シェアサイクルの時系列特性を鑑みた末端交通に焦点を当てた行動モデルへの考察

Considerations for behavior models based on the time-series characteristics of shared cycles

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Problems of Bicycle-Sharing service

1. O-D Heterogeneity

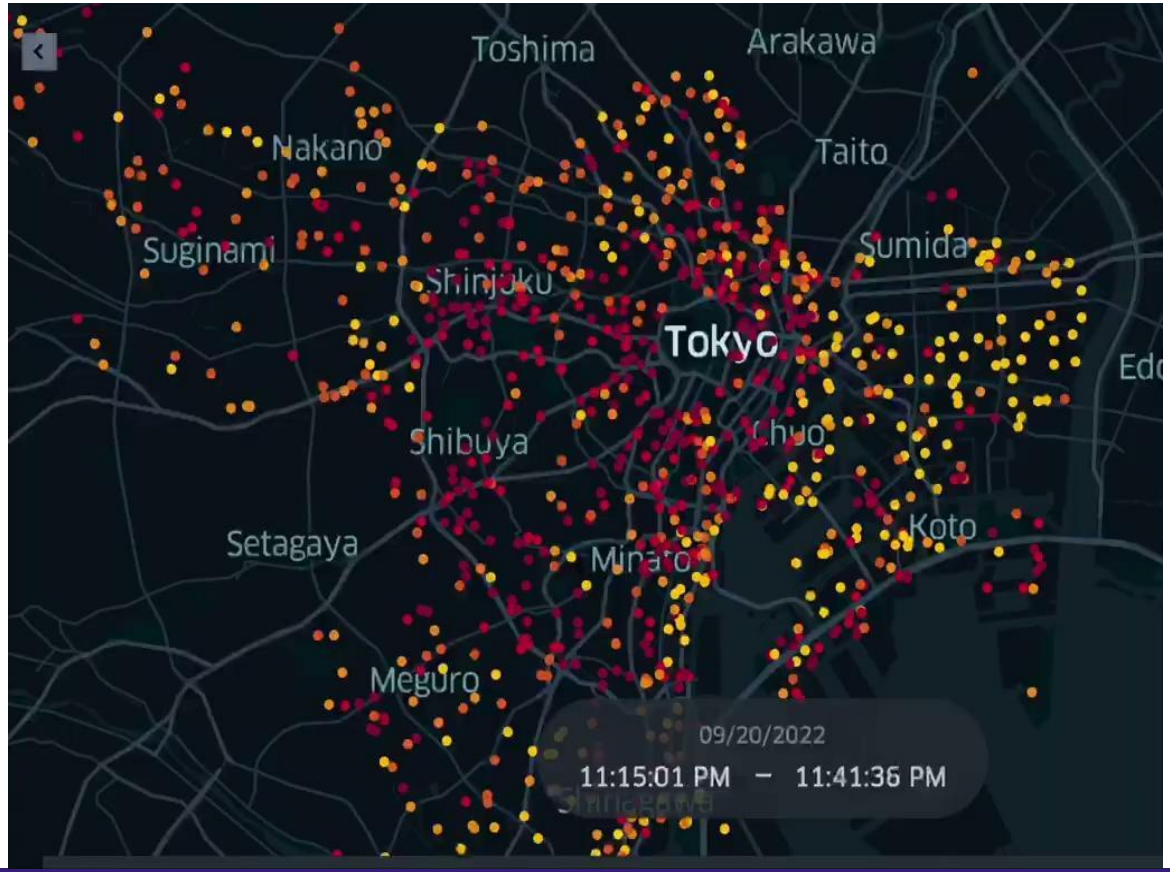
Availability varies widely by time zone

https://www.okayama-u.ac.jp/tp/news/news_id4912.html

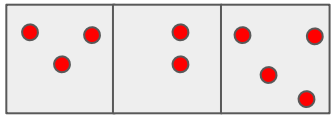
2. High Initial Cost

Psychological Barrier for Registration

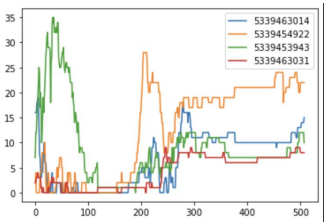
Distribution of available units



Clustering Result

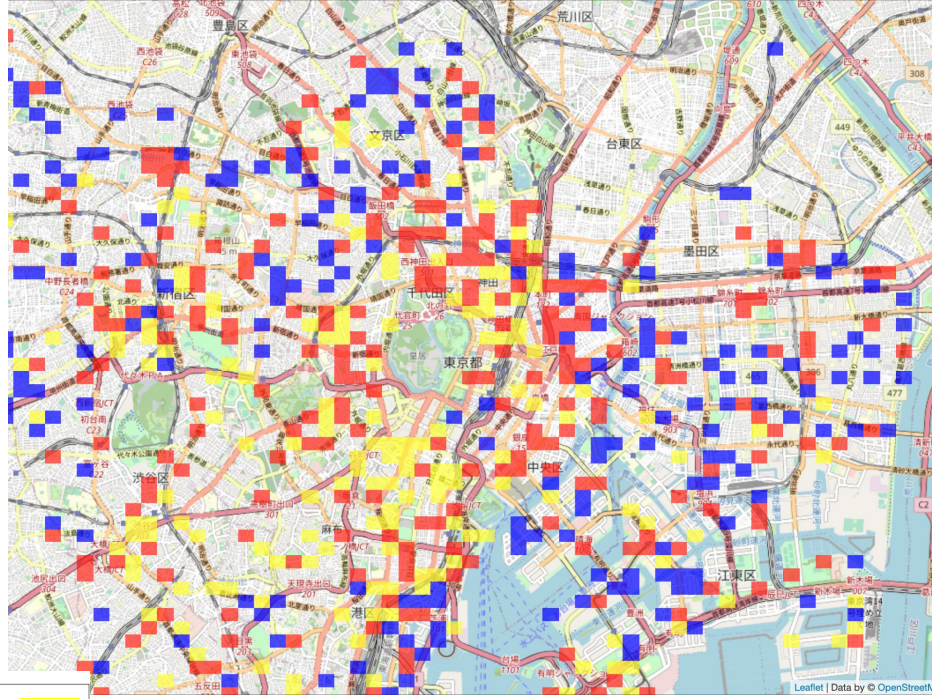


Point to 250m mesh



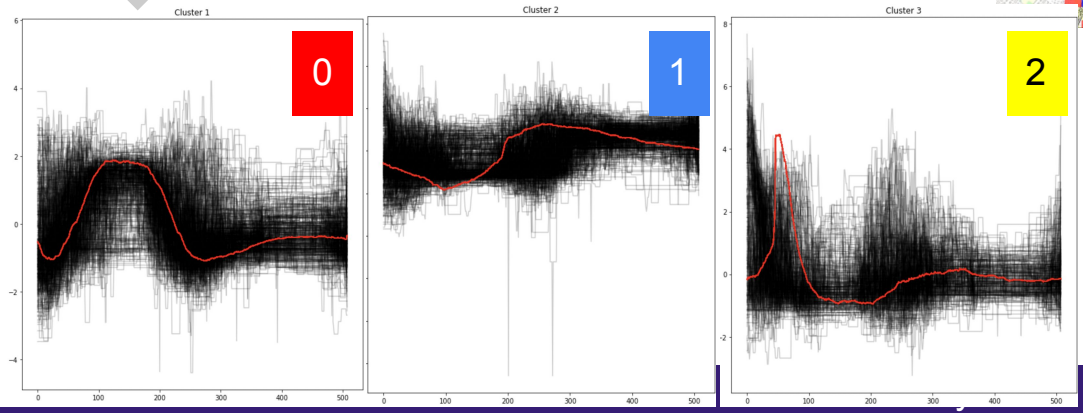
time-series data
of available units

mapping



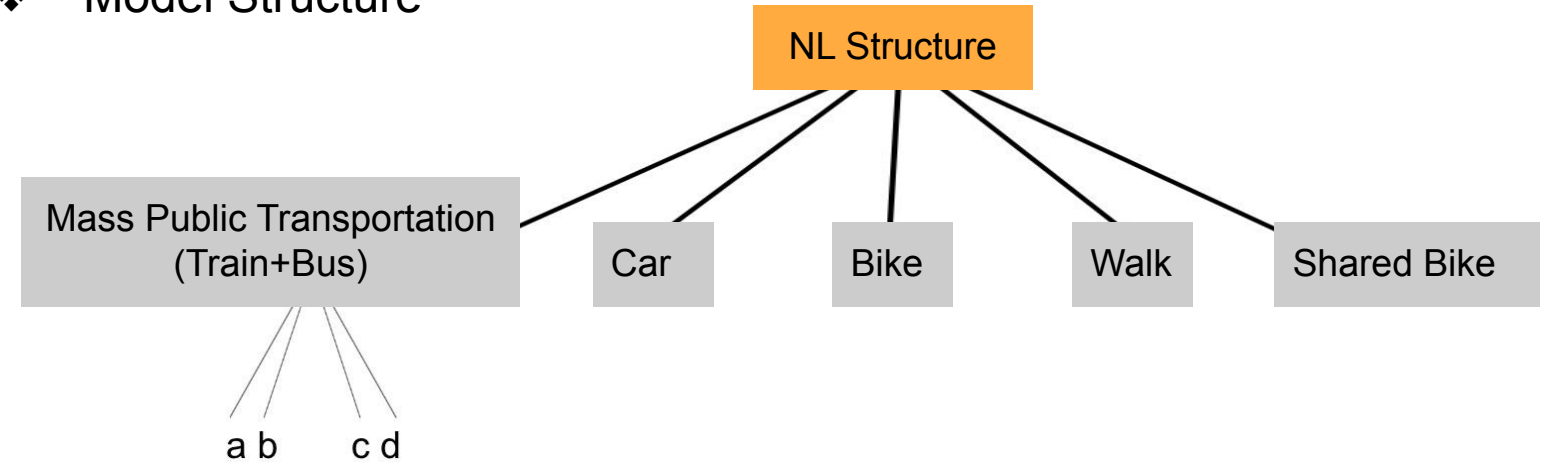
Spatial Distribution

Clustering: KShape(k = 3)



Modeling

❖ Model Structure



➢ A: using a shared bike between Origin and Station

➢ B: using a shared bike between Station and Destination

a: A=True ∧ B=True	**b**: A=True ∧ B=False
c: A=False ∧ B=True	**d**: A=False ∧ B=True

Model Estimation

❖ Utility Function

Car $u_n = \beta_t time + \beta_c cost$

Walk $u_n = \beta_t time$ ·

Bike $u_n = \beta_t time + \beta_c cost + \beta_r \text{sigmoid}(rain - 1)$

if use Shared Bike $u_n = \beta_t time + \beta_c cost + \beta_a access\&egress + \beta_r \text{sigmoid}(rain - 1) + \sum_c \beta_{b,c} \delta_c f(bikes)$

Mass Public Transportation (Train+Bus) $u_n = \beta_t time + \beta_c cost + \beta_a access\&egress + \delta_b \beta_r \text{sigmoid}(rain - 1) + \sum_c \beta_{b,c} \delta_c f(bikes)$

- ➢ **sigmoid(*rain-1*)** : consideration for weather conditions
- ➢ ***bikes*** : number of available bikes

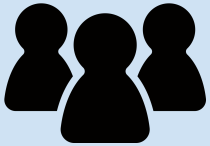
Estimation Results

Variable		Estimated Parameter	t statistic
time		-3.367	-5.126
cost		34.1993	NaN
access egress time		-8.5801	-1.764
class 1:	d(bikes)/dt	-27.501	-0.176
class 2:	d(bikes)/dt	22.843	0.262
class 3:	d(bikes)/dt	9.467	0.048
constant term	a- MPT	-4.496	NaN
	b- MPT	-14.137	NaN
	car	-0.921	-13.246
	sharebike	-8.1693	-9.321
scale parameter		1.09	13.161
Number of sample			104639
Initial LL			-443295
Final LL			-35392
LL Ratio			0.9202
Adjusted LL Ratio			0.9201

Heterogeneity in user - High initial cost

Perception for the cost changes a lot depending on each person's past usage.

Class. A
-not have used ever



Great resistance for registration→*"high cost"*

$u = \beta_t * time + \beta_c * cost + \beta_{ic} * initial\ cost + v$

Class. B
-have used **a few times**

so-so resistance

$u = \beta_t * time + \beta_c * cost + v$

Class. C
-already registered for subscription

no resistance for extra cost→*"$0"*

$u = \beta_t * time + v$

Consideration for Endogenous

Crowdedness (high demand)

Vacant

Used a lot

model estimation

"higher probability to be chosen"

Crowdedness provides higher utility??

Generate even more demand?

No! Endogenous should be considerated!

$$u_n = \beta_t time + \beta_c cost + \beta_r \text{sigmoid}(rain - 1) + \beta_b bikes + \beta_{\dot{b}} \frac{\partial(bikes)}{\partial t}$$

Discussion

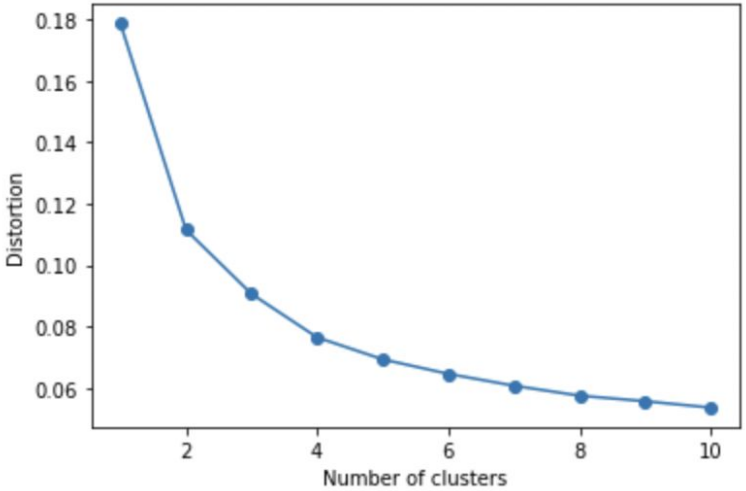
- Due to the lack of data, we couldn't finish constructing useful behavior model.
- For example … The amount of data related to bicycle-sharing was too small to descript its choice behavior.

  → We need to accumulate more data on its selection behavior.
- Also, there may be some problems in current way of collecting data.
- If a detailed model could be built, it would be possible to analyze changes in public transportation choice behavior due to the optimization of shared bike port placement and the introduction of shared bikes as terminal transportation.

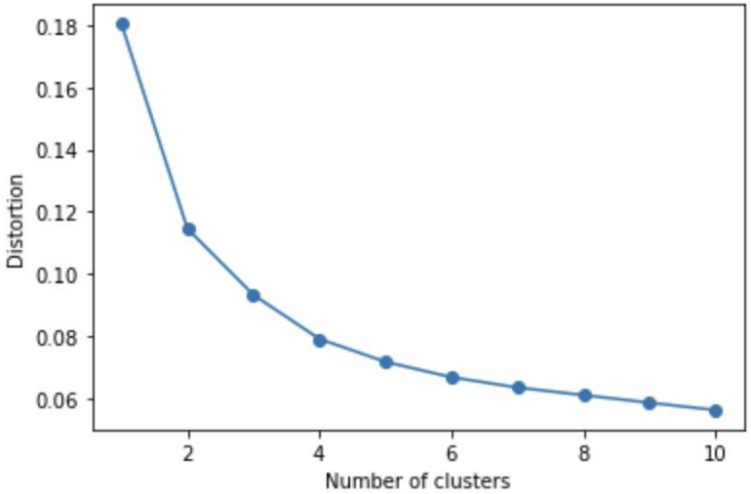
- More detailed and thorough data will enable us to construct useful models featuring shared bikes.

Thank you for your attention

Consideration of Accuracy: Elbow method



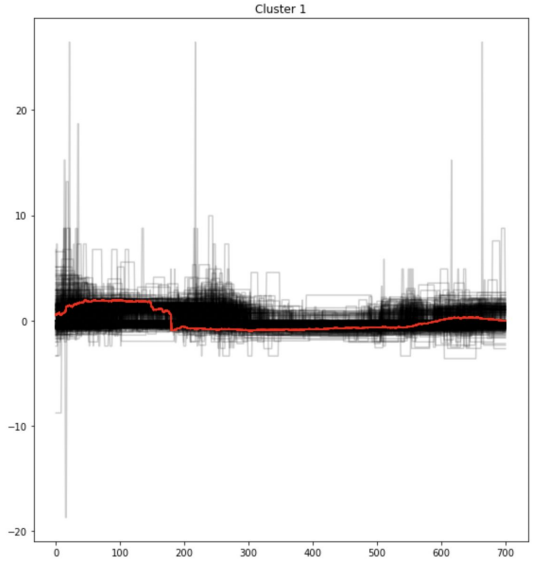
the number of available bikes

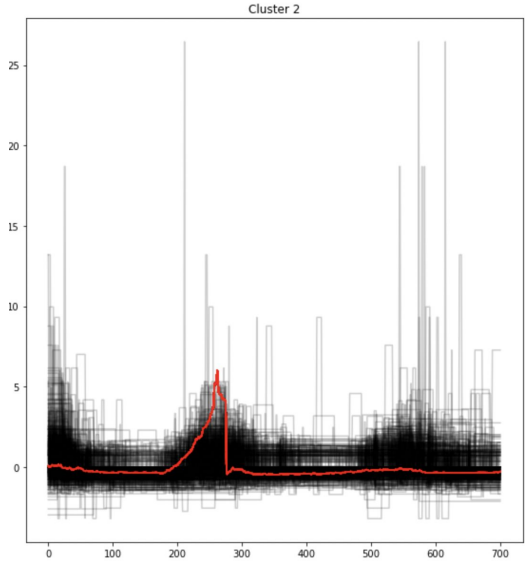


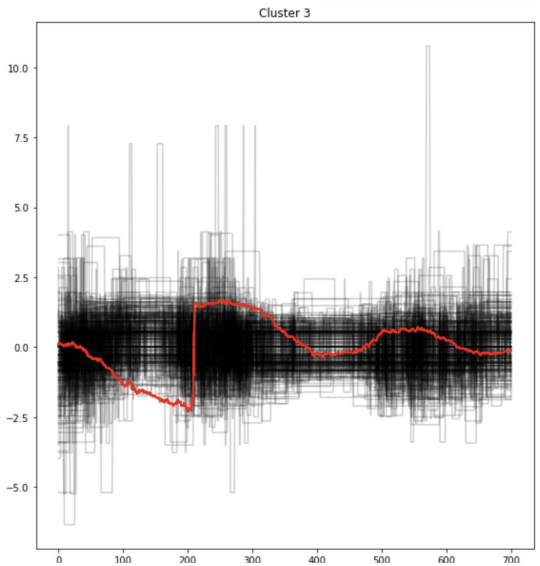
Probability of unavailable port

Appendix

clustering result







Appendix

the number of trip

	代表交通手段N			0
0	--	0.0	0.0	2
1	シェアサイクル	0.0	0.0	1238
2	シェアバイク	0.0	0.0	189
3	タクシー	0.0	0.0	938
4	タクシー	0.0	1.0	1
5	バイク	0.0	0.0	1912
6	ベロタクシー	0.0	0.0	8
7	モノレール	0.0	0.0	366
8	モノレール	0.0	1.0	1
9	モノレール	1.0	0.0	1

access↓ ↓egress

10	乗用車	0.0	0.0	10835
11	乗用車	0.0	1.0	1
12	地下鉄	0.0	0.0	15633
13	地下鉄	0.0	1.0	8
14	地下鉄	1.0	0.0	4
15	徒歩	0.0	0.0	36192
16	徒歩	0.0	1.0	1
17	自転車（個人所有）	0.0	0.0	15314
18	貨物車	0.0	0.0	656
19	路面電車	0.0	0.0	219
20	鉄道(新幹線,JR,私鉄)	0.0	0.0	21089
21	鉄道(新幹線,JR,私鉄)	0.0	1.0	11
22	鉄道(新幹線,JR,私鉄)	1.0	0.0	19
23	飛行機	0.0	0.0	1