EPFL
ENAC TRANSP-OR
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Mathematical Modeling of Behavior
Fall 2017



## EXERCISES SESSION 6

The topic of this session is *Segmentation and tests*. You will estimate different model specifications for the *Airline Itinerary Choice* (Boeing) case study and you will go through some provided files to see how to test different specifications. The purposes of this lab are the following:

- improve the model specification with alternative-specific coefficients by adding some non-linearities in the deterministic part of the utility function,

- test models whose hypothesis are non-nested, and

- improve the *Multinomial Logit* model by applying a socio-economic segmentation.

First, download the file `MNL_Airline_Seg_Tests.zip`. It contains:

1. the data file `airline.dat`,

2. the description and interpretation of the base model (`MNL_Airline_Session06_2017.pdf`),

3. folder to develop the non linear specifications and the corresponding description (`NonLinear`),

4. folder with the non nested specifications and the corresponding description (`NonNested`), and

5. folder with the market segmentation and the corresponding description (`MarketSegmentation`).

**Nonlinear specifications**
For this part of the lab, copy the `MNL_airline_specific.py` file (included in the `NonLinear` folder) and use it as a template to perform the following tasks.

1. Try to code the proposed specifications. You should create the following files:

    (a) `MNL_airline_piecewise.py`
    (b) `MNL_airline_powerseries.py`
    (c) `MNL_airline_boxcox.py`

2. Estimate the model specifications. You should obtain the following files:

    (a) `MNL_airline_piecewise.html`
    (b) `MNL_airline_powerseries.html`
    (c) `MNL_airline_boxcox.html`

3. For each specification, perform a likelihood ratio test against the base model
    (`MNL_airline_specific.py`)

4. In order to verify that your code is correct, compare the results you obtain with the ones we provide in the description.

5. Can you use a likelihood ratio test to decide between models with different non-linearities?

**Non nested specifications**
For this part of the lab, we provide all the required `.py` files and ask you to perform the following tasks.

1. Estimate the model specifications contained in the following files:

   (a) `MNL_airline_specific.py` (`Fare` is considered linear)
   (b) `MNL_airline_log.py` (`Fare` is considered logarithmic)

2. You should obtain the following files:

   (a) `MNL_airline_specific.html`
   (b) `MNL_airline_log.html`

3. Perform a Cox-test between the model where the fare is considered linear and the one where it is considered logarithmic. To do so, estimate the model in `MNL_airline_composite.py`. You should obtain the file `MNL_airline_composite.html`.

4. What is the outcome of this test?

**Market Segmentation**
For this part of the lab, we provide all the required `.py` files and ask you to perform the following tasks.

1. Estimate the model specification contained in the file `MNL_airline_specific.py`. You should obtain the file `MNL_airline_specific.html`.

2. To test if there is a taste variation across segments, more precisely across gender, estimate the following models:

   (a) `MNL_airline_male.py` (only for male)
   (b) `MNL_airline_female.py` (only for female)
   (c) `MNL_airline_GenderNA.py` (only for no answer for the gender variable)

3. You should obtain the following files:

   (a) `MNL_airline_male.html`
   (b) `MNL_airline_female.html`
   (c) `MNL_airline_GenderNA.html`

4. Perform a likelihood ratio test between the base model (`MNL_airline_specific.py`) and the *segmented* models (`MNL_airline_male.py`, `MNL_airline_female.py` and `MNL_airline_GenderNA.py`).

5. What is the outcome of the test?

**Create and analyze**

You can develop other model specifications using your own hypotheses. We suggest you to take `MNL_airline_specific.py` as the base model and then do the following:

1. Try a socio-economic segmentation of the constant, which is equivalent to adding socioeconomic parameters directly to the utilities. Is this segmentation significant?

2. Try a socio-economic segmentation of attributes of the alternatives one-by-one. Remember the difference between discrete and continuous segmentations. Are your segmentations significant?

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