# Activity choice in pedestrian facilities

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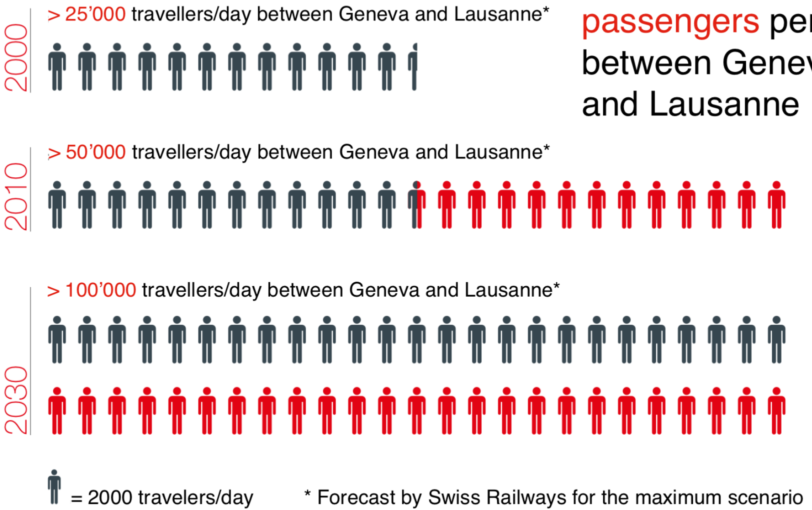
# Outline

1. Motivation: Pedestrian demand management strategies
2. Detection: A Bayesian approach for WiFi traces
3. Modeling: Path choice in activity network
4. Conclusion: Forecasting behavior and building decision-aid tools

# Swiss context

By 2030, 100'000 passengers per day between Geneva and Lausanne

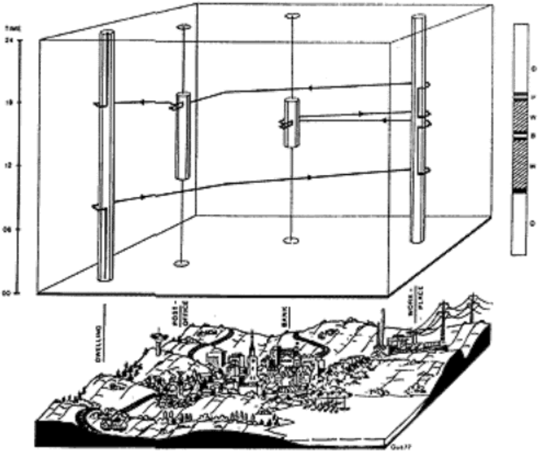


# Pedestrian demand management strategies

- Pedestrian facilities
  - Transportation hubs (train stations, airports, ...)
  - Mass gathering (music festivals, ...)
  - Shops
  - ...
- Challenges
  - Designing efficient buildings
  - Locating points of interest
  - Modifying schedules
  - ...

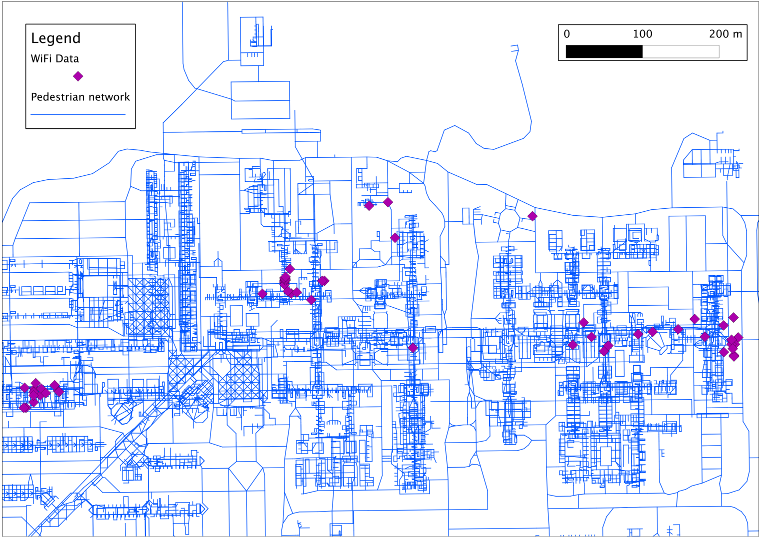
$\Rightarrow$ Pedestrian demand management strategies

# Activity modeling: Sensitivity to policies

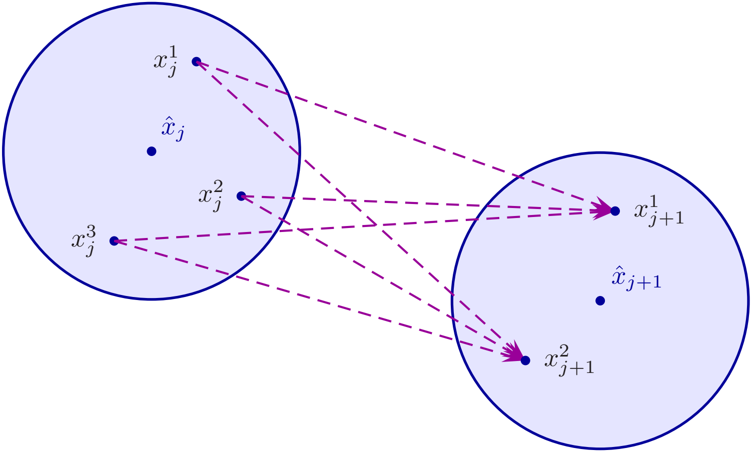



(Lenntorp; 1978)

# WiFi traces: No stop, no semantics



# Generation of activity-episode sequences



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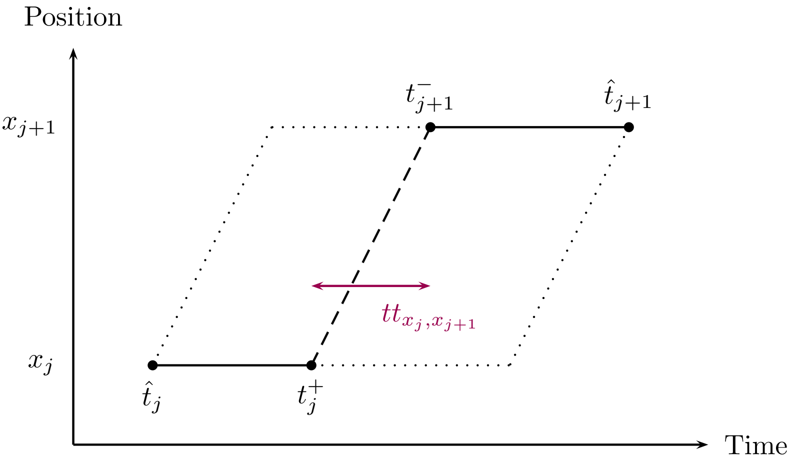


# Probabilistic measurement model

$$P(a_{1:K}|\hat{m}_{1:J}) \propto P(\hat{m}_{1:J}|a_{1:K}) \cdot P(a_{1:K})$$

where

- $P(a_{1:K}|\hat{m}_{1:J})$, the activity probability of an activity-episode sequence
- $P(\hat{m}_{1:J}|a_{1:K}) = \prod_{k=1}^{K} \prod_{j=1}^{J} P(\hat{x}_j^k|x_k)$, the measurement likelihood
- $P(a_{1:K})$, the prior based on attractivity of the POI

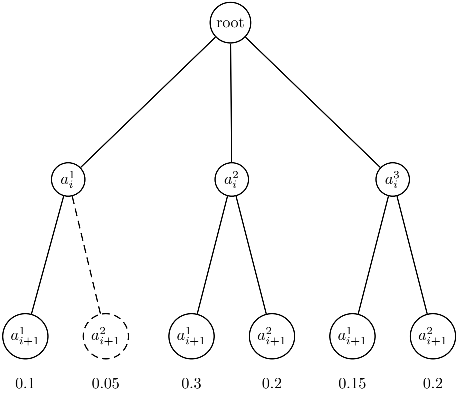
## Intermediary measurements

Eliminate intermediary measurement if

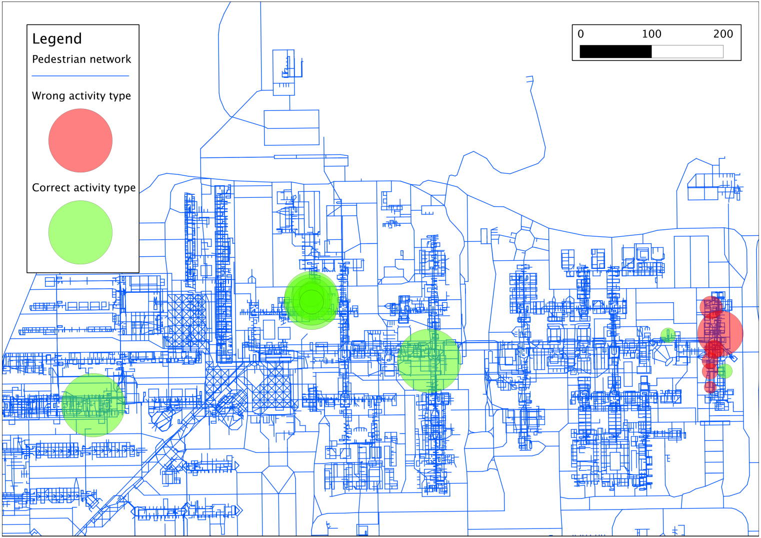
$$E(t^{+}) - E(t^{-}) < T_{min}$$

since we generate an activity episode at each measurement

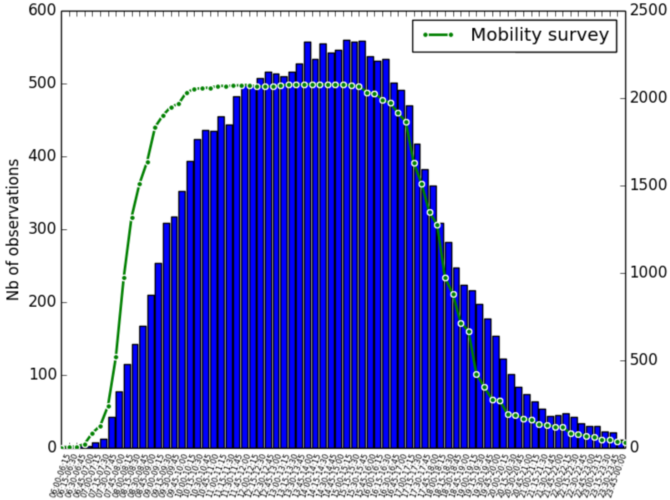
## Sequence elimination procedure



# Individual results



# Aggregate results

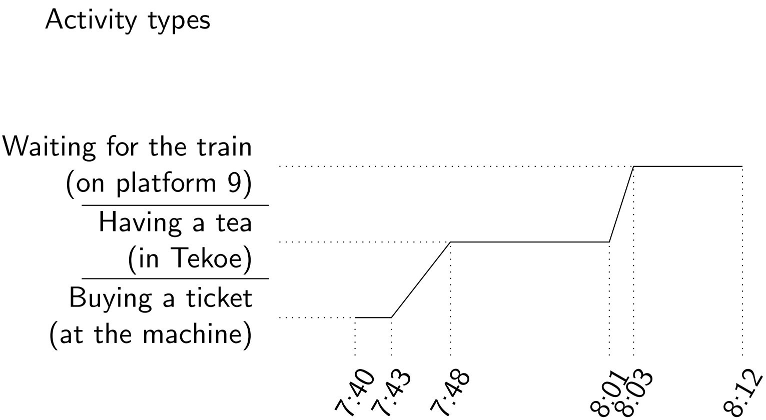


# Demand analysis

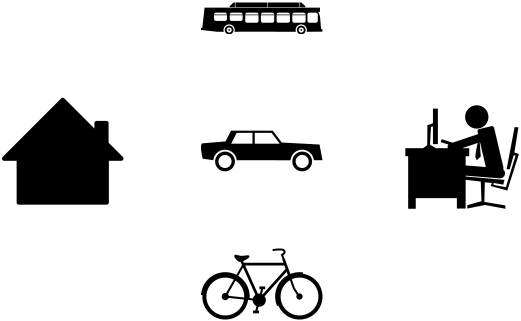
- Model and forecast individual behavior
- Impact on the system


(Kirk Anderson)

# Observations: activity patterns in a transport hub



# Discrete choice models

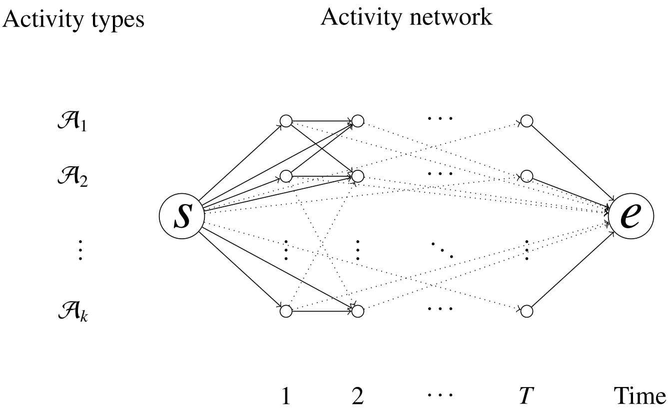


- Utility theory : we maximize our satisfaction
- Evaluation of the trade-off between the attributes of the alternatives
    - e.g., willingness to pay (value of time)

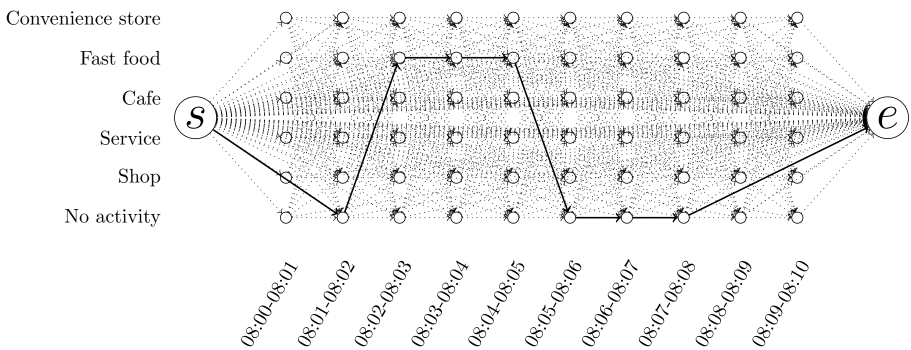
# Modeling assumption

- Sequential choice:
  1. activity type, sequence, time of day and duration
  2. destination choice conditional on 1
- Motivations:
  - Behavior: precedence of activity choice over destination choice
  - Dimensional: destinations $\times$ time $\times$ position in the sequence is not tractable

# Activity network



# Activity network



# Challenges

- **Choice set generation**
  What are the considered alternatives during the choice process?
- **Utility**
  What is the mathematical expression of the utility?
- **Correlation structure**
  Different alternatives share unobserved attributes.

One can get inspired by the route choice literature...
e.g., Metropolis-Hastings algorithm for sampling routes in a network

# Utility function

$$V_{\Gamma n} = \eta_k \ln(t_k) + \sum_k \beta_k I_k + \ln \frac{k_{\Gamma n}}{b(\Gamma)}$$

where

- $\eta_k$ the satiation parameter for activity type $k$
- $\sum_{k,\tau} \beta_{k,\tau} I_{k,\tau}$ the time-of-day utility
- $\ln \frac{k_{\Gamma n}}{b(\Gamma)}$ is a sampling correction

# Forecasting behavior

- Where are the pedestrians?
  WiFi tracking is cheap, covers the whole area and - mixed with other data - is precise enough (Danalet et al.; 2014)
- Why are they here?
  Parameters of the utility function answer this question (Danalet and Bierlaire; 2014)
- What would happen if some environmental characteristics change?
  For small variations, the utility function answer this question

Thank you!

Questions?

# References I


Danalet, A. and Bierlaire, M. (2014). A path choice approach to activity modeling with a pedestrian case study, *14th Swiss Transport Research Conference (STRC)*, Monte Verità, Ascona, Switzerland.
**URL:** *http://www.strc.ch/conferences/2014/Danalet_Bierlaire.pdf*

Danalet, A., Farooq, B. and Bierlaire, M. (2014). A Bayesian approach to detect pedestrian destination-sequences from WiFi signatures, *Transportation Research Part C* **44**: 146–170.
**URL:** *http://dx.doi.org/10.1016/j.trc.2014.03.015*

Lenntorp, B. (1978). A Time-Geographic Simulation Model of Individual Activity Programmes, *in* T. Carlstein, D. Parkes and N. Thrift (eds), *Timing space and spacing time, vol. 2; Human activity and time geography*, Edward Arn, London, p. 286.
**URL:** *http://trid.trb.org/view.aspx?id=1170511*

# Visiosafe in Lausanne train station

**Animation**
January 16, 2013
7h40-7h46