Mathematical Modeling of Individual Choice Behavior （選択行動の数理モデル） [CVE.D401]

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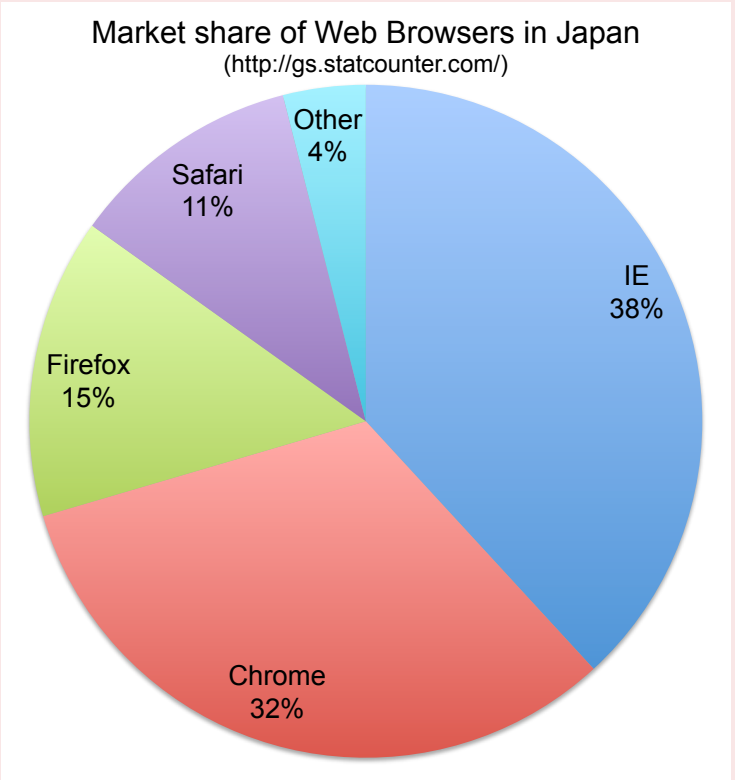
Motivation of this Course

Individuals Choices (Decision-making)

Aggregate Output (Market Demand/Share)



Motivation of this Course

Human dimension in

- Engineering
- Planning
- Marketing
- Business
- Policy-making

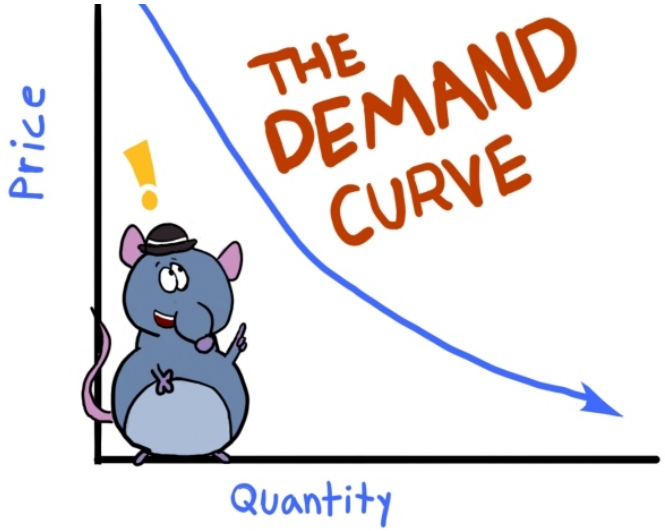
Need for

- Behavioral theories
- Quantitative methods
- Mathematical models
- Computing with programming languages or softwares

Aggregate Demand

Source: marcusgohmarcusgoh.com

- Homogenous population



Source: economnomnomics.com

- Identical behavior

Disaggregate Demand

- Heterogeneous population
- 十人一色 (ten people, one color) → 一人一色 (one people, one color) → 一人十色 (one people, ten colors) . . .

- Different behaviors
- Many variables:
  - Attributes: price, travel time, reliability, frequency, etc.
  - Characteristics: age, income, education, etc.
- Complex demand/inverse demand functions.

Aims and Scopes

- To study the theory of "Discrete Choice Model (DCM, 離散選択モデル)", which is one of the most popular method of market demand analysis.
  - Theoretical Basis: Microeconomics, Applied Statistics, Optimization Theory, Simulation
  - Applications: Predicting future demand in transportation or other markets, Economic evaluation of transport infrastructures
- To learn knowledge on practical applications of DCM through some exercises and assignments (model estimations with some dataset).
  - "BIOGEME": Free software for estimation and simulation
  - Computer laboratories with the dataset from various research field such as "transportation", "telecommunication", "energy" and "marketing".

Applications of DCM

- Most of early studies deal with individual mode choice.
  - McFadden (1974): Seminal paper
  - Domencich and McFadden (1975): Forecasting the passenger demand for Bay Area Rapid Transit (BART) in San Francisco.
- Other applications include:
  - Trip destination choice (Yai 1985)
  - Recreation demand (Fukuda & Morichi 1999)
  - Telephone-service choice (Train et al. 1987)
  - Occupation (job) choice (Schmidt & Strauss 1975)
  - Rail route choice in Tokyo (Yai et al. 1997)
  - Choice of a daily activity pattern (Fujii 1997)
  - Car-parking choice (Muromachi 1993)
  - Analysis of illegal-bicycle-parking (Fukuda 2004)
  - Pedestrian behavior (Fukuda et al. 2013)
  - Facial expressions (Robin et al. 2011)
  - Political party to support (Carey et al. 1995)

BART (Bay Area Rapid Transit) and DCM

Professor D. McFadden

(2001 Novel Prize in Economics Winner)

McFadden, D. ”Conditional logit analysis of qualitative choice behavior,” in P. Zarembka (ed.), *Frontiers in Econometrics*, pp. 105–142, Academic Press: New York, 1974.

Transportation: One of the most advanced DCM applications

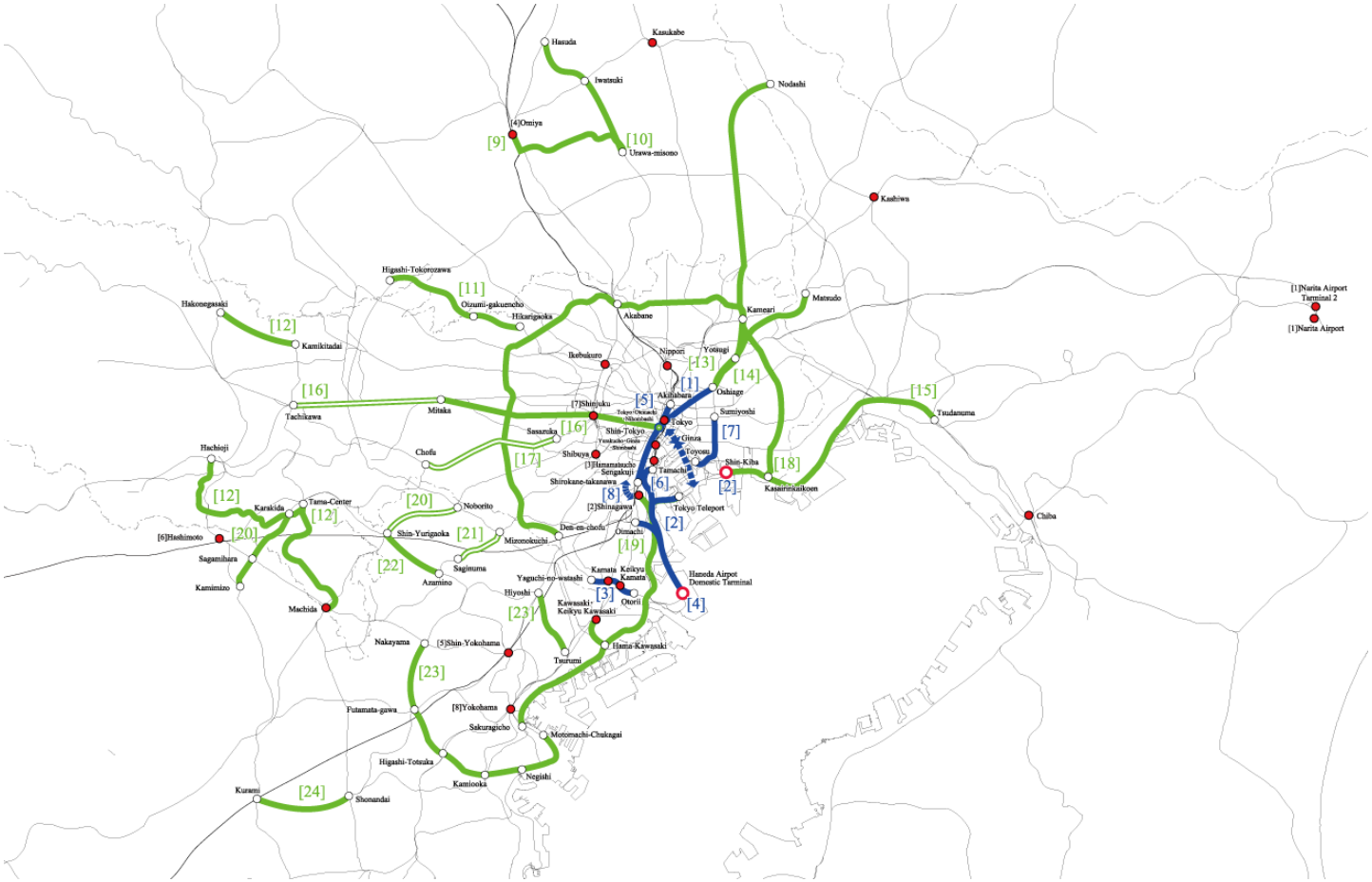
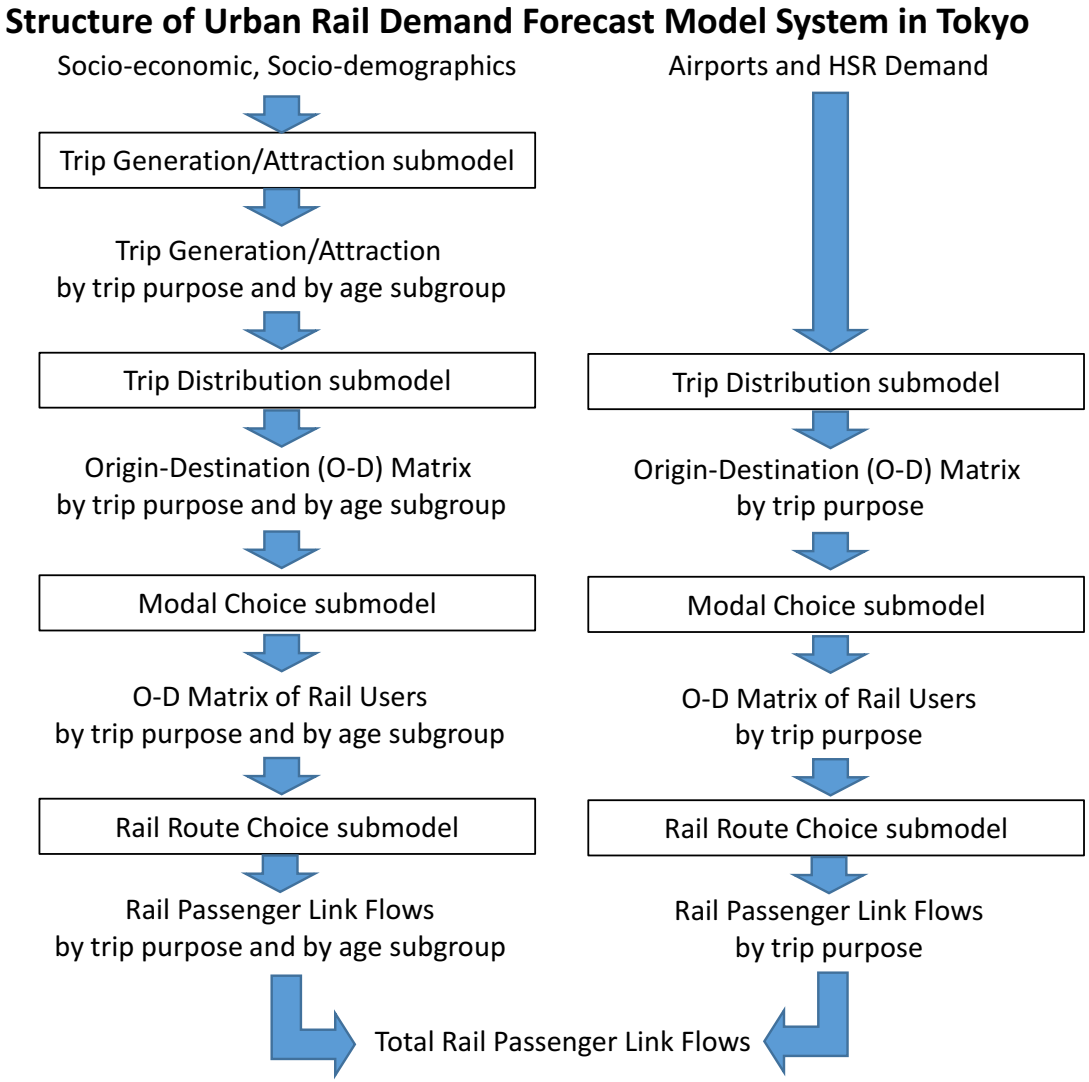


Figure: Planned rail routes in 2016 by 2030 with DCM-based demand forecasting (Kato, Fukuda, Yamashita, Iwakura and Yai, 2017)

Transportation: One of the most advanced DCM applications



Transportation: One of the most advanced DCM applications

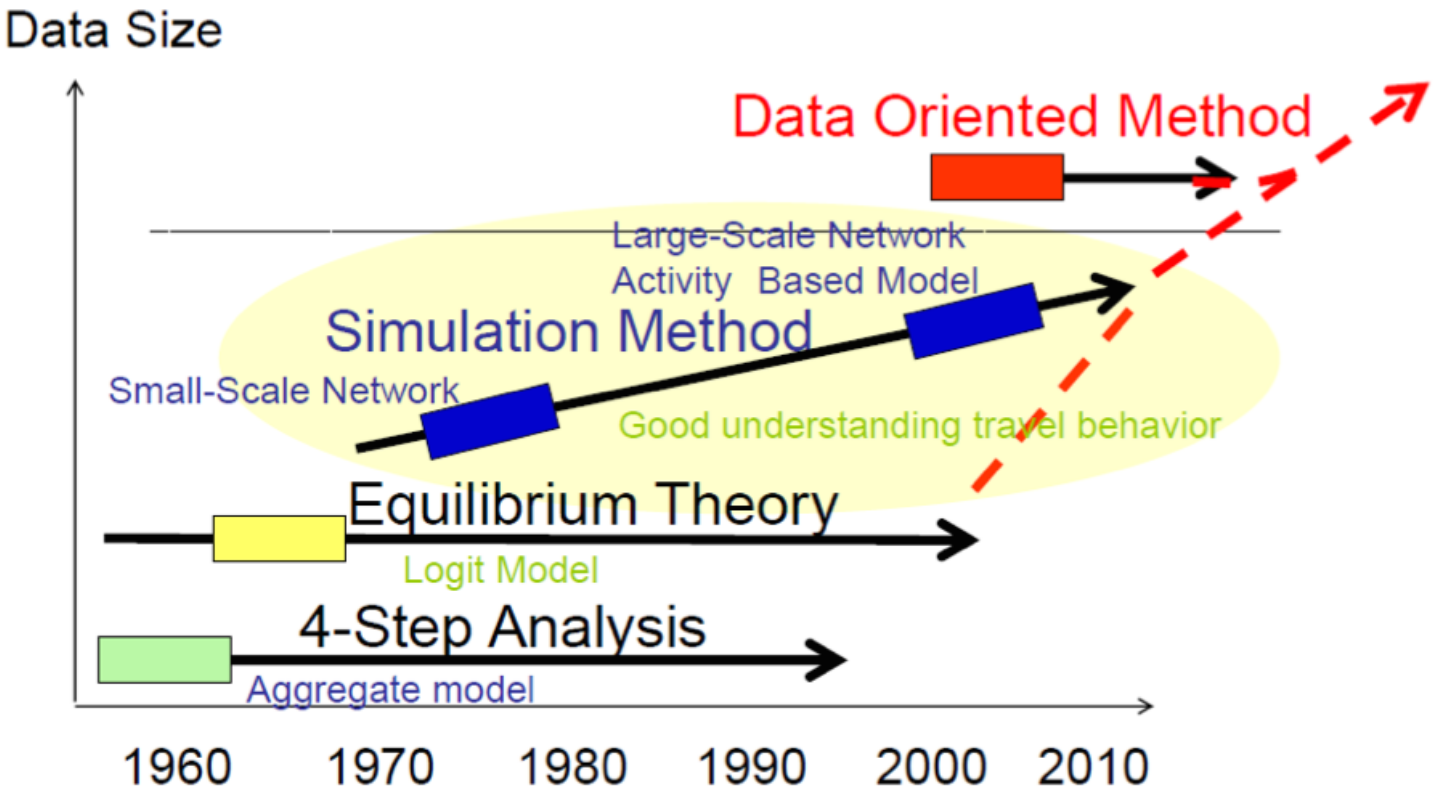
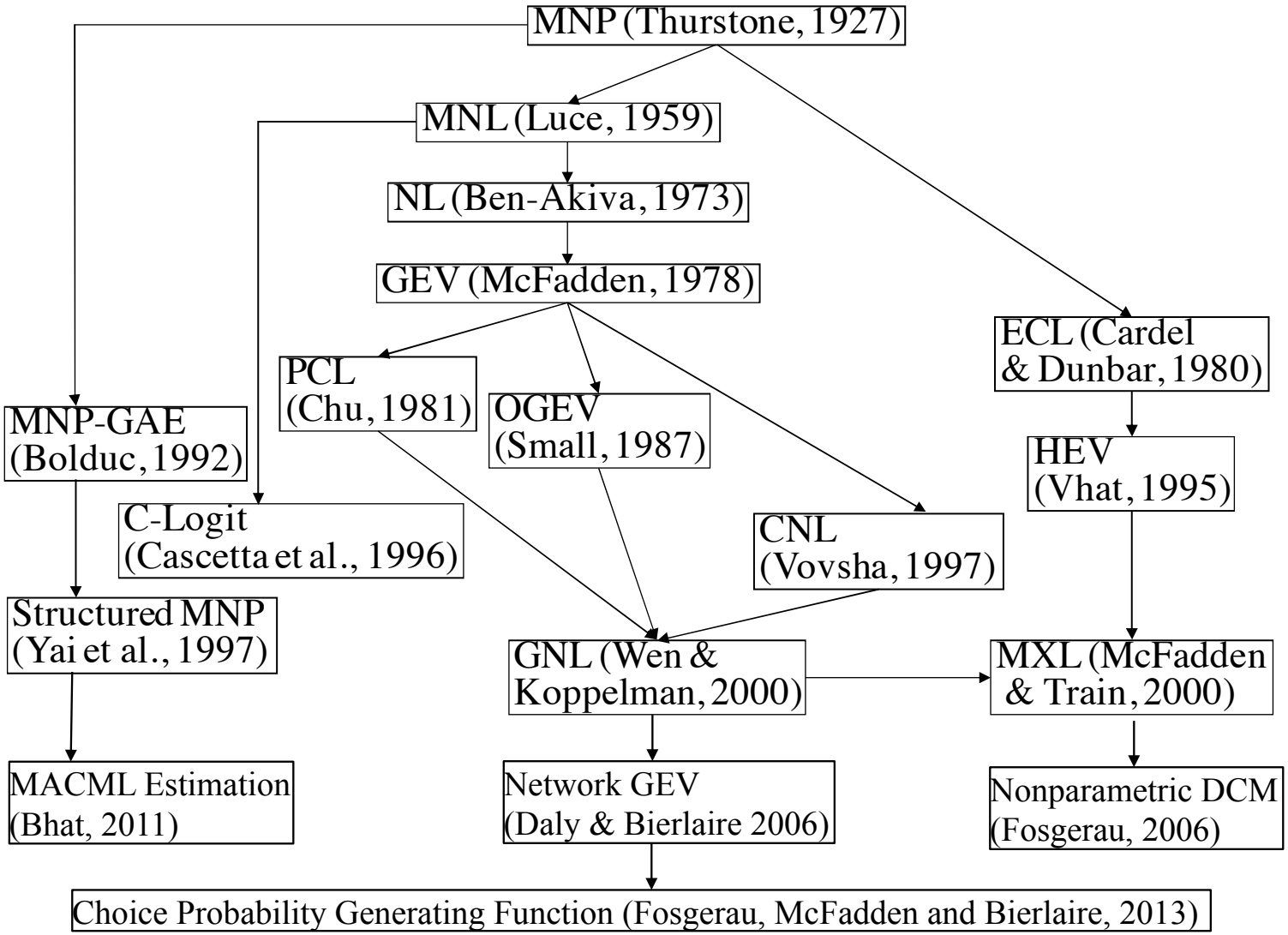


Figure: History of Travel Survey Methods (Hato, 2013)

History of Discrete Choice Models



Textbooks

BL Ben-Akiva, M. & Lerman, S. (1985) Discrete Choice Analysis: Theory and Applications to Travel Demand, MIT Press.

["BBBW" Fully upgraded by Ben-Akiva and his colleagues. Downloadable at OCW-i]

Tr Train, K. (2003) Discrete Choice Methods with Simulation, Cambridge University Press. Downloadable at `http://eml.berkeley.edu/books/choice2.html`

[Also, the Japanese version (translated by Fukuda) will be downloadable at OCW-i.]

KM 北村隆一・森川高行 [編] (2002) 交通行動の分析とモデリング, 技報堂出版.

JSCE 土木学会 [編] (1996) 非集計行動モデルの理論と応用, 土木学会.

- Supplemental materials will be provided at OCW-i.

Class Schedule

1. (April 5) Choice Behavior and Binary Choice Models (BCM)
2. (April 9) Estimation of BCM
3. (April 12) *Computer Lab. (1)*: Estimation of BCM
4. (April 16) Multinomial Choice Models: Logit and Probit
5. (April 19) Specification and Estimation of Multinomial Logit Models (MNL)
6. (April 23) *Computer Lab. (2)*: Estimation of MNL
7. (April 26) Statistical Tests of Discrete Choice Models
8. (May 7) Independent from Irrelevant Alternatives, Forecasting and Microsimulation
9. (May 10) *Computer Lab. (3)*: Statistical Testing & Forecasting
10. (May 14) Nested Logit Model (NL)
11. (May 17) Issues on Sampling
12. (May 21) *Computer Lab. (4)*: NL & Sampling Issues
13. (May 24) Mixed Logit Model (MXL) & Simulation-based Estimation
14. (May 28) *Computer Lab. (5)*: Estimation of MXL
15. (May 31) Recent Developments of DCM in Transportation

Course Evaluation and Advance Preparation

- Class participation
- Five assignments
  - Estimation of DCM, programming and forecasting
  - The "BIOGEME" will be used in all exercises and assignments. The website of BIOGEME: `http://biogeme.epfl.ch`
  - Interpretation, discussion & new suggestions with your estimation results
- You may write assignments either in English or in Japanese.

- Students are required to bring a laptop PC for those five exercises.
- All lecture materials have already been uploaded on TITECH OCW-i (`https://secure.ocw.titech.ac.jp/ocwi/`). Students are required to print them out and bring them to each class.
- Exercise materials have also been uploaded. Students are required to download and save them into your PC in advance.