

Exploration of day trippers' movement in Tokyo metropolitan area through the pattern mining of people flow data

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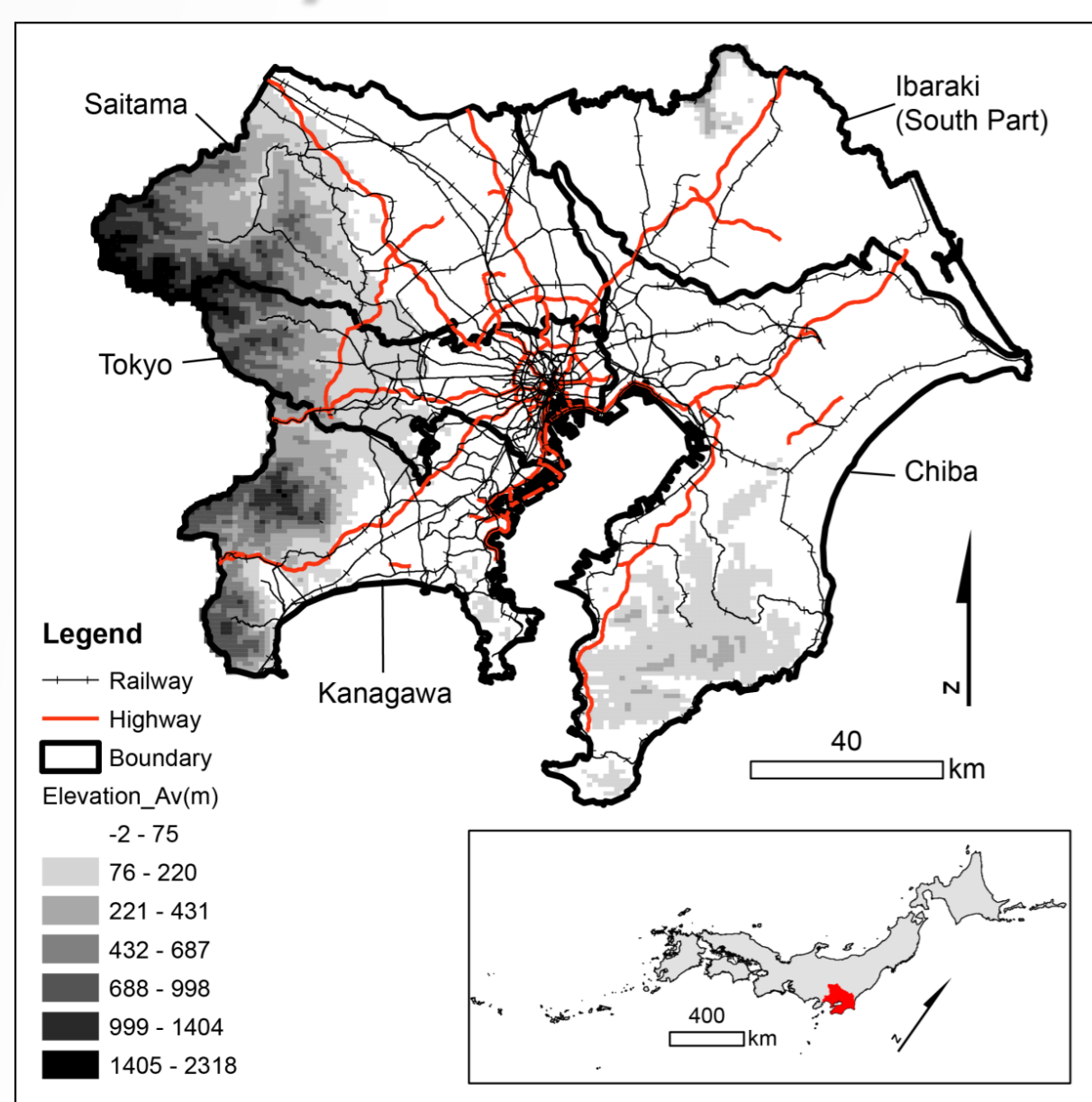
Background

- In the field of geography on tourism, exploring patterns of tourist movement in a space-time dimension have been regarded as important research theme.
- Researchers have investigated it in different scales and settings for clarifying or characterizing tourists in their movement patterns by using various instruments such as questionnaires, GPS loggers, and statistics data, and selected an appropriate analytical method for each.
- However, tourist movement in the area across multiple prefectures such as metropolitan areas including a mega city and peripheral sites has not been sufficiently studied because of difficulties of large data acquisition of tourist to (from) urban area.

Purpose To clarify patterns of day trippers' movements for sightseeing purposes in the metropolitan areas using a large dataset of people flow

Methodology

Study area



Tokyo Metropolitan area

Annual number of tourist visits

Prefecture	Annual Number of Tourist arrivals (×1,000)						Total
	Japanese Tourists		From Others		Foreign Tourists		
	Day Trip	2 or more	Day Trip	2 or more	Day Trip	2 or more	
Tokyo	222,544	2,880	194,876	6,325	1,379	1,646	429,650
Kanagawa	30,038	2,874	26,163	4,823	150	287	64,335
Chiba	31,811	1,439	37,777	7,820	145	716	79,708
Saitama	66,109	1,436	27,286	1,295	-	11	96,137
Ibaraki	12,780	456	12,564	1,139	26	14	26,979

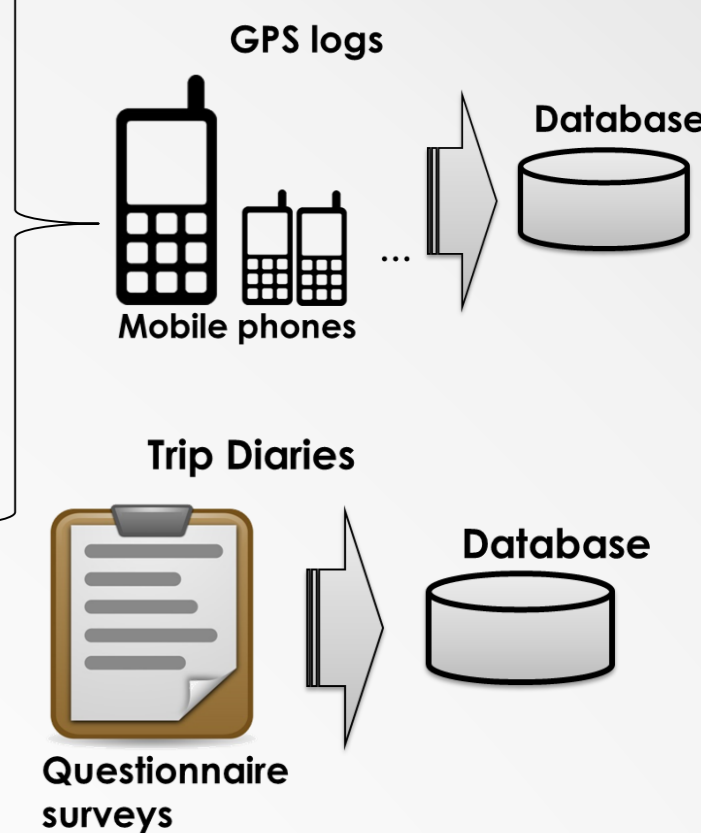
※tips for sightseeing, not included in business trips
The number of day trippers is overwhelmingly larger than those who come for trips of two or more days.

Data

- A series of people flow data which inter-regional person trip data in urban areas all over Japan is converted into point vector data
- the location of each person on every 1 minute
- for Tokyo metropolitan area on October 1, 2008 (one of typical weekdays)
- about 576,000 persons' day trips information (829 million records)
- attributes: gender, age, job, trip purpose, transport and etc.

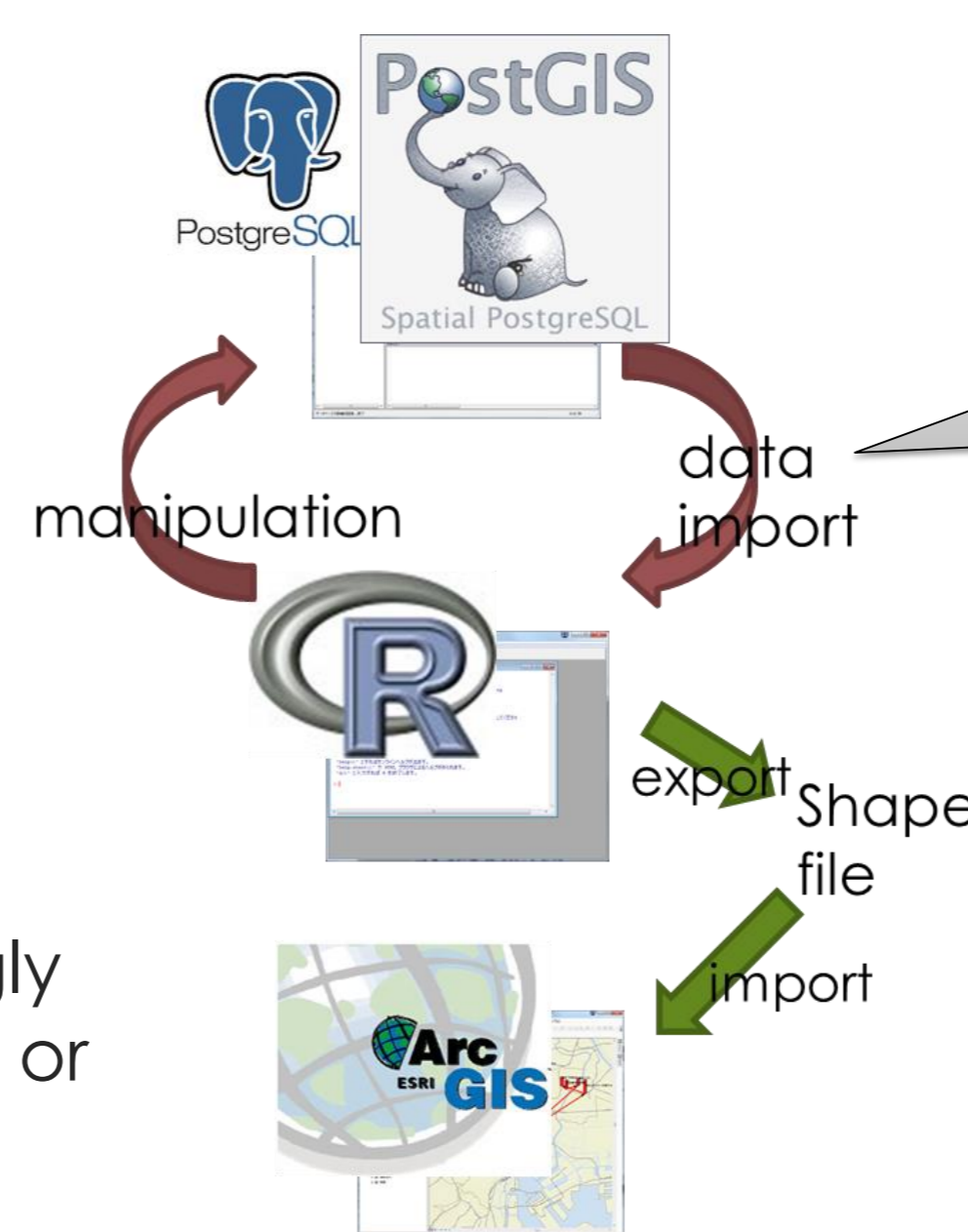
Recent data providing services in Japan

Company	Data Collection	Data	Area	Date	Price
DoCoMo	Mobile phone	GPS logs	Whole country	365 days	Expensive
KDDI Colopl	Mobile phone	GPS logs	Whole country	365 days	Expensive
AGOOP Corp. MicroSoft	Mobile Phone	GPS logs	Whole country	365 days	Expensive
NAVITIME	Car Navigation	GPS logs	Whole country	365 days	Expensive
CSIS (Tokyo University)	Questionnaire Survey	Trip Diary	Metropolitan Area	Once every ten year	No cost



In Japan, recent development of providing services for data of people flow enabled us to conduct the investigation about human trajectories based on large samples.

Data processing



Data Management

the data for 10,213 individuals who acted as sightseers

Mathematical Analysis

- Descriptive statistics
- Pattern mining of multiple zone visits association rules

Visualitic Analysis

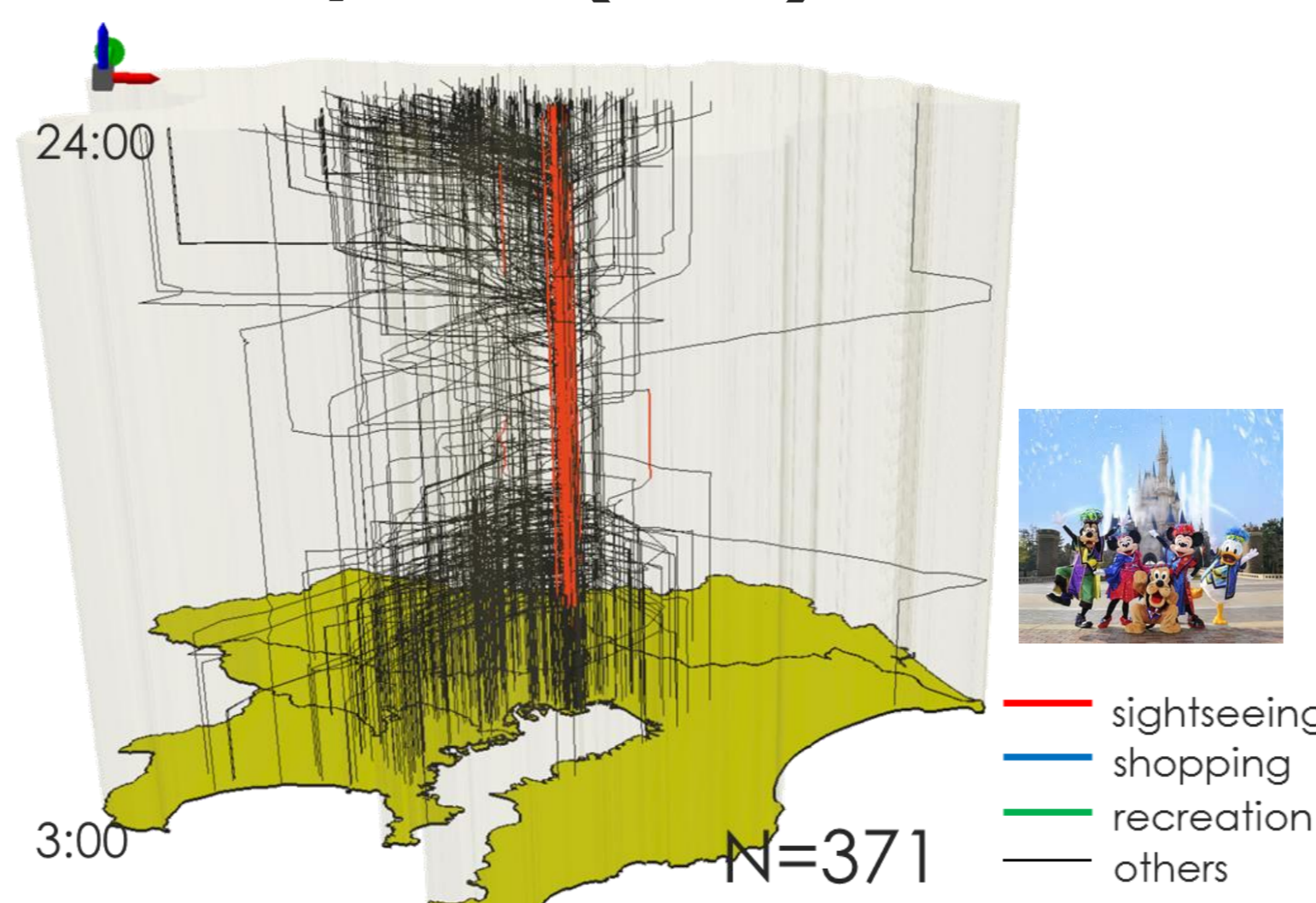
- Mapping tourist flows space-time pass

Results

Top 10 Zones in number of tourist visits

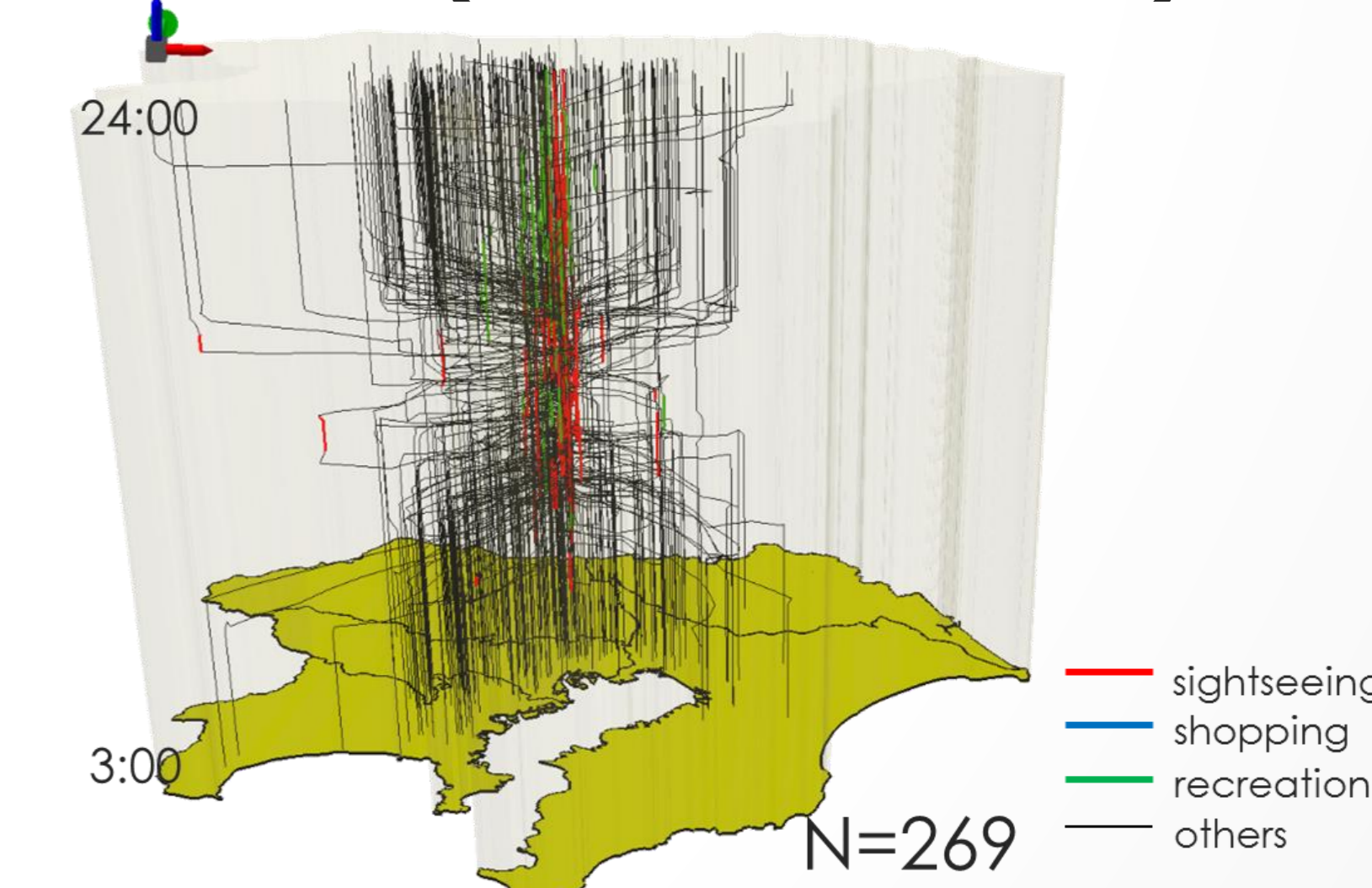
Rank	Prefecture	Zone (Municipality)	Number of people	Ave. staying time	Ratio of number of visits	
					1 zone	2 or more
1	Chiba	Urayasu	371	506	98.1(%)	1.9(%)
2	Tokyo	Taito_1 (Ueno)	269	152	84	16
3	Tokyo	Tachikawa	151	193	92.1	7.9
4	Tokyo	Taito_2 (Asakusa)	123	169	75.6	24.5
5	Tokyo	Shinjuku_1	115	164	80	20
6	Tokyo	Minato_1 (Roppongi)	113	153	73.5	26.6
7	Tokyo	Shibuya	90	178	76.7	23.3
8	Tokyo	Bunkyo_1	88	195	88.6	11.4
9	Kanagawa	Yokohama_1 (Minatomirai)	88	179	79.5	20.5
10	Kanagawa	Kamakura_1	81	169	82.7	17.3

① Urayasu (TDR)



- the average staying time for people who visited Urayasu is longer than for others.
- They visit in the early morning, return home late at night

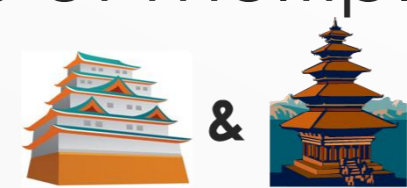
② Taito (Ueno, Yanaka)



- Short stay in various time
- multiple zone visits and purposes

Multiple zone visits

Extracting frequent patterns of multiple zone visits



Association Rule Mining

One of data mining techniques that find rules which will predict the occurrence of an item based on the occurrences of other items in the transaction

Market-Basket transactions	If	Then
ID Items		
1 Bread, Milk		{Bread} ⇒ {Milk}
2 Bread, Butter, Beer, Eggs		{Bread, Milk} ⇒ {Butter}
3 Bread, Milk, Butter, Beer		
4 Bread, Milk, Butter, Coke		

※ Based on the conditional probability
→ **Not sequential patterns!!**

Extracted Rules

No.	Rules
1	{320 Taito} ⇒ {321 Taito}
2	{20 Chuo} ⇒ {323 Taito}
3	{220 Bunkyo} ⇒ {323 Taito}
4	{2410 Fujisawa} ⇒ {2312 Kamakura}
5	{31 Minato, 323 Taito} ⇒ {241 Shibuya}
6	{31 Minato, 323 Taito} ⇒ {1011 Yokohama_Nishi}
7	{2130 Kawasaki_Tama} ⇒ {2122 Kawasaki_Miyamae}
8	{1021 Yokohama_Naka} ⇒ {1022 Yokohama_Naka}
9	{2812 Aikawa} ⇒ {2813 Kiyokawa}

It is similar with the result of previous study for foreign tourists conducted by Yabe and Kurata(2013)

Conclusion

Findings

- Clarification of the day tripper movement patterns in the Tokyo Metropolitan Area using a large dataset of people flow
- Most tourists visit one zone in a day
- Patterns of Multiple zone visit are extracted
- Japanese tourists visit similar places to foreign tourists, although there are differences in a few cases

Future Works

- Analysis combining other attribute information such as age, gender, job, home address, transportation etc.
- Other metropolitan areas