Assistant Professorship of Modeling Spacial Mobility
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Mode Choice in R

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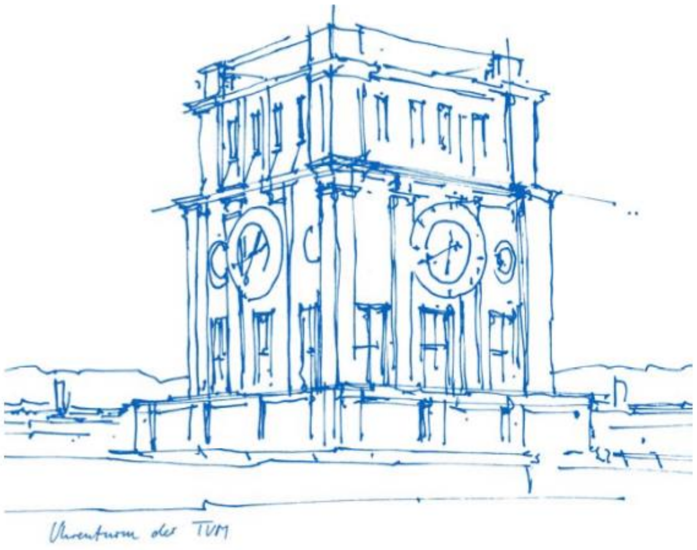
Based on material from Hema Sharanya Rayaprolu

02 December 2019



Discrete Choice Modeling

- Modeling individual choice behaviour econometrically using the principle of ***utility maximization***.
- The utility of an alternative is expressed as a function of the alternative's attributes.

$$\boxed{V_{in} = \beta_{1i}X_{1in} + \beta_{2i}X_{2in} + \cdots + \beta_{ki}X_{kin}}$$

where, V_{in} is the (deterministic) utility of individual n choosing alternative i;

$X_{1in}, X_{2in}, \ldots, X_{kin}$ are k attributes (independent variables); and

$\beta_{1i}, \beta_{2i}, \ldots, \beta_{ki}$ are unknown parameters (to be estimated).

- Assumption: Individuals behave rationally, possess complete information about all alternatives, and are faced with a mutually exclusive and collectively exhaustive choice set.

Discrete Choice Modeling

- **Random utility theory**: To account for model imperfections.

$$\boxed{U_{in} = V_{in} + \varepsilon_{in}}$$

where, U_{in} is the total utility of individual n choosing alternative i;

V_{in} is the deterministic component; and

ε_{in} is the random component.

- ε_{in} is a random variable that caters to the unobserved taste variations among individuals and other observational errors.

Discrete Choice Modeling

- **Probabilistic choice theory**: To accounts for behavioral inconsistencies.
- Probability that an alternative is chosen is now the probability that it has the greatest utility among all the available alternatives.
- Considering a choice set containing two alternatives i and j, the probability that the individual n chooses the alternative i is –

$$P_{in} = Pr\ (\ U_{jn} \leq U_{in}\ )$$

$$P_{in} = Pr\ \{(\varepsilon_{jn} - \varepsilon_{in}) \leq (V_{in} - V_{jn})\}$$

$$P_{in} = Pr\ \{\varepsilon_n \leq \boldsymbol{\beta}'(x_{in} - x_{jn})\}$$

- To solve this, different assumptions on the distribution of the random variable ε_n have been made – e.g. linear, probit, logit,…

Discrete Choice Modeling

- **Logit models**: Assume a logistic (Gumbel) distribution of the random variable.

$$F(\varepsilon_n) = \frac{1}{1+ e^{-\mu\varepsilon_n}}$$

where, μ is a positive scale parameter.

- Under this assumption, the probability of individual n choosing the alternative i is –

$$P_{in} = \frac{1}{1+e^{-\mu\boldsymbol{\beta}'(xin - x_{jn})}}$$

Assuming $\mu = 1$,

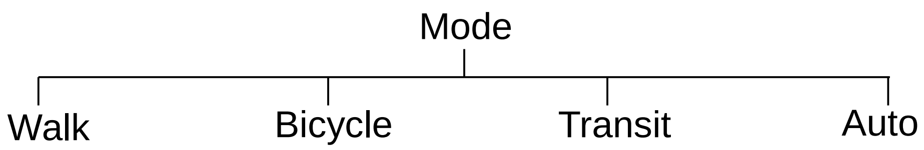
$$P_{in} = \frac{e^{\boldsymbol{\beta}' x_{in}}}{e^{\boldsymbol{\beta}' x_{in}} + e^{\boldsymbol{\beta}' x_{jn}}}$$

- Extending the above to multiple (j) alternatives,

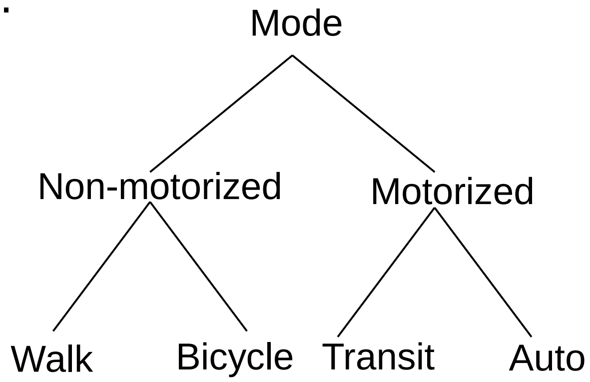
$$P_{in} = \frac{\exp(V_{in})}{\Sigma_j \exp(V_{jn})}$$

Discrete Choice Modeling

- **Multinomial logit (MNL) models**: Assume all alternatives are mutually exclusive (and exhaustive.

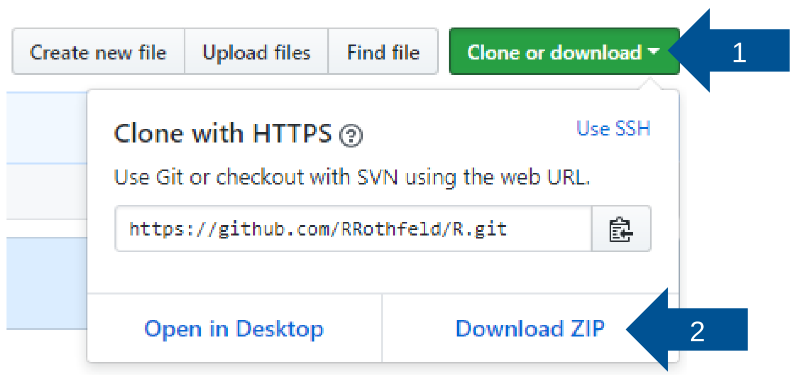


- **Nested logit models**: Allow for correlation between alternatives.
- Group correlated alternatives into separate nests.



Material for Today’s Class

https://github.com/RRothfeld/R



Estimation in R

- Using the ***mlogit* package** (though, there are alternatives)
- Model specification:
  - Choice alternatives (modes)
  - Independent variables
  - Data formats: wide (one row for each choice observation) or long (one row for each alternative of each observation)
  - Formula:

Choice ~ Part 1 | Part 2 | Part 3

Part 1: Alternative-specific variables

Part 2: Individual-specific variables

Part 3: Alternative-specific variables with coefficients varying across alternatives

References

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

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