

Measuring Individual Regularity in Human Visiting Patterns

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Overview

- Introduction
- Method – IVI-irregularity
- Datasets and results
- Conclusions

Introduction

Can we quantify and exploit regularity in individuals' patterns of visits to locations?



routine in human mobility gives rise to **regular visiting behaviour**

identifying regular visiting patterns has many possible **applications**



virus spreading patterns



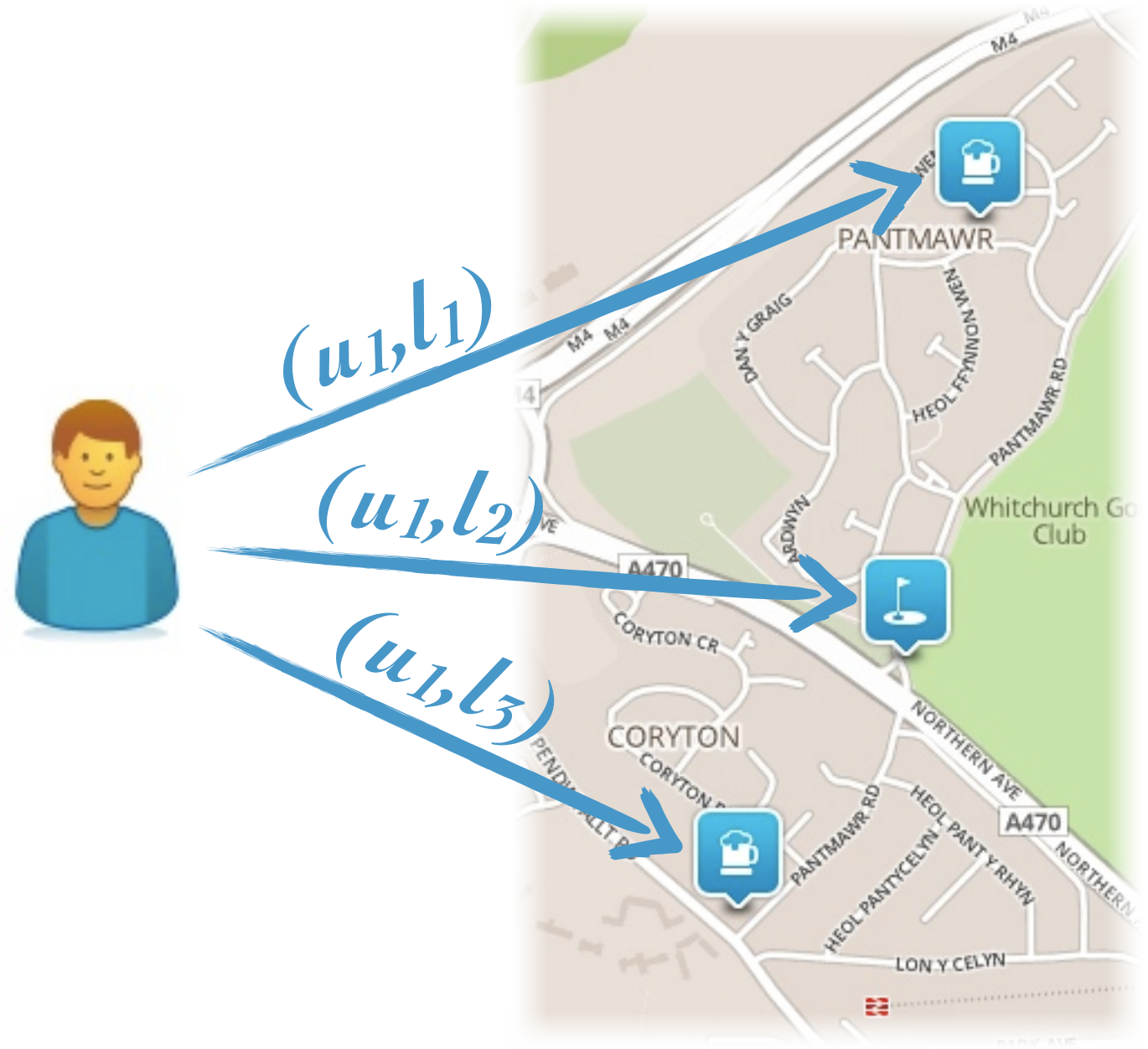
context for
digital assistants



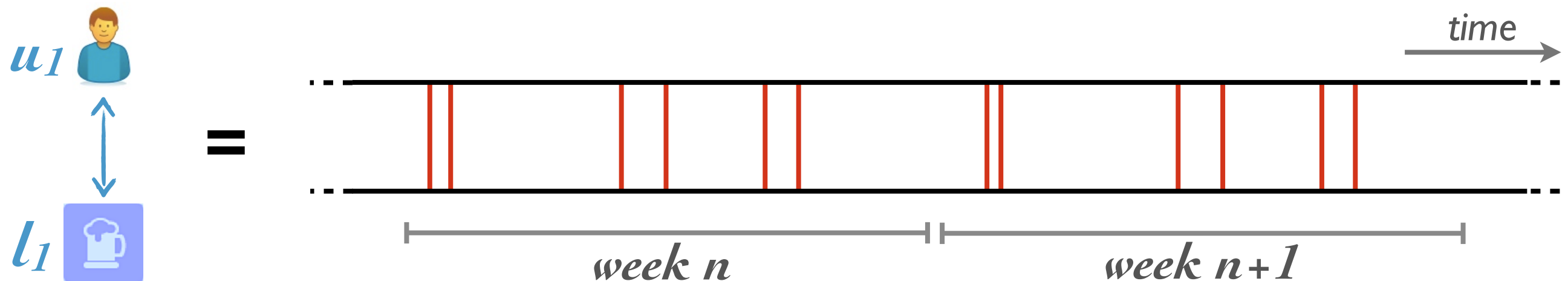
personalised customer
service

user-at-location chronologies

We call the history of visits for a **particular user** u at a **particular location** l a visit **chronology**



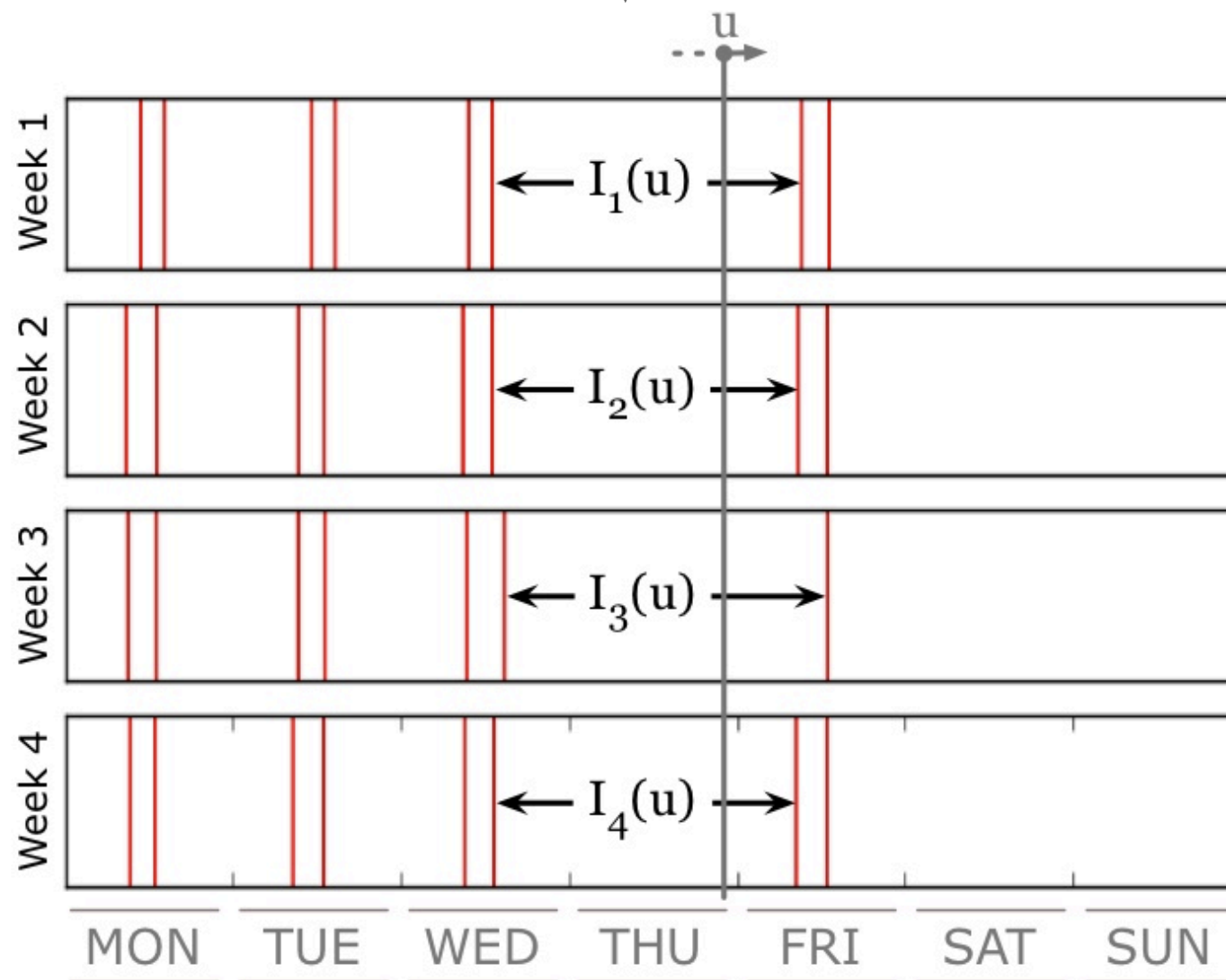
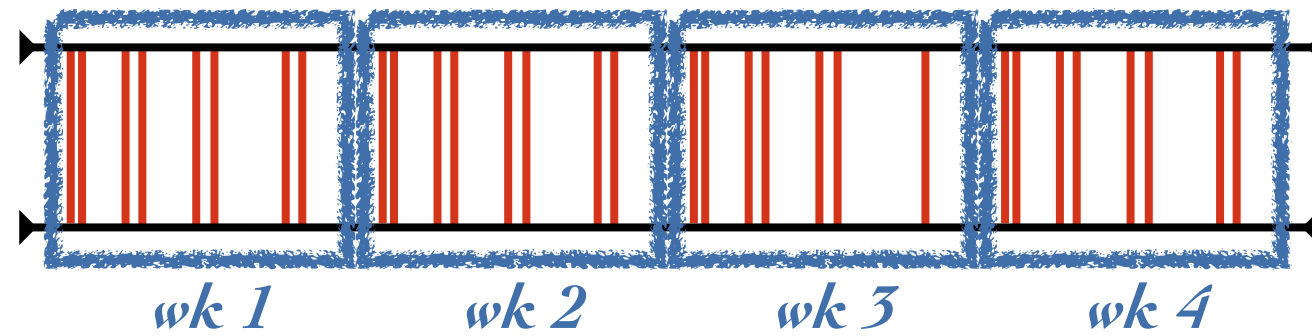
Event-based visit chronologies



- Many systems record visit data as **zero-duration events**
 - e.g., Foursquare checkins, transactions at retail stores, travel payment card swipes
- The data are also **sparse**; an individual rarely visits the same location more than **six or seven times a week**
- We need an **efficient** measure that handles **event-based** visit data that may be **sparse**

Quantifying regularity

...using IVI-irregularity



- **IVI-Irregularity**: “inter-visit interval irregularity”
- Approach adapted from **neural coding**
- Compare the **inter-visit intervals** at the same **time of week**
- If the **inter-visit intervals** are **similar** in each week, then the user’s visits to the location are considered regular

IVL-irregularity score

score = 0.040

score = 0...

- perfect regularity
- the user visits the location the **same time each week**

score = 0.392

scores > 0...

- higher scores mean **more irregularity** in the user's visiting patterns

Results



Foursquare



Dartmouth
College

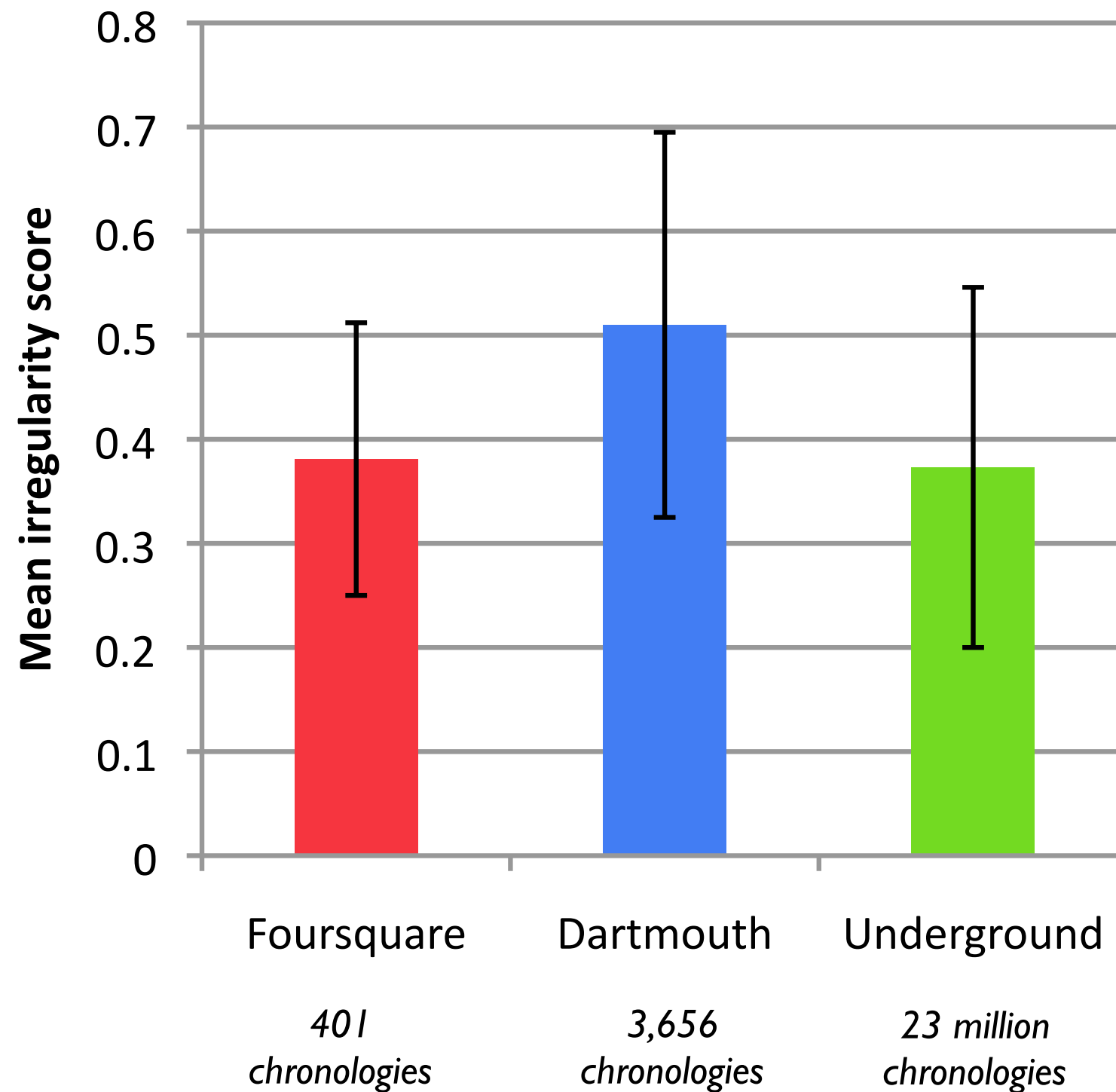


London
Underground

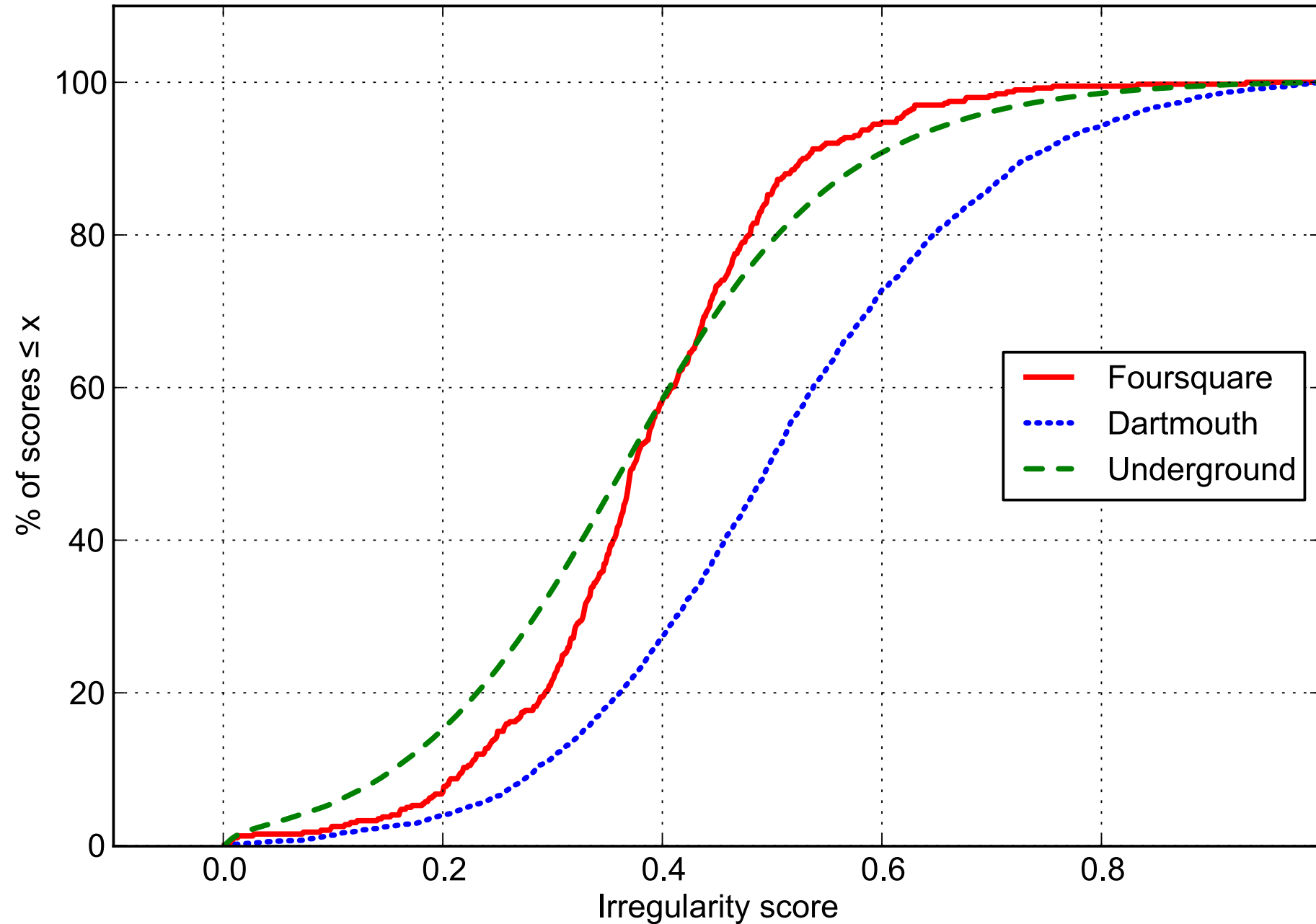
Scale	Visit type	Num. users	Num. locs.	Num. visits	Num. chronologies	Avg visits per chronology
Urban	Check in	293	336	4,640	401	11.6
Campus	WLAN access point association	1,681	391	229,300	3,656	62.7
Metrop.	Card swipe	1,167,363	270	58 million	2.3 million	26.1

- Only chronologies with at least **two visits per week** are considered
- All datasets represent 28-day periods

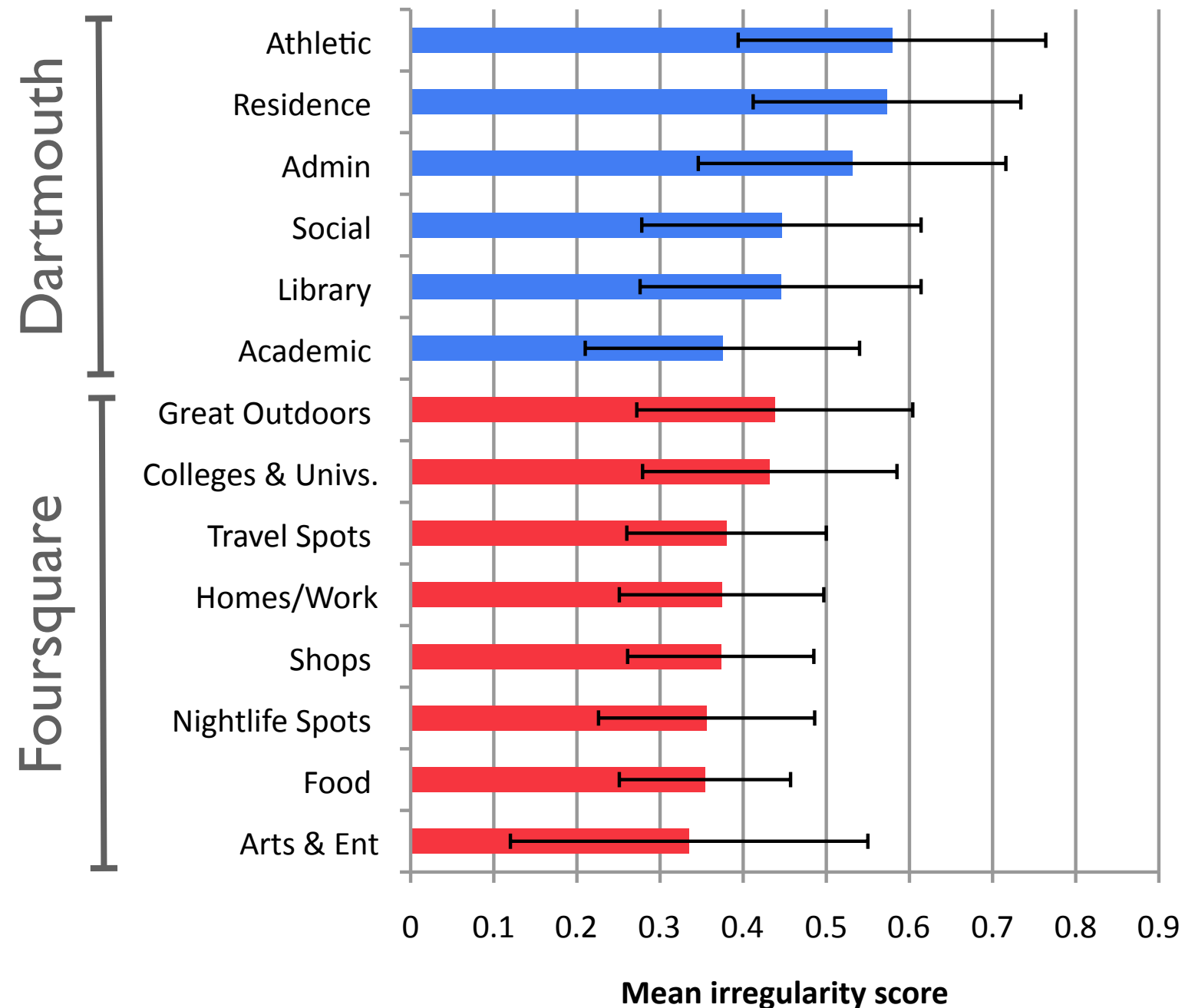
Dataset comparison



Dataset comparison



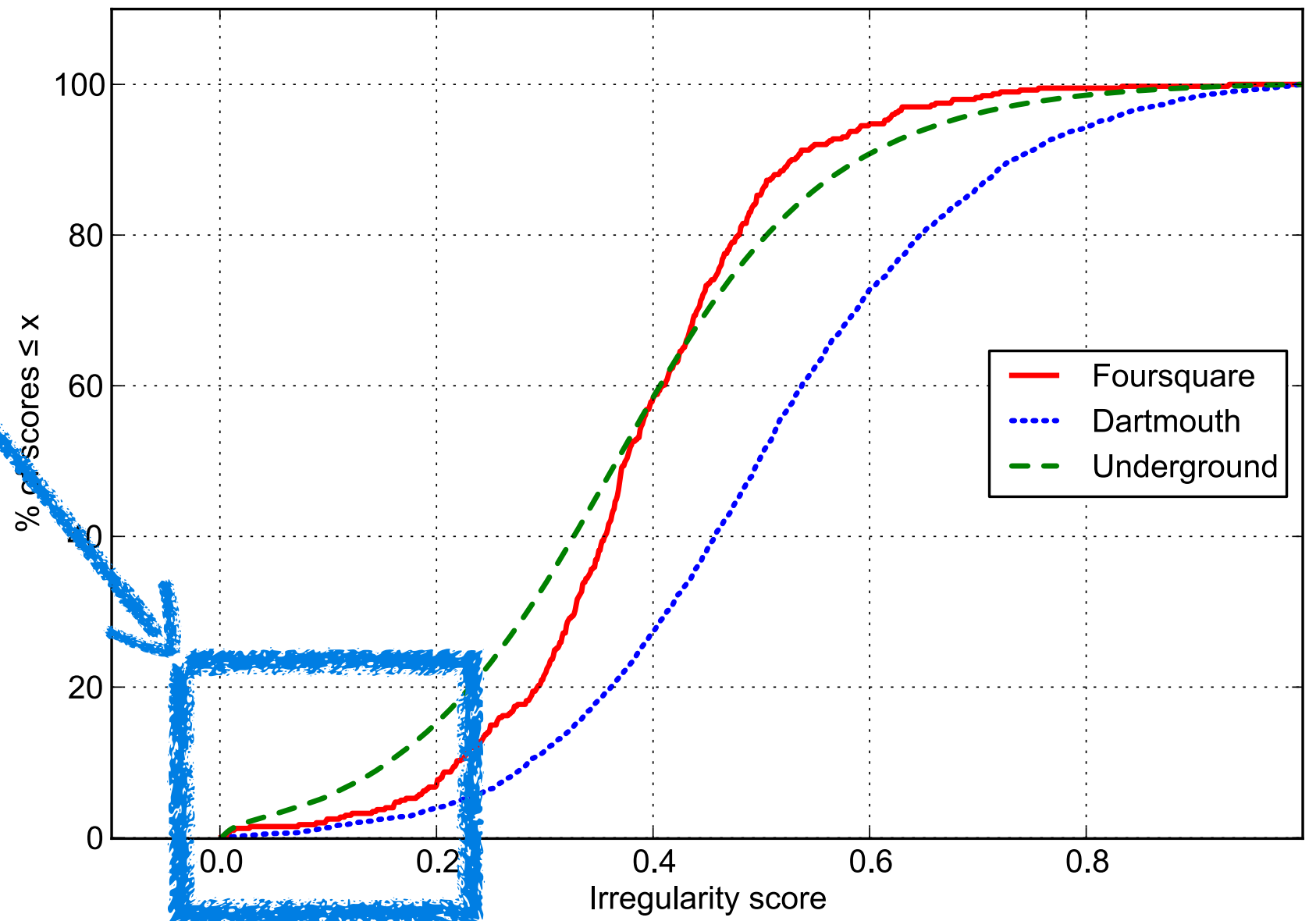
Comparison by location type



Very regular chronologies

- Number of 'very regular' chronologies (those with irregularity ≤ 0.2):

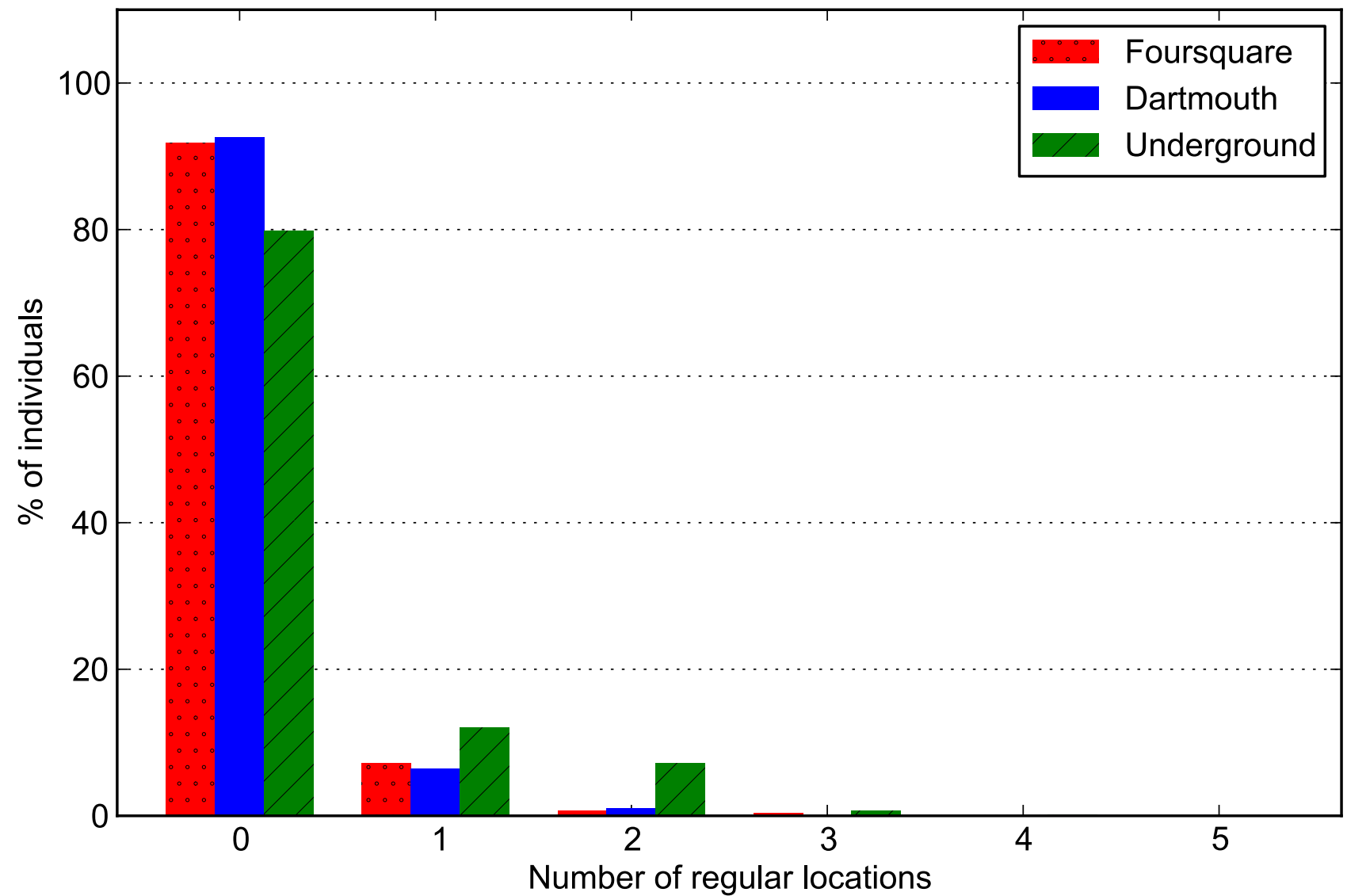
- Foursquare: 8.2%
- Dartmouth: 4.4%
- Underground: 17.4%



Very regular locations per user

- Number of users with at least one 'very regular' location:

- Foursquare
9.3%
- Dartmouth
8.2%
- Underground
21.2%



Conclusions

- IVI-irregularity: efficient measure for computing week-on-week irregularity in **event-based visit data**
- Small **core of users** (8% to 21%) in each dataset with **at least one regular location**
 - Core largest for an urban transit system
- University campus access point visiting patterns least regular
 - Flexible and spontaneous student behaviour, and finer-grained movements
- Urban transit system most regular
 - Significant **commuter population** following rigid routines

Thanks for listening!
Any questions?

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Supported by...

www.recognition-project.eu



Attribution

Foursquare maps:

<https://foursquare.com/>

User icons:

UX People stencil by "jcallender"

<http://graffletopia.com/stencils/639>

Students in class:

FOSDEM 2008 main lecture theatre

http://commons.wikimedia.org/wiki/File:FOSDEM_2008_Main_lecture_theatre.jpg

Crowd wearing masks:

http://www.ickypeople.com/2009_04_26_archive.html

Coffee shop counter:

"Counter stocked for opening day" by Buz Carter

<http://www.flickr.com/photos/pizzabytheslice/2320006035/in/photostream/>

Foursquare pub icon:

<https://foursquare.com/>

Foursquare logo:

<https://foursquare.com/about/logos>

Access point icon:

By IconShock

http://www.iconfinder.com/icondetails/45228/128/access_point_router_icon

London Underground logo:

<http://en.wikipedia.org/wiki/File:Underground.svg>