Joint Activity有無の状況が及ぼす交通手段選択への影響差 ― トリップ／GPSデータによる実証分析

“An Empirical Analysis of How Joint Activity Status Affects Mode Choice: Evidence from Trip and GPS Data”

2025年09月24日

広島大学 交通工学研究室 Hiroshima University Transportation Engineering Laboratory

一ノ瀬 翔輝 Ichinose Shoki
清水 怜一郎 Shimizu Reiichiro
白木 啓人 Shiraki Keito
北川 紘宇 Kitagawa Ko
大田 光之心 Ota Konoshin
錦織 俊光 Nishikiori Toshimitsu

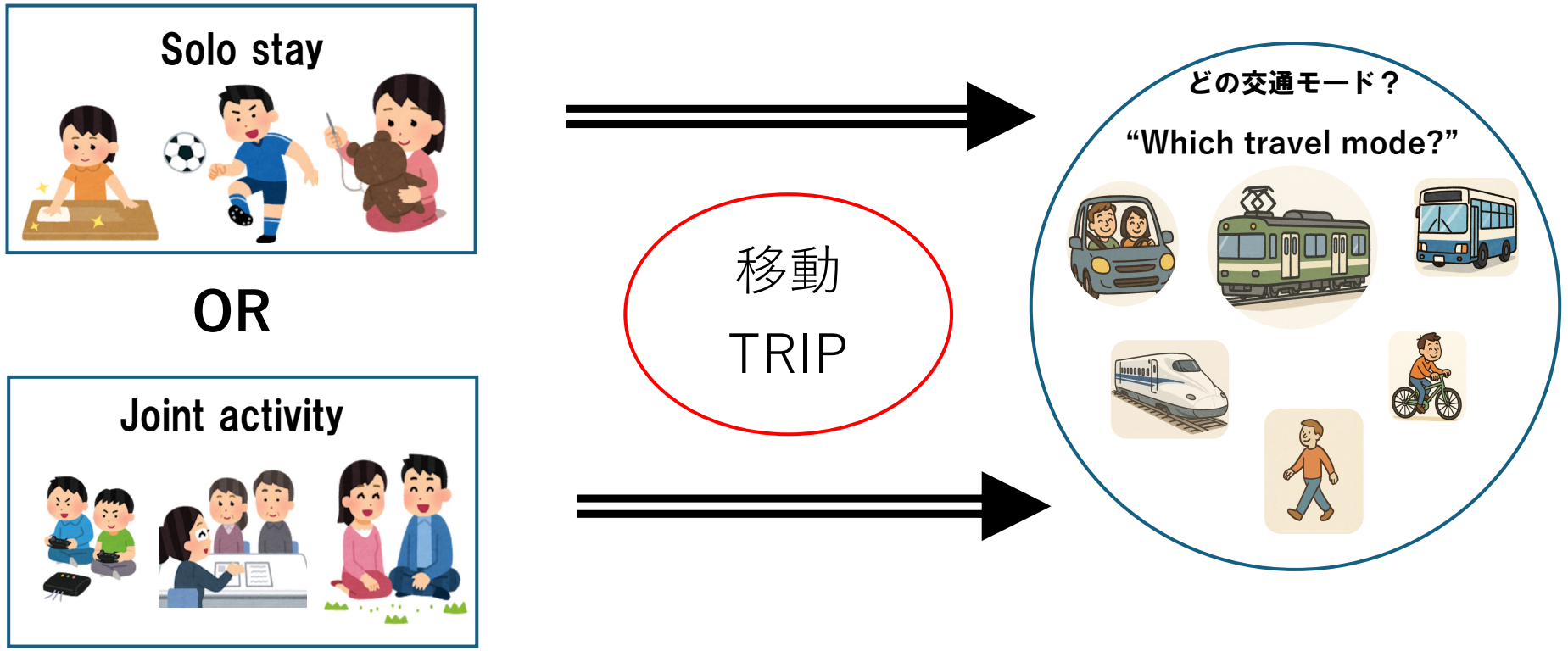
Background

- 交流を目的とするトリップと、交流を伴わない単独トリップとでは、交通手段選択行動に異なる影響が及ぶ可能性がある。

“Travel mode choice behavior may be influenced differently by trips intended for social interaction compared with solitary trips that do not involve such interaction.”

- Joint activity×交通手段選択の特定⇒政策に示唆を与える

“Identifying the interaction between joint activity and mode choice provides implications for policy.”

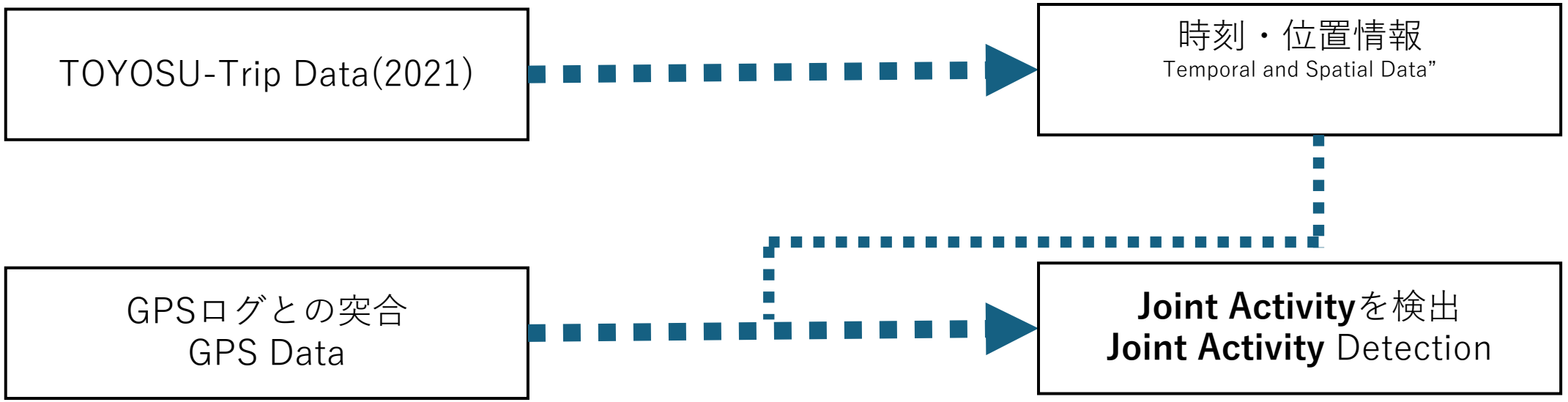


Analysis Flow

1.使用データ Data Used
2.基礎集計　Basic Aggregation
3.モデル構築　Model construction
4. Joint Activityの検出　Joint Activity Method of Preparation
5.推定結果　Estimation Results
6.考察　Discussion

1. Data Used

- trip_toyosu_2021(trip数:38,491トリップ,ユーザー数:325人)
- loc_data



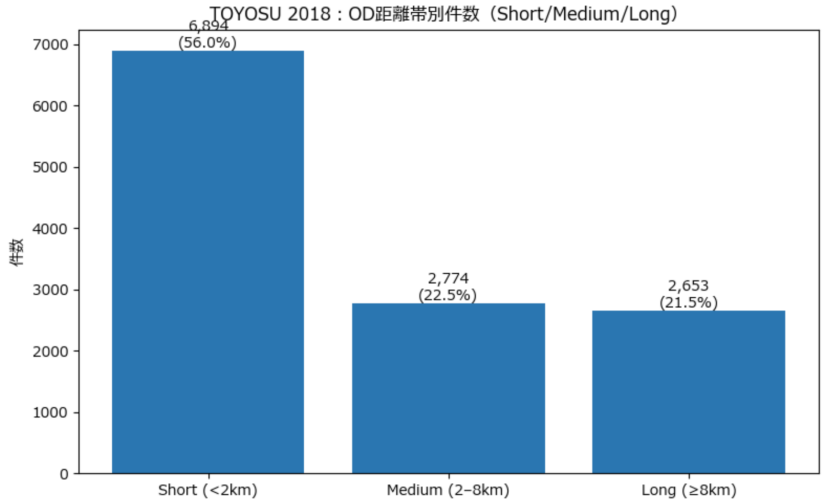
2. Basic Aggregation

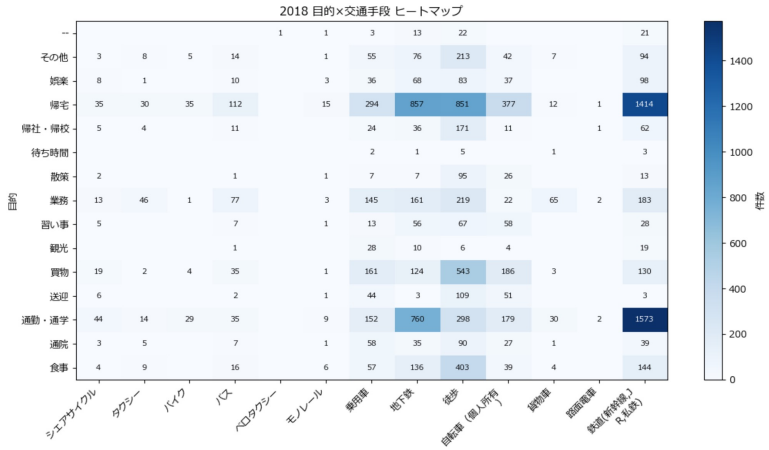
- Daily use is the main purpose (commuting, shopping, homing)
- Many short-distance travelers

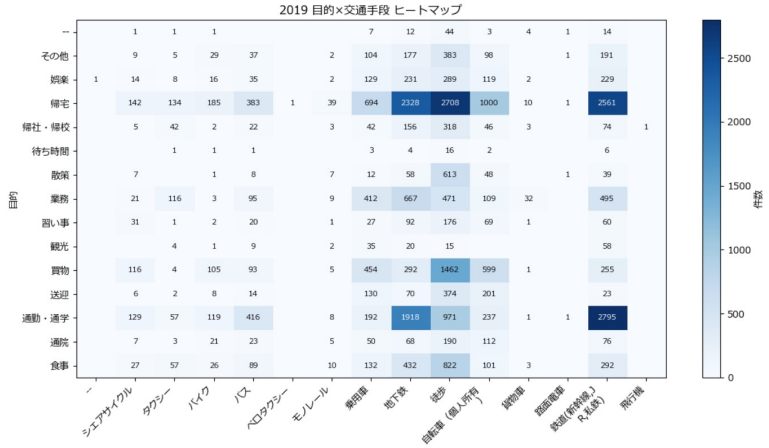
→Concentration of Residential areas & workplace

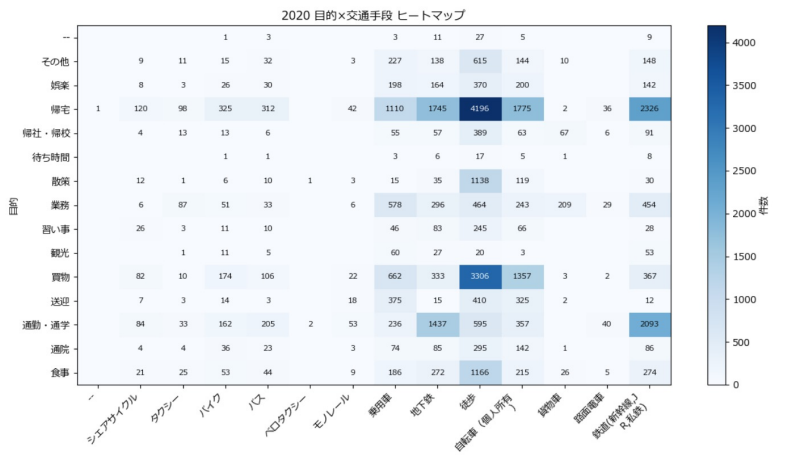
距離帯別件数

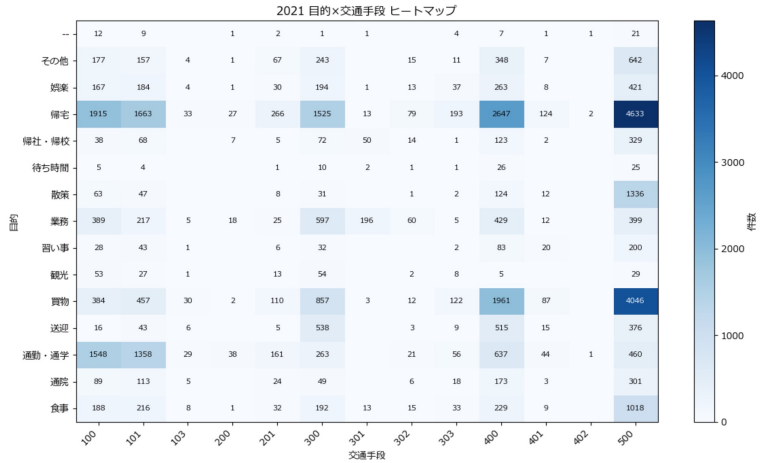
	count	share_%
Short (<2km)	6894	56.0
Medium (2–8km)	2774	22.5
Long (≥8km)	2653	21.5











3. Method construction

Explanatory Variables
説明変数

- 費用
- 所要時間

Multinomal logit model
多項ロジットモデル

$$U_{in} = \beta X_{in} + \epsilon_{in}$$

$$P_{in} = \frac{e^{U_{in}}}{\sum_j e^{U_{jn}}}$$

X_{in}：説明変数、β：推定パラメータ、ϵ：誤差項

Choices
選択肢

- 徒歩
- 自動車
- バス
- 鉄道/地下鉄

効用関数

$$V_{Walk} = \beta_{time} \cdot Time_{Walk} + ASC_{Walk}$$
$$V_{car} = \beta_{time} \cdot Time_{Car} + \beta_{fare} \cdot Fare_{Car}$$
$$V_{Train} = \beta_{time} \cdot Time_{Train} + \beta_{fare} \cdot Fare_{Train} + ASC_{Train}$$
$$V_{Bus} = \beta_{time} \cdot Time_{Bus} + \beta_{fare} \cdot Fare_{Bus} + ASC_{Bus}$$

4. Joint Activity Method of Preparation

Joint Activityの定義

Definition of Joint Activity

Joint Activity ：任意の二者が一定時間以上にわたり空間的近接を保ちながら同一の移動を共有した後（共移動）その移動の到達地点においてさらに一定時間以上空間的近接を維持しつつ共に滞在した場合に成立する（交流活動）を指す

This refers to an "interaction" that is established when any two individuals, after sharing the same movement (co-move) while maintaining spatial proximity for a certain period of time, then continue to stay together at the destination of that movement while still maintaining spatial proximity for a further certain period(co-stay)

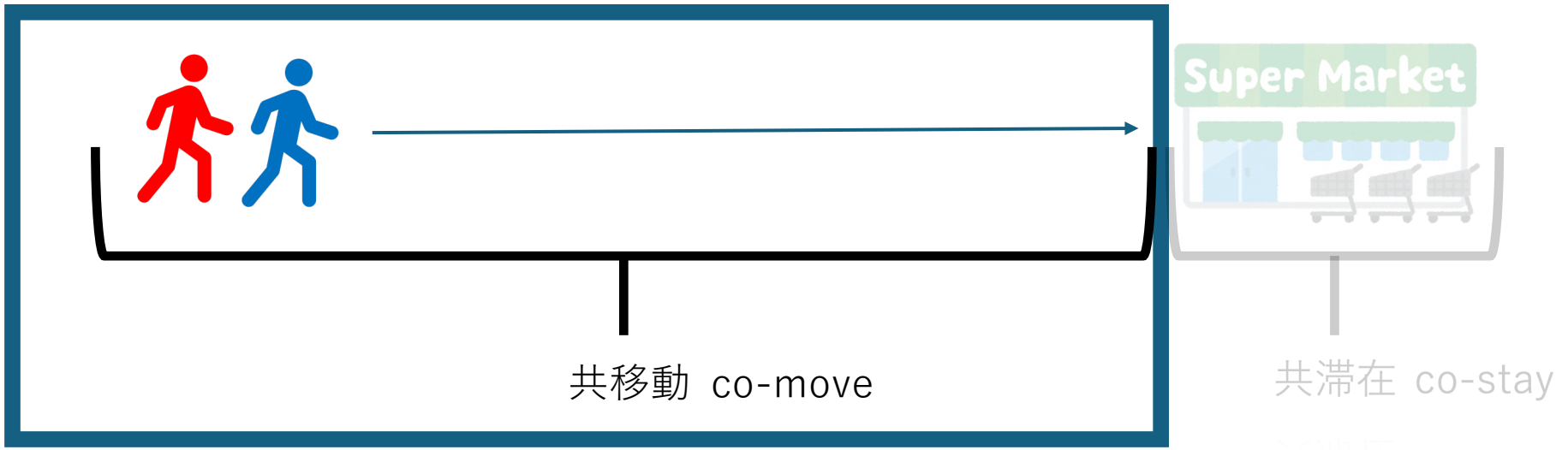
イメージ

image

4. Joint Activity Method of Preparation

①共移動データの作成

①How to make co-move data



4. Joint Activity Method of Preparation

①共移動データの作成

①How to make co-move data

任意のユーザー2人の任意のトリップについて以下の2つの条件を満たす場合、共移動とする

If the following two conditions are met for any two trips by any two users, it is considered co-move

$T_A = [t_{A,start}, t_{A,end}]$:ユーザーAのトリップ区間 Trip segment of User A

$T_B = [t_{B,start}, t_{B,end}]$:ユーザーBのトリップ区間 Trip segment of User B

(1)時間条件 time constraints

$$|T_A \cap T_B| \geq 60s$$

(2)空間条件 spatial constraints

共通時間幅内のサンプリング時刻集合を$S = \{t_1, t_2, \ldots., t_n\}$としたとき,
ユーザーA、Bの位置をそれぞれ$p_A(t), p_B(t)$とする
距離関数d()を用いて、

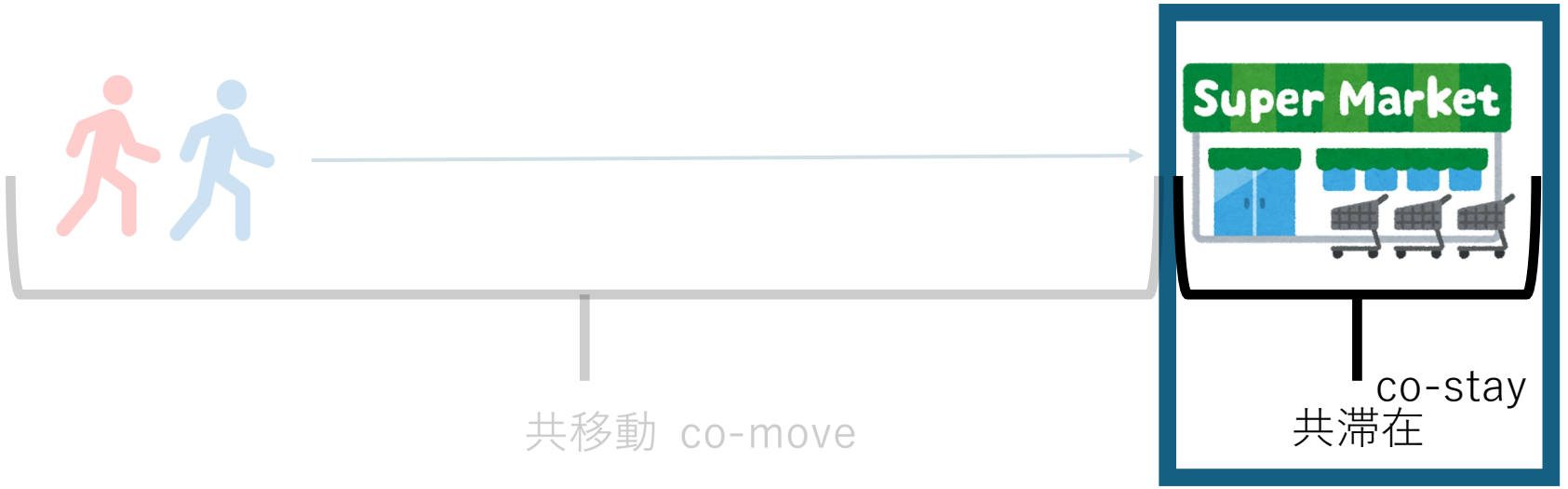
Given the set of sampling timestamps within the common time window as $S = \{t_1, t_2, \ldots., t_n\}$,and the locations of users A and B at time t as $p_A(t)$, $p_B(t)$ respectively,using the distance function d(),

$$\frac{|t \in S | d(p_A(t),\ p_B(t)) \leq 30m|}{|S|} \geq 0.8$$

4. Joint Activity Method of Preparation

②共滞在データの作成

②How to make co-stay data



4. Joint Activity Method of Preparation

②共滞在データの作成
②How to make co-stay data

UserID	Purpose	DepartureTime	ArrivalTime	Start_cording	End_cording
A	買い物 shopping	12:00	15:00	位置1 location1	位置2 location2
A	帰宅 go Home	16:00	17:00	位置3 location3	位置4 location4
A	買い物 shopping	19:00	19:30	,,,,,	,,,,,
A	帰宅 go Home	22:00	23:00	,,,,,	,,,,,

15:00から16:00の間、Aさんは**位置2**と**位置3**付近で**買い物**活動をしていると仮定

“Assume that between 15:00 and 16:00, Person A is engaged in shopping activities around Location 2 and Location 3.”

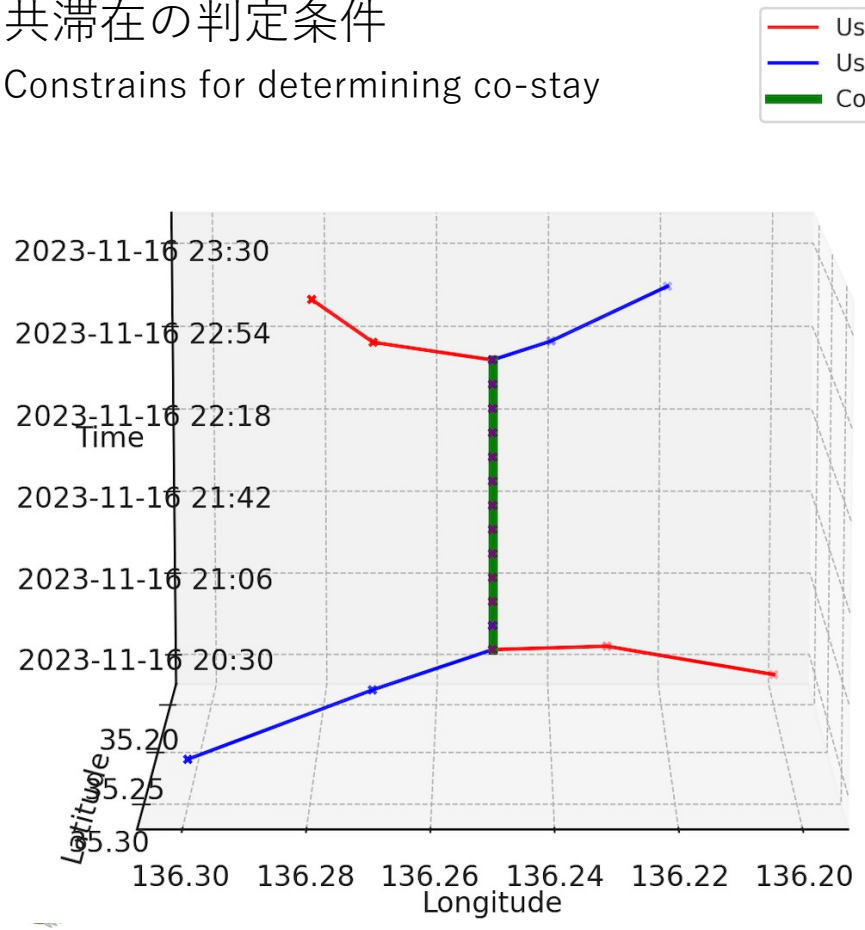
ユーザの滞在データの作成
“How to make Stay Data”

4. Joint Activity Method of Preparation

②共滞在データの作成 ②How to make co-stay data

滞在データを使用し、共滞在を検出
Using stay data to detect co-presence

共滞在の判定条件
Constrains for determining co-stay



滞在データの目的が同じデータセットに関して、以下の条件を満たす滞在データの組み合わせを共滞在と定義する
For stay data with the same purpose within the same dataset, combinations of stay data that meet the following constraints are defined as co-stay.

(1)時間条件
time constraints

$$|S_A \cap S_B| \geq 5min$$

(2)空間条件
spatial constraints

ユーザーA,Bの位置をそれぞれ$p_A(A_A), p_B(A_B)$としたとき、距離関数d()を用いて
When the locations of users A and B are denoted as $p_A(A_A), p_B(A_B)$, respectively, using the distance function d,...

$$d(p_A(A_A), p_B(A_B)) \leq 30m$$

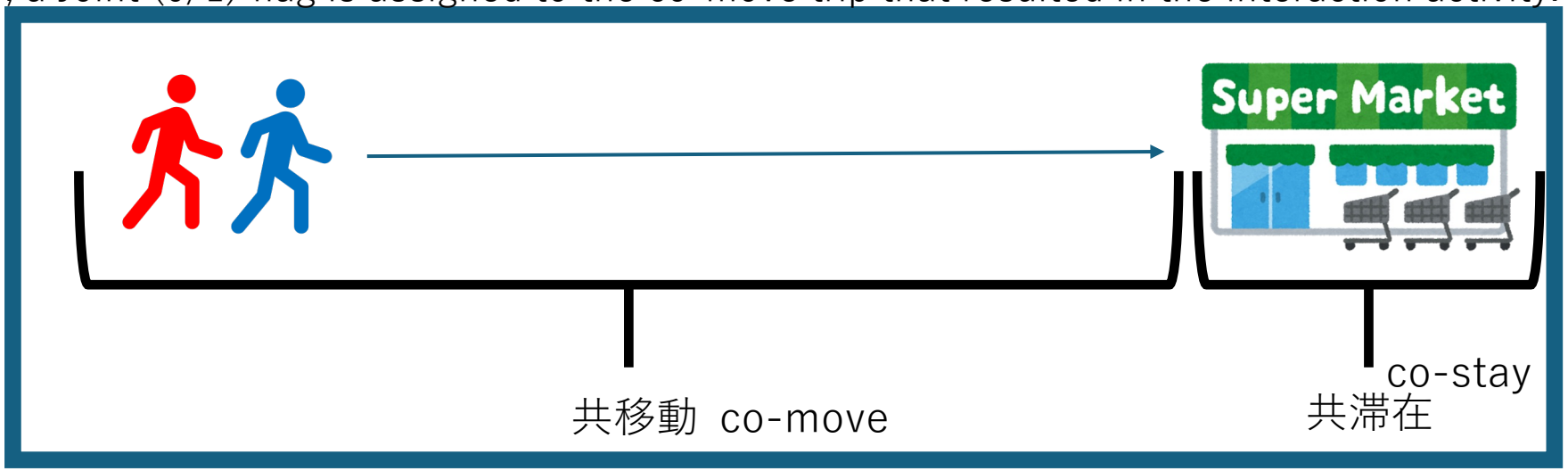
$S_A = [s_{A,start}, s_{A,end}]$:ユーザーAの活動区間 Activity segment of User A
$S_B = [s_{A,start}, s_{A,end}]$:ユーザーAの活動区間 Activity segment of User B

4. Joint Activity Method of Preparation

③Joint Activityデータの作成
③How to make Joint Activity

共移動を行ったのち、その移動の到達地点において共滞在を行なった任意のユーザーの組み合わせを交流活動とする。

また、交流活動を行なった共移動トリップにJoint(0/1)を付与する
Any pair of users who, after co-moving, remain co-present at the destination of that movement is defined as engaging in an interaction activity.
Additionally, a Joint (0/1) flag is assigned to the co-move trip that resulted in the interaction activity.



5. Estimation Results

Joint = 0 (normal trip)

説明変数名	推定値 (coef)	t値 (z)
バス　定数項	-3.1789	-19.571
乗用車の定数項	-1.2808	-59.797
電車の定数項	-0.8557	-12.771
徒歩の定数項	-1.8952	-38.021
バスの時間パラメータ	-5.6253	-15.487
乗用車の時間パラメータ	0.703	15.757
電車の時間パラメータ	-3.9091	-26.171
徒歩の時間パラメータ	-8.1009	-67.243
バスの料金パラメータ	-0.246	-1.248
電車の料金パラメータ	1.472	25.279

	値
標本数	70,744
初期対数尤度 (LL-Null)	-46,650.00
最終対数尤度 (Log-Likelihood)	-26,076.00

Joint = 1 (trip for Joint Activity)

説明変数名	推定値 (coef)	t値 (z)
バスの定数項	-0.4675	-0.159
乗用車の定数項	-1.613	-6.411
電車の定数項	-3.5382	-2.983
徒歩の定数項	-2.3539	-3.694
バスの時間パラメータ	-0.5758	-0.33
乗用車の時間パラメータ	-0.1133	-0.224
電車の時間パラメータ	-5.2669	-2.69
徒歩の時間パラメータ	-10.7027	-6.427
バスの料金パラメータ	-2.5919	-0.686
電車の料金パラメータ	3.6259	3.46

	値
標本数	640
初期対数尤度 (LL-Null)	-429.9
最終対数尤度 (Log-Likelihood)	-206.24

6. Discussion

○**Order of time disutility**(Joint-activity trips) **:** Walking > Rail > Bus > Car.
Very strong aversion to walking time vs. **very weak time sensitivity for car**.
→ Designing routes and facilities to **minimize walking (transfers/access)** is crucial.
Because car users are comparatively **insensitive to time**, **car is more likely to be chosen**.

○For joint-activity trips, the **rail alternative-specific constant** is **strongly unfavorable**.
→ In group outings, **cars** are **relatively preferred** due to easier coordination and higher comfort◎.
→ Public transport (**especially rail**) tends to be intrinsically **less attractive** in this context.

【SUGGESTIONs】
○**Places/leverages likely to increase joint-activity trips**
・**Pedestrians: ** station-front access and elevator flows ⇒ **high time-saving impact**.
・**Cars: ** improve **parking congestion/fees** and **ingress/egress accessibility**.
・**Rail: ** focus on **non-time attributes** with high impact, e.g., **seat comfort**, **stroller/buggy friendliness**, etc.
○**Regular trips (especially non-joint)**
⇒Measures that **reduce travel time** are generally the most effective.