Modeling the human dimension of transport

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In a nutshell…

Infrastructures & Vehicles

Travelers & Goods

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In a nutshell…

Supply

Demand

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Travel demand

- Most people don't travel for the sake of it
- Travel demand = derived demand
- Results of many choices:
  - Choice of activity
  - Choice of destination
  - Choice of departure time
  - Choice of transportation mode
  - Choice of access point (parking, bus stop)
  - Choice of itinerary
  - Etc…

Choice…

- « It is our choices that show what we truly are, far more than our abilities »

  Prof. Albus Dumbledore

- « Liberty, taking the word in its concrete sense, consists in the ability to choose »

  Simone Weil

- « for his development of theory and methods for analyzing discrete choice"

  Nobel Committee to Daniel McFadden, 2000

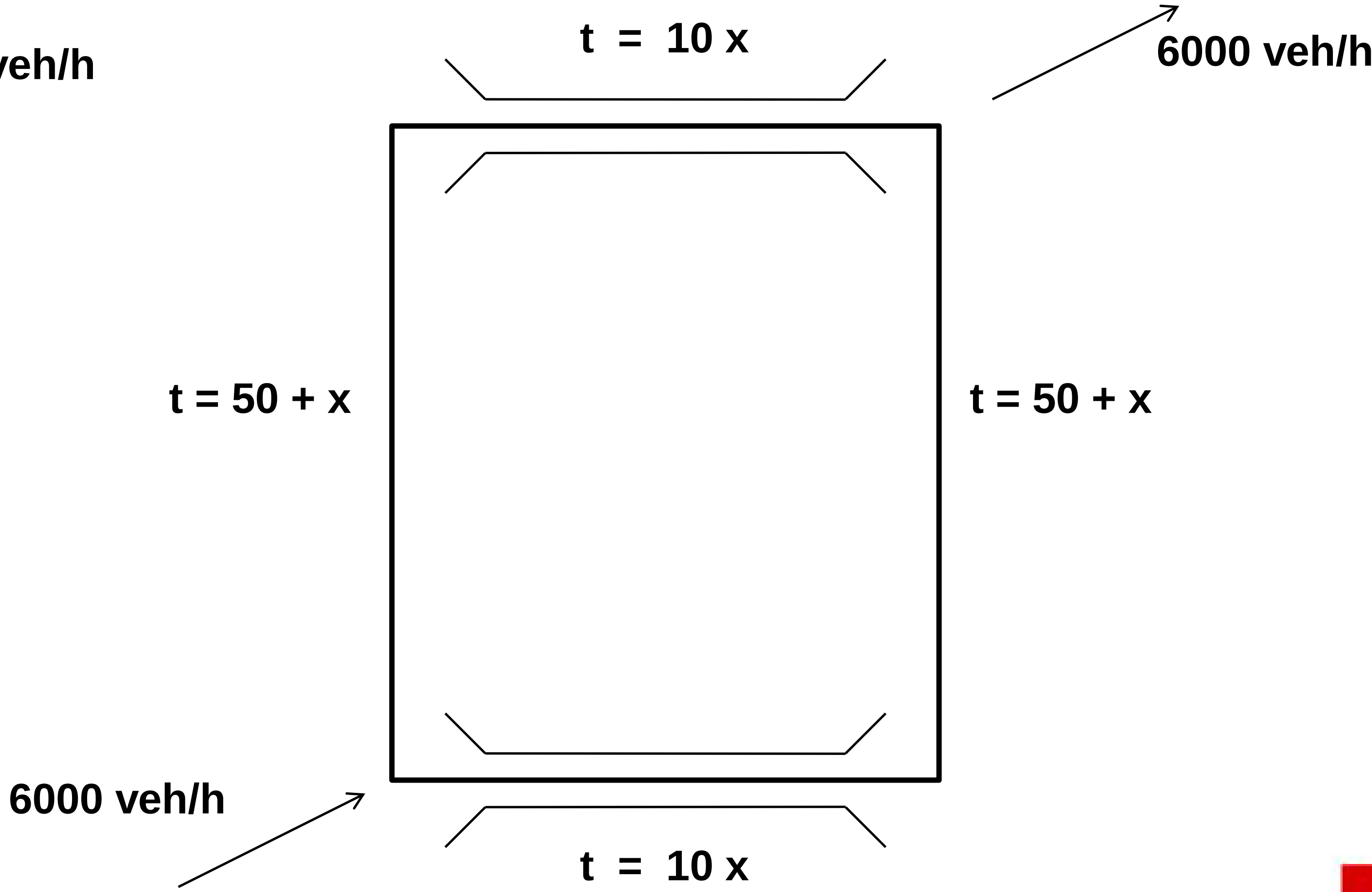
Route choice for car drivers

Route choice for car drivers

- Assumption #1: drivers prefer the fastest route
- Warning:
  - Their presence affects the other drivers
  - More cars = increased travel time
- So…
  - Travel time influences route choice
  - Route choice influences travel time

A simple example

x : 10^3 veh/h
t : time

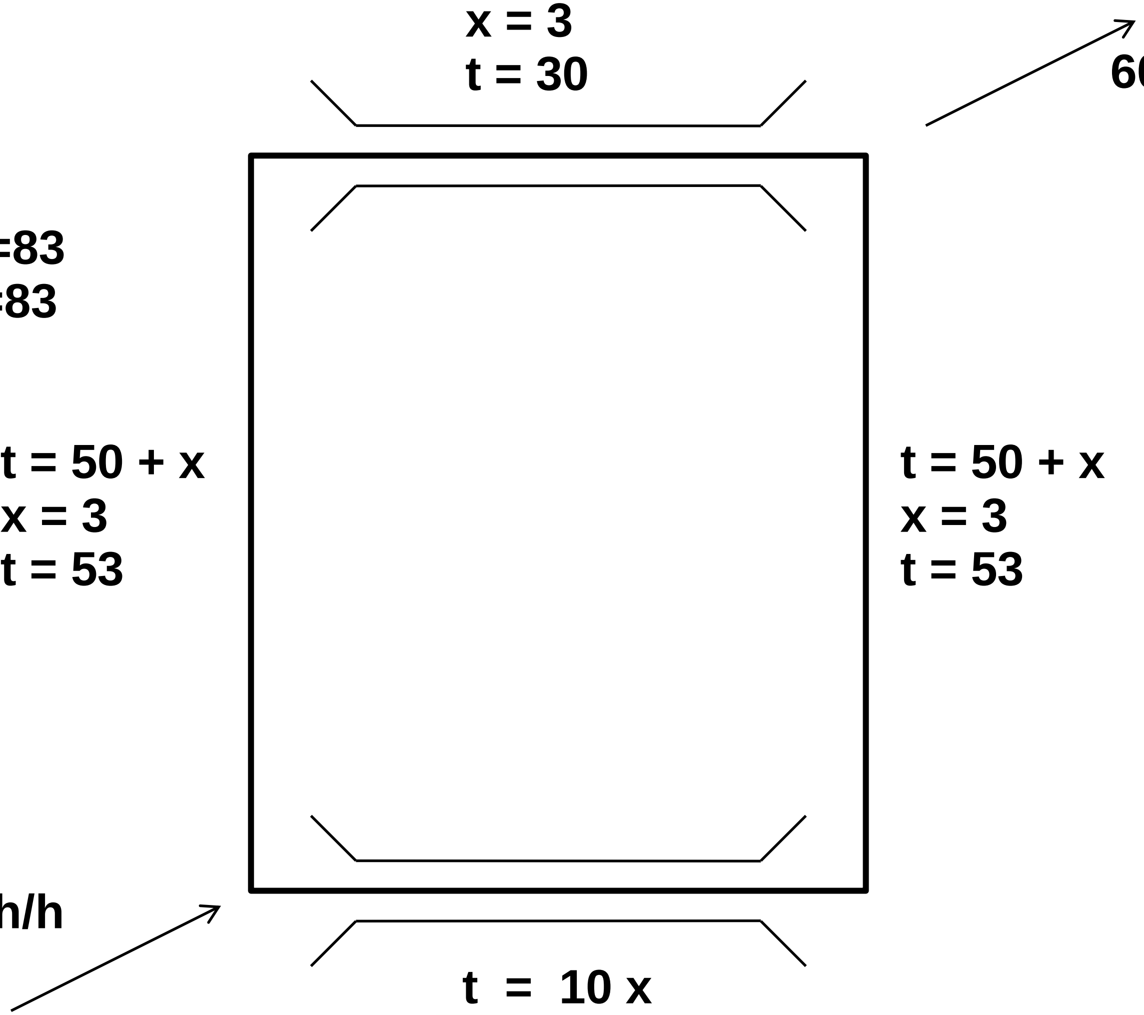


A simple example

x : 10^3 veh/h
t : time

Left-top: t=83
Bottom-right: t=83

Equilibrium



A simple example

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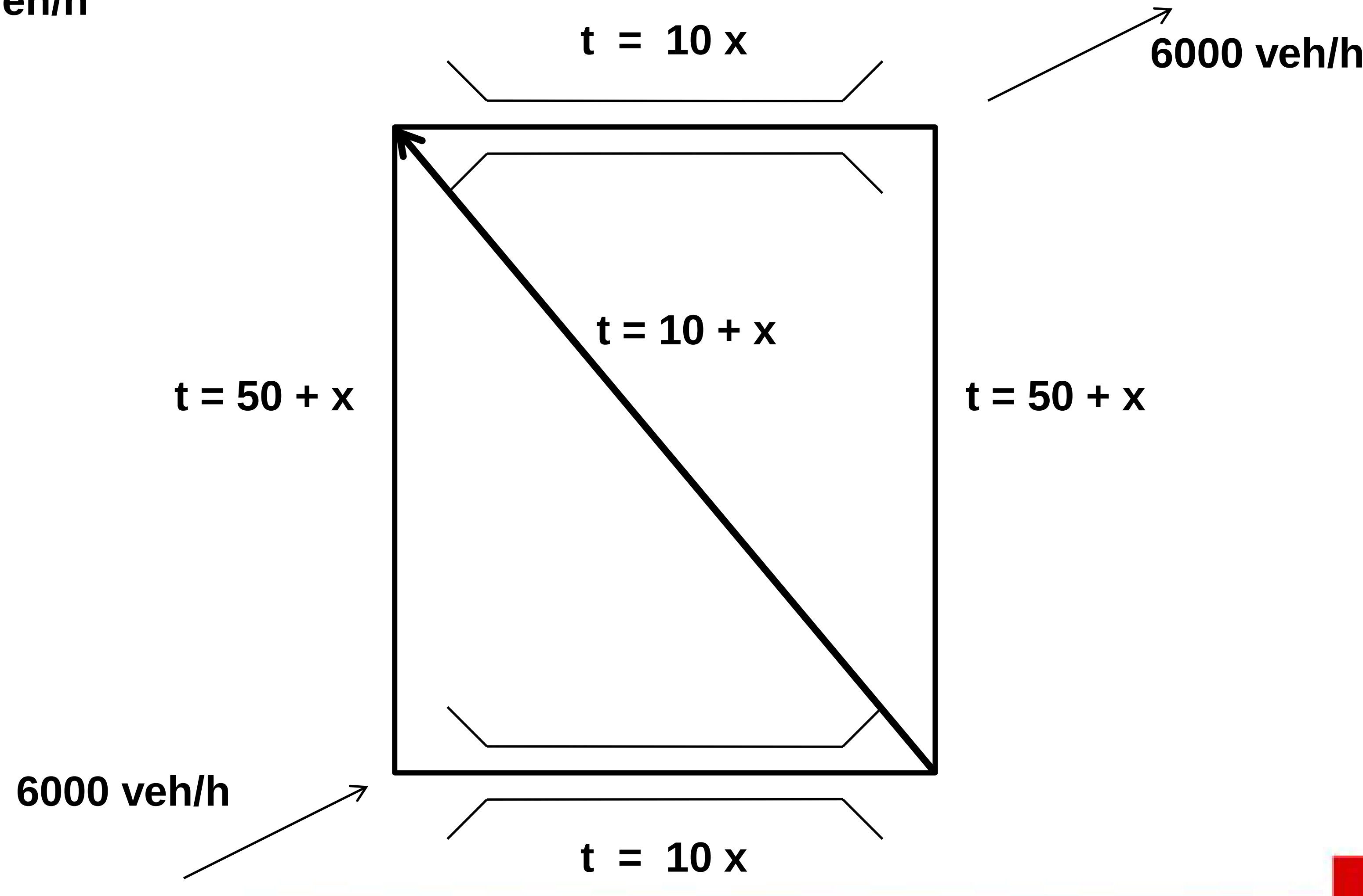
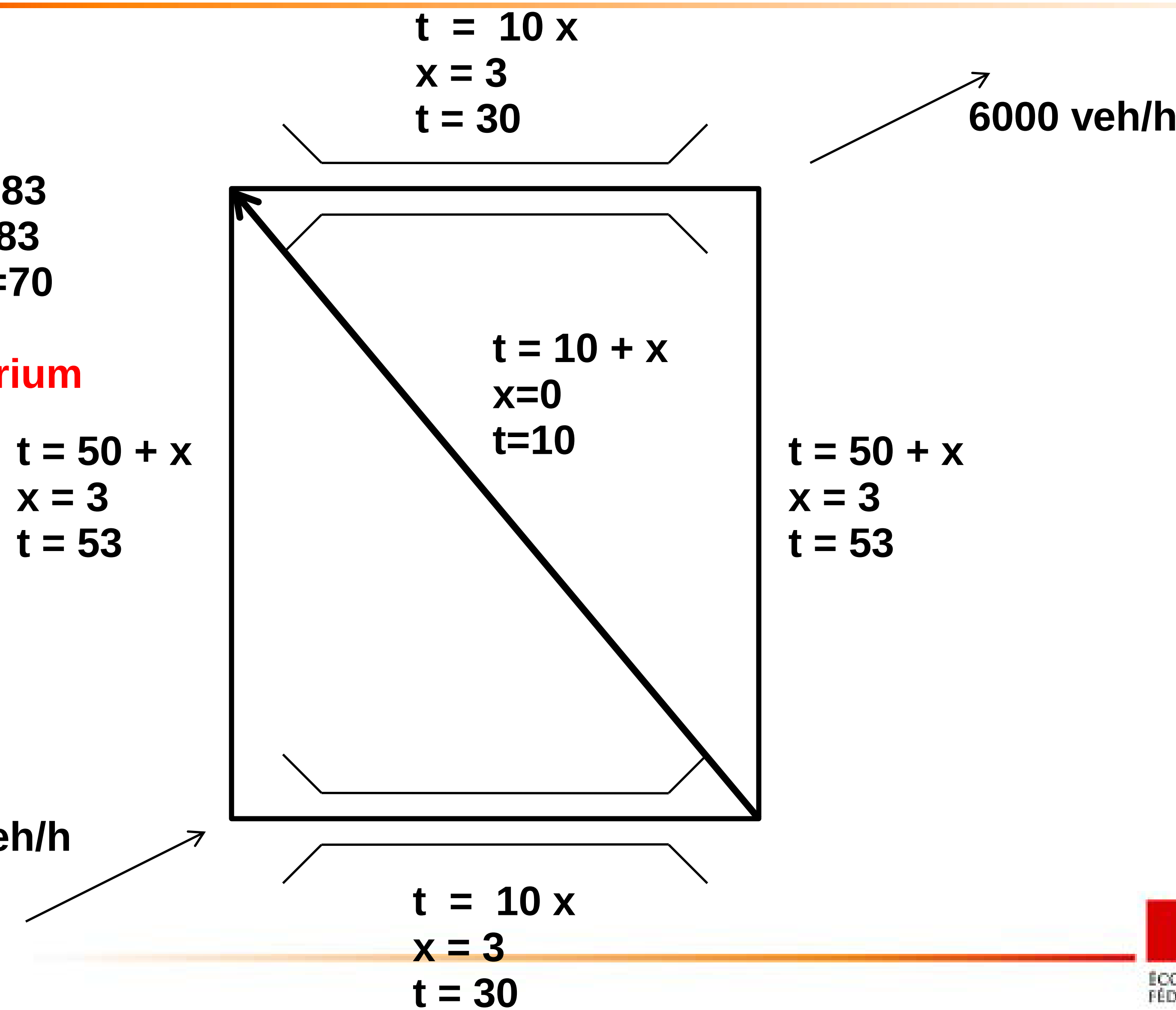


A simple example

x : 10^3 veh/h
t : time

Left-top: $t=83$
Bottom-right: $t=83$
New path: $t=70$

No more equilibrium

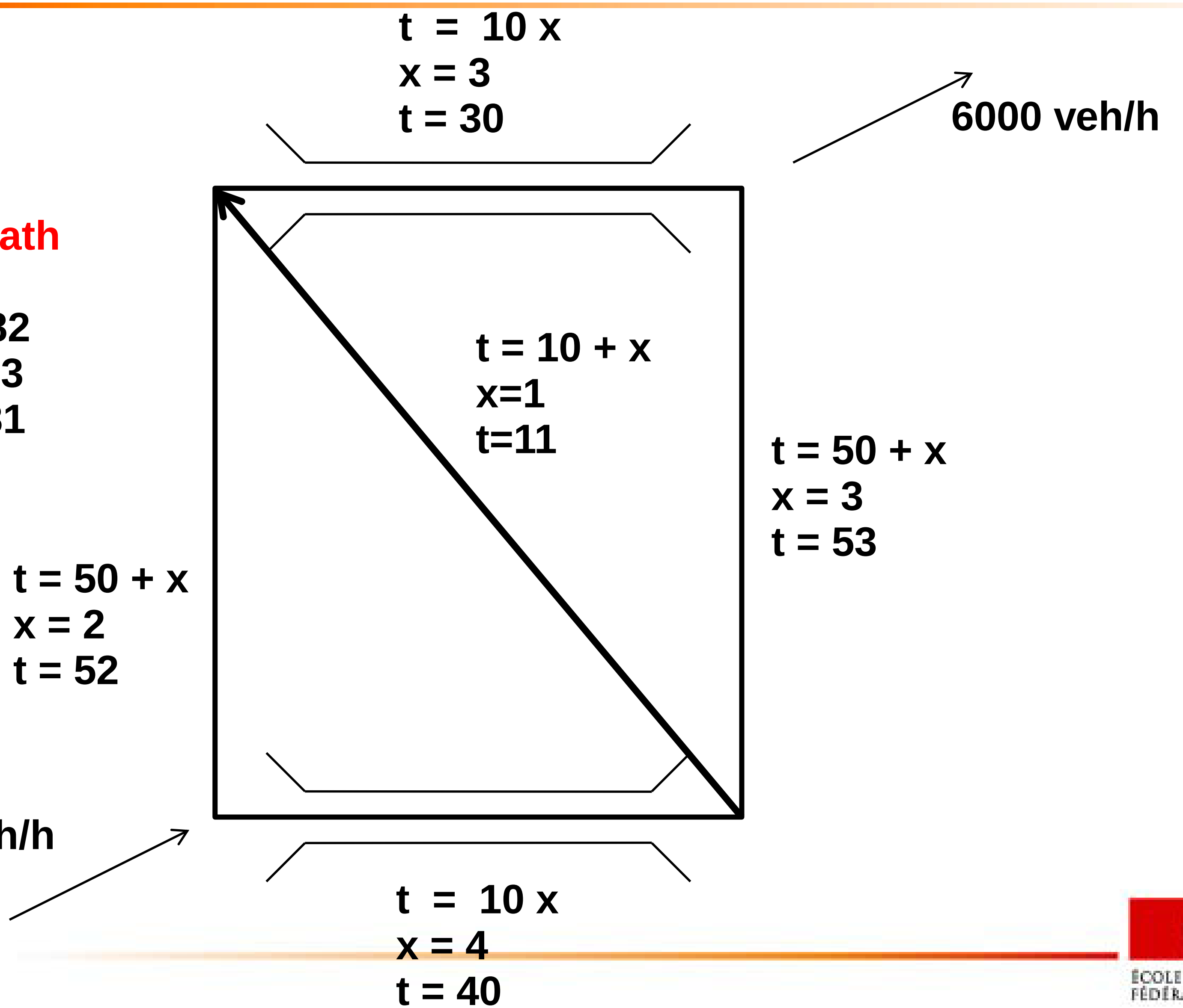


A simple example

x : 10^3 veh/h
t : time

1000 veh change
Left-top → new path

Left-top: t=82
Bottom-right: t=93
New path: t=81



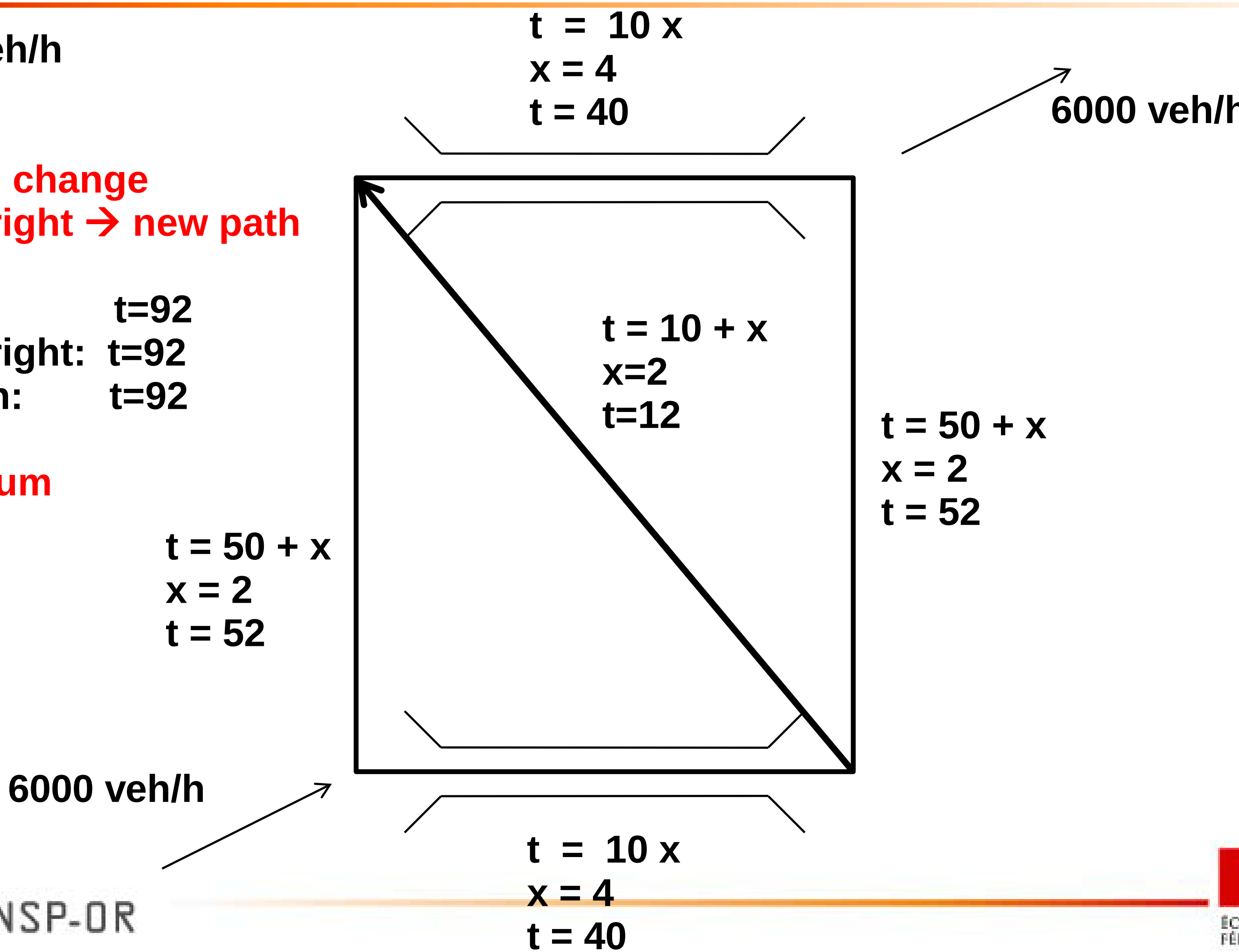
A simple example

x : 10^3 veh/h
t : time

1000 veh change
Bottom-right → new path

Left-top: t=92
Bottom-right: t=92
New path: t=92

Equilibrium



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A simple example

- A new infrastructure is built
- Before, travel time = 83 minutes
- After, travel time = 92 minutes

Increasing the physical capacity of the network does not necessarily increase the mobility

- Braess' paradox

Polluters pay principle

- Concept of marginal travel time

  $t = 50 + x$ Marginal ttime = 1

  $t = 10 + x$ Marginal ttime = 1

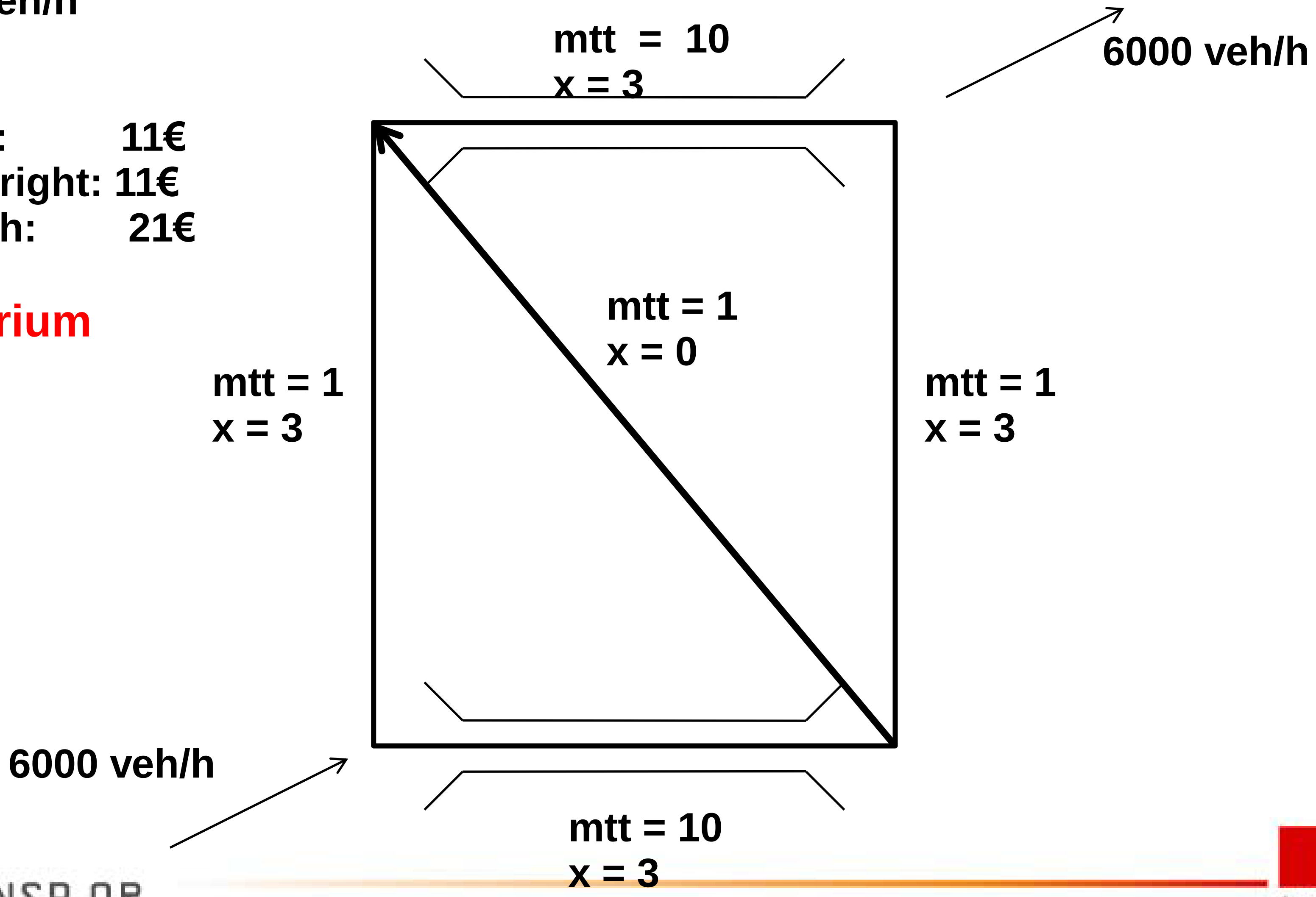
  $t = 10\,x$ Marginal ttime = 10
- Drivers are tolled proportionally to the nuisance they produce
- 1 min marginal travel time = 1€
- Assumption #2: drivers prefer the cheapest route

Back to the simple example

x : 10^3 veh/h
t : time

Left-top: 11€
Bottom-right: 11€
New path: 21€

Equilibrium



Behavioral assumption?

- Do people minimize time?
- Do people minimize cost?
- Each assumption gives different results
- Behavior is more complex…

Time is money

- Path 1: 11€ - 83 minutes
- Path 2: 11€ - 83 minutes
- Path 3: 21€ - 70 minutes

- Would you be willing to pay 10€ to save 13 minutes ?
- Assumption #3: drivers consider **both** time and cost
- But how do we identify the best path then?

Value of time

- We can measure the willingness to pay for travel time savings

- Axhausen, K., Hess, S., Koenig, A., Abay, G., Bates, J., and Bierlaire, M. (to appear). Income and distance elasticities of values of travel time savings: new Swiss results, *Transport Policy*

	Trip purpose			
WTP at sample mean	Business	Commuting	Leisure	Shopping
PT travel time (CHF/hour)	49.57	27.81	21.84	17.73
Car travel time (CHF/hour)	50.23	30.64	29.2	24.32
Headway red.(CHF/hour)	14.88	11.18	13.38	8.48
Interchange red. (CHF/change)	7.85	4.89	7.32	3.52

Value of time

- Assume it is 15€/h, that is about 0.25€/min
- We can convert everything into cost or time
- Path 1&2: 83 min = 20.75€ + 11€ = 31.75€
- Path 3: 70 min = 17.50€ + 21€ = 38.50€

More behavioral aspects

- Value of time varies with
  - Type of choice (mode or route)
  - Trip purpose
  - Income
  - Distance traveled
  - And maybe more…
- Moreover, there’s more than time and cost explaining route choice
- Need for more advanced behavioral models

Examples

- Long distance route choice in Switzerland
  - Travel time
  - Type of road (cantonal, national, freeway)
- Bierlaire, M., and Frejinger, E. (to appear). Route choice modeling with network-free data, Transportation Research Part C: Emerging Technologies
- Urban route choice in Sweden
  - Travel time
  - Number of left turns
  - Number of speed bumps
  - Number of intersections
- Frejinger, E., and Bierlaire, M. (2007). Capturing correlation with subnetworks in route choice models, Transportation Research Part B: Methodological 41(3):363-378.

Behavior is complex, so are the models

$$P(i|\mathcal{C}_n) = \frac{e^{V_{in} + \ln q(\mathcal{C}_n|i)}}{\sum_{j \in \mathcal{C}_n} e^{V_{jn} + \ln q(\mathcal{C}_n|j)}}$$

$$q(\mathcal{C}_n|i) = q(\widetilde{\mathcal{C}}_n|i) = \frac{R!}{(k_{in}-1)! \prod_{\substack{j \in \mathcal{C}_n \\ j \neq i}} k_{jn}!} q(i)^{k_{in}-1} \prod_{\substack{j \in \mathcal{C}_n \\ j \neq i}} q(j)^{k_{jn}}$$

$$P(i|\mathcal{C}_n) = \frac{e^{V_{in} + \ln\left(\frac{k_{in}}{q(i)}\right)}}{\sum_{j \in \mathcal{C}_n} e^{V_{jn} + \ln\left(\frac{k_{jn}}{q(j)}\right)}}$$

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The human dimension of transport

- Huge topic…
- In this lecture:
  - Focus on travel demand
  - Focus on travel choices
  - Focus on route choice
- But there is much more in our research activities

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Pedestrian models

G. Antonini, J-Ph Thiran, M. Weber, J. Cruz, Th. Robin, I. Spassov, B. Merminod

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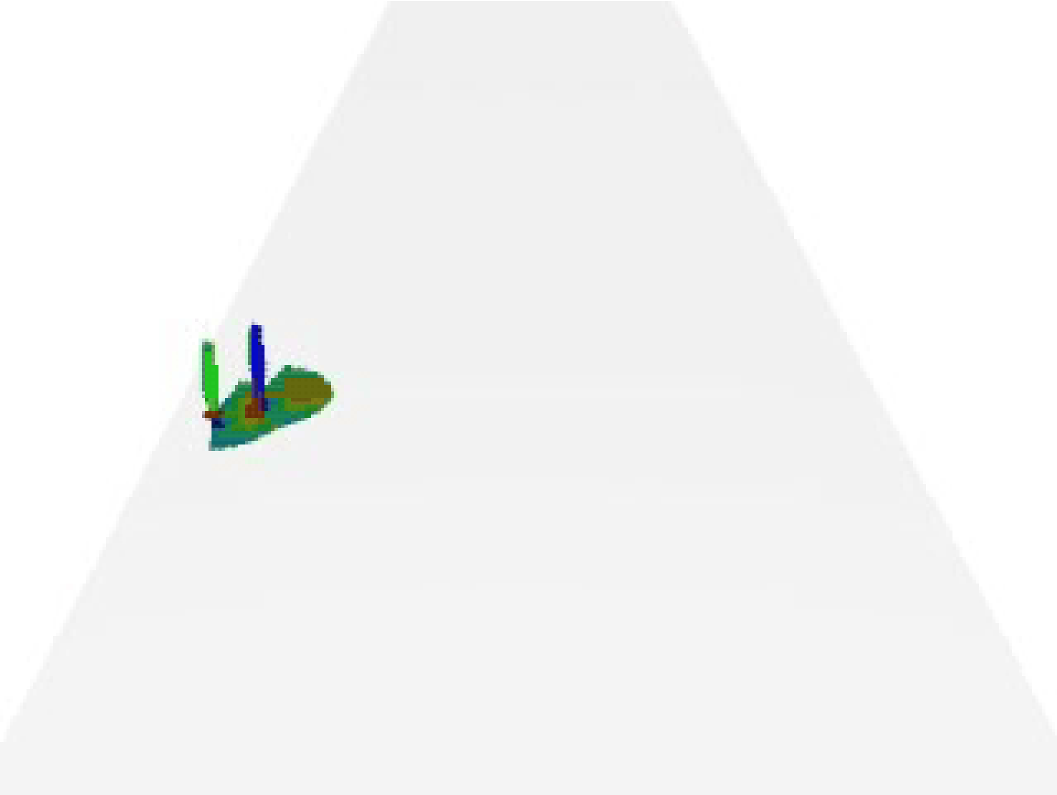
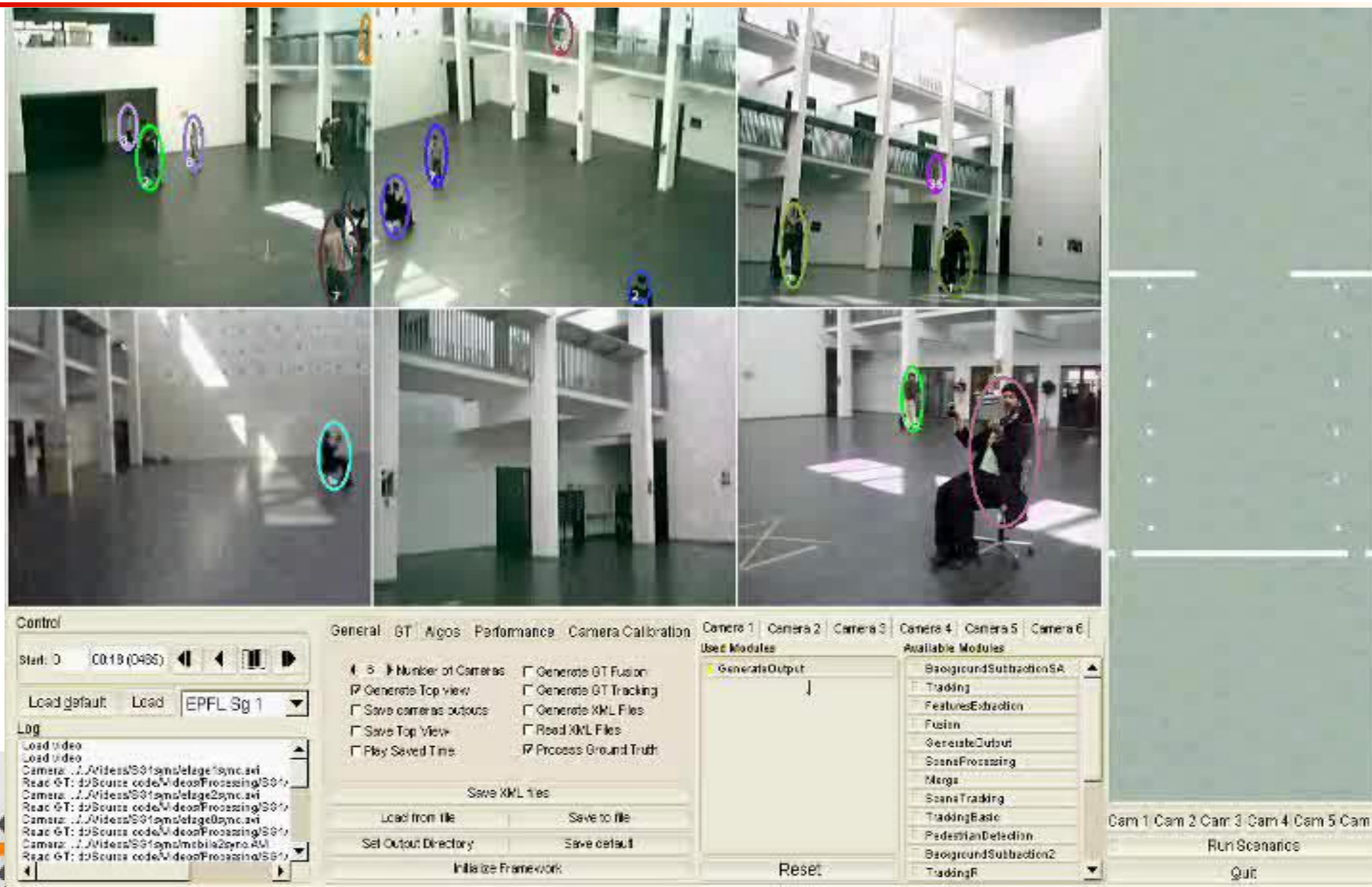
Pedestrian simulation



G. Antonini, J-Ph Thiran, M. Weber, J. Cruz, Th. Robin, I. Spassov, B. Merminod

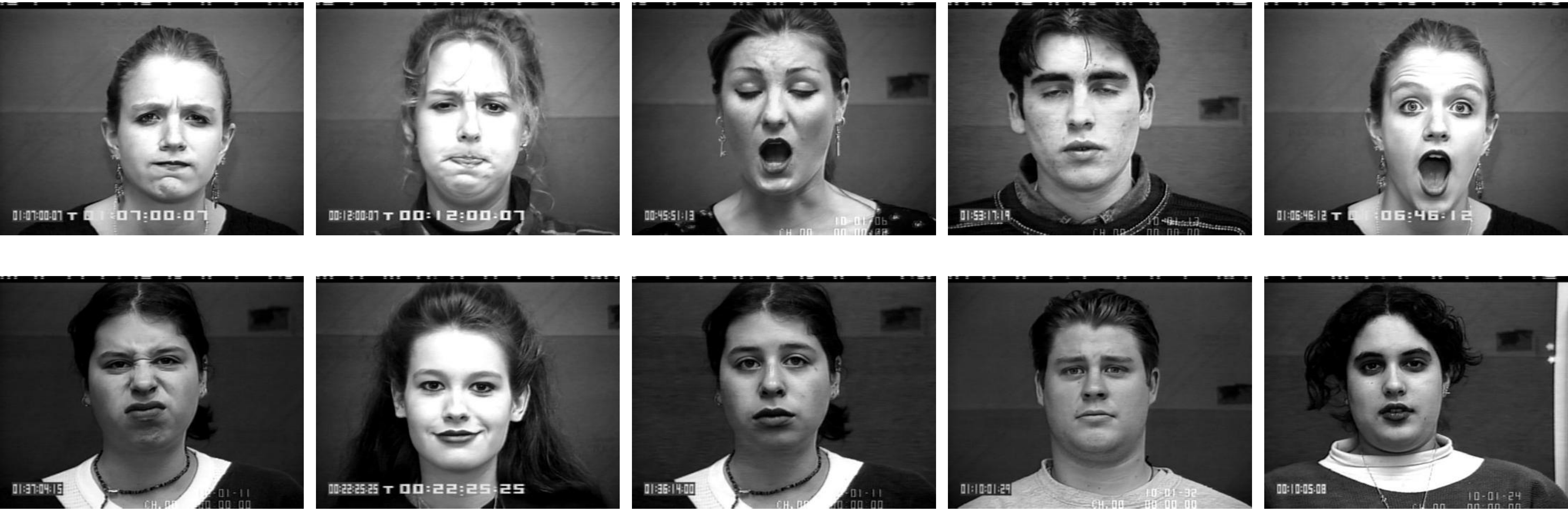
Multi-camera: mobile and fixed



A. Alahi, M. Kunt

Image analysis: facial expressions

- Signal Processing Institute, EPFL



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J-Ph. Thiran, J. Cruz, Th. Robin, M. Sorci, G. Antonini

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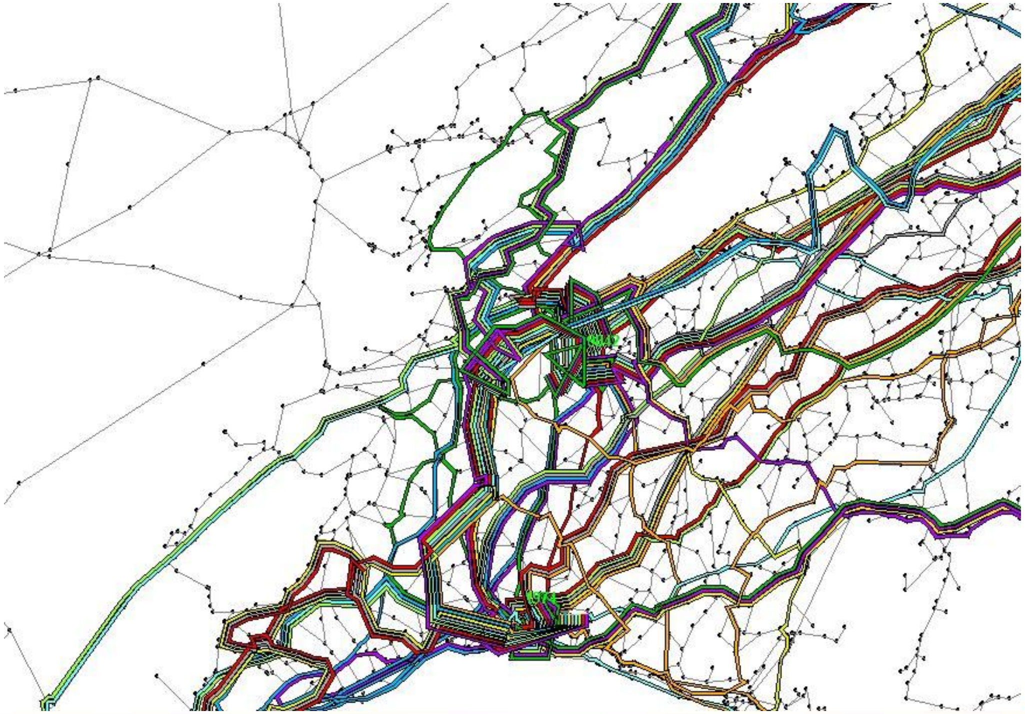
Transport Planning

- Robert-Grandpierre et Rapp SA
- Service de la mobilité du canton de Vaud
- Transports Lausannois

Route Choice

- ASTRA
- IVT- ETHZ
- USI-Lugano



Airline Scheduling

- CTI: The Innovation Promotion Agency
- APM Technologies, Geneva

Container terminals

- Port of Antwerp, Belgium
- Port of Gioia Tauro, Italy
- Port of Beirut, Lebanon

Land use and transportation

- Stratec, SA, Belgium
- University of Washington, Seattle

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Z. Patterson, V. Kaufmann, F. Golay, M. Schüler

Congestion models

- Swiss National Science Foundation
- Hôpitaux Universitaires de Genève

C. Osorio

Thank you!

Marianne Ruegg | Michaël Thémans | Emma Frejinger | Carolina Osorio | Niklaus Eggenberg | Matteo Salani | Zachary Patterson

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