Behavior Modelling Summer School 2025
25.09.23@U.Tokyo

Things didn’t go as planned until the very end

Today’s Menu

1. Watershed moments in my personal history
2. Challenges in travel behavioral modeling
3. Rhythm analysis in travel behavior

Akimasa Fujiwara, Hiroshima University

1. Watershed moments in my personal history

Akimasa Fujiwara

September 24,1960

1983.3	B. Eng. from Hiroshima Univ.
1985.3	M. Eng. from Hiroshima Univ.
1985.4	Res. Asso., Kure NCT
1992.4	Res. Fellow, U. Tokyo
1993.3	D. Eng. from Hiroshima Univ.
1993.5	Res. Asso., Civil Eng., HU
1994.6	Associate Prof., IDEC, HU
1996.3	Res. Fellow, Imperial College (JSPS)
2002.4	Full Prof., IDEC, HU
2005.5	KS Award Selection Committee
2012.4	Dean, IDEC, HU
2018.4	Vice President, HU
2018.6	Chair IP Committee, JSCE
2022.4	Vice President, JSCE
2023.9	President, EASTS

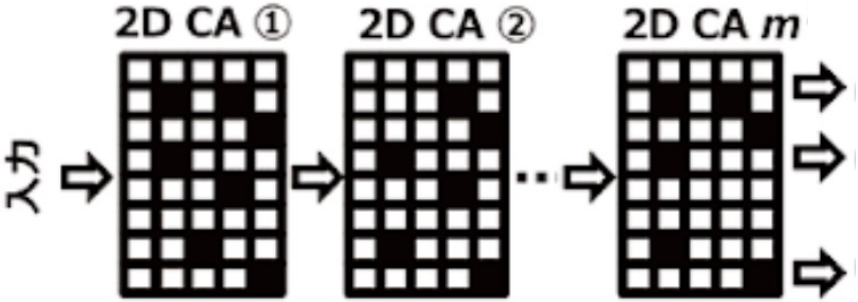
Watershed moments #1

B. Eng. 1983

Cellular automata model of walking behavior on street

By Prof. Monden and Prof. Imada

Practice-Oriented Research—messy but meaningful for practice

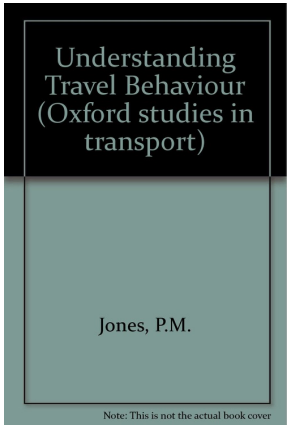


M.Eng. 1985

Log-linear model of Travel activity patterns in Life-cycle stages

By Prof. Sugie

Theory-Oriented Research—stylish and rewarding in academia



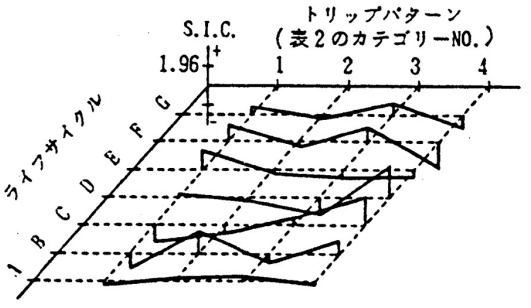


図2．妻の交通行動パターンと
ライフサイクルの関係

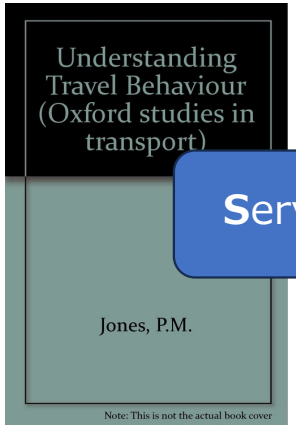
Watershed moments #2

M.Eng. 1985

Log-linear model of Travel activity patterns in Life-cycle stages

By Prof. Sugie

Theory-Oriented Research—stylish and rewarding in academia



Serve Passenger

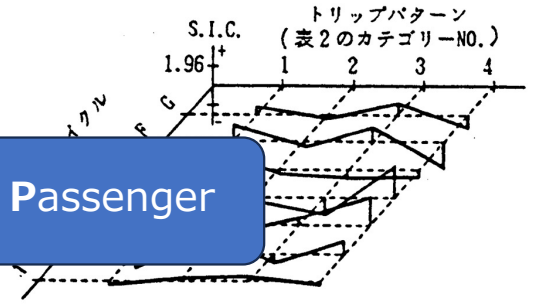


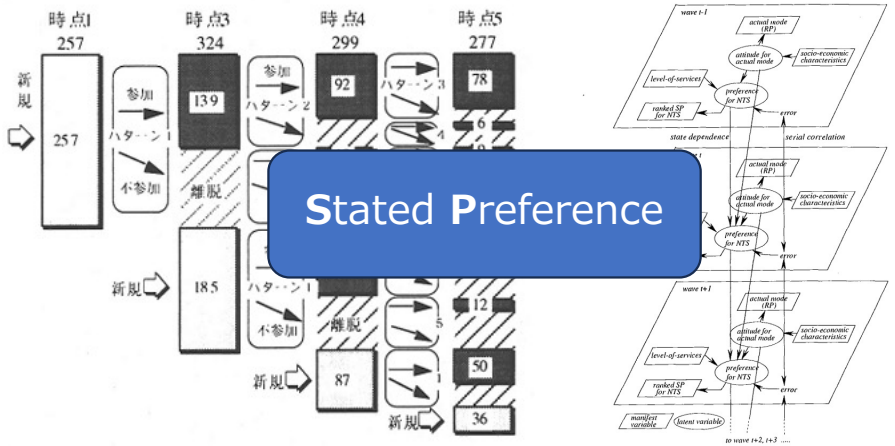
図2．妻の交通行動パターンと
ライフサイクルの関係

D.Eng. 1993

Discrete choice models on SP panel data

By Prof. Sugie

Data-Driven Research—novel, idea-driven, and labor-intensive in both



Stated Preference

Watershed moments #3

D.Eng. 1993

Discrete choice models on SP panel data

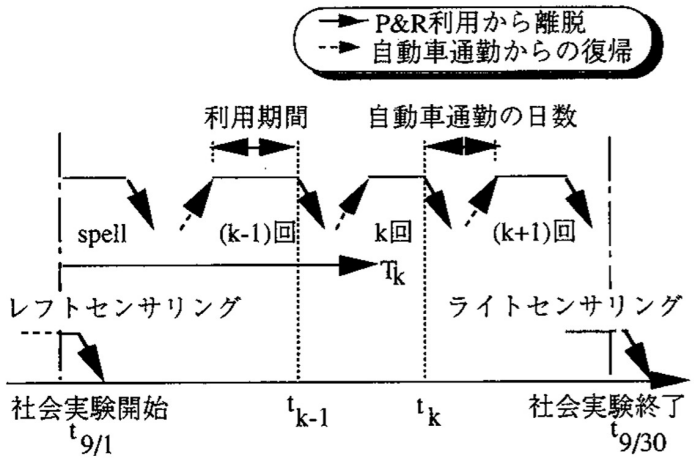
By Prof. Sugie

Visiting Res. Fellow@CTS/IC 1996

EM algorism for incomplete data

Duration model of recurrent

Multiple-spell proportional hazard models



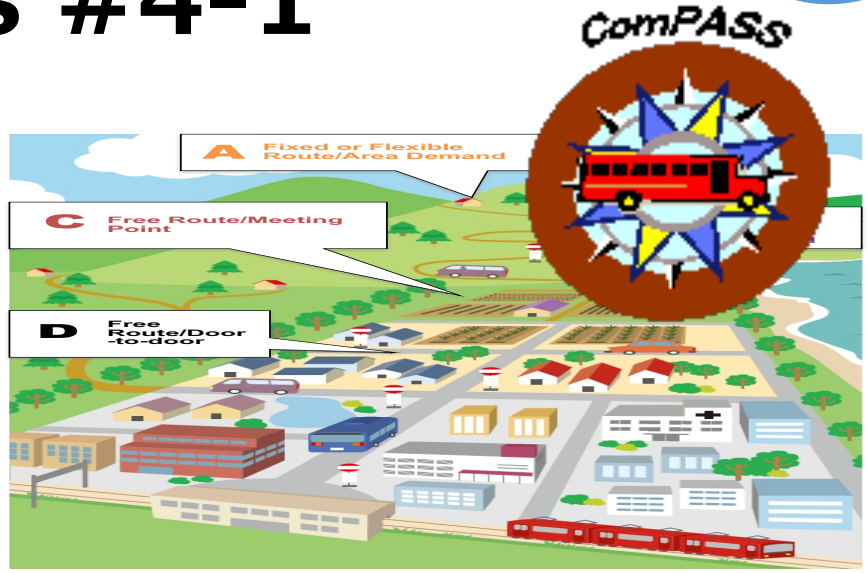
Akimasa Fujiwara

September 24,1960

1983.3	B. Eng. from Hiroshima Univ.	Walking trajectory: C-automaton model
1985.3	M. Eng. from Hiroshima Univ.	Activity-based approach: LL model
1985.4	Res. Asso., Kure NCT	SP panel analysis: DC models
1992.4	Res. Fellow, U. Tokyo	
1993.3	D. Eng. from Hiroshima Univ.	
1993.5	Res. Asso., Civil Eng., HU	
1994.6	Associate Prof., IDEC, HU	
1996.3	Res. Fellow, Imperial College (JSPS)	SP panel analysis, EM algorism, Duration models, Collective decision-making model
2002.4	Full Prof., IDEC, HU	
2005.5	KS Award Selection Committee	
2012.4	Dean, IDEC, HU	Local transport policy: Impact Ass. app.
2018.4	Vice President, HU	Old newtown policy: Unmet needs
2018.6	Chair IP Committee, JSCE	Disaster management: Model systems
2022.4	Vice President, JSCE	Bio-censor measurement: EEG analysis
2023.9	President, EASTS	Mobility-Oriented Dev., CW Simulator

Watershed moments #4-1

Year	Research Theme	Keywords
1998	Study on Effect Forecasting Methods of Advanced Traffic Information Systems	Arrival Time Information Provision
1999		Parking Guidance Information
2000	Study on the Impact of Road Development in Local Areas on Tourist Circulation Traffic	Tourist Tour Model
2001	Study on Tourist Circulation Traffic in Mountainous Regions Considering Environmental Load	Tourism Promotion, Environmental Load
2002	Study on Transportation Services for the Elderly in Mountainous Regions	**Latent Demand, DRT**
2003	Development of a Planning Support Tool for Transportation Planning in Mountainous Regions	**ComPASS**



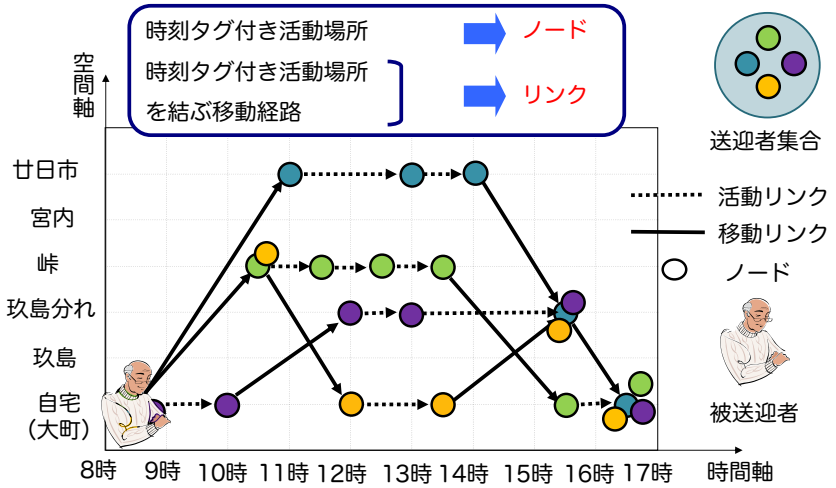
Non-compensatory linear utility function:
the weighted generalized mean

$$\bar{x}_{in} = \left\{ w_1 x_{in,1}^{\alpha} + w_2 x_{in,2}^{\alpha} + \cdots + w_Z x_{in,Z}^{\alpha} \right\}^{\frac{1}{\alpha}}$$

$$\text{st.} \quad \sum_{i=1}^{Z} w_i = 1$$

Watershed moments #4-2

Year	Research Theme	Keywords
2006	Analysis of Household Car Ownership and Use Behavior and Environmental Efficiency in Local Cities	**Collective Decision-Making Model**
2007	Policy Analysis for Securing Mobility in Local Cities Facing an Aging Society	Car Dependence
2008	Study on Securing Mobility and Regional Restructuring Strategies in Depopulated Mountainous Villages	Residential Continuity
2009	Study on Measures to Improve Access to Daily-Life Services in Mountainous Region	Pick-up and Drop-off Services
2010	Study on Household-Based Pick-up Services in Mountainous Regions Based on the Actual Conditions of Transport-Disadvantaged Settlements	Pick-up and Drop-off Services

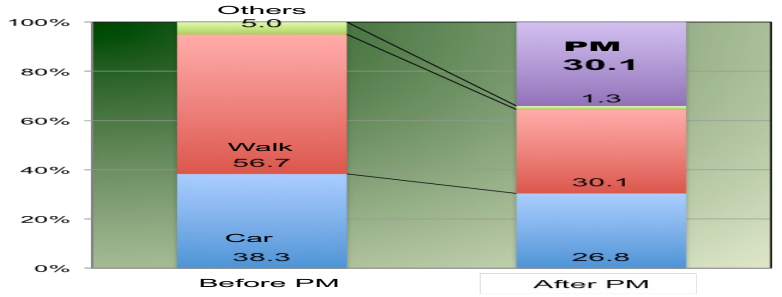


Collective Decision-Making Model

$$p_{hj} = \frac{\exp\left(\sum_i w_{hi} v_{hij} + \sum_i \sum_{i'>i} \lambda_h w_{hi} v_{hij} w_{hi'} v_{hi'j}\right)}{\sum_k \exp\left(\sum_i w_{hi} v_{hik} + \sum_i \sum_{i'>i} \lambda_h w_{hi} v_{hik} w_{hi'} v_{hi'k}\right)}$$

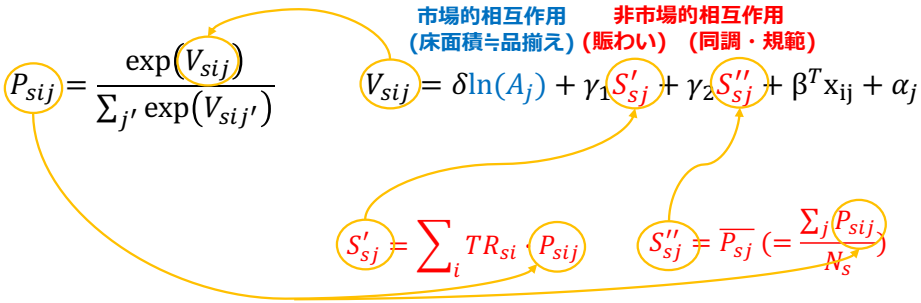
Watershed moments #4-3

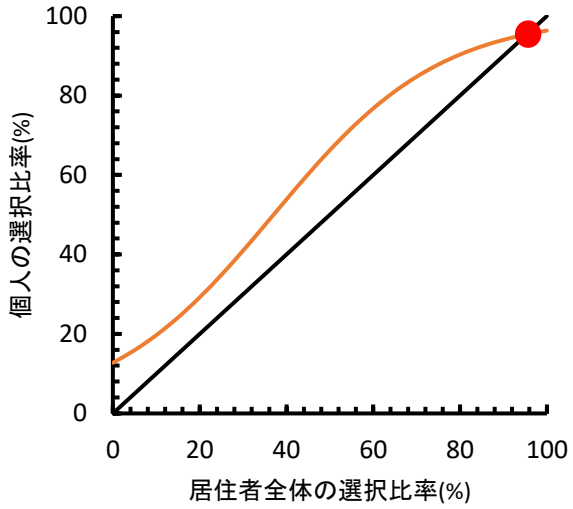
Year	Research Theme	Keywords
2011	Mobility and Social Exclusion of the Elderly in Old New Towns	Personal Mobility in **Old New Town**
2012	Intra-District Mobility Strategies in Old New Towns	Capability Approach
2013	Fundamental Study on the Dilemma of New Town Regeneration	Risk Perception of Living in New Towns
2014	Feasibility of Transport Sharing in New Towns at Different Development Stages	Shopping Destination Choice



Watershed moments #4-4

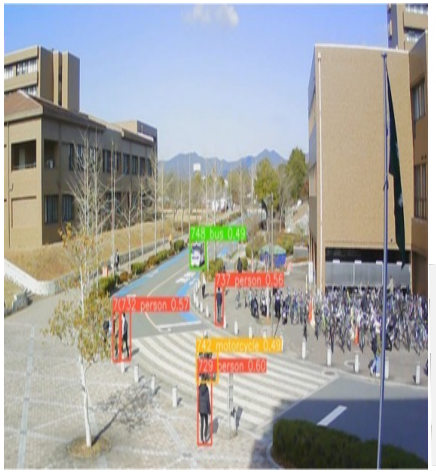
Year	Research Theme	Keywords
2016	Evaluation of Transport Policies Considering the Interaction Between Consumer Behavior and Facility Location: A Case of the Retail Sector	**Non-Market Interactions**
2017	The Value of Driver's License Ownership Among the Elderly	License Surrender, Unmet Needs
2018	Multitasking Behavior and Its Impact on Urban Structure with the Introduction of Next-Generation Mobility Services	Autonomous Driving, Urban Structure

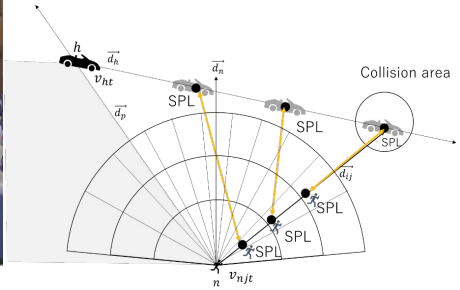




Watershed moments #4-5

Year	Research Theme	Keywords
2019	Disaster Traffic Management Strategies Focusing on the Distribution of Workplace Starting Times	**Disaster Traffic Management**
2020	Equilibrium Analysis of Work Start Time and Departure Time Choice During Disasters	Choice Model Systems during Disaster
2021	Study on Road Network Resilience Using Mobile Bridges	**Braess's Paradox**
2022	Empirical Analysis of Changes in Pedestrian Behavior with the Introduction of Autonomous Vehicles	**Autonomous Driving and Pedestrian Behavior**
2023	Traffic Flow Simulation in Shared Spaces with Pedestrians and Vehicles	Shared Spaces, Pedestrian Flow Simulation





$$V_{vdn} =$$

$$\beta_{central} dir_{dn} I_{d,central} + \beta_{ncentral} dir_{dn} I_{d,ncentral}$$

$$+\beta_{ddir} ddir_{vdn}$$

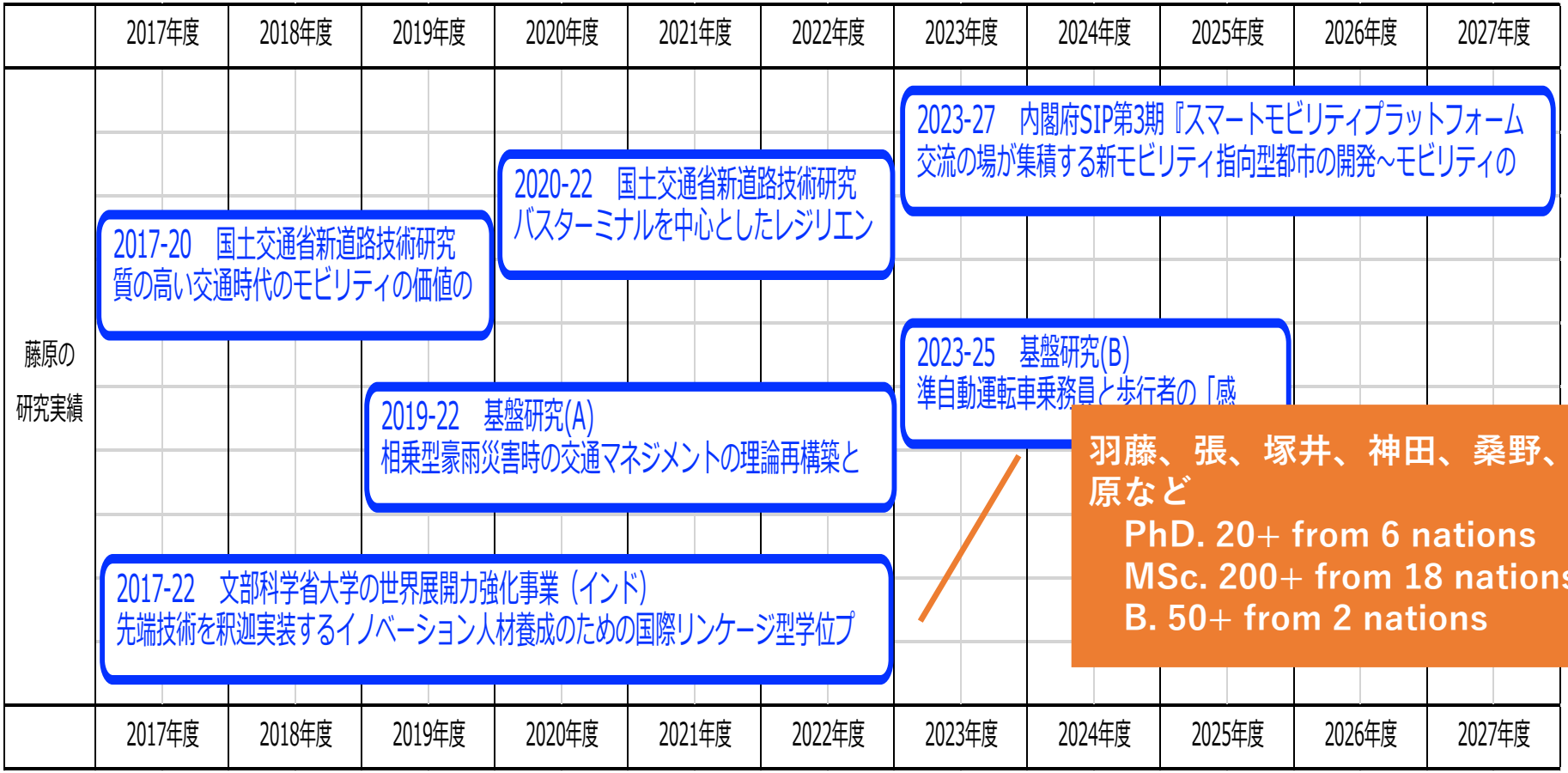
$$+\beta_{dec} I_{v,dec} (v_n / v_{max})^{\lambda_{acc}} + \beta_{acc} I_{v,acc} (v_n / v_{max})^{\lambda_{acc}}$$

$$+ I_{v,dec} I^L_{d,dec} \beta^L_{dec} \Delta v_L \; + I_{v,acc} I^L_{d,acc} \beta^L_{acc} \Delta v_L$$

$$+ I_{d,CP} \beta_{CP} e^{D_{CP}} \Delta v_C \; \Delta\theta_{CP}$$

$$+ I^C_{d,Car} \beta_{car} x^D_{d,Car} \; + I^C_{d,hiro} \beta_{hiro} x^D_{d,AV}$$

Research Funding & Education



2. Challenges in travel behavioral modeling

Modest Motto

- Design and collect the necessary data by myself from the survey stage!

  -> The sample size is limited, and the cost is high.

- Without being swayed by novelty or trends, apply and/or refine models in a theoretically sound manner within a natural context!

  -> Outdated models are often used, with many excuses for the results.

The significance of refining model and error structures

How have you been lately?
Are you still working on that?
Come on, that's enough already!

by Ryuichi Kitamura

- Exploring model and error structures enhances its internal validity
  - ->Scientifically elegant, but of little practical value
  - ->Poor accuracy of trip rate & OD estimations
- Even with high external validity may not inform policy decisions
  - ->Uncertainty classification: UE, UR, UV
  - ->Only a part of the process: phenomenon → data → model → prediction

The data collection design is far from optimal

- Limited information
  - -> Temporal variation, episode/time slice/random points
  - -> Choice set, alternatives
  - -> Expenditure (in-/out-home), durable goods, income
  - -> Unobserved (belief, principle, character, attitude, etc)
- Optimization
  - -> max Z= f(model validity, survey interval, choice set, monetary flow, unobserved factors, sampling)

Truman Show Effect

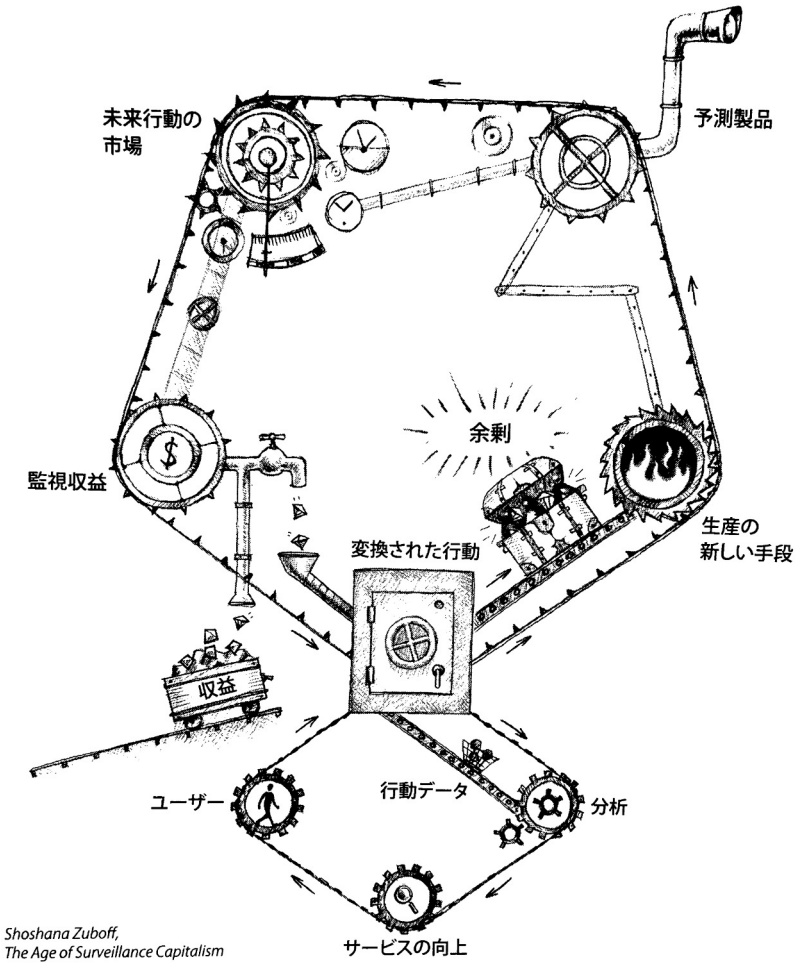
Unconscious observation and control

- GPS, IC card, POS, CAN, probe PT, cold call interview
- e-hailing records, AV rideshare

Behavioral Surplus

Google initially began collecting this as essentially “waste data”, but it later gained value as a product for behavioral prediction.

Shoshana Zuboff（2019）
The Age of Surveillance Capitalism

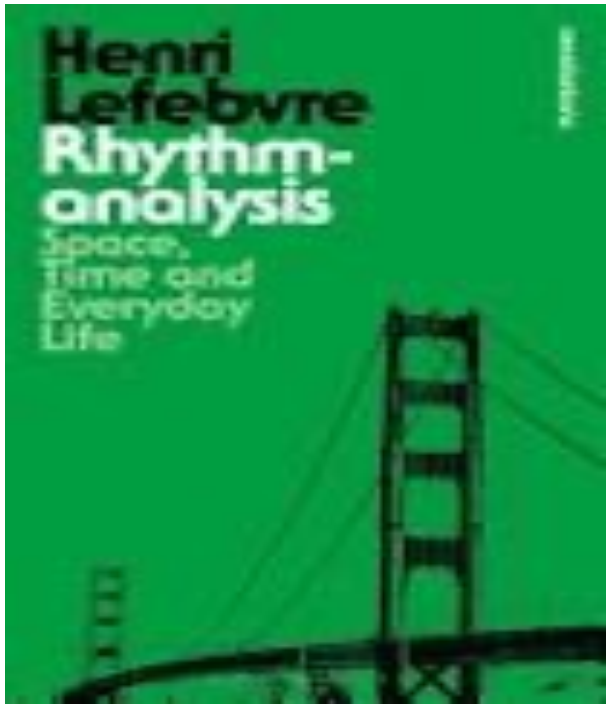


Why Activity-Based?

- To understand the scale of urban disasters
- To predict increased pollutants from frequent cold starts
- To address social exclusion from sequential functions and stratification of action space
- To revisit the Modifiable Areal Unit Problem (MAUP)
- *“The pursuit of a grande latte may be stirring up traffic congestion.” (Washington Post)*

3. Rhythm analysis in travel behavior

Lefebvre's Rhythm Analysis



Lefebvre H. (2013)
Rhythmanalysis: Space, Time and Everyday Life
ISBN:9781472522023, 1472522028
Bloomsbury Publishing

Urban life is shaped by rhythms — natural, social, and their (a)synchronies.

- **Linear rhythms**
  Rhythms based on homogeneous, linear time, such as work schedules or transportation timetables.

- **Cyclical rhythms**
  Rhythms rooted in nature, such as day and night or the changing of seasons.

- **Polyrhythmia**
  In urban space, multiple rhythms overlap.
  When they clash, *arrhythmia* (disruption of rhythm) arises.

Rhythm Analysis in Travel Behavior

Spatial Rhythms

- One-way traffic network (MDF, Pedestrian–Vehicle Interaction Model)
- Allocation and control of safety infrastructure facilities (lighting, traffic signals) (EGG analysis)

Temporal Rhythms

- Co-movement and co-presence (linear, cyclical): Community-scale Simulator
- Disaster risks

Spatio-Temporal Rhythms

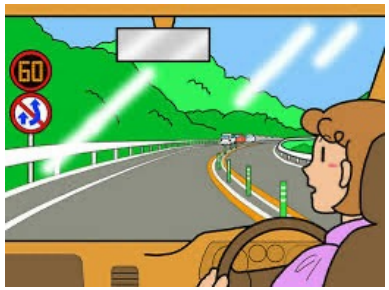
- Mobility hubs
- Urban prosperity and decline (Non-Market Interaction Model)

One-way traffic network

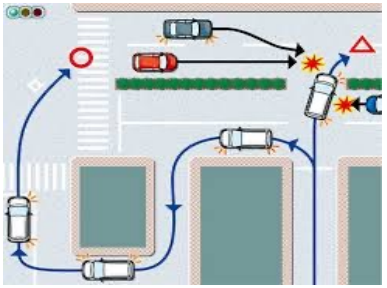
■ Fundamental Review of Road Design and Control

- Configuration of road networks around neighborhood units (without central dividers)
- Pedestrian-centric spatial reallocation

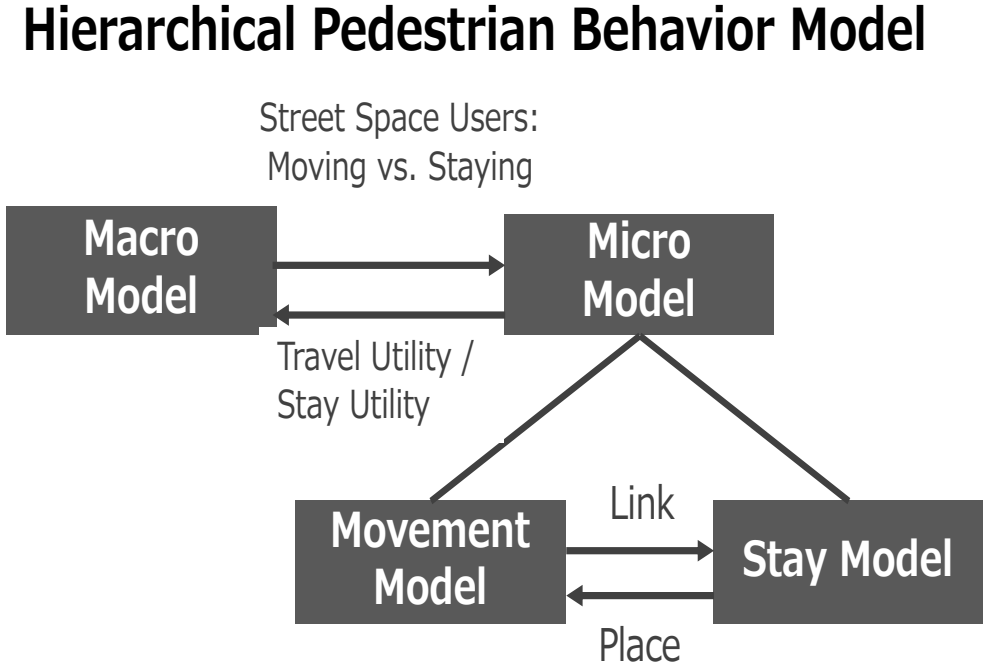
https://www.youtube.com/watch?v=RQyCWXd010s



https://jaf.or.jp/



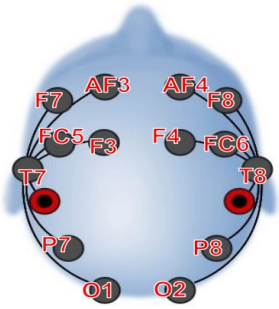
https://jaf.or.jp/

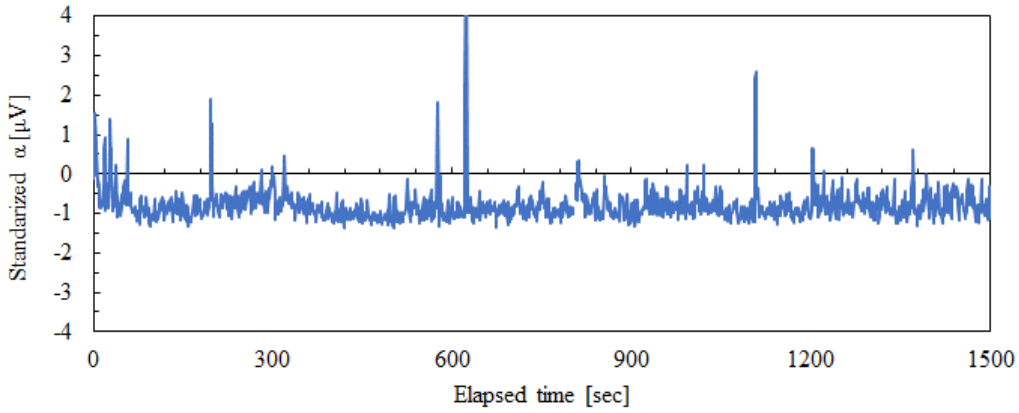


Allocation/Control of Safety Facilities

- Stimulating lighting layout in tunnel
- Traffic signal design

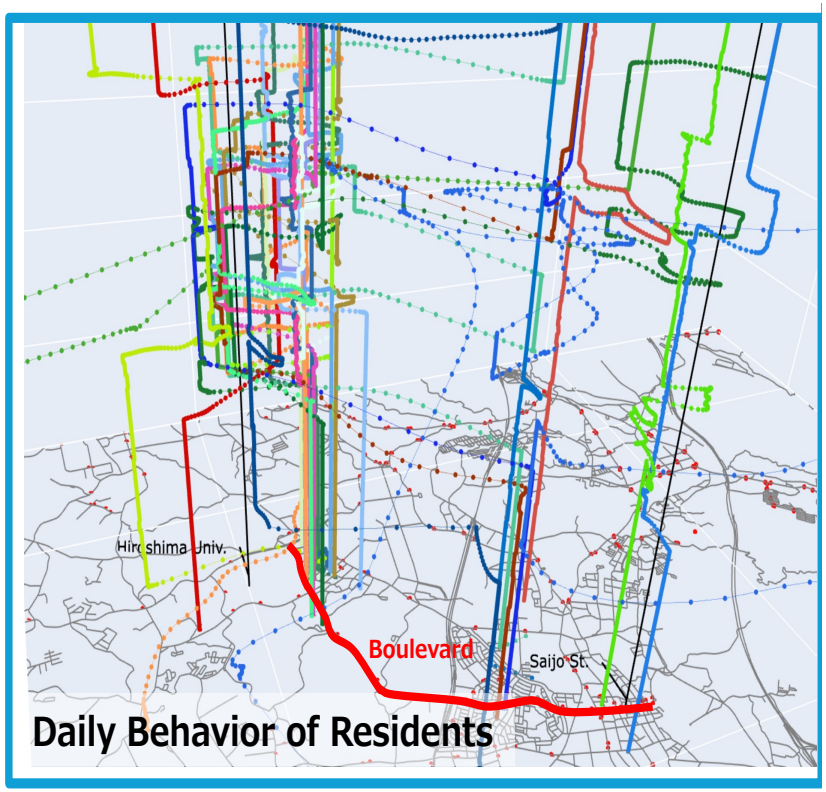
Lighting layout for maximizing (or minimizing) 1/f fluctuations





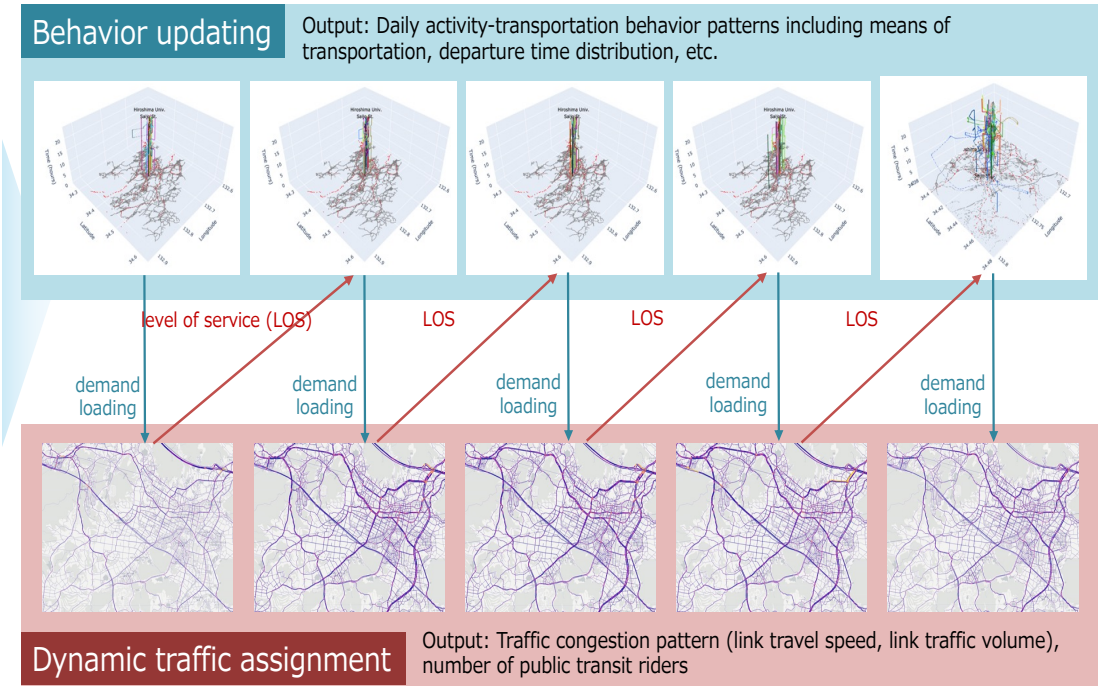
Co-travel & Co-stay Behavior

■ Temporal, Seasonal, and Life-Cycle Variations



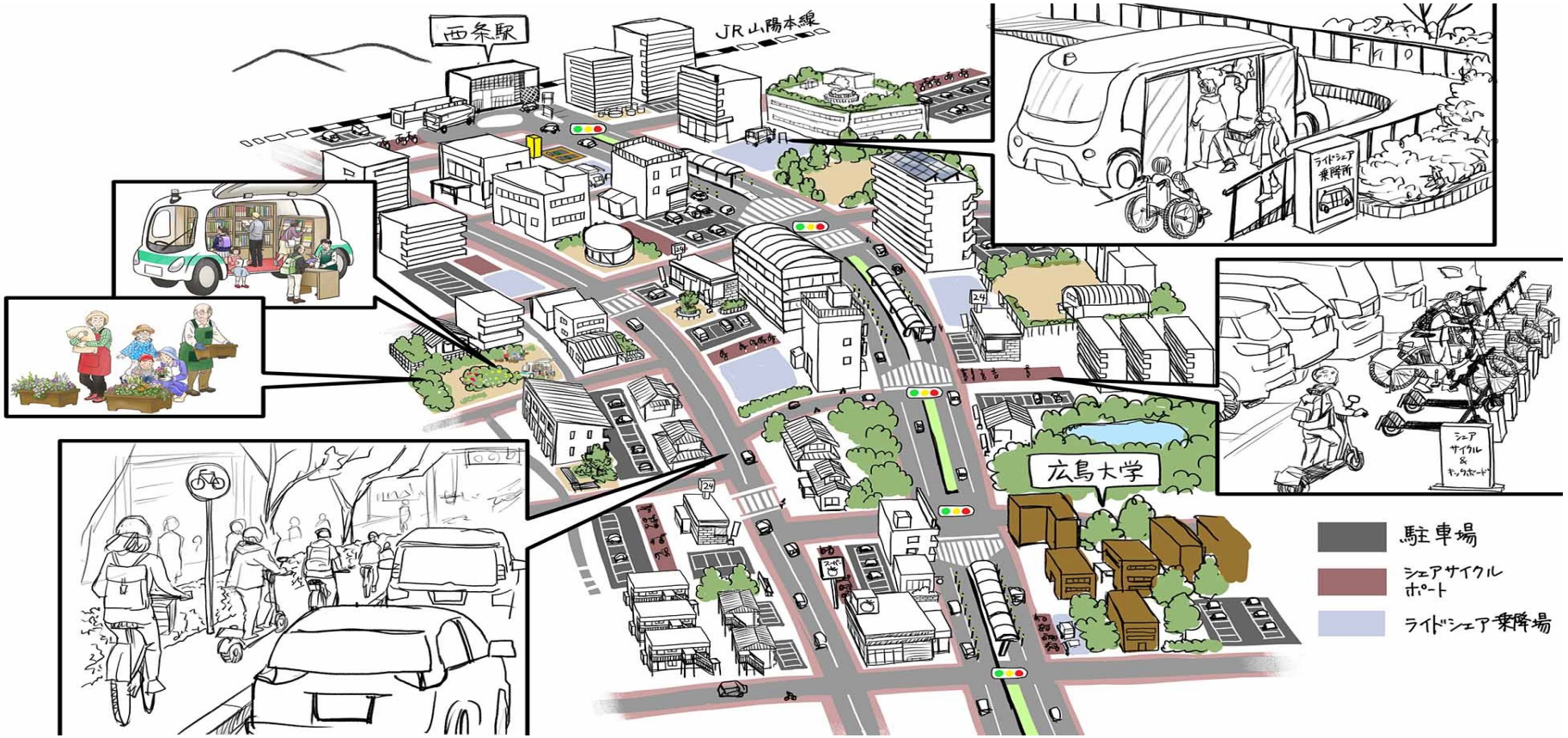
MATSim (Multi-Agent Transport Simulation)

Replicate on a computer the traffic behavior of residents interacting with each other through traffic congestion



Mobility-Oriented Development

■ Allocation of mobility hubs for ride-sharing



Reflections on 40 Years of Education

1. **Optimization-oriented thinking** cannot break the mold.
   - Objective: Maximize $f(x, y \mid a, b)$, ***s.t.*** constraints **(***).**

2. **Cloning education** to set themes, give methodologies, and rewrite papers.
   - Role assignment and tasking in education, like soldier?

3. Not just the increase of knowledge or skills, but changing "**the way of looking at society**".
   - Unable to predict one's future 40 years ahead, even though specializing in planning studies.

“Hope” is a wish for sustainable cities to come true by action together among travel behavioural researchers.

Thank you for listening!

afujiw@hiroshima-u.ac.jp