A Mobility Model of Theme Park Visitors

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Abstract

We present a novel human mobility model for theme parks. In our model, the non-determinism of movement decisions of visitors is combined with deterministic behavior of attractions. The attractions are categorized as rides, restaurants, and live shows. The time spent at these attractions are computed using queueing-theoretic models. The realism of the model is evaluated through extensive simulations and compared with existing mobility models and the GPS traces of theme park visitors. The results show that our proposed model provides a better match to the real-world data (from CRAWDAD archive) compared to current state-of-the-art movement models.

Introduction

Recent advances in mobile devices enabled the increased popularity and usage of mobile applications. The realistic modeling of human movement has significant importance for the performance assessment of mobile wireless systems.

Motivation

- Mobility models drastically change performance results of networks
- Early models based on random walks are very coarse approximations
- Focusing on human walks due to limited vehicle use in theme parks

Outcomes of our model are useful for:

- *Performance evaluation of mobile applications*
- *Theme park administration*

Contributions

- A novel scenario-specific mobility model
- Representing the social behavior of gathering in attractions, spending time in queues, and the least-action principle
- The best statistical match to the GPS traces amongst the tested synthetic models

Modeling a Theme Park

Fractal points and clusters

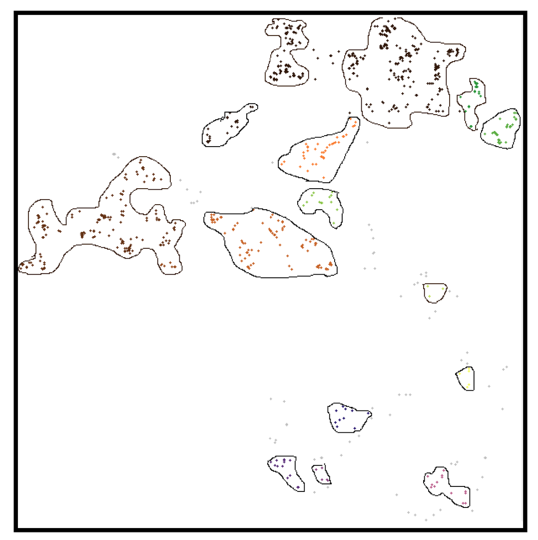

Figure 1: Clusters generated by DBScan

- Self-similar fractal points and least action trip planning satisfy fundamental statistical features of human walks.
- The areas with high densities represent the popular places.

Attractions

Attractions are represented by queueing models. The types and the weights of the queues are based on the previous work on theme park design.

Attraction	Queue model	Percentage
Main rides (RD)	M/D/n	17%
Medium-size rides (M-RD)	M/D/n	56%
Restaurants (RT)	M/M/1	17%
Live shows (LS)	M/M/n	10%

Landmark

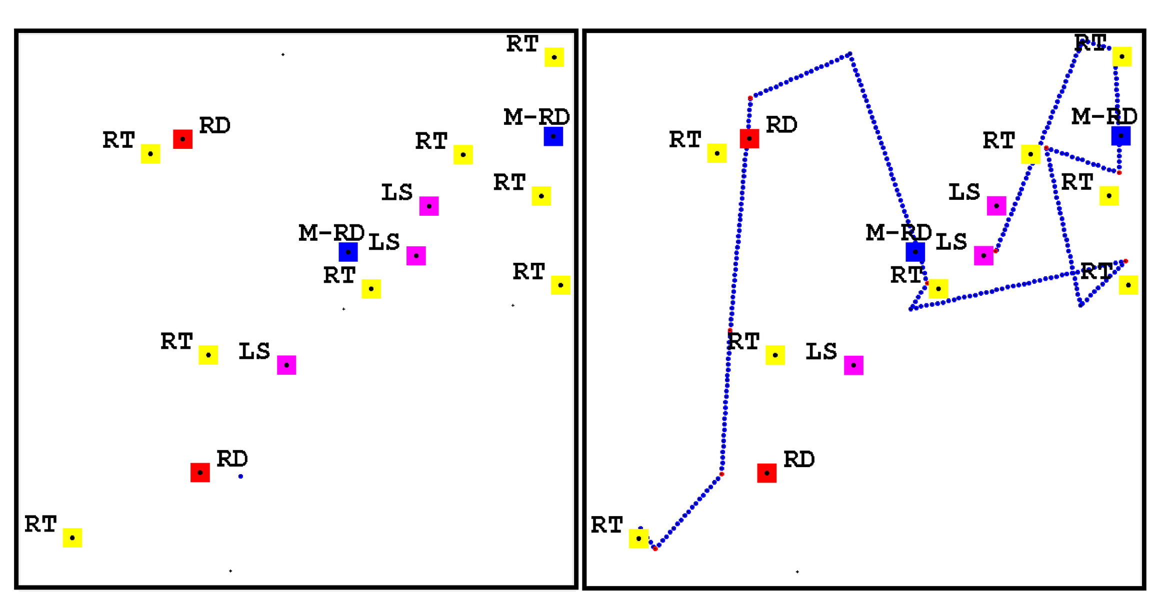

Figure 2: Left: a landmark model, right: trajectory of a visitor.

A *landmark* is a place where there are multiple static queues, static noise points, and mobile nodes.

Visitor Model

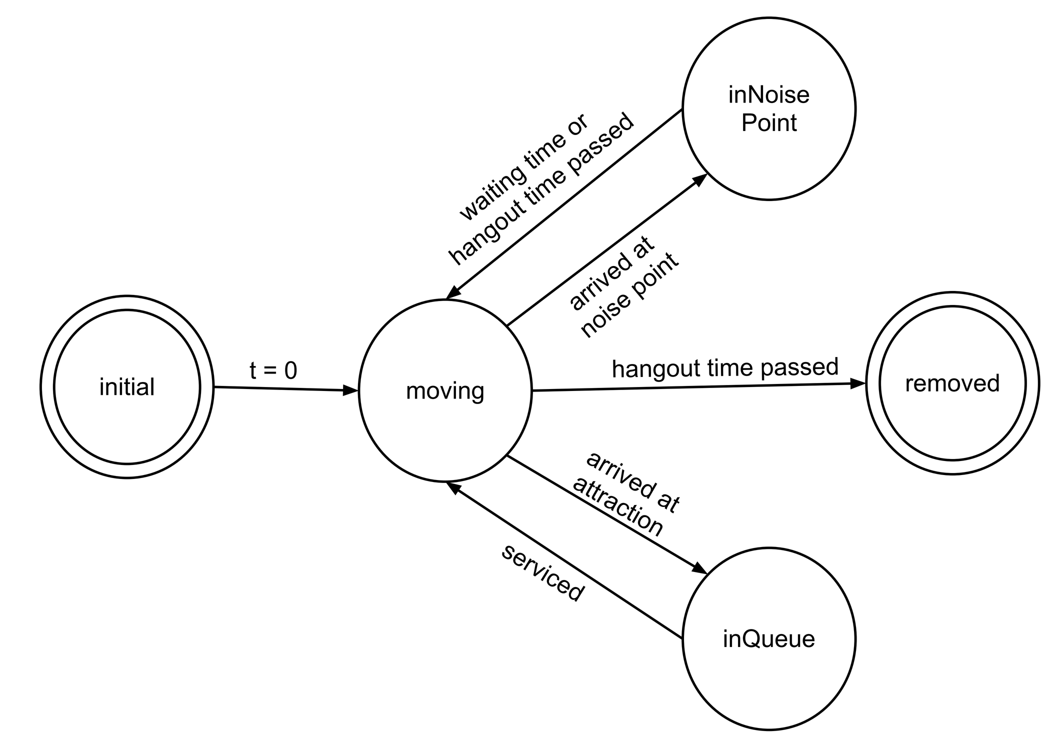

Figure 3: States of a visitor.

- Visitors pre-plan their visit by deciding hangout times and the set of attractions to be visited.
- The modified LATP algorithm decides the next destinations and minimizes the travel distances.

Theme Park with Landmarks

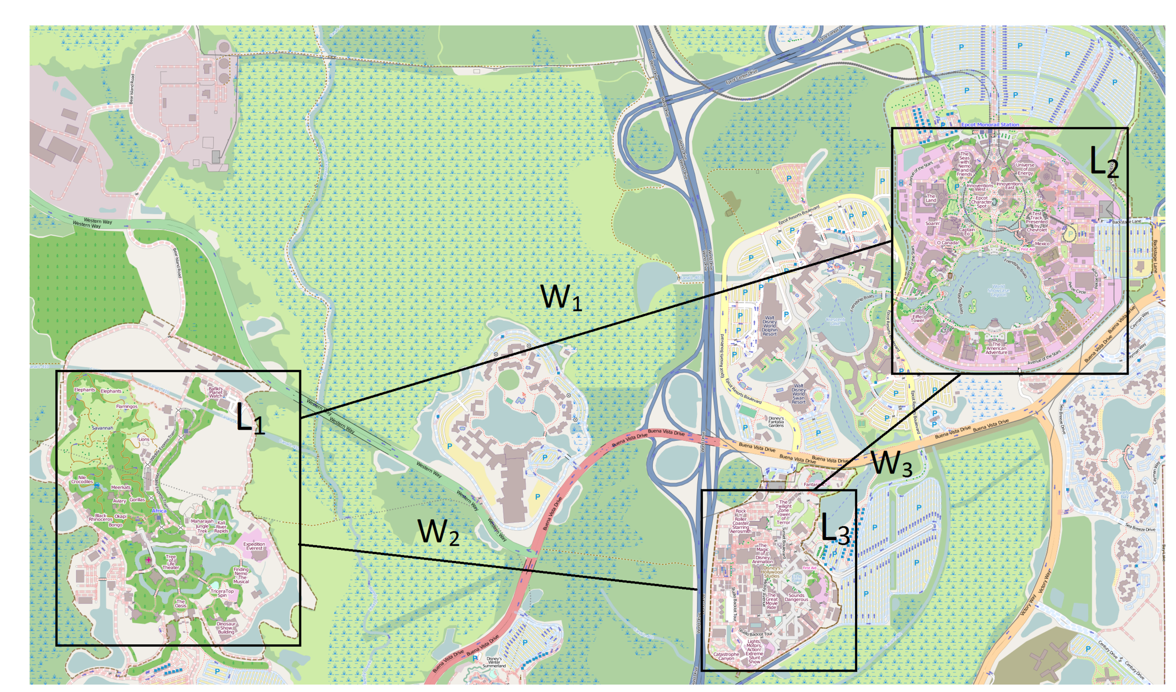

Figure 4: Application to a real-world scenario: Disney World.

The mobility model can be easily applied to model a complete theme park scenario. By separating landmarks as vertices and adding weighted non-directional edges, we can generalize the mobility from a landmark to the whole theme park.

Figure 5: The phases of modeling a theme park.

Simulation Results

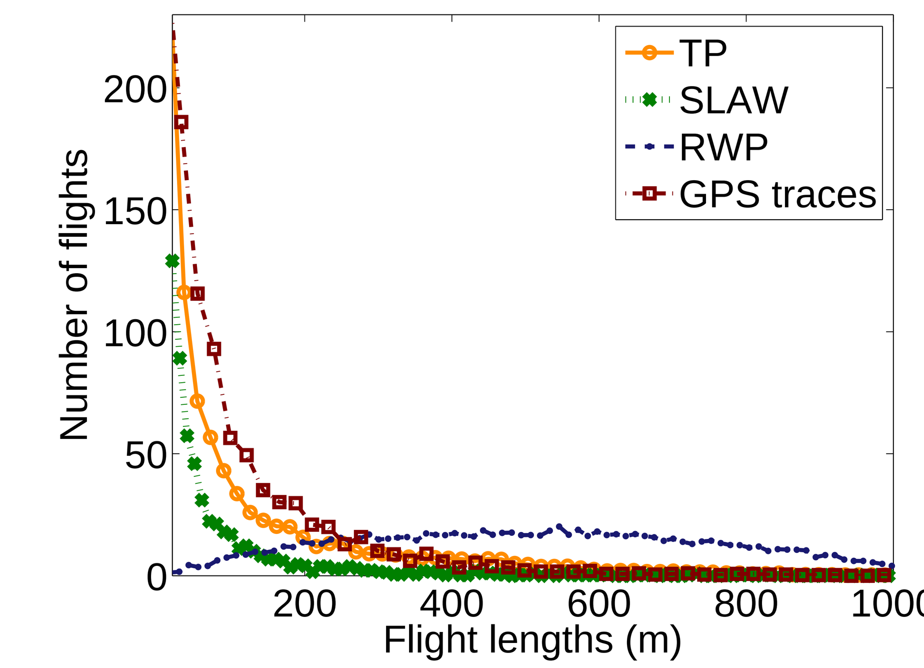

Figure 6: Flight length distributions.

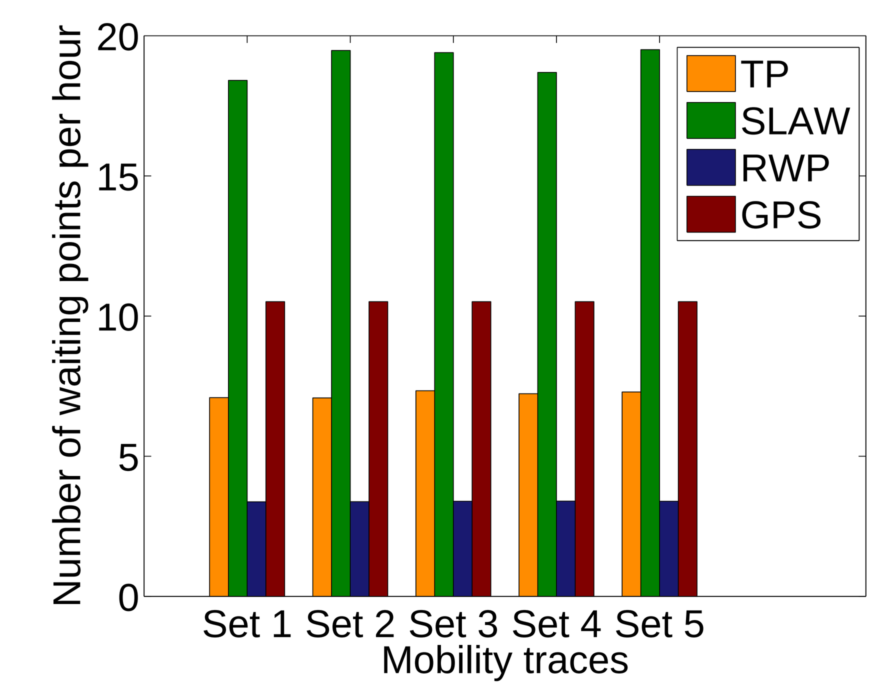

Figure 7: Number of waiting points.

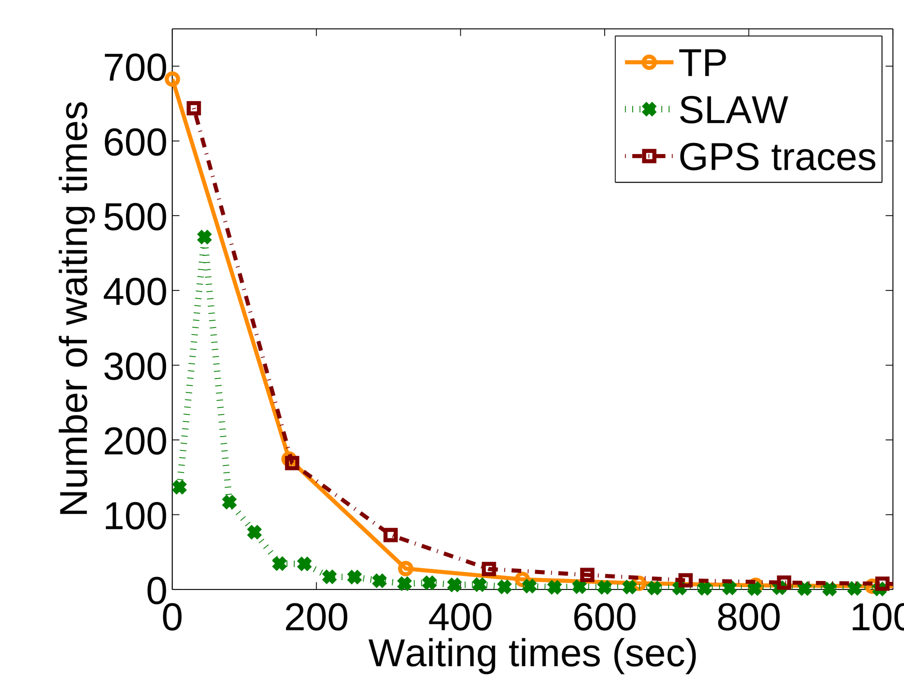

Figure 8: Waiting time distributions.

References

[1] G. Solmaz, M.I. Akbas, and D. Turgut.
A mobility model of theme park visitors.
IEEE Trans. on Mobile Computing, February 2015.

[2] G. Solmaz and D. Turgut.
Pedestrian mobility in theme park disasters.
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