Assignment 1

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Course Name: Dynamic Structural Models

1 Overview

The goal of this assignment is to generate data for a single agent dynamic model using value function iteration. We will follow a simple specification of the Rust bus engine problem, with i.i.d GEV errors. Use the Expected Value function iteration to generate the EV_θ values at each combination of the observed state variable and choice.

2 Model specifications

- One observed state variable x_t, which is mileage
- Assume a deterministic state transition such that:

$$\begin{aligned} x_t &= x_{t-1} + 1 \text{ if } x_{t-1} < M \\ x_t &= x_{t-1} \text{ if } x_{t-1} = M \end{aligned} \tag{1}$$

- Assume the per period maintenance cost to be $\theta_1 \cdot x_t$
- Assume a fixed cost of replacement to be θ_2

3 Inputs

Your code should take the following inputs:

- Number of buses N
- Number of periods per bus, T
- Maximum mileage M
- Discount factor β
- Parameters $\{\theta_1, \theta_2\}$

4 Outputs

For a given set of input parameters (described above), the code should generate the following outputs:

- The observed probability distribution of mileage.
- A histogram of choice probabilities at each mileage level.
- A dataset of mileage and observed choices for each bus for each period in .txt format.
  - Hint 1: Use the choice probabilities at each mileage to make a draw of an observed choice.
  - Hint 2: The dataset should have the following fields: BusNo., Timeperiod, DecisionNo. (0 – continue, 1 – replace), Mileage, ExpChoiceSpecificValuefunction, Chosen (0 – this option was not chosen, 1 – this option was chosen). Figure 1 shows you an example snapshot of how the data should look.

I will test the correctness of your code by asking you to generate data for a set of parameters and then importing the data into Stata and recovering the parameters. So you should make sure that your dataset does not have strings or other types of bugs, and is importing into Stata without any difficulty. To test if the dataset is in the correct format and behaving well, use this command in Stata – insheet using data.txt. The text data should be in the same directory that you are operating Stata from for the command to work.

5 Some suggestions

- Play with the input parameters to understand how often replacement happens, and what parameter values generate data so you see replacement sufficient number of times per bus, but not always.
- Vary the tolerance values for convergence and see how your data varies.
- Numerical precision can be an issue when working with exponentiated variables and your code may run into overflow problems or have difficulty converging. To avoid this problem, employ these fixes:

$$log(e^x + e^y) = max(x, y) + log(e^{x-max(x,y)} + e^{y-max(x,y)}) \tag{2}$$

$$\frac{e^x}{e^x + e^y} = \frac{e^{x-max(x,y)}}{e^{x-max(x,y)} + e^{y-max(x,y)}} \tag{3}$$

	v1	v2	v3	v4	v5	v6
1	0	0	0	0	-21.18135	1
2	0	0	1	0	-21.18135	0
3	0	1	0	1	-21.90644	1
4	0	1	1	1	-21.18135	0
5	0	2	0	2	-22.04089	0
6	0	2	1	2	-21.18135	1
7	0	3	0	1	-21.90644	1
8	0	3	1	1	-21.18135	0
9	0	4	0	2	-22.04089	0
10	0	4	1	2	-21.18135	1
11	0	5	0	1	-21.90644	1
12	0	5	1	1	-21.18135	0
13	0	6	0	2	-22.04089	0
14	0	6	1	2	-21.18135	1
15	0	7	0	1	-21.90644	1
16	0	7	1	1	-21.18135	0
17	0	8	0	2	-22.04089	0
18	0	8	1	2	-21.18135	1
19	0	9	0	1	-21.90644	0
20	0	9	1	1	-21.18135	1

Figure 1: Example of a dataset with the six columns in the same order as that described above.