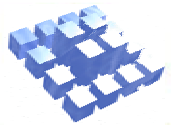
Measuring & Predicting Adaptation in Multidimensional Activity-Travel Patterns

promovendus: Chang-Hyeon Joh
1st promotor: prof. dr. H.J.P. Timmermans (TU/e)
2de promotor: prof. dr. W.W. Recker (UC Irvine)
co-promotor: dr. T.A. Arentze (TU/e)



Outline

- Backgrounds/Research Problems/Objectives
- Predicting activity-travel adaptation behavior
- Measuring activity-travel patterns
- Empirical studies
- Conclusions

Backgrounds

- Amadeus Research Project sponsored by NWO

  Long-term decision: Household (UvA) Firm (TU/d)

  Mid-term decision: Activity program (UU)

  Short-term decision: Activity schedule (TU/e)

  → Share data, project management

Research Needs

- Measurement of activity-travel patterns
- Prediction of activity-travel adaptation

➔ Providing contextual and dynamic information embedded in activity-travel adaptation behavior

➔ Evaluating a variety of policy measures concerned with activity-travel adaptation

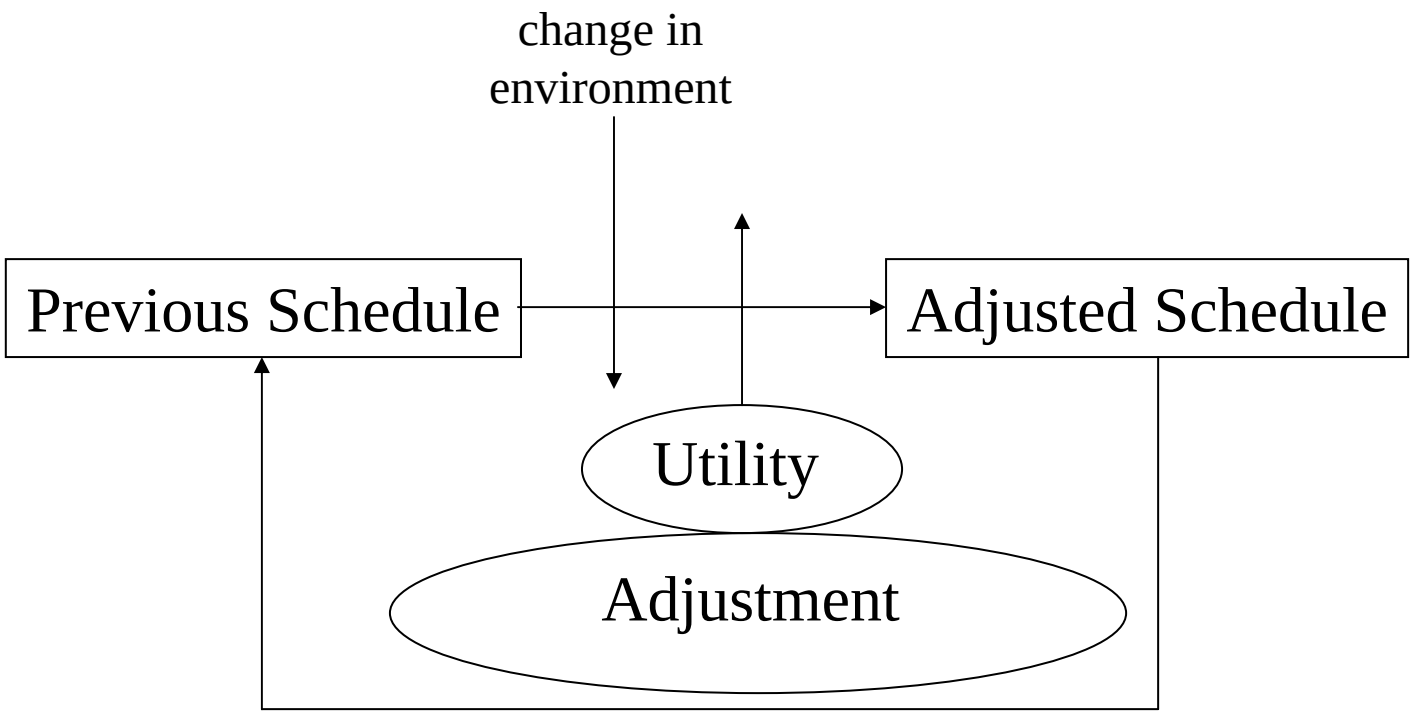
Objectives

- Measuring and predicting activity-travel adaptation behavior that can contribute to the evaluation of short-term policy measures of transport demand management

- Not only for its own sake, the ***measurement*** method also provides a measure of classification and goodness-of-fit that is essential to ***prediction*** of activity-travel adaptation behavior.

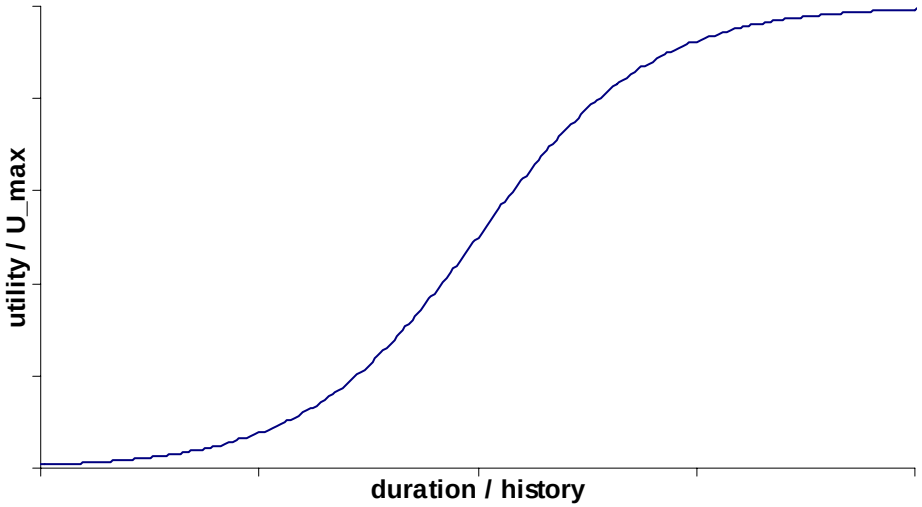
Predicting activity-travel adaptation behavior

Aurora Agent for Utility-driven Rescheduling Of Routinized Activities



U fn / search tree

Utility function



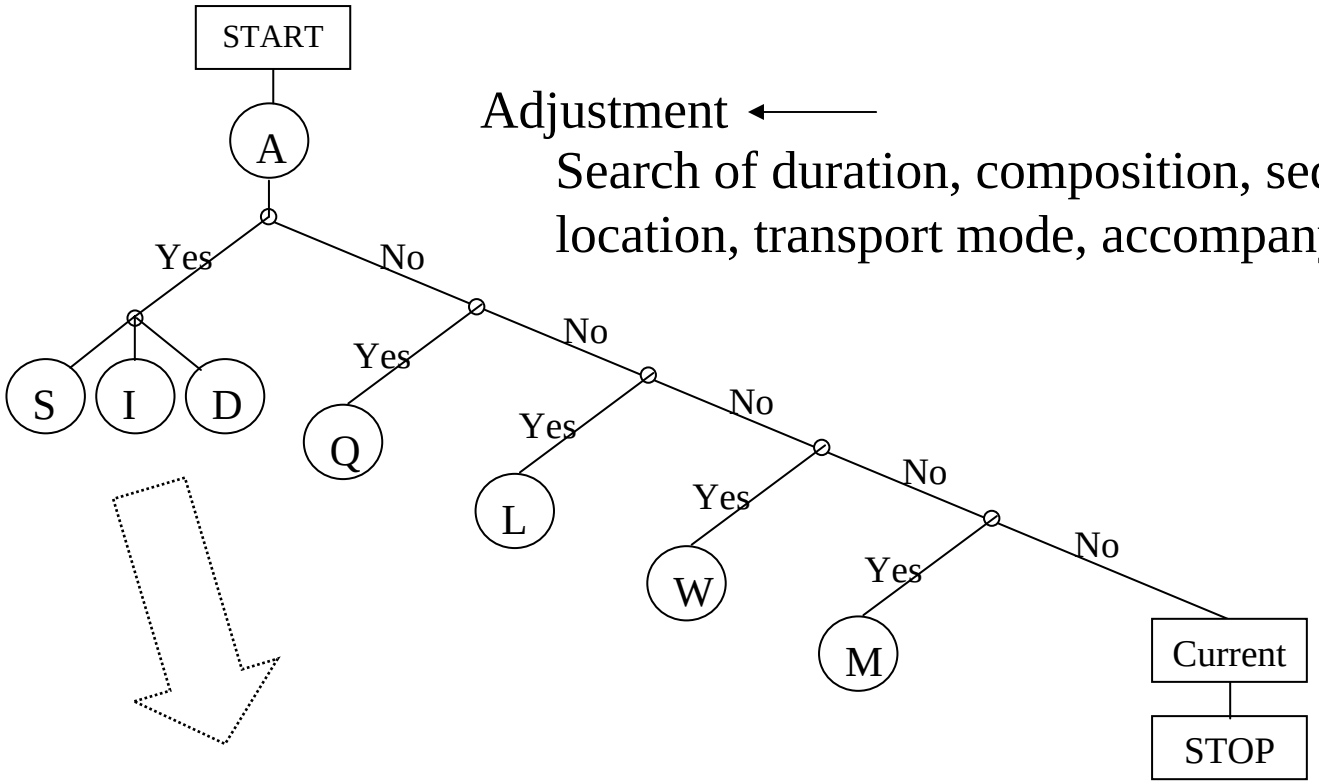
Parameters

- Position (α)
- Slope (β)
- Inflection point (γ)
- U_max position (α_x)
- U_max slope (β_x)
- Intrinsic U_max (U_x)

$$\text{Utility} = \frac{U^{\max}}{\left(1+\gamma \exp[-\beta(\text{Duration}-\alpha)]\right)^{1/\gamma}}$$

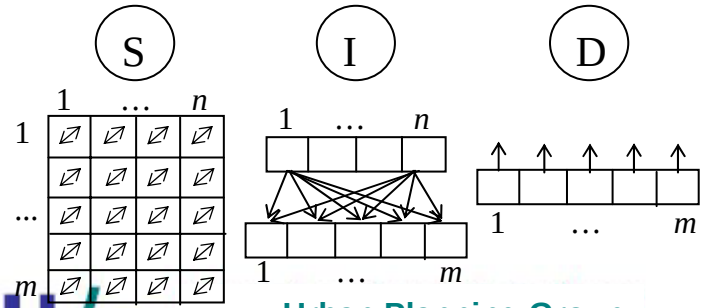
$$U^{\max} = \frac{U_x}{1+\exp[-\beta_x(\text{History}-\alpha_x)]}$$

Search Tree



Adjustment ←

Search of duration, composition, sequence, location, transport mode, accompanying, etc.



Characteristics of the Model

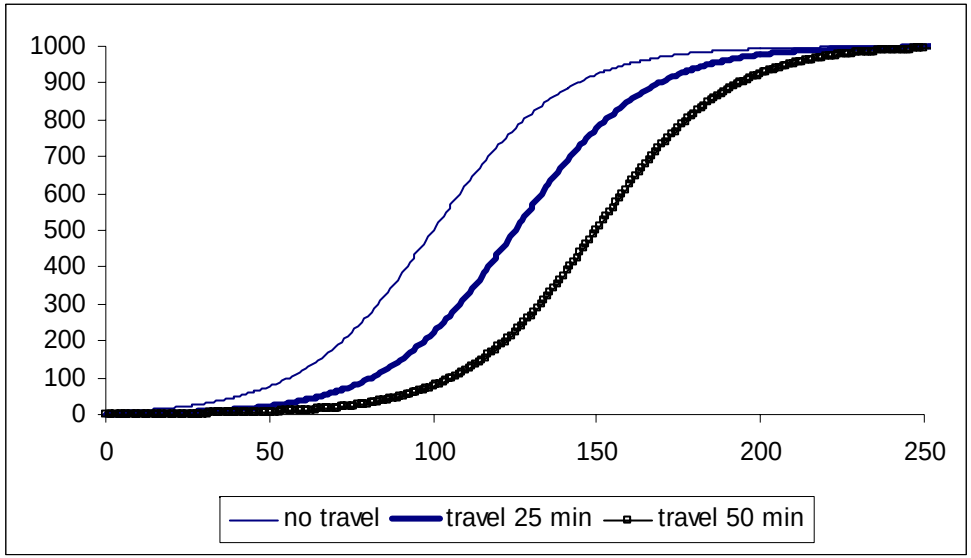
Utility function: more realistic U fn of choice facets

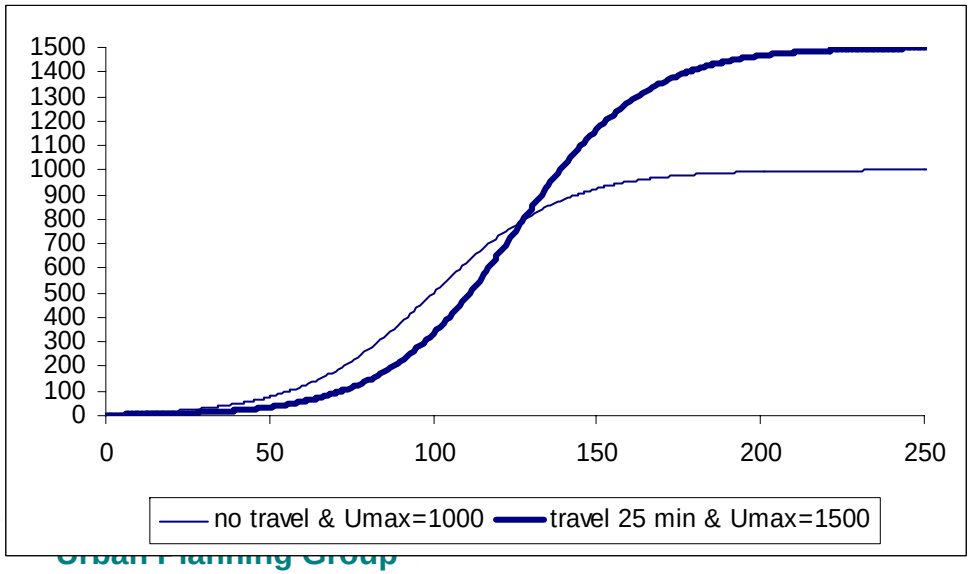
- S-shaped utility function of duration and history with inflection point
- Uncertainty by introducing perceived value of parameters
- A variety of choice facets incorporated into U^{max} function
- Estimable on the duration and history data

Search Tree: more realistic scheduling decision model

- Non-combinatorial search by choice facet-by-choice facet evaluation
- Comprehensive search for better solution by recursive structure
- Non-hierarchical search avoiding pre-assumed decision order

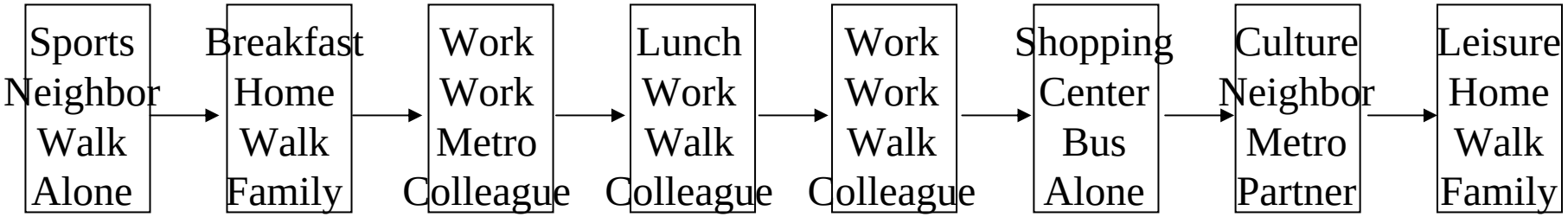
Travel time effect on U fn (for example)





Measuring activity-travel pattern

- Activity-travel pattern:
  A record of series of daily activities conducted
  (activity type-location-transport mode-travel party-…)



- Information I - Sequential information
- Information II – Interdependency information

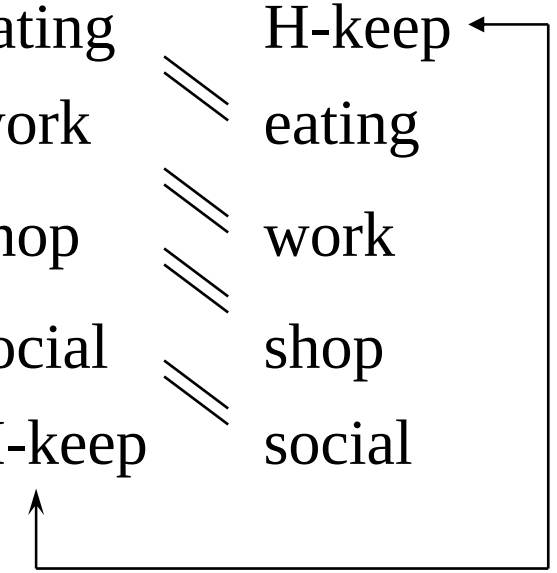
➔ MDSAM method developed

Sequential information

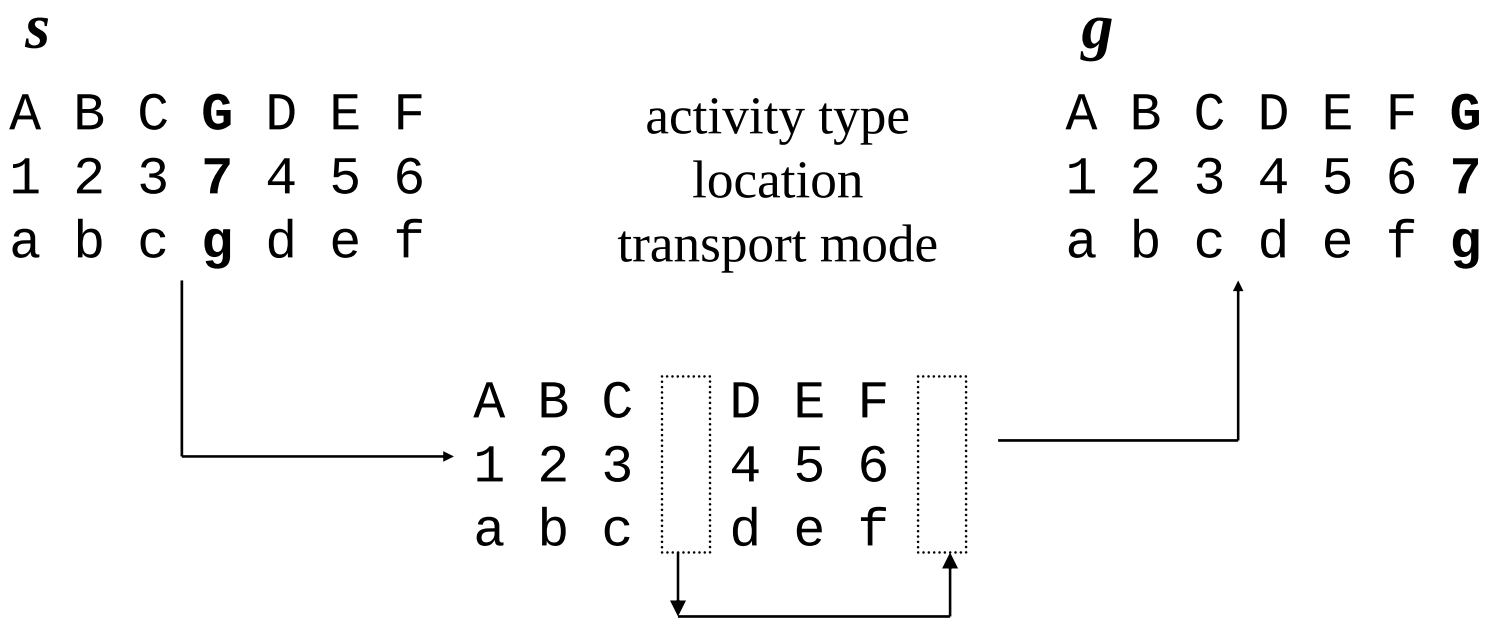
g H-keep eating work shop social
s eating work shop social H-keep

s		***g***
eating	≠	H-keep
work	≠	eating
shop	≠	work
social	≠	shop
H-keep	≠	social

s	***g***
eating	H-keep
work	eating
shop	work
social	shop
H-keep	social



Interdependency information



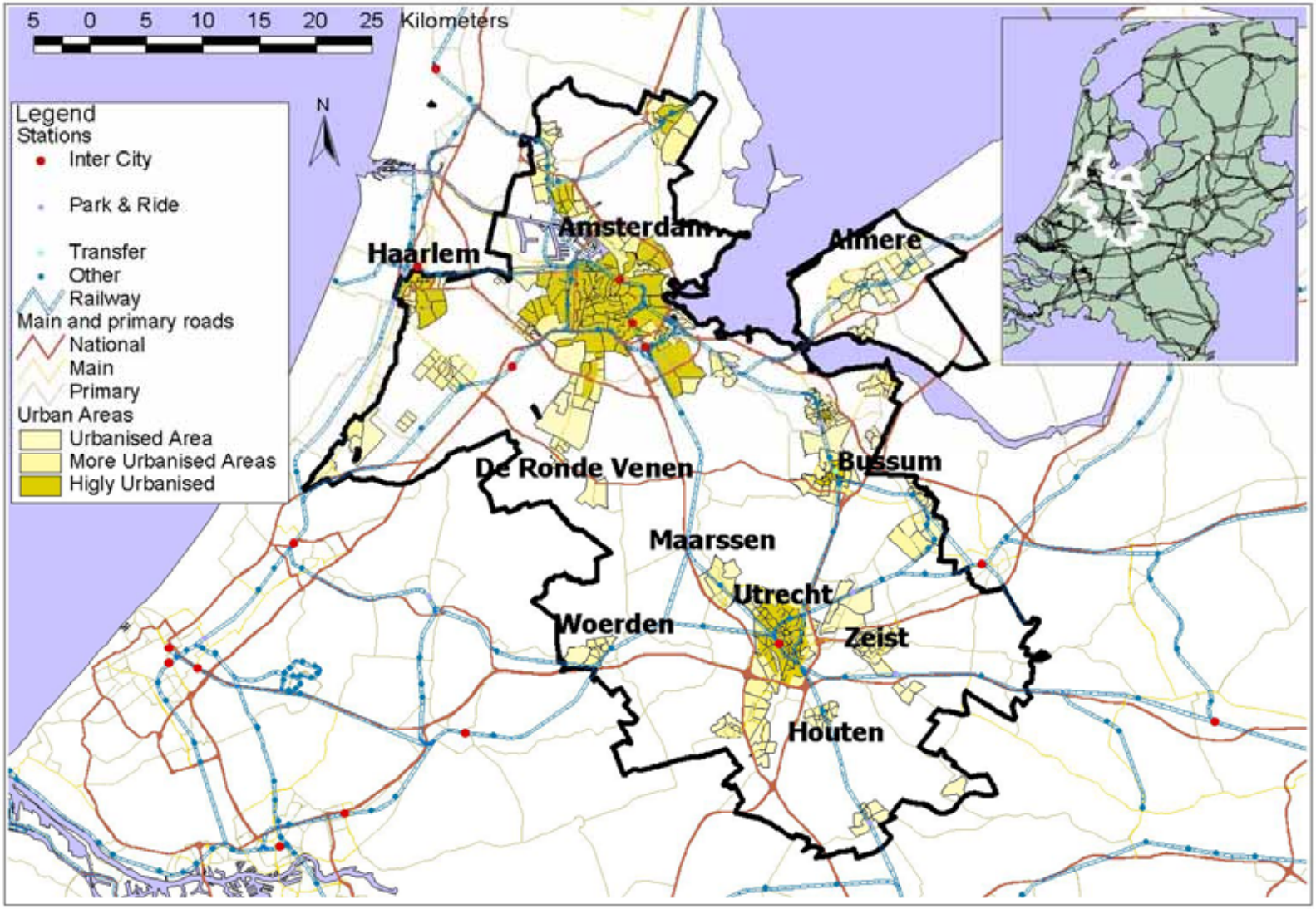
- Comparison with other methods

➔ Structural information is important in comparison

➔ MDSAM good captures such information

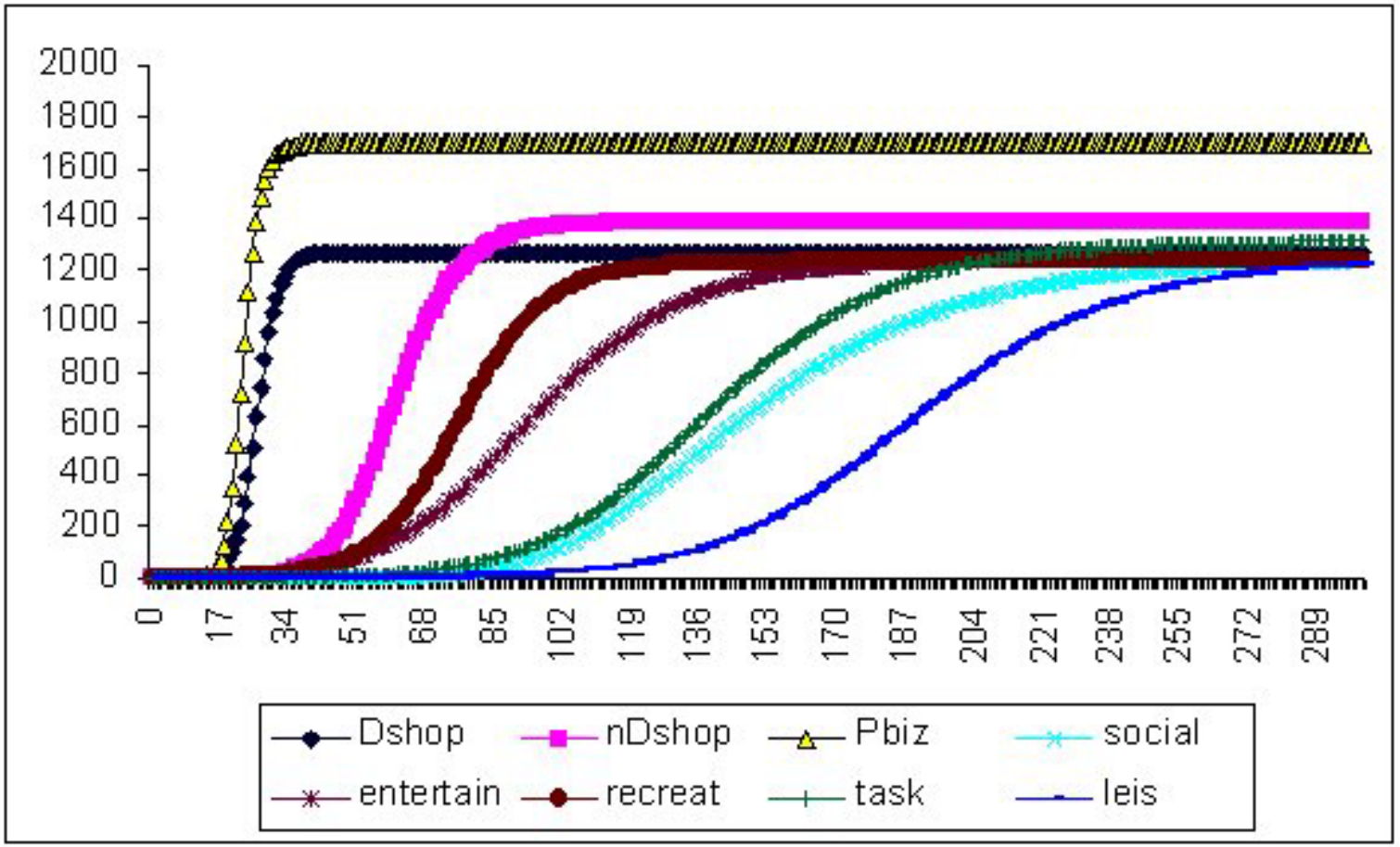
Study Area

In 2000, 50000 – 7600 – 4800 – 1966:6950 – 303 & 1000



Source: Krygsman PhD dissertation

- Estimated U function



- MDSAM-based segments of activity-travel patterns
  → consistent with estimated utility functions

- **Example: Transport Use in daily scheduling of multi-dimensional activity patterns**

1	3	5	7	9	11	1	3	5	7	9	11
Sleep			Pc	Work1		Lun	Work2		Din	Leis_in	Sleep
Home				Work					Centre	Home	
-				**Pub**					**Slow**	**Slow**	

1	3	5	7	9	11	1	3	5	7	9	11
Sleep			Pc	Work1		Lun	Work2		Din	Leis_in	Sleep
Home				Work					Centre	Home	
-				**Car**					**Car**	**Car**	

- Utility
- Constraint
- Problem solving

Conclusions and discussion

- MDSAM copes with structural information (cross-sectional, sequential and interdependency) embedded in multidimensional activity-travel patterns.

- Aurora utility function copes with a variety choice facets and uncertainty effects.

- Aurora search tree realizes a sub-optimal heuristic decision making in activity-travel adaptation behavior.

- Aurora estimation method predicts activity-travel utility parameters as expected.

- MDSAM: Search for common components to profile clusters

- Aurora: Further extension of the framework and implementation in a micro-simulation system.

Thank you for your attention

bwchjoh@khu.ac.kr