

# Stay of Interest: A Dynamic Spatiotemporal Stay Behavior Perception Method for Private Car Users



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## Introduction

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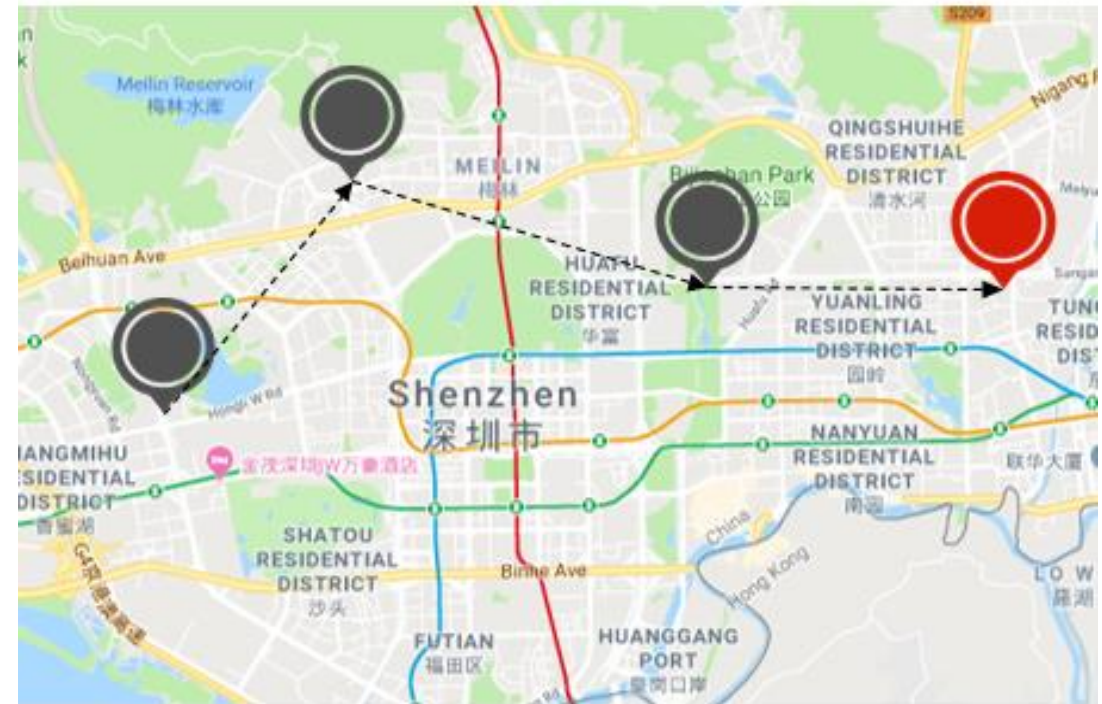
## Method

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## Conclusion





# Part I

# Introduction

# Introduction (1)

- **The stay behavior** that people need to **stay and take time to** carry out their own **activities** when they drive **to a specific location**, contains crucial information for understanding users' travel behavior and mobility motivations.



- Research in *Science* measured the entropy of each individual's trajectory and found a 93% potential predictability in user mobility across the whole user base [1].

[1] C. Song and A. L. Barabasi, *Limits of predictability in human mobility*, *Science* 2010.

- Stay interest is an indicator used to describe the duration of stay behavior indirectly reflecting the intensity of stay interest.
- Stay interest is divided into three levels by *stay interest ratio* (SIR), and each level is assigned to a descriptor.

## Stay interest levels

$$SIR = \begin{cases} \tau/b & \tau < b, \\ 1 & \tau \geq b, \end{cases}$$

<i>Stay Interest Ratio (SIR)</i>	<i>Stay Interest Levels</i>
$SIR < 0.1$	Low
$0.1 \leq SIR < 1$	Medium
$SIR \geq 1$	High





# Part II

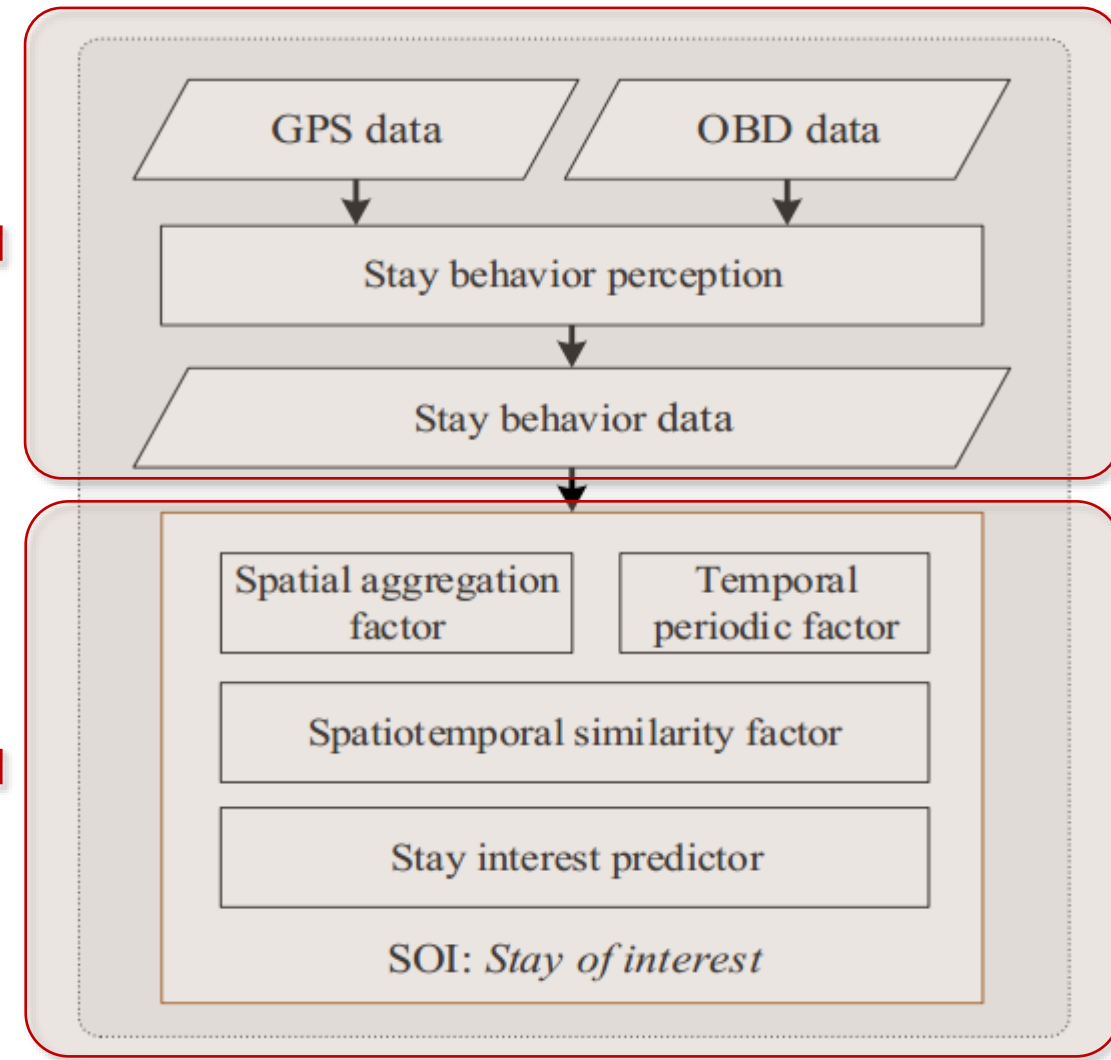
# Method

- *Stay Behavior Perception*

- Collect the trajectory and status data. ←
- Extract the location and time information of stay behavior.

- *Stay Interest Prediction* ←

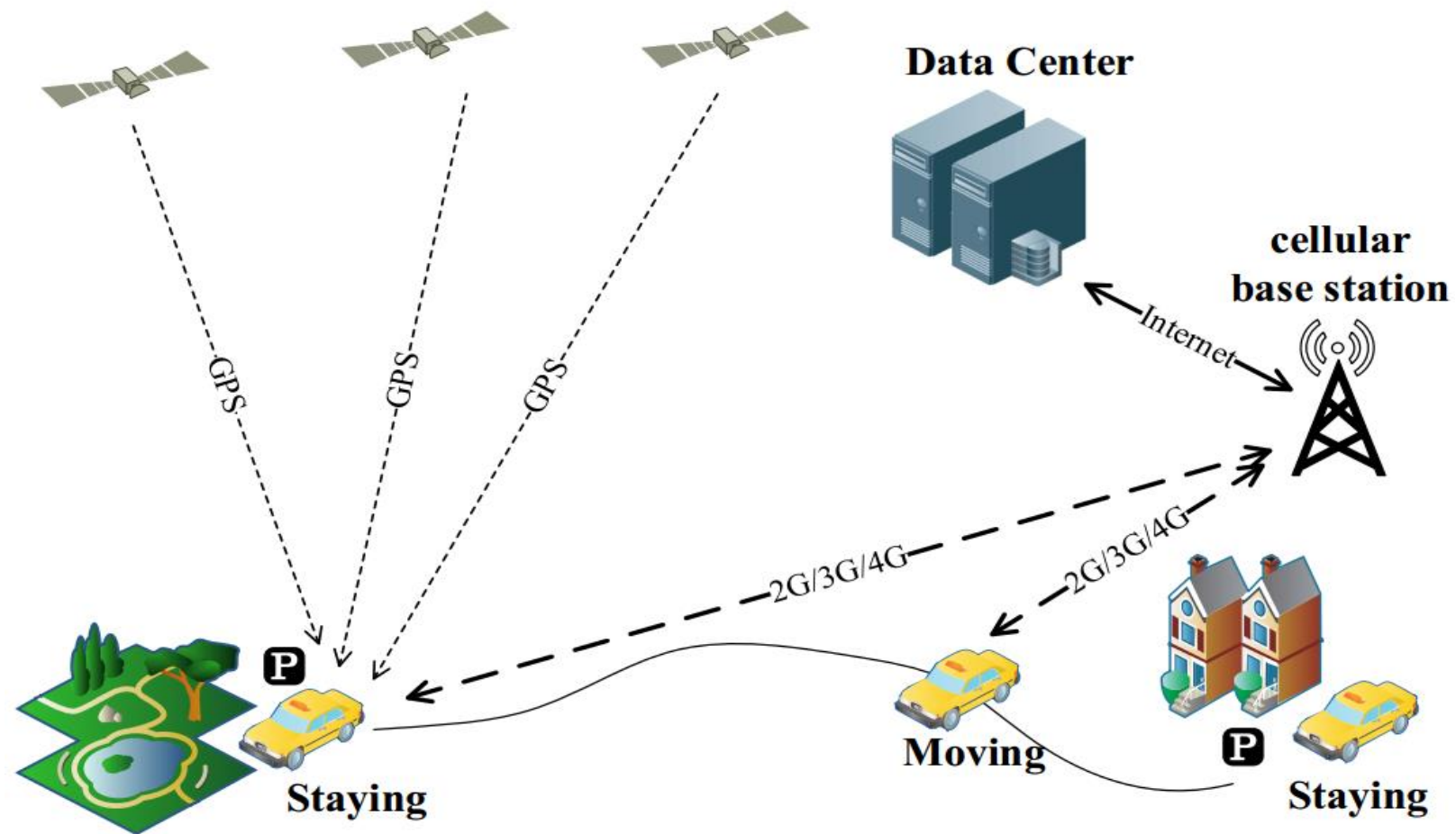
- Extract the spatiotemporal factors.
- Predict the Stay Interest Level.



# Stay Behavior Perception (1)



The vehicle location terminal

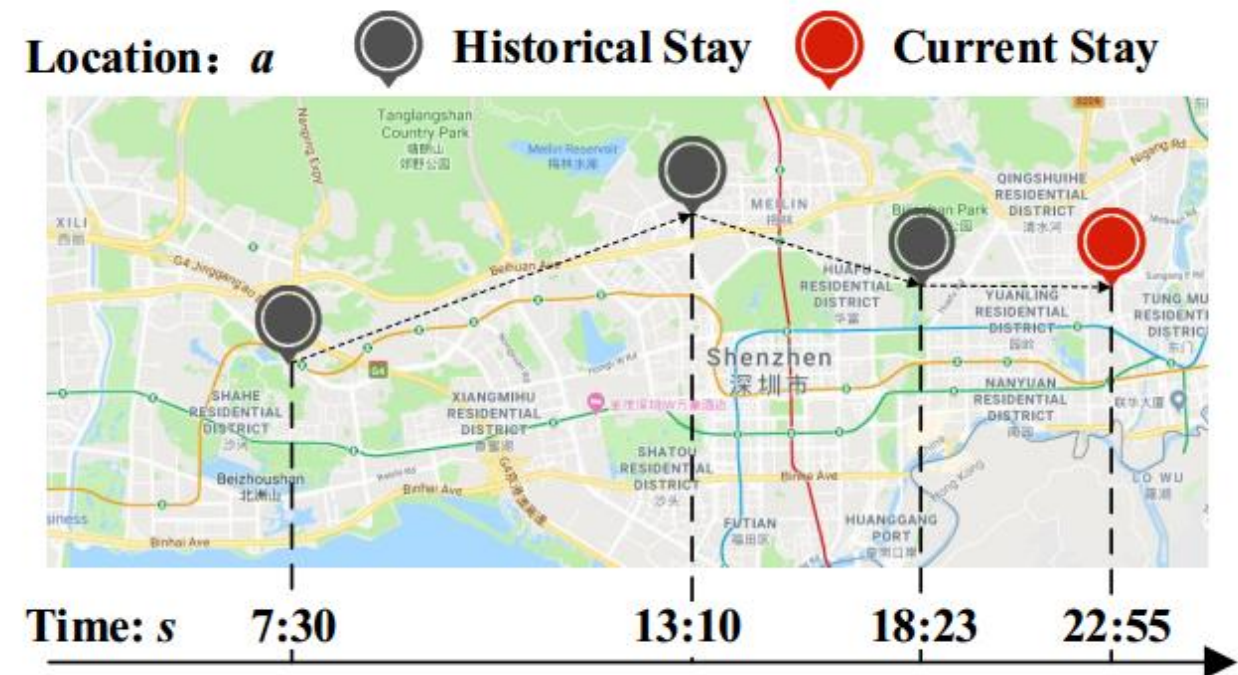
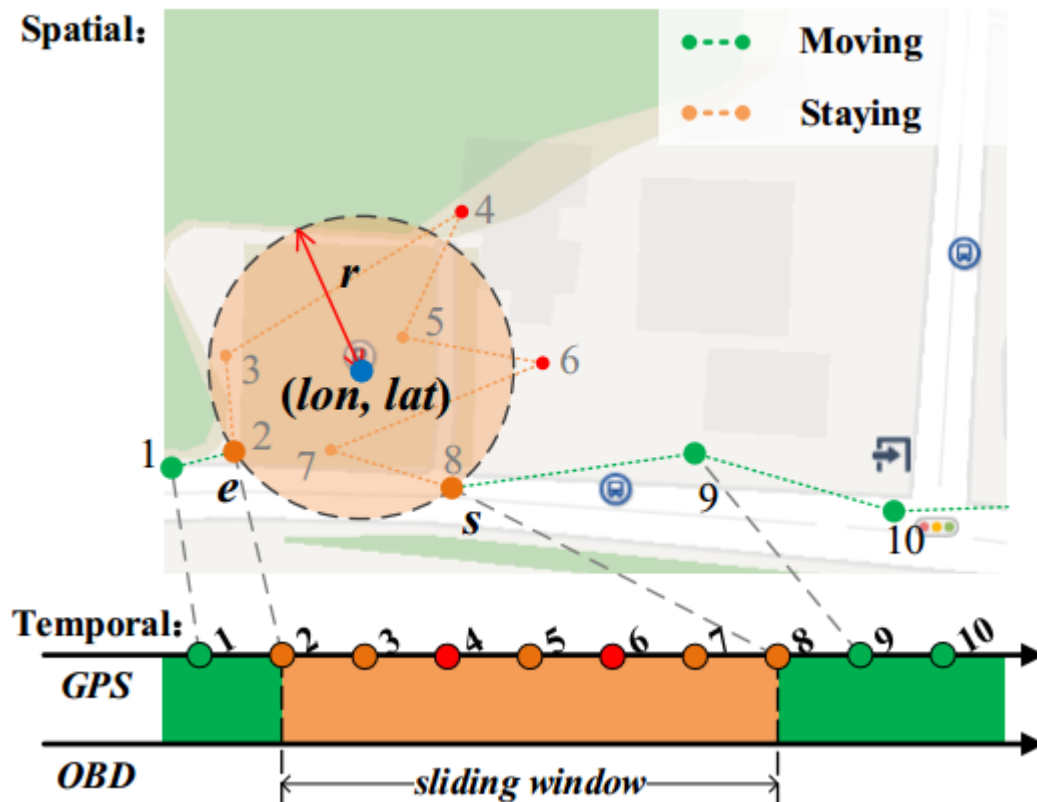


- By using the location terminal, we obtained large scale real-life private car trajectory data in China.



# Stay Behavior Perception (2)

- A fusion algorithm based on sliding window, which combines GPS and OBD data to detect the users' stay behavior.
- A stay behavior: longitude, latitude, start time, stay duration



# Stay Interest Prediction (1)

- Extract the spatiotemporal factors.
  - Density-based clustering → Spatial aggregation factor
  - Timestamp split → Temporal periodic factor
  - Gaussian kernel density estimation → Spatiotemporal similarity factor

*Raw data of stay behavior*

Start time $s$	Lon	Lat
2015/9/28 16:57:44	114.039072	22.547745
2015/9/29 08:52:22	114.039795	22.548085
2015/9/30 16:08:05	114.048041	22.536377
2015/9/30 16:56:30	114.039127	22.548757
2015/10/1 08:43:37	116.178407	23.284088
2015/10/1 10:13:01	116.176288	23.288707

*Spatiotemporal factors of stay behavior*

$f_a$	$f_y$	$f_{mon}$	$f_w$	$f_d$	$f_m$	$f_k$	$f_{kw}$	$f_{ka}$
1	2015	9	0	270	1017	30	30	55
1	2015	9	1	271	532	45	40	55
0	2015	9	2	272	968	70	50	100
1	2015	9	2	272	1016	75	50	505
3	2015	10	3	273	523	490	805	525
8	2015	10	3	273	613	490	805	440

- A *stay of interest* (SOI) prediction model, which based gradient boosting decision trees to predict the stay interest of user's stay behaviors.

$$\hat{F}(\xi) = \arg \min \sum_{i=1}^n L(\kappa_i, F(\xi_i)). \quad (3)$$

$$r_{im} = - \left[ \frac{\partial L(\kappa_i, F(\xi_i))}{\partial F(\xi_i)} \right]_{F(\xi)=F_{m-1}(\xi)}, \quad (5)$$

$$F_m(\xi) = F_{m-1}(\xi) + \gamma_m h_m(\xi). \quad (7)$$

$$\hat{F}(\xi) = \sum_{m=1}^M F_m(\xi). \quad (8)$$



# Part III

# Results



The results of compare with baselines.

**Metrics:**

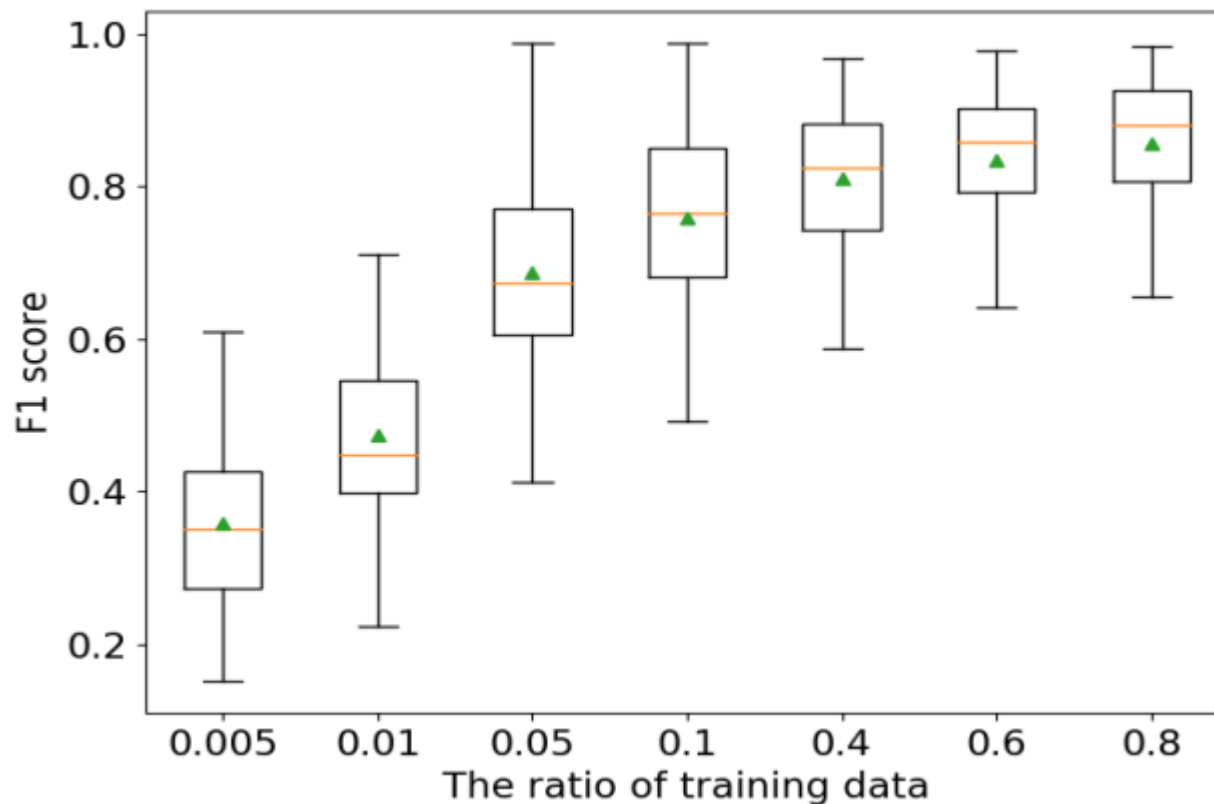
$$precision = \frac{TP}{TP + NP}$$

$$recall = \frac{TP}{TP + FP}$$

$$F1 = \frac{2 \times precision \times recall}{precision + recall}$$

Model	F1		precision		recall	
	mean	std	mean	std	mean	std
SVC	0.24	<b>0.03</b>	0.21	0.07	0.34	<b>0.01</b>
KNN	0.35	0.04	0.38	<b>0.05</b>	0.36	0.04
LR	0.36	0.06	0.43	0.09	0.38	0.05
GBDT	0.44	0.12	0.48	0.14	0.47	0.11
SOI-SVC	0.46	0.13	0.53	0.18	0.50	0.11
SOI-KNN	0.61	0.07	0.64	0.08	0.61	0.08
SOI-LR	0.64	0.10	0.70	0.10	0.65	0.10
<b>SOI</b>	<b>0.86</b>	0.10	<b>0.89</b>	0.07	<b>0.85</b>	0.10

# Results (2)



**The results of model efficiency.  
(seconds per 1000 samples)**

Stage	mean	std
<i>preprocessing</i>	3.287	0.903
<i>training</i>	1.382	0.308
<i>predicting</i>	0.0059	0.0052

**The robustness compare with different ratios of training data.**



# Part IV


# Conclusion

- Stay of Interest:
  - A novel model SOI for estimating the **stay interest** of **private car users**.
  - Experimental results on the real-life private car trajectory dataset prove the effectiveness of proposed model for stay interest estimation.

## Stay of Interest

A Dynamic Spatiotemporal Stay Behavior Perception Method for Private Car Users





# Thanks!

## Q & A ?

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