Technical Report for 1.1 Day Pattern Model

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Model Description

The pattern choice is a function of many types of household characteristics and personal demographic variables. It predict the occurrence of tours and intermediate stops. The occurrence is expressed as a binary variable (0 or 1+). Noticed that this model is the very first model of benchmark models, the only available information is personal and household characteristics.

Choice Set

There are 4 tour purposes: **Work(W)**, **Education(E)**, **Shopping(S)** and **Others(O)**. And 4 stop purposes (same as tour purposes). In total there are $2^8 = 128$ possible combinations. In our model, we use a choice set of 51 alternatives.

Please find the file **DayPatternChoiceSet51.txt** for a complete list of 51 alternatives. `WorkT`, `EduT`, `ShopT` and `OthersT` are bool type variables indicatign whether there are at least 1+ tours for that purpose. `WorkI`, `EduI`, `ShopI`, and `OthersI` are bool type variables indicate whether intermediate stops of a purpose is avaiable. If a tour purpose has 1 as its value, it need to further go to 1.2 Exact Number of Tour Model. If a stop purpose has 1 as its value, the stop purpose is available when generating intermediate stops. The `Code` range from 1 to 51 and is the index for the day pattern it represents. Alternative 1 where all 8 columns are 0 is the base alternative where the agent stays at home for the whole day.

Model Structure

The Day Pattern Model is a MNL model.

```python
#systematic utility for V1 (base alternative)
V_1=0

#systematic utilities for V2-V51 (i=range(2,52))
#Notice: The utility function contains all the parameters
#no matter estimated or not.

V_i=beta_tour_work * WorkTi + beta_stop_work * WorkIi +
    beta_tour_edu * EduTi + beta_stop_edu * EduIi +
    beta_tour_shop * ShopTi + beta_stop_shop * ShopIi +
    beta_tour_others * OthersTi + beta_stop_others * OthersIi +
    beta_onetour_onestop * onetour_onestopi +
    beta_onetour_twostop * onetour_twostopi +
    beta_onetour_threestop * onetour_threestopi +
    beta_twotour_onestop * twotour_onestopi +
    beta_twotour_twostop * twotour_twostopi +
    beta_twotour_threestop * twotour_threestopi +
    beta_threetour_onestop * threetour_onestopi +
    beta_threetour_twostop * threetour_twostopi +
    beta_parttime_work * (worki * parttime) +
    beta_parttime_edu * (edui * parttime) +
    beta_parttime_shop * (shopi * parttime) +
    beta_parttime_others * (otheri * parttime) +
    beta_selfemployed_work * (worki * selfemployed) +
    beta_selfemployed_edu * (edui * selfemployed) +
    beta_selfemployed_shop * (shopi * selfemployed) +
    beta_selfemployed_others * (otheri * selfemployed) +
    beta_universitystudent_work * (worki * universitystudent) +
    beta_universitystudent_edu * (edui * universitystudent) +
    beta_universitystudent_shop * (shopi * universitystudent) +
    beta_universitystudent_others * (otheri * universitystudent) +
    beta_homemaker_work * (worki * homemaker) +
    beta_homemaker_edu * (edui * homemaker) +
    beta_homemaker_shop * (shopi * homemaker) +
    beta_homemaker_others * (otheri * homemaker) +
    beta_retired_work * (worki * retired) +
    beta_retired_edu * (edui * retired) +
    beta_retired_shop * (shopi * retired) +
    beta_retired_others * (otheri * retired) +
    beta_unemployed_work * (worki * unemployed) +
    beta_unemployed_edu * (edui * unemployed) +
    beta_unemployed_shop * (shopi * unemployed) +
    beta_unemployed_others * (otheri * unemployed) +
    beta_nationalservice_work * (worki * nationalservice) +
    beta_nationalservice_edu * (edui * nationalservice) +
    beta_nationalservice_shop * (shopi * nationalservice) +
```

```
beta_nationalservice_others * (otheri * nationalservice) +
beta_voluntary_work * (worki * voluntary) +
beta_voluntary_edu * (edui * voluntary) +
beta_voluntary_shop * (shopi * voluntary) +
beta_voluntary_others * (otheri * voluntary) +
beta_domestic_work * (worki * domestic) +
beta_domestic_edu * (edui * domestic) +
beta_domestic_shop * (shopi * domestic) +
beta_domestic_others * (otheri * domestic) +
beta_otherworker_work * (worki * otherworker) +
beta_otherworker_edu * (edui * otherworker) +
beta_otherworker_shop * (shopi * otherworker) +
beta_otherworker_others * (otheri * otherworker) +
beta_student16_work * (worki * student16) +
beta_student16_edu * (edui * student16) +
beta_student16_shop * (shopi * student16) +
beta_student16_others * (otheri * student16) +
beta_student515_work * (worki * student515) +
beta_student515_edu * (edui * student515) +
beta_student515_shop * (shopi * student515) +
beta_student515_others * (otheri * student515) +
beta_child4_work * (worki * child4) +
beta_child4_edu * (edui * child4) +
beta_child4_shop * (shopi * child4) +
beta_child4_others * (otheri * child4) +
beta_age2025_work * (worki * age2025) +
beta_age2025_edu * (edui * age2025) +
beta_age2025_shop * (shopi * age2025) +
beta_age2025_others * (otheri * age2025) +
beta_age2635_work * (worki * age2635) +
beta_age2635_edu * (edui * age2635) +
beta_age2635_shop * (shopi * age2635) +
beta_age2635_others * (otheri * age2635) +
beta_age5165_work * (worki * age5165) +
beta_age5165_edu * (edui * age5165) +
beta_age5165_shop * (shopi * age5165) +
beta_age5165_others * (otheri * age5165) +
beta_maleage4_work * (worki * maleage4) +
beta_maleage4_edu * (edui * maleage4) +
beta_maleage4_shop * (shopi * maleage4) +
beta_maleage4_others * (otheri * maleage4) +
beta_maleage515_work * (worki * maleage515) +
beta_maleage515_edu * (edui * maleage515) +
beta_maleage515_shop * (shopi * maleage515) +
beta_maleage515_others * (otheri * maleage515) +
beta_femalenone_work * (worki * femalenone) +
```

```
        beta_femalenone_edu * (edui * femalenone) +
        beta_femalenone_shop * (shopi * femalenone) +
        beta_femalenone_others * (otheri * femalenone) +
        beta_femaleage4_work * (worki * femaleage4) +
        beta_femaleage4_edu * (edui * femaleage4) +
        beta_femaleage4_shop * (shopi * femaleage4) +
        beta_femaleage4_others * (otheri * femaleage4) +
        beta_femaleage515_work * (worki * femaleage515) +
        beta_femaleage515_edu * (edui * femaleage515) +
        beta_femaleage515_shop * (shopi * femaleage515) +
        beta_femaleage515_others * (otheri * femaleage515) +
        beta_onlyadults_work * (worki * onlyadults) +
        beta_onlyadults_edu * (edui * onlyadults) +
        beta_onlyadults_shop * (shopi * onlyadults) +
        beta_onlyadults_others * (otheri * onlyadults) +
        beta_onlyworkers_work * (worki * onlyworkers) +
        beta_onlyworkers_edu * (edui * onlyworkers) +
        beta_onlyworkers_shop * (shopi * onlyworkers) +
        beta_onlyworkers_others * (otheri * onlyworkers) +
        beta_income_work * (worki * income) +
        beta_income_edu * (edui * income) +
        beta_income_shop * (shopi * income) +
        beta_income_others * (otheri * income) +
        beta_workathome_work * (worki * workathome) +
        beta_workathome_edu * (edui * workathome) +
        beta_workathome_shop * (shopi * workathome) +
        beta_workathome_others * (otheri * workathome) +
        beta_caravail_work * (worki * caravail) +
        beta_caravail_edu * (edui * caravail) +
        beta_caravail_shop * (shopi * caravail) +
        beta_caravail_others * (otheri * caravail) +
        beta_motoravail_work * (worki * motoravail) +
        beta_motoravail_edu * (edui * motoravail) +
        beta_motoravail_shop * (shopi * motoravail) +
        beta_motoravail_others * (otheri * motoravail) +
        beta_work_logsum * WorkTi * worklogsum +
        beta_edu_logsum * EduTi * edulogsum +
        beta_shopping_logsum * ShopTi * shoplogsum +
        beta_other_logsum * OthersTi * otherlogsum

#Estimated values for all betas
#Notice: the betas that not estimated are fixed to zero.

#Tour constants
beta_tour_work = Beta('beta_tour_work',0,-10,10,0) = -6.34
beta_tour_edu = Beta('beta_tour_edu',0,-10,100,1) = 0
```

```python
beta_tour_shop = Beta('beta_tour_shop',0,-10,10,0) = -3.54
beta_tour_others = Beta('beta_tour_others',0,-10,10,0) = -4.00

#Intermediate Stops constants
beta_stop_work = Beta('beta_stop_work',0,-10,10,1) = 0
beta_stop_edu = Beta('beta_stop_edu',0,-10,10,1) = 0
beta_stop_shop = Beta('beta_stop_shop',0,-10,10,1) = 0
beta_stop_others = Beta('beta_stop_others',0,-10,10,1) = 0

#Person type
beta_parttime_work = Beta('beta_parttime_work',0,-10,10,0) = -0.300
beta_parttime_edu = Beta('beta_parttime_edu',0,-10,10,1) = 0
beta_parttime_shop = Beta('beta_parttime_shop',0,-10,10,0) = 0.0938
beta_parttime_others = Beta('beta_parttime_others',0,-10,10,0) = 0.630

beta_selfemployed_work = Beta('beta_selfemployed_work',0,-10,10,0) = -1.55
beta_selfemployed_edu = Beta('beta_selfemployed_edu',0,-10,10,1)  = 0
beta_selfemployed_shop = Beta('beta_selfemployed_shop',0,-10,10,0) = -0.121
beta_selfemployed_others = Beta('beta_selfemployed_others',0,-10,10,0) = 0.803

beta_universitystudent_work = Beta('beta_universitystudent_work',0,-10,10,0) = -2.31
beta_universitystudent_edu = Beta('beta_universitystudent_edu',0,-10,100,1) = 0
beta_universitystudent_shop = Beta('beta_universitystudent_shop',0,-10,10,1) = 0
beta_universitystudent_others = Beta('beta_universitystudent_others',0,-10,10,1) = 0

beta_homemaker_work = Beta('beta_homemaker_work',-20,-10,10,1) = 0
beta_homemaker_edu = Beta('beta_homemaker_edu',0,-10,10,1) = 0
beta_homemaker_shop = Beta('beta_homemaker_shop',0,-10,10,0) = 0.753
beta_homemaker_others = Beta('beta_homemaker_others',0,-10,10,0) = 1.11

beta_retired_work = Beta('beta_retired_work',0,-100,10,1) = 0
beta_retired_edu = Beta('beta_retired_edu',0,-10,10,1) = 0
beta_retired_shop = Beta('beta_retired_shop',0,-10,10,0) = 0.548
beta_retired_others = Beta('beta_retired_others',0,-10,10,0) = 1.23

beta_unemployed_work = Beta('beta_unemployed_work',-20,-10,10,1) = 0
beta_unemployed_edu = Beta('beta_unemployed_edu',0,-10,10,1) = 0
beta_unemployed_shop = Beta('beta_unemployed_shop',0,-10,10,0) = 0.475
beta_unemployed_others = Beta('beta_unemployed_others',0,-10,10,0) = 1.64

beta_nationalservice_work = Beta('beta_nationalservice_work',0,-10,10,0) = 0.494
beta_nationalservice_edu = Beta('beta_nationalservice_edu',0,-10,10,1) = 0
beta_nationalservice_shop = Beta('beta_nationalservice_shop',0,-10,10,1) = 0
beta_nationalservice_others = Beta('beta_nationalservice_others',0,-10,10,0) = -0.270

beta_voluntary_work = Beta('beta_voluntary_work',0,-10,10,0) = -1.18
```

```
beta_voluntary_edu = Beta('beta_voluntary_edu',0,-10,10,1) = 0
beta_voluntary_shop = Beta('beta_voluntary_shop',0,-10,10,0) = 0.177
beta_voluntary_others = Beta('beta_voluntary_others',0,-10,10,1) = 0

beta_domestic_work = Beta('beta_domestic_work',0,-10,10,1) = 0
beta_domestic_edu = Beta('beta_domestic_edu',0,-10,10,1) = 0
beta_domestic_shop = Beta('beta_domestic_shop',0,-10,10,0) = -1.39
beta_domestic_others = Beta('beta_domestic_others',0,-10,10,0) = -0.391

beta_otherworker_work = Beta('beta_otherworker_work',0,-10,10,0) = -1.49
beta_otherworker_edu = Beta('beta_otherworker_edu',0,-10,10,1) = 0
beta_otherworker_shop = Beta('beta_otherworker_shop',0,-10,10,0) = -3.98
beta_otherworker_others = Beta('beta_otherworker_others',0,-10,10,0) = -3.12

beta_student16_work = Beta('beta_student16_work',0,-10,10,0) = -2.24
beta_student16_edu = Beta('beta_student16_edu',0,-10,10,1) = 0
beta_student16_shop = Beta('beta_student16_shop',0,-10,10,0) = -0.736
beta_student16_others = Beta('beta_student16_others',0,-10,10,0) = -0.199

beta_student515_work = Beta('beta_student515_work',-20,-10,10,1) = 0
beta_student515_edu = Beta('beta_student515_edu',0,-10,10,1) = 0
beta_student515_shop = Beta('beta_student515_shop',0,-10,10,0) = -1.33
beta_student515_others = Beta('beta_student515_others',0,-10,10,0) = -0.191

beta_child4_work = Beta('beta_child4_work',-20,-10,10,1) = 0
beta_child4_edu = Beta('beta_child4_edu',0,-10,10,1) = 0
beta_child4_shop = Beta('beta_child4_shop',0,-10,10,1) = 0
beta_child4_others = Beta('beta_child4_others',0,-10,10,1) = 0

#Adult age group

beta_age2025_work = Beta('beta_age2025_work',0,-10,10,1) = 0
beta_age2025_edu = Beta('beta_age2025_edu',0,-10,10,1) = 0
beta_age2025_shop = Beta('beta_age2025_shop',0,-10,10,1) = 0
beta_age2025_others = Beta('beta_age2025_others',0,-10,10,1) = 0

beta_age2635_work = Beta('beta_age2635_work',0,-10,10,1) = 0
beta_age2635_edu = Beta('beta_age2635_edu',0,-10,10,1) = 0
beta_age2635_shop = Beta('beta_age2635_shop',0,-10,10,1) = 0
beta_age2635_others = Beta('beta_age2635_work',0,-10,10,1) = 0

beta_age5165_work = Beta('beta_age5165_work',0,-10,10,1) = 0
beta_age5165_edu = Beta('beta_age5165_edu',0,-10,10,1) = 0
beta_age5165_shop = Beta('beta_age5165_shop',0,-10,10,1) = 0
beta_age5165_others = Beta('beta_age5165_others',0,-10,10,1) = 0
```

```
#Adult gender/children

beta_maleage4_work = Beta('beta_maleage4_work',0,-10,10,1) = 0
beta_maleage4_edu = Beta('beta_maleage4_edu',0,-10,10,1) = 0
beta_maleage4_shop = Beta('beta_maleage4_shop',0,-10,10,0) = -0.718
beta_maleage4_others = Beta('beta_maleage4_others',0,-10,10,0) = 0.454

beta_maleage515_work = Beta('beta_maleage515_work',0,-10,10,1) = 0
beta_maleage515_edu = Beta('beta_maleage515_edu',0,-10,10,1) = 0
beta_maleage515_shop = Beta('beta_maleage515_shop',0,-10,10,0) = -0.674
beta_maleage515_others = Beta('beta_maleage515_others',0,-10,10,0) = 0.575

beta_femalenone_work = Beta('beta_femalenone_work',0,-10,10,0) = -0.236
beta_femalenone_edu = Beta('beta_femalenone_edu',0,-10,10,1) = 0
beta_femalenone_shop = Beta('beta_femalenone_shop',0,-10,10,1) = 0
beta_femalenone_others = Beta('beta_femalenone_others',0,-10,10,0) = -0.366

beta_femaleage4_work = Beta('beta_femaleage4_work',0,-10,10,0) = -1.02
beta_femaleage4_edu = Beta('beta_femaleage4_edu',0,-10,10,1) = 0
beta_femaleage4_shop = Beta('beta_femaleage4_shop',0,-10,10,0) = -0.379
beta_femaleage4_others = Beta('beta_femaleage4_others',0,-10,10,0) = 0.219

beta_femaleage515_work = Beta('beta_femaleage515_work',0,-10,10,1) = 0
beta_femaleage515_edu = Beta('beta_femaleage515_edu',0,-10,10,1) = 0
beta_femaleage515_shop = Beta('beta_femaleage515_shop',0,-10,10,0) = -0.161
beta_femaleage515_others = Beta('beta_femaleage515_others',0,-10,10,0) = 0.289

#Household composition
beta_onlyadults_work = Beta('beta_onlyadults_work',0,-10,10,1) = 0
beta_onlyadults_edu = Beta('beta_onlyadults_edu',0,-10,10,1) = 0
beta_onlyadults_shop = Beta('beta_onlyadults_shop',0,-10,10,0) = -0.498
beta_onlyadults_others = Beta('beta_onlyadults_others',0,-10,10,0) = 0.325

beta_onlyworkers_work = Beta('beta_onlyworkers_work',0,-10,10,1) = 0
beta_onlyworkers_edu = Beta('beta_onlyworkers_edu',0,-10,10,1) = 0
beta_onlyworkers_shop = Beta('beta_onlyworkers_shop',0,-10,10,0) = 0.172
beta_onlyworkers_others = Beta('beta_onlyworkers_others',0,-10,10,0) = 0.321


#Personal income
beta_income_work = Beta('beta_income_work',0,-10,10,0) = 0.000268
beta_income_edu = Beta('beta_income_edu',0,-10,10,1) = 0
beta_income_shop = Beta('beta_income_shop',0,-10,10,0) = -0.000208
beta_income_others = Beta('beta_income_others',0,-10,10,0) = 0.000104
```

```
#Others
beta_workathome_work = Beta('beta_workathome_work',0,-10,10,1) = 0
beta_workathome_edu = Beta('beta_workathome_edu',0,-10,10,1) = 0
beta_workathome_shop = Beta('beta_workathome_shop',0,-10,10,1) = 0
beta_workathome_others = Beta('beta_workathome_others',0,-10,10,1) = 0

beta_caravail_work = Beta('beta_caravail_work',0,-10,10,0) = -0.902
beta_caravail_edu = Beta('beta_caravail_edu',0,-10,10,1) = 0
beta_caravail_shop = Beta('beta_caravail_shop',0,-10,10,0) = -0.0947
beta_caravail_others = Beta('beta_caravail_others',0,-10,10,0) = 0.623

beta_motoravail_work = Beta('beta_motoravail_work',0,-10,10,0) = 0.465
beta_motoravail_edu = Beta('beta_motoravail_edu',0,-10,10,1) = 0
beta_motoravail_shop = Beta('beta_motoravail_shop',0,-10,10,0) = -0.231
beta_motoravail_others = Beta('beta_motoravail_others',0,-10,10,0) = 0.0117


#Additional constants
beta_onetour_onestop = Beta('beta_onetour_onestop',0,-10,10,0) = -2.66
beta_onetour_twostop = Beta('beta_onetour_twostop',0,-10,10,0) = -4.45
beta_onetour_threestop = Beta('beta_onetour_threestop',0,-10,10,1) = 0
beta_twotour_onestop = Beta('beta_twotour_onestop',0,-10,10,0) = -2.91
beta_twotour_twostop = Beta('beta_twotour_twostop',0,-10,10,1) = 0
beta_twotour_threestop = Beta('beta_twotour_threestop',0,-10,10,1) = 0
beta_threetour_onestop = Beta('beta_threetour_onestop',0,-10,10,1) = 0
beta_threetour_twostop = Beta('beta_threetour_twostop',0,-10,10,1) = 0

beta_work_logsum=Beta('beta_work_logsum',0,-10,10,0) = 0.596
beta_edu_logsum=Beta('beta_edu_logsum',1,-10,10,1) = 0
beta_shopping_logsum=Beta('beta_shopping_logsum',0,-10,10,0) = 0.0675
beta_other_logsum=Beta('beta_other_logsum',0,-10,10,0) = 0.146
```

Variables

This section will introduce how to acquare variables needed in estimating the model. Variable name, describtion, accessing method or generating pseudo code will be provided.

1. WorkTi,EduTi,ShopTi,OthersTi, WorkIi,EduIi,ShopIi,OthersIi

i in the variable range from 1-51. The eight variables are just the bool variables that define a day pattern. they can be acquared directly from **DayPattern-ChoiceSet51.txt**.

2. `XXXtour_XXXstop...` series

The series include:

- `onetour_onestop1` to `onetour_onestop51`
- `onetour_twostop1` to `onetour_twostop51`
- `onetour_threestop1` to `onetour_threestop51`
- `twotour_onestop1` to `twotour_onestop51`
- `twotour_twostop1` to `twotour_twostop51`
- `twotour_threestop1` to `twotour_threestop51`
- `threetour_onestop1` to `threetour_onestop51`
- `threetour_twostop1` to `threetour_twostop51`

They describe the composition of each day pattern. for example `onetour` means there are 1 tour purpose has value 1, `twostop` means there are 2 stop purposes has value 1.

Those variables can be derived from `WorkT1-51,EduT1-51,ShopT1-51,OthersT1-51,` `WorkI1-51,EduI1-51,ShopI1-51,OthersI1-51` in the following way.

```python
for i in range(1,52):
    exec('onetour_onestop%s =
    1*(((WorkT%s + EduT%s + ShopT%s + OthersT%s)== 1) and
    ((WorkI%s + EduI%s + ShopI%s + OthersI%s)== 1))' % (i,)*9)

    exec('twotour_threestop%s =
    1*(((WorkT%s + EduT%s + ShopT%s + OthersT%s)== 2) and
    ((WorkI%s + EduI%s + ShopI%s + OthersI%s)== 3))' % (i,)*9)

    #etc...
```

3. `worki,edui,shopi,otheri` series ($i = 1 - 51$)

This series define the activity dummies for each of the 51 alternatives. For example, `work37 = 1` means that the 37th alternative has `WorkT37 + WorkI37>=1`.

```python
for i in range(1,52):
    exec('work%s = 1*(WorkT%s+WorkI%s>=1)' % (i,)*3)
    exec('edu%s = 1*(EduT%s+EduI%s>=1)' % (i,)*3)

    #etc...
```

4. Person type related variables

The person type related variables can be acquaried by acess **population** database.

```
fulltime = (person_type_id == 1)
parttime = (person_type_id == 2)
selfemployed = (person_type_id == 3)
universitystudent = (person_type_id == 4) * (universitystudent == 1)
homemaker = (person_type_id == 5)
retired = (person_type_id == 6)
unemployed = (person_type_id == 7)
nationalservice = (person_type_id == 8)
voluntary =  (person_type_id == 9)
domestic =  (person_type_id == 10)
otherworker = (person_type_id == 12)
student16 = (person_type_id == 4) * (age_id == 3)
student515 = (person_type_id == 4) * ((age_id == 1) + (age_id == 2))
child4 = (age_id == 0)
```

4. Age group

The age group related variables can be acquaried by acess **population** database.

```
age20 = (age_id < 4)
age2025 = (age_id == 4)
age2635 = (age_id == 5) + (age_id == 6)
age3650 = (age_id == 7) + (age_id == 8) + (age_id == 9)
age5165 = (age_id == 10) + (age_id == 11) + (age_id == 12)
age65 = (age_id > 12)
```

5. Household Composition

The variables listed here are related to household composition. Notice that household characteristics only different by different household. People in the same household have the same household characteristics. The variables listed here can be acquaried by acess **household** database. Make sure household characteristics are associate with the agents with right household id, `household[agent['1']['household']]['characteristics']`

```
onlyadults = (only_adults == 1)
onlyworkers = (only_workers == 1)
HH_with_under_4 = (num_underfour >= 1)
HH_with_under_15 = (presence_of_under15 >= 1)
```

6. Adult gender/children

```
maleage4 = (female_dummy == 0) * (HH_with_under_4 == 1)
maleage515 = (female_dummy == 0) * (HH_with_under_15 - HH_with_under_4)
malenone = (female_dummy == 0) * (HH_all_adults == 1)
femalenone = (female_dummy == 1) * (HH_all_adults == 1)
femaleage4 = (female_dummy == 1) * (HH_with_under_4 == 1)
femaleage515 = (female_dummy == 1) * (HH_with_under_15 - HH_with_under_4)
```

7. Income

The income need to be accessed from **population** database. `incmid` is the middle point of each income level. `missingincome` means that income information is not provided for the person.

```
missingincome = (income_id>=13)
income = income_mid[income_id] * (1 - missingincome)
```

8. Other

Note that car ownership and motor ownership are household characteristics.

```
workathome = (work_at_home_dummy == 1)
caravail = (car_own_normal + car_own_offpeak == 1)
motoravail = (motor_own == 1)
```

9. logsums

Four logsums `worklogsum`, `edulogsum`, `shoplogsum` and `otherlogsum` are included. Generating the 4 logsums will be introduced in seperate report.

Availability of Alternatives

For day pattern model, the availibility of 51 alternatives is only determined by `person_type`.

- For Full time student (`person_type_id=4`): All alternatives are available.
- For other person type: only alternatives with `EduT=0` are available to them. (alternative 13-28 and 45-51 are not available)