Study on the Arrival Profile of Large Public Events

Author: Siyao Li (*siyao.li.18@ucl.ac.uk*)
Supervisors: Dr Stephen Law, Dr Hui Xie

UCL Geography – MSc Social and Geographic Data Science

Introduction

To prevent hurt caused by crowd disasters at large public events, it is crucial to know the audience's arrival distribution since the shape and peak of the distribution would have a big impact on crowd management and venue operations. This project studies the arrival profile of 23 large events from 4 sport types (football, rugby, tennis and golf) held in 6 stadiums and tend to answer:

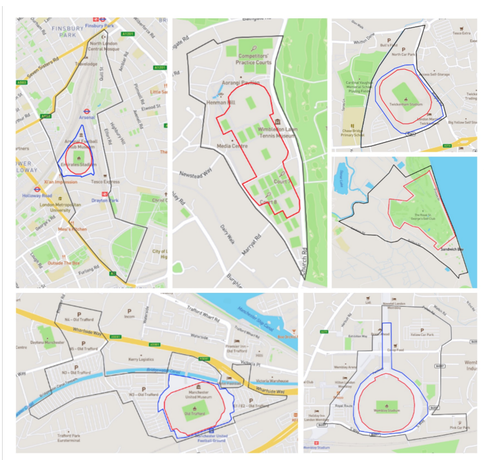
1. Does the arrival profile follow any general distribution?
2. What are the key factors that cause differences in the arrival profiles?

Methodology

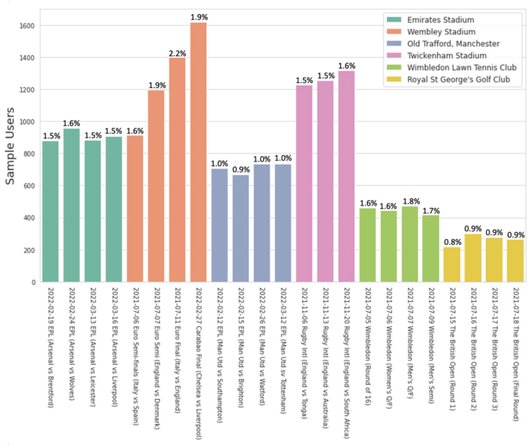
1. *Arrival Distribution*
   - Arrival trend
   - ECDF plots
   - K-S test
   - Distribution fit
2. *Demographic Profiles*
   - Home location
   - Travel distance
3. *Mobility Studies*
   - Average time spent nearby
   - Stop point detection
   - Hexagon cluster map

Zoning and Data Cleaning

Zone Selection



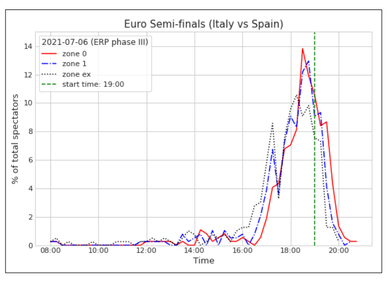
Sample GPS Data

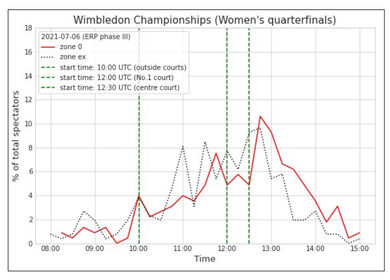


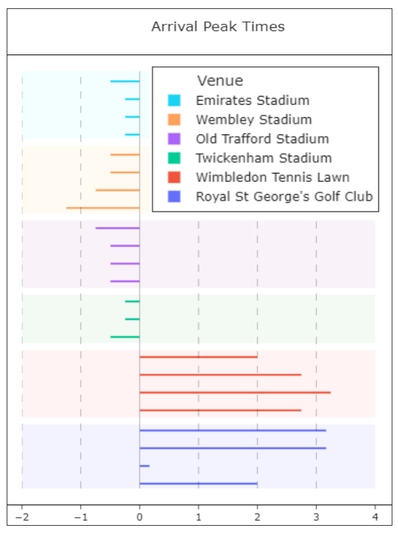
Result

1. Arrival Distribution

1.1 Arrival Trend

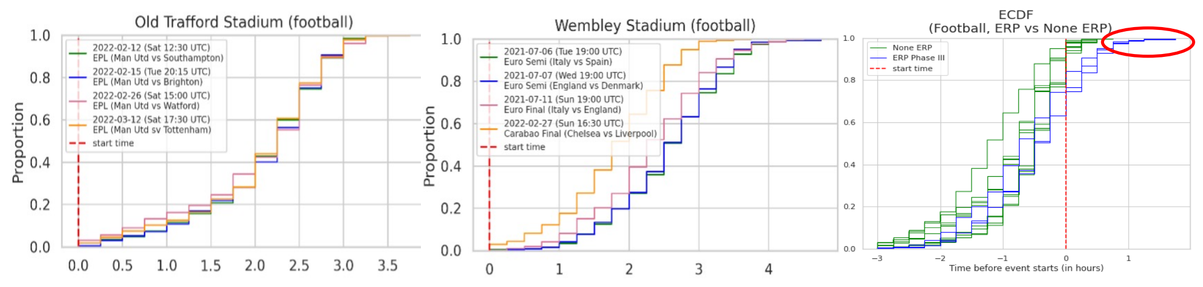






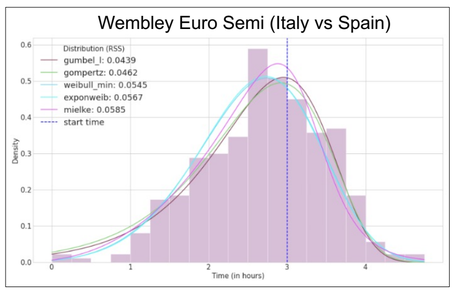
Time record of users first being discovered to be inside of each zone of the stadium were extracted and plotted. On a general view, the arrival shape for football and rugby looked similar, whereas the trend seemed more volatile for tennis and golf.

1.2 ECDF Plot

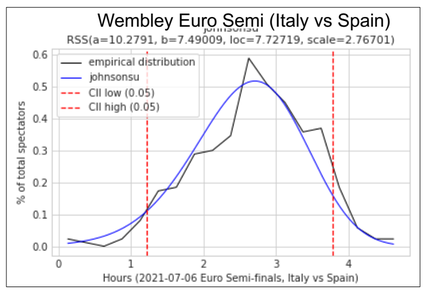


For EPL games held in the same venue, the shape of arrival distribution was alike, regardless of opponent teams, day of the week or start time. However, arrival rate differed for football matches held in different stadiums. The general arrival trend seemed to be earlier in international competitions and decisive games such as the finals, compared with domestic and preliminary rounds.

1.3 Distribution Fitting



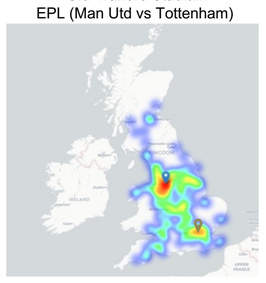
Arrival data lists were fitted to a range of continuous distributions supported in `scipy.stats`. 5 best-fit ones with the smallest RSS aggregated by sport type and displayed in a word cloud.



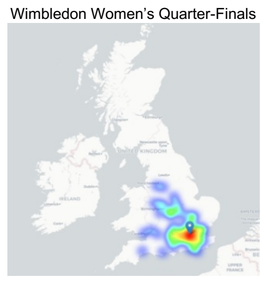
Distributions for football and rugby were close to theoretical Johnson's S_U, Burr]capture a general trend for tennis and golf. Peak-time arrivals for all events seemed to be underestimated.

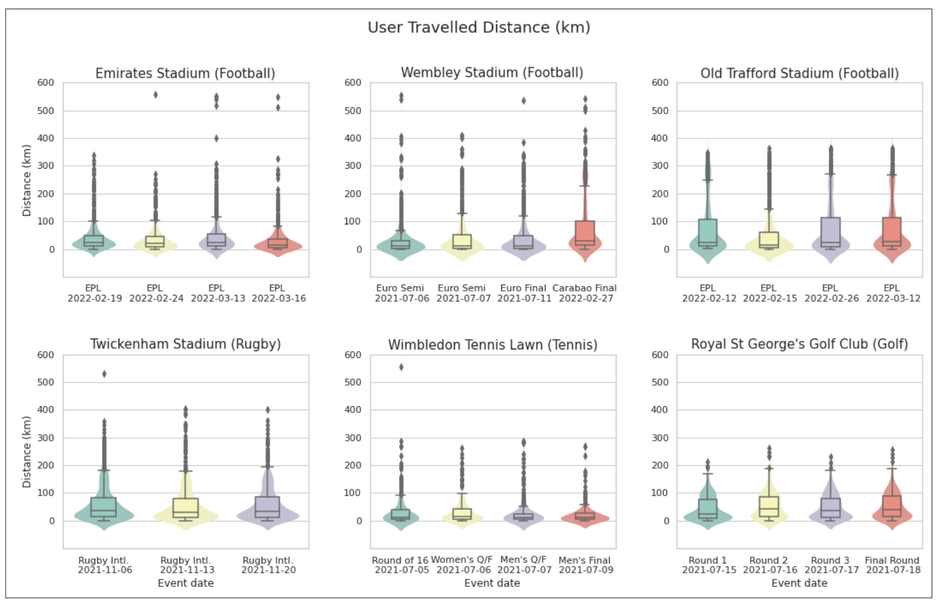
2. Demographic Profiles

Old Trafford Stadium
EPL (Man Utd vs Tottenham)



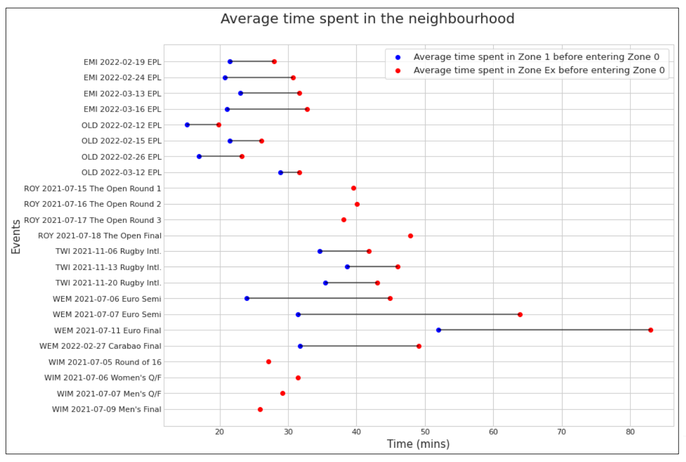
Wimbledon Women's Quarter-Finals

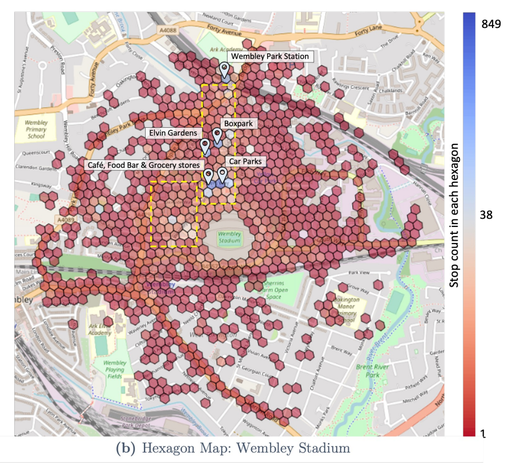




Demographic profiles for football and rugby audience were more diverse than Wimbledon and Royal St George's Golf Club. This was also reflected in the box-violin plot that travel distance for Wimbledon and Royal St George's were much shorter compared with other stadiums.

3. Mobility Studies





(b) Hexagon Map: Wembley Stadium

People spent 15-35 minutes on average in surrounding areas for EPL games held in Emirates and Old Trafford Stadium, and in Wimbledon Championships, whereas a bit longer for the Open Golf and Rugby matches. Stops mostly clustered near car park and transport stations, which calls out the importance of traffic management, as traffic jams would increase the risk of late-arrivals clusters.

Conclusion

1. Johnson's S_U and Burr were suggested as a good representation of arriving trend for football and rugby, tennis and golf, respectively.
2. Arrival distribution was alike for the same type of sports events held in the same venue; The general arrival trend seemed to be earlier in decisive games than preliminary rounds;
3. More late arrivals for football matches held during the ERP period.
4. Audience's demographic profiles were more diverse in team competitions than games with individual players.
5. Facilities around the venue have an impact on arrival behaviours.