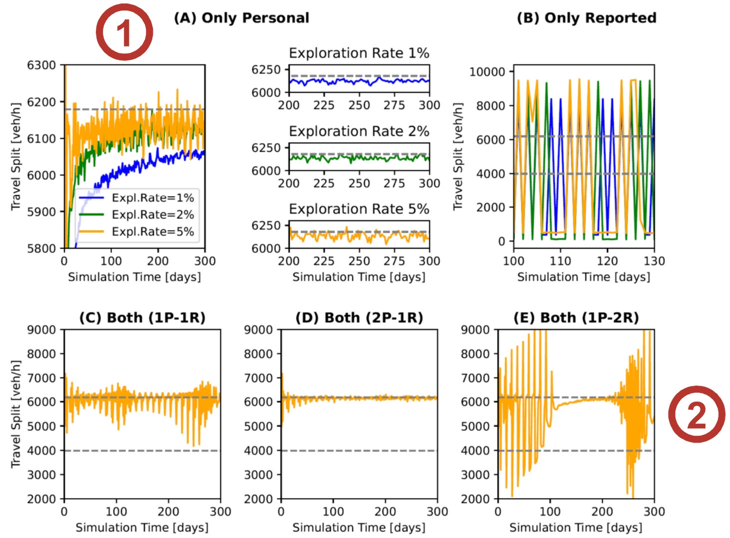
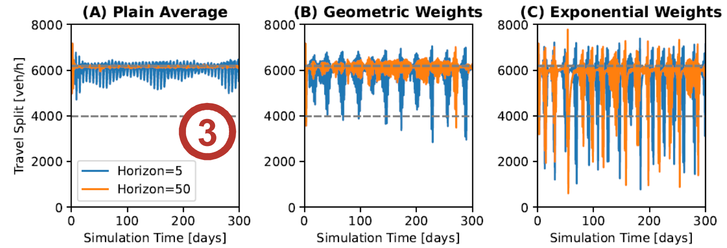


Figure 3.1: Plain Average (Horizon 10)

Information sources

- Personal Experiences → Stable Equilibria 1
- Reported, Historical Data → Oscillations 2



Information Horizon

- Longer horizon → Equilibrium Stability 3
- Shorter horizon → Faster Convergence 4

Figure 3.2: Different Weighting Schemes Compared (2P-1R, 5 % Exploration Rate)

Conclusion

- More reported information does not necessarily support the population to converge to its equilibrium
- Choice of different models does not change the position of equilibrium in our simulation

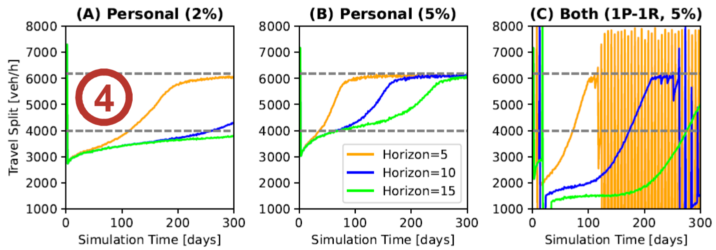


Figure 3.3: Maximum Scheme

Outlook / Future Works

- Heterogeneous populations with different information availability and travel time estimation schemes
- More routes & options and more complex information
- Systematic misinformation to push user equilibrium towards system optimum?