Sequential tourist behavior choice modeling based on uncertain observational data

UTokyo bin.B

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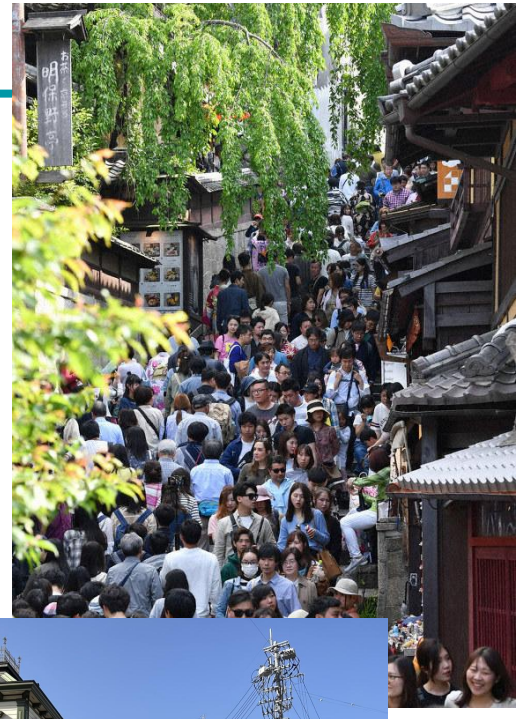
Background

- **Over-tourism** is now becoming big issue in the world.
- **Dogo Onsen (hot spring in Matsuyama, Ehime)** is so popular that numbered tickets are distributed in order to **control congestion**.



time bias of congestion

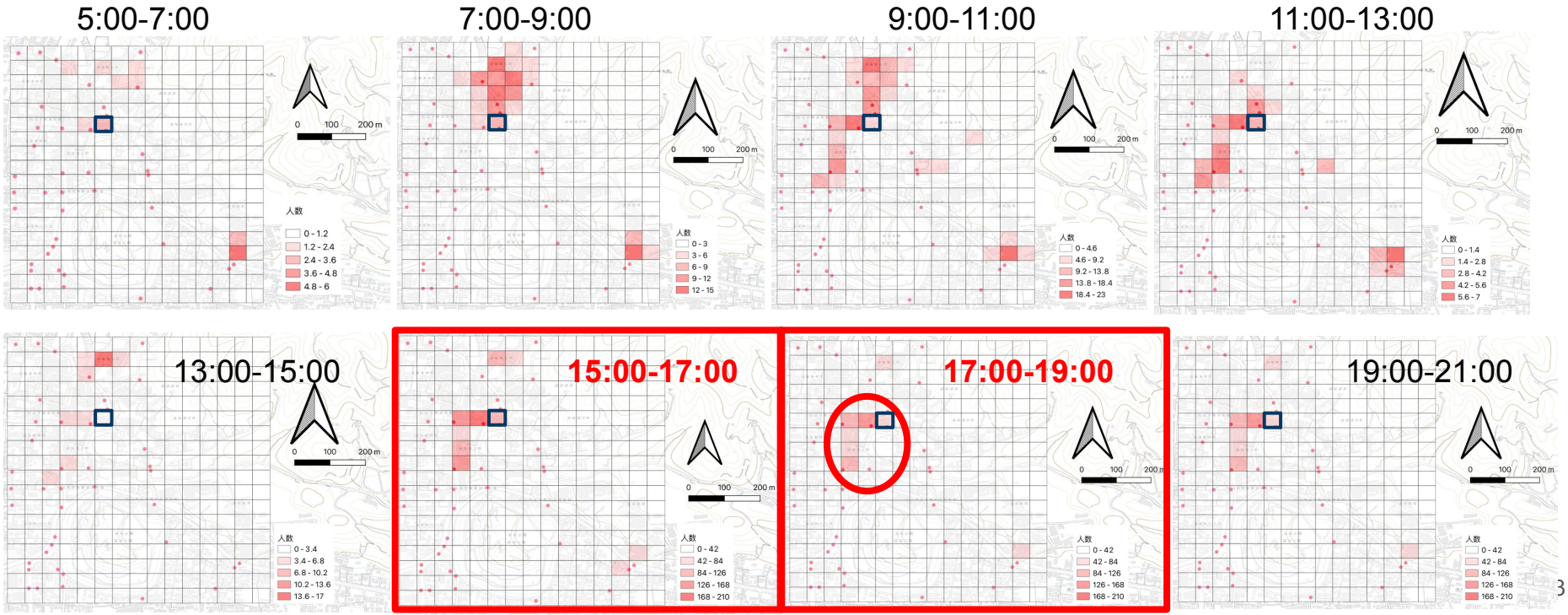
Tourism behavior varies by time of day

→*Utility of each activity may change by time*

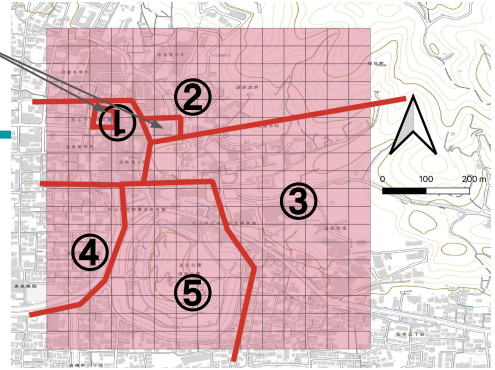
→Analyze tourists' activity choices, focusing on hot springs and time variation

Basic analysis

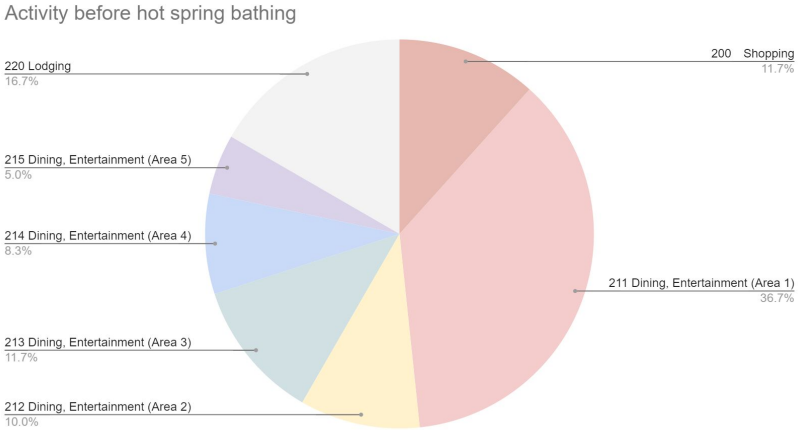
- Congestion degree at the center of Dogo differs by time zone
  (note that each maps has a different scale, used data: Dogo PP in 2017)

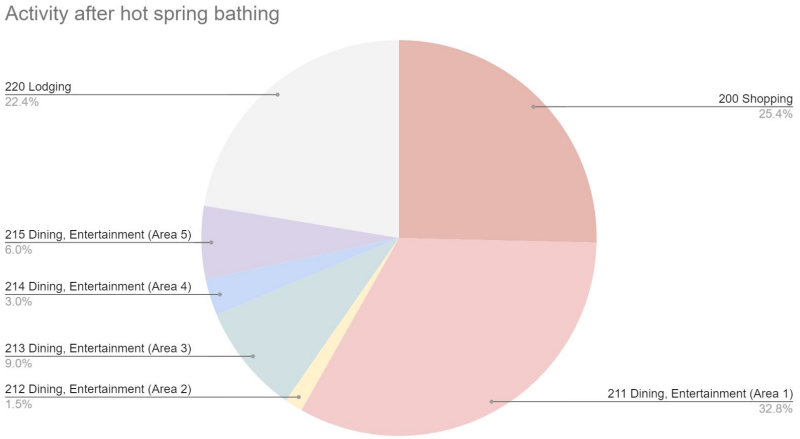


Basic analysis



- Hypothesis : **Utility of each activity will change by time**
  - In particular, before and after visiting a hot spring
  - e.g. People will be less likely to walk a lot after visiting a hot spring.





Framework

Discrete activity choice model in Dogo

- **Activity based model**
  →route selection model in time-activity NW
  - timestep: 30min
  - choice of activity:
    hot-spring, shopping, eating or entertainment,
    stay hotel, outside of Dogo, unknown

- Data
  - Shinjyuku-Matsuyama PP(2022)

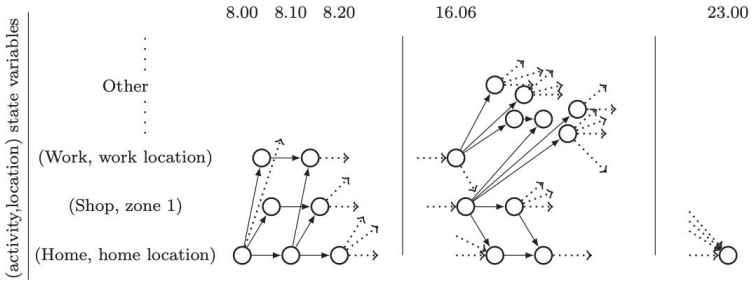


Fig. 1. Illustration of an activity network.

Zimmermann(2018)

models

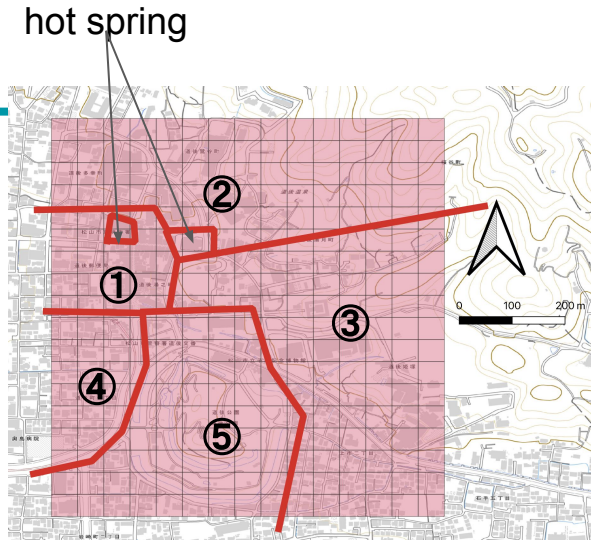
state at t

- eating / entertainment
- hot spring
- shopping
- at hotels
- in/out (Dogo)

Area 1
Area 2
Area 3
Area 4
Area 5

state at t+1

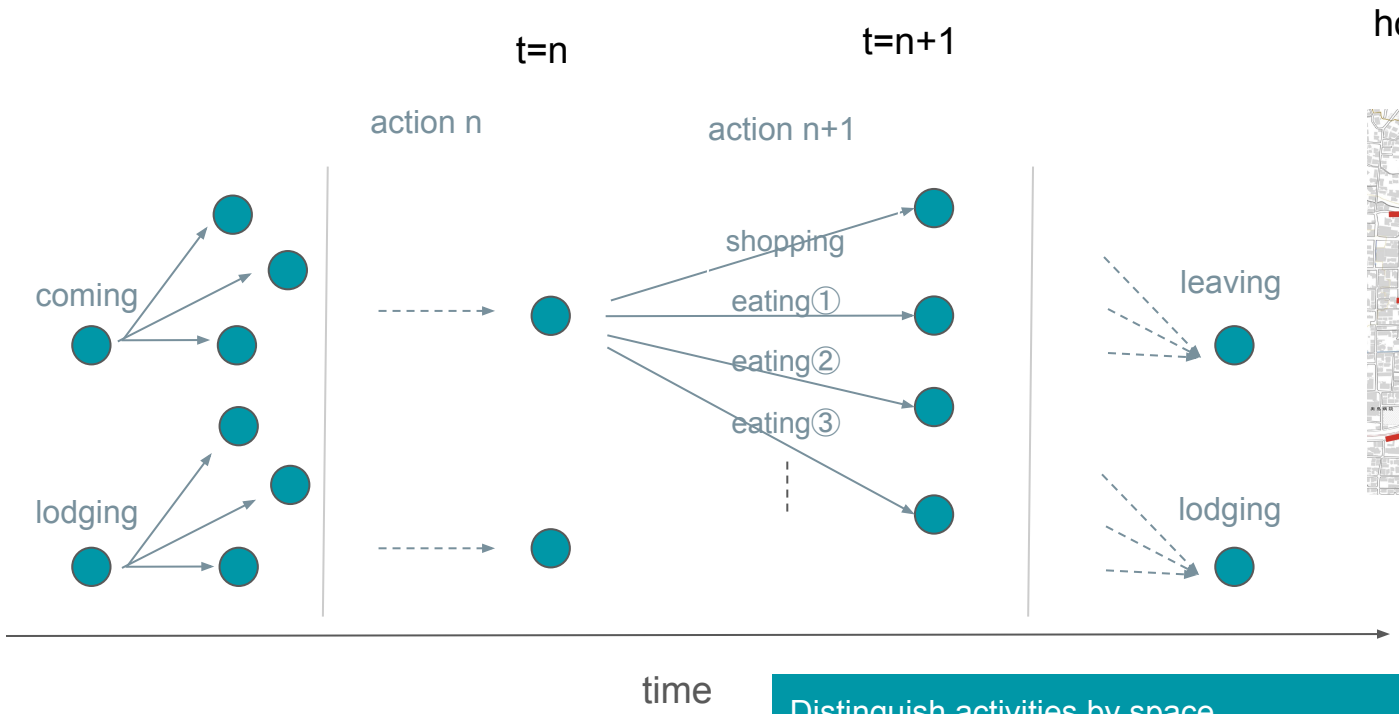
- eating / entertainment
- hot spring
- shopping
- at hotels
- in/out (Dogo)



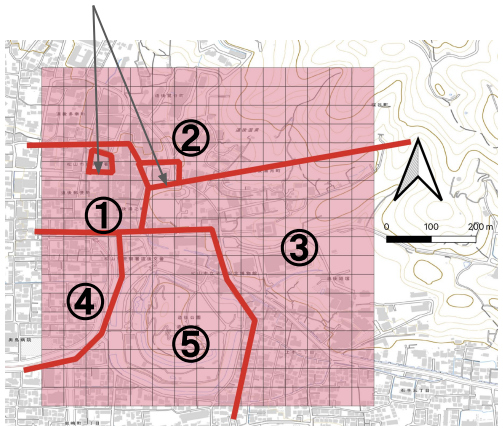
We defined Dogo area as the above knitted zone, which are divided into 5 zones and hot spring spot.

活動を空間ごとに区別（一応特徴ではある）

models



hot spring



We defined Dogo area as the above knitted zone, which are divided into 5 zones and hot spring spot.

Distinguish activities by space
(a feature, in case you were wondering)

Utility function

- timestep = 30min
- V = E[max{u + eps + beta*V (DRLmodel)}] s.t. beta=0.9
- u =
  - variables
    - hot spring dummy
    - eating/entertainment at zone 1 dummy
    - eating/entertainment at zone 2 dummy
    - eating/entertainment at zone 3 dummy
    - eating/entertainment at zone 4 dummy
    - eating/entertainment at zone 5 dummy
    - shopping dummy
    - hotel dummy
    - outside of Dogo dummy
    - activity changing dummy (1: when activity changes)

Estimation

- Because of bad coding, Hesse Matrix cannot be calculated and also t statistic could not be estimated.
- As for estimated parameter, activity change dummy has importance.

Variable	Estimated Parameter	t statistic
Activity change dummy	950.29	NaN
Hot spring dummy	107.5	NaN
Shopping dummy	113.37	NaN
eating / entertainment at zone 1 dummy	111.3	NaN
eating / entertainment at zone 2 dummy	103.03	NaN
eating / entertainment at zone 3 dummy	103.52	NaN
eating / entertainment at zone 4 dummy	103.11	NaN
eating / entertainment at zone 5 dummy	104.6	NaN
Staying at hotel dummy	123.8	NaN
Outside of Dogo dummy	240.34	NaN
Number of sample		85
Initial LL		28291.99
Final LL		NaN
LL Ratio		NaN
Adjusted LL Ratio		NaN

Further thought

- Analysis of how agents' choice behavior changes before and after bathing and at different times of the day
  - Estimate two models by dividing the input data into before and after taking a bath and compare the parameter values
  - →What difference in the utility of the activity before and after taking a bath
- Differences per action
  - Estimates time discount rate for each action → Represents characteristics of each action

References

- M. Zimmermann, O. B. V¨astberg, E. Frejinger, and A. Karlstr¨om, “Capturing correlation with a mixed recursive logit model for activity-travel scheduling,” Transportation Research Part C: Emerging Technologies, vol. 93, pp. 273–291, 2018.
- H. Shirai, E. Hato, “繰り返し行動を考慮したスケジューリングモデルによる需要調整型公共交通システム”, 2023