

You are where you eat: Foursquare checkins as indicators of human mobility and behaviour

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Applications
(PerMoby)
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Overview

- Background
 - Motivation
 - Foursquare
- Data collection
- Observations

Motivation

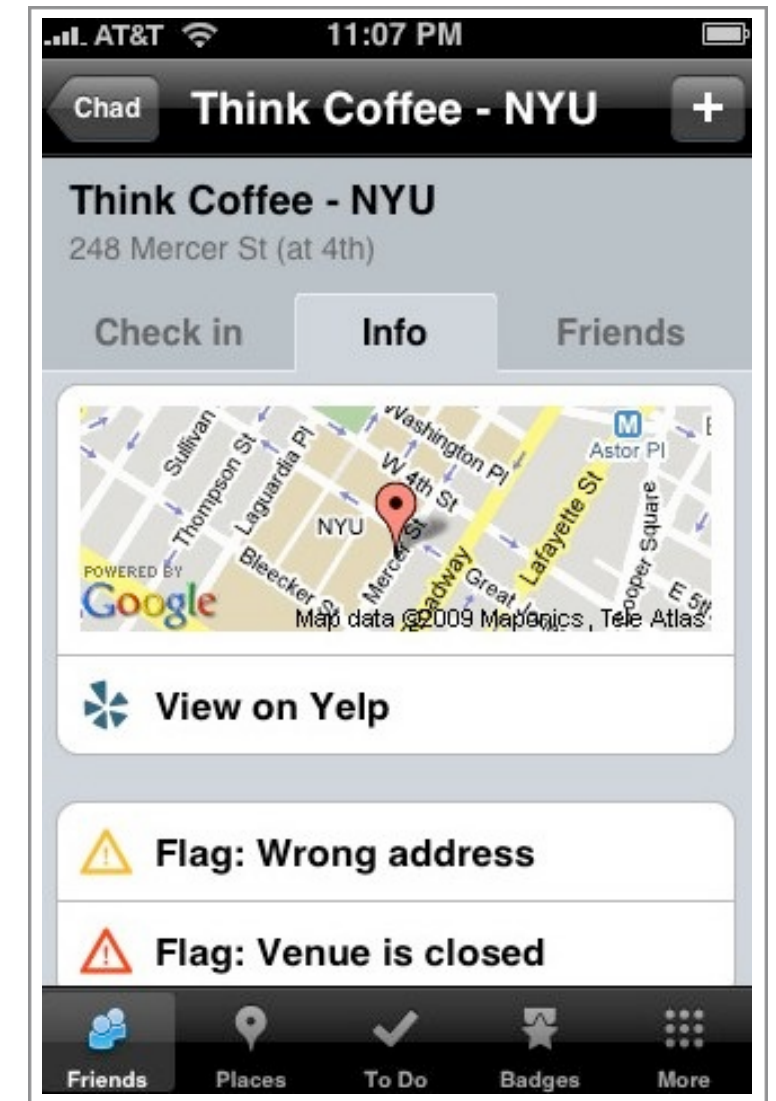
- Areas of study:
 - Presence of routine (regularity) in mobility and encounters
 - Relationship between personality traits and mobility behaviour
 - Heterogeneity in individuals' behaviours
- Applications:
 - Content provisioning
 - User profiling
 - Recommender systems

Why Foursquare?

- Appropriate datasets hard to find!
- In addition to the mobility trace, we want:
 - social graph
 - profiles of individuals
 - properties of the places individuals visit
- ...and comprehensive coverage of a geographic region!

About Foursquare

- “Location-based online social network”
- Users ‘**check-in**’ to their current venue to indicate they’ve **visited** it
- Venues are user-contributed
- Points, “mayorships”, and discounts to incentivise participation

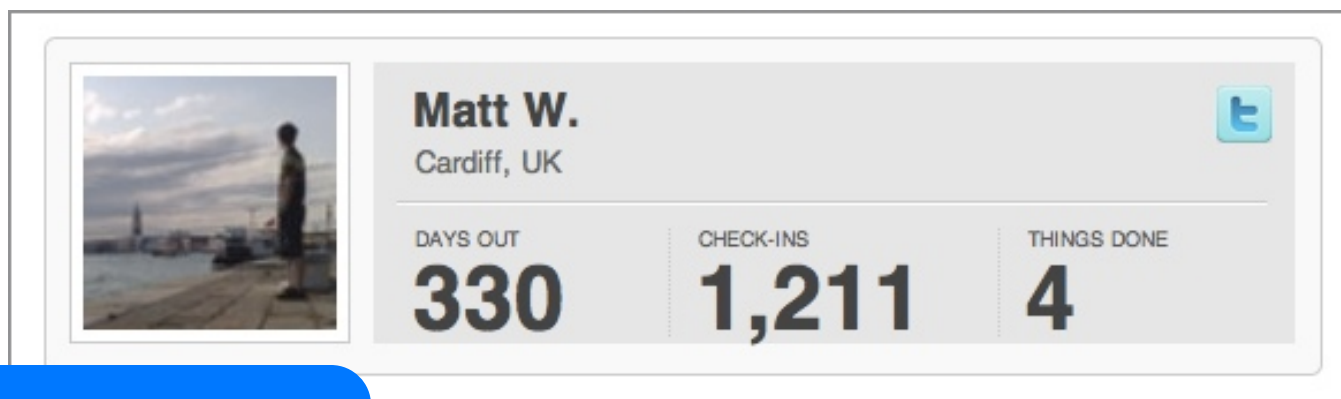
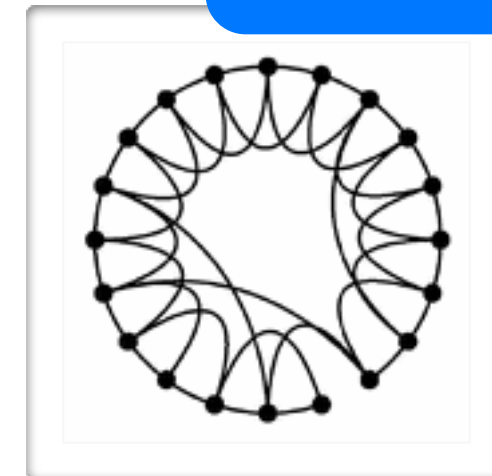
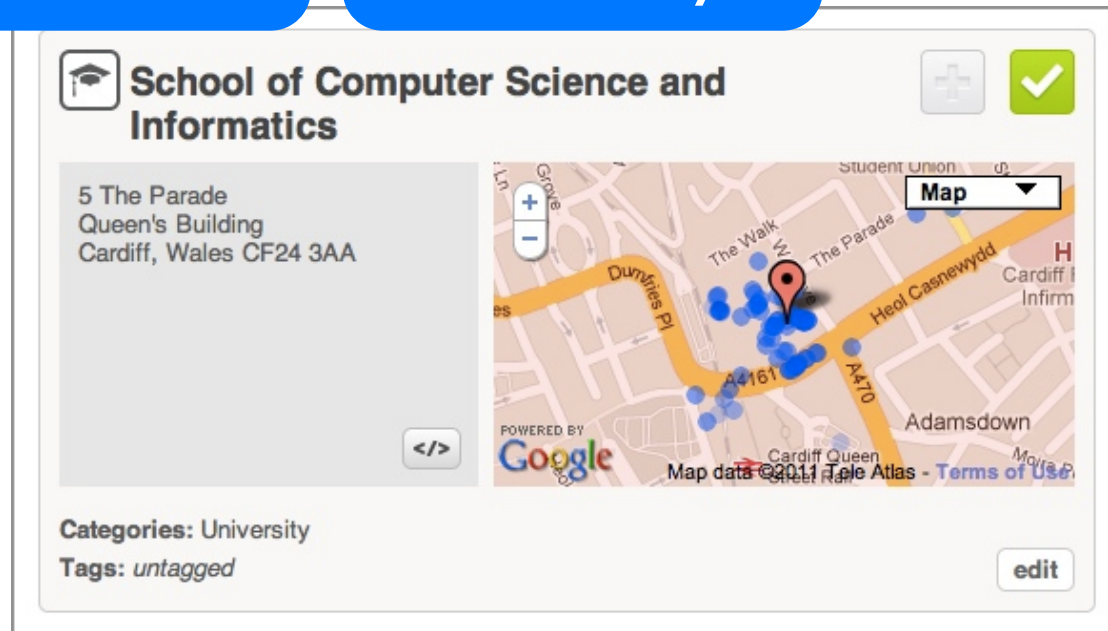


About Foursquare

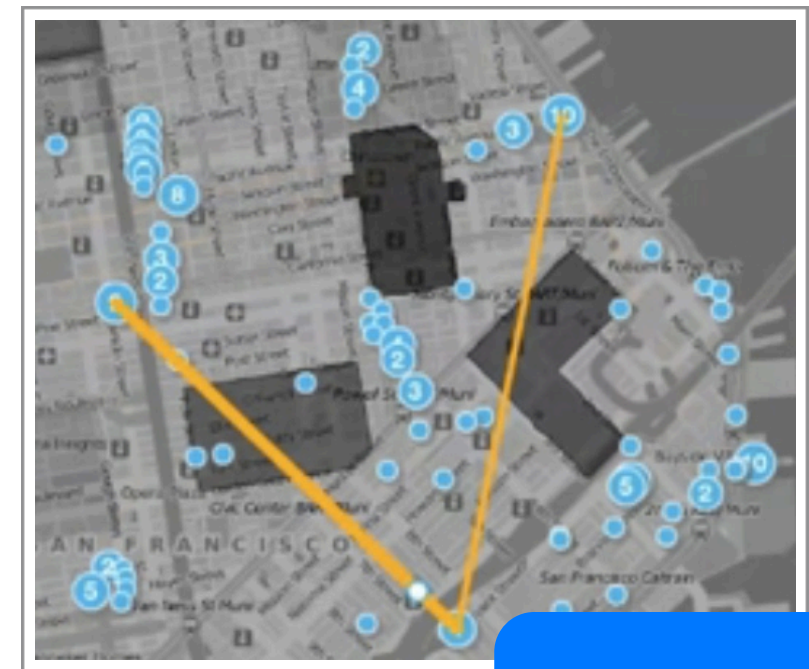
venue
database

+ category
hierarchy

social graph

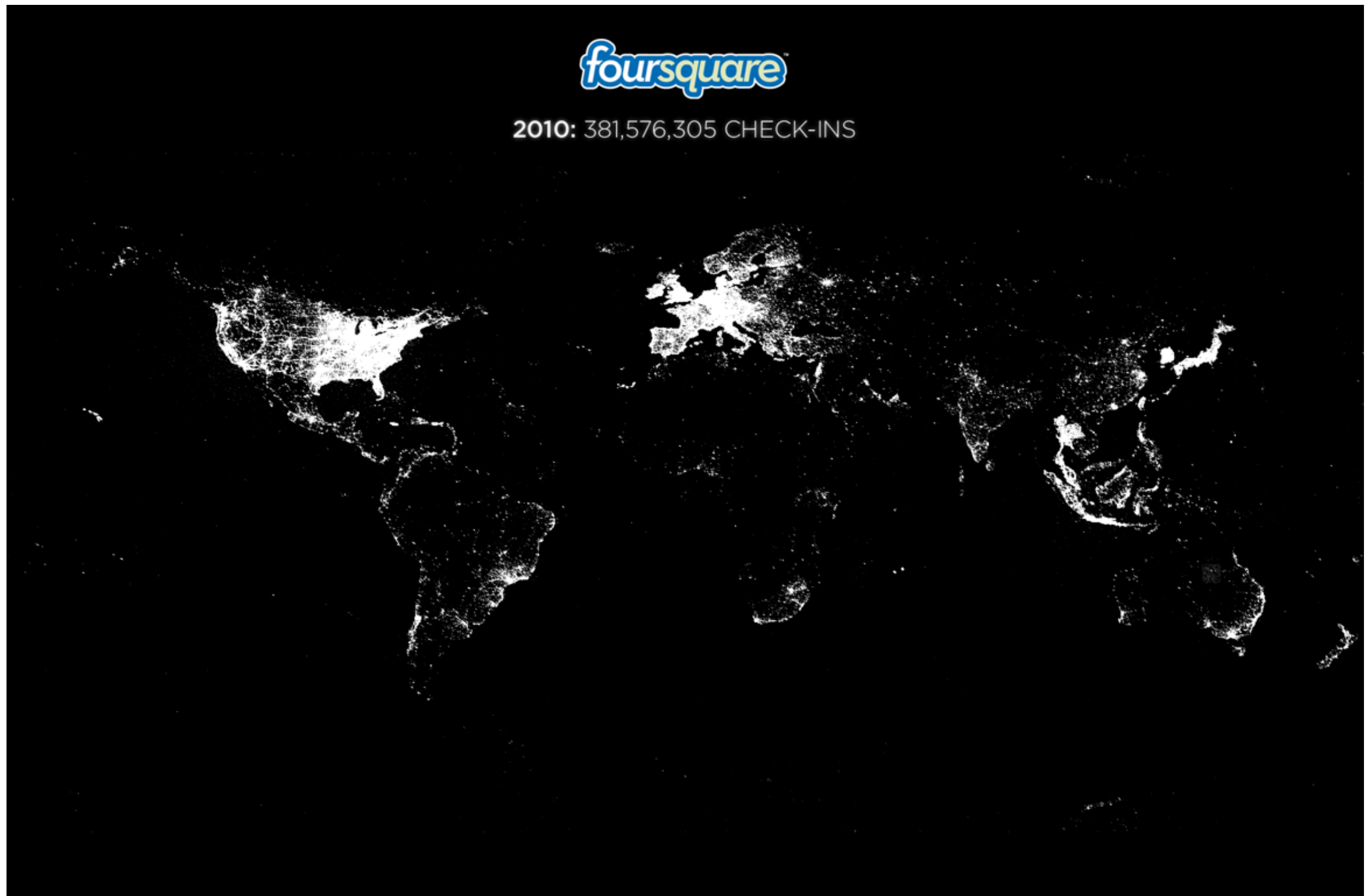


user
database

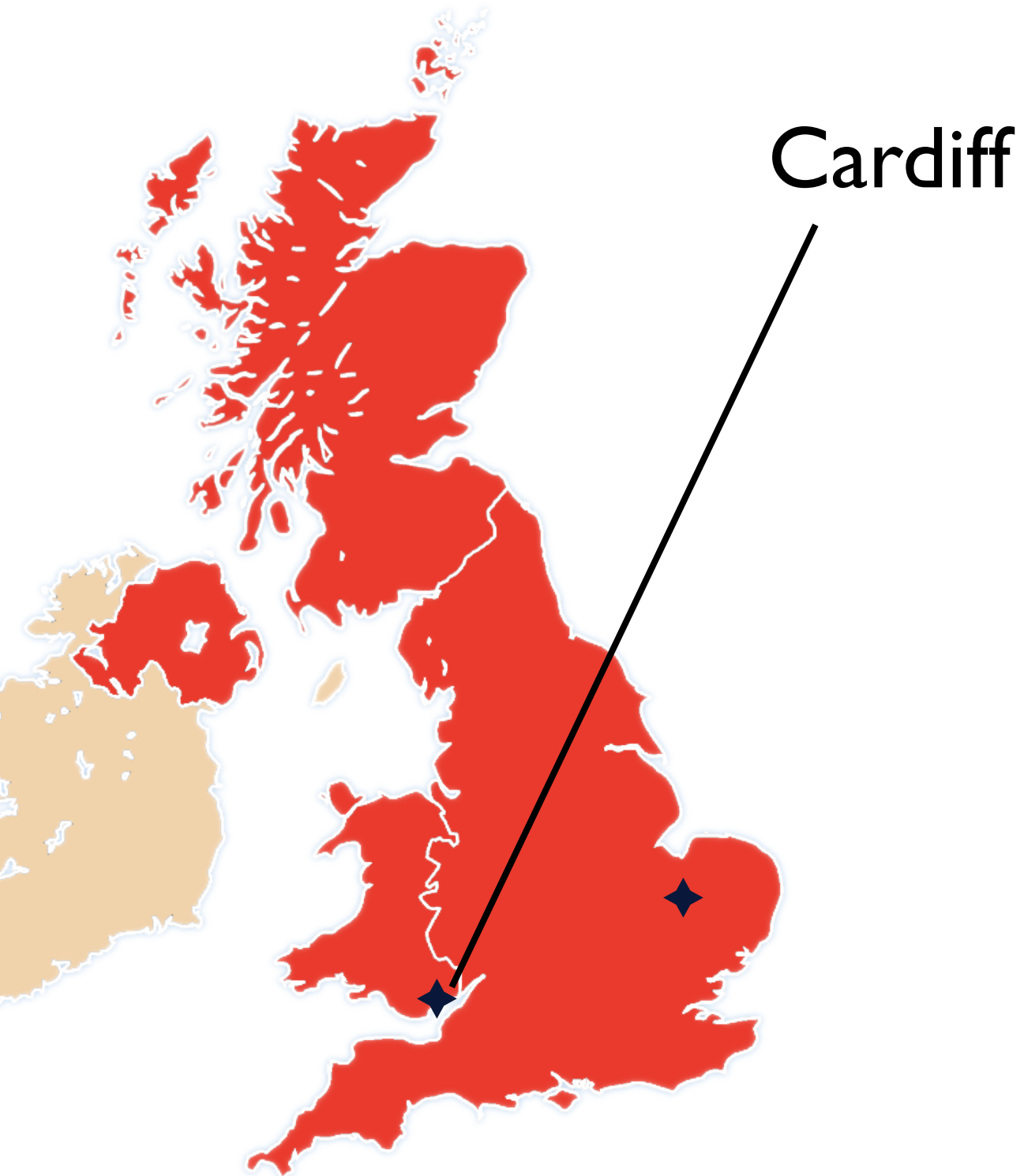


visit history

World Foursquare usage



Data collection

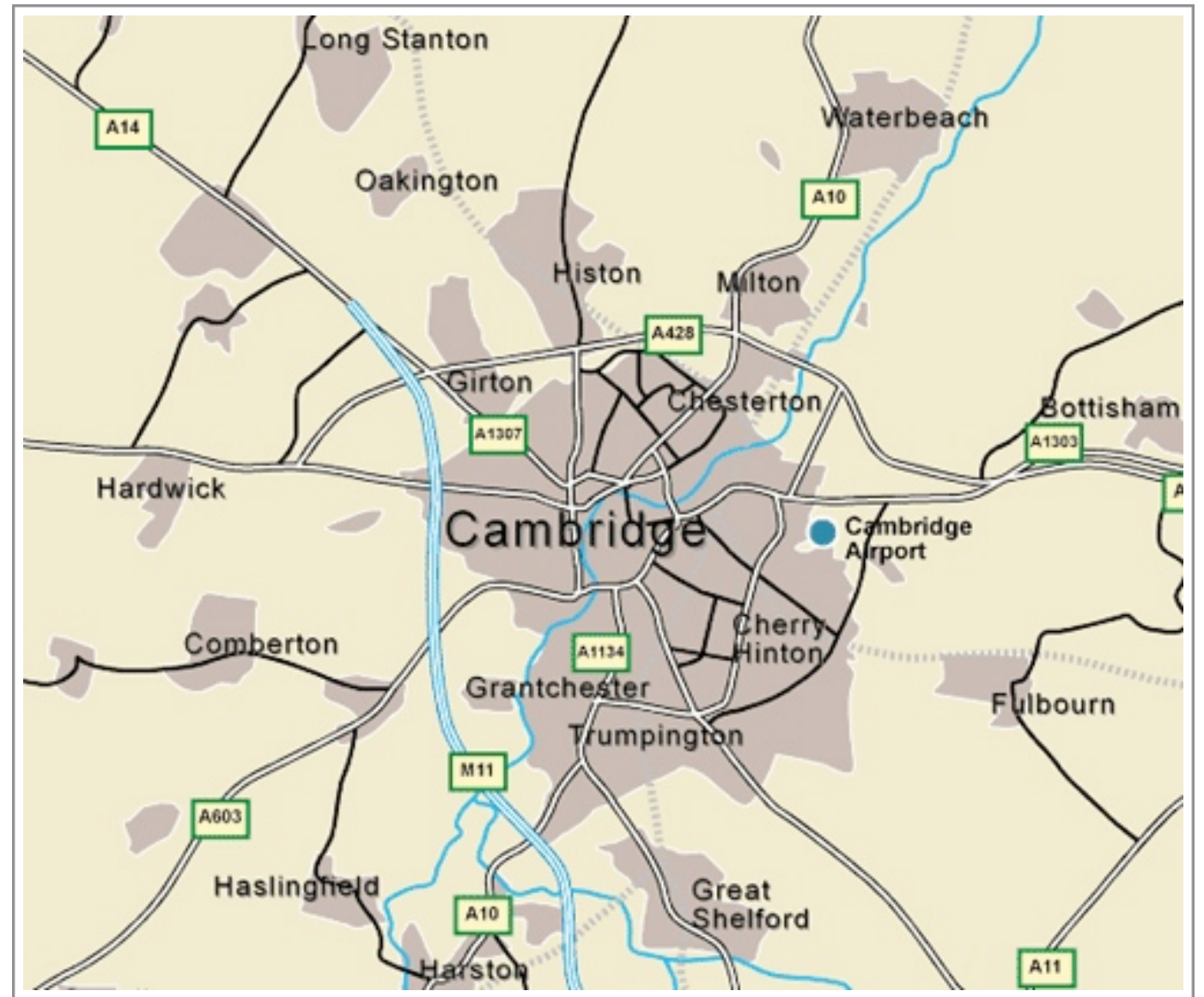
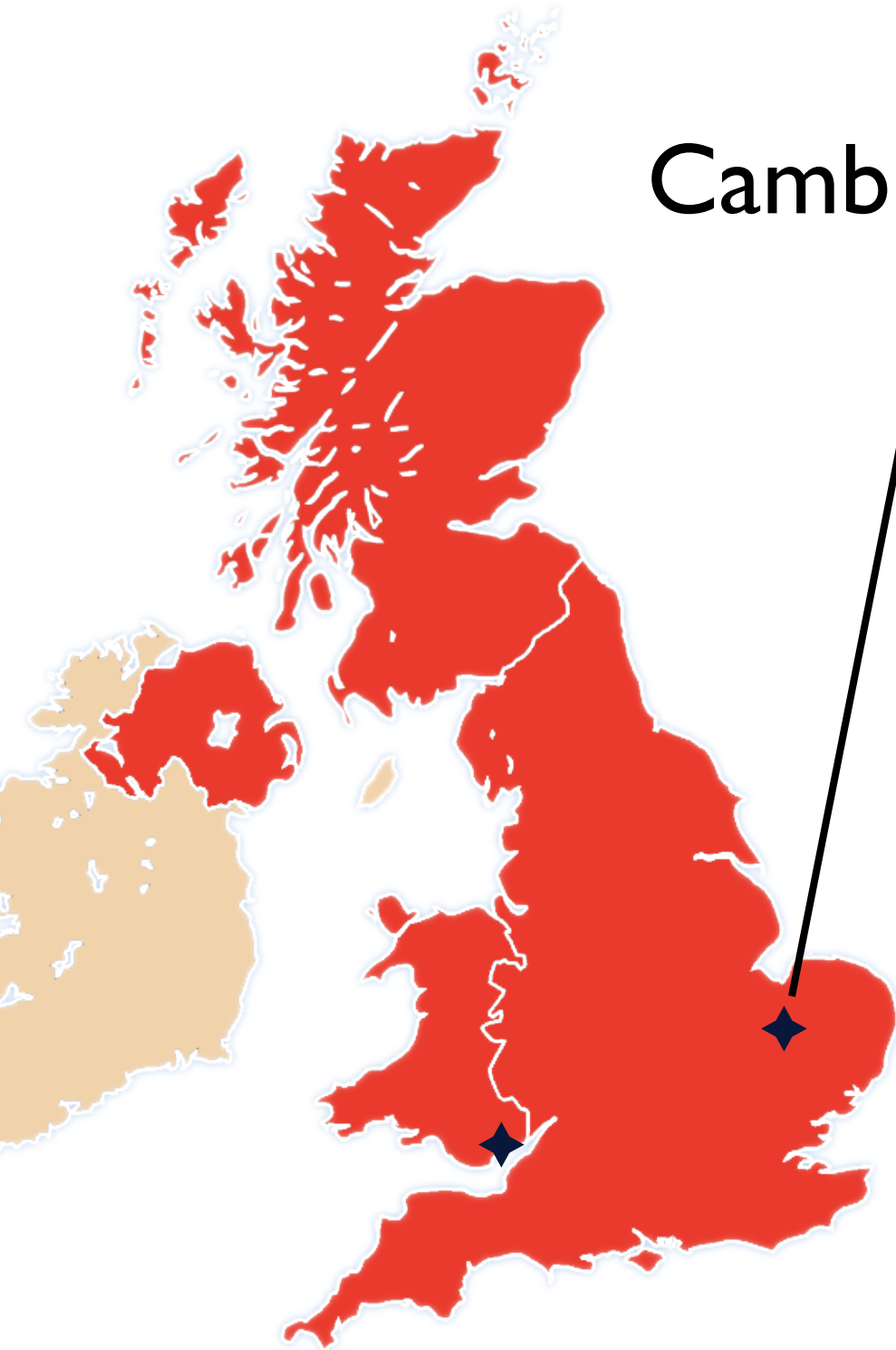


city area: 140 km²

city population: 341,000

Data collection

Cambridge



city area: 116 km²

city population: 130,000

Collected data

	City pop.	Collection area	# users (≥ 1 visit)	# venues (≥ 1 visit)	Checkins		
					Total	per venue	per user
Cardiff	320,000	7.0 x 9.0 km	1,701	1,234	13,299	10.78	7.82
Camb.	120,000	5.0 x 3.5 km	1,196	852	6,464	7.59	5.40

Collection period: Mon 21st March – Fri 13th May
53 continuous days

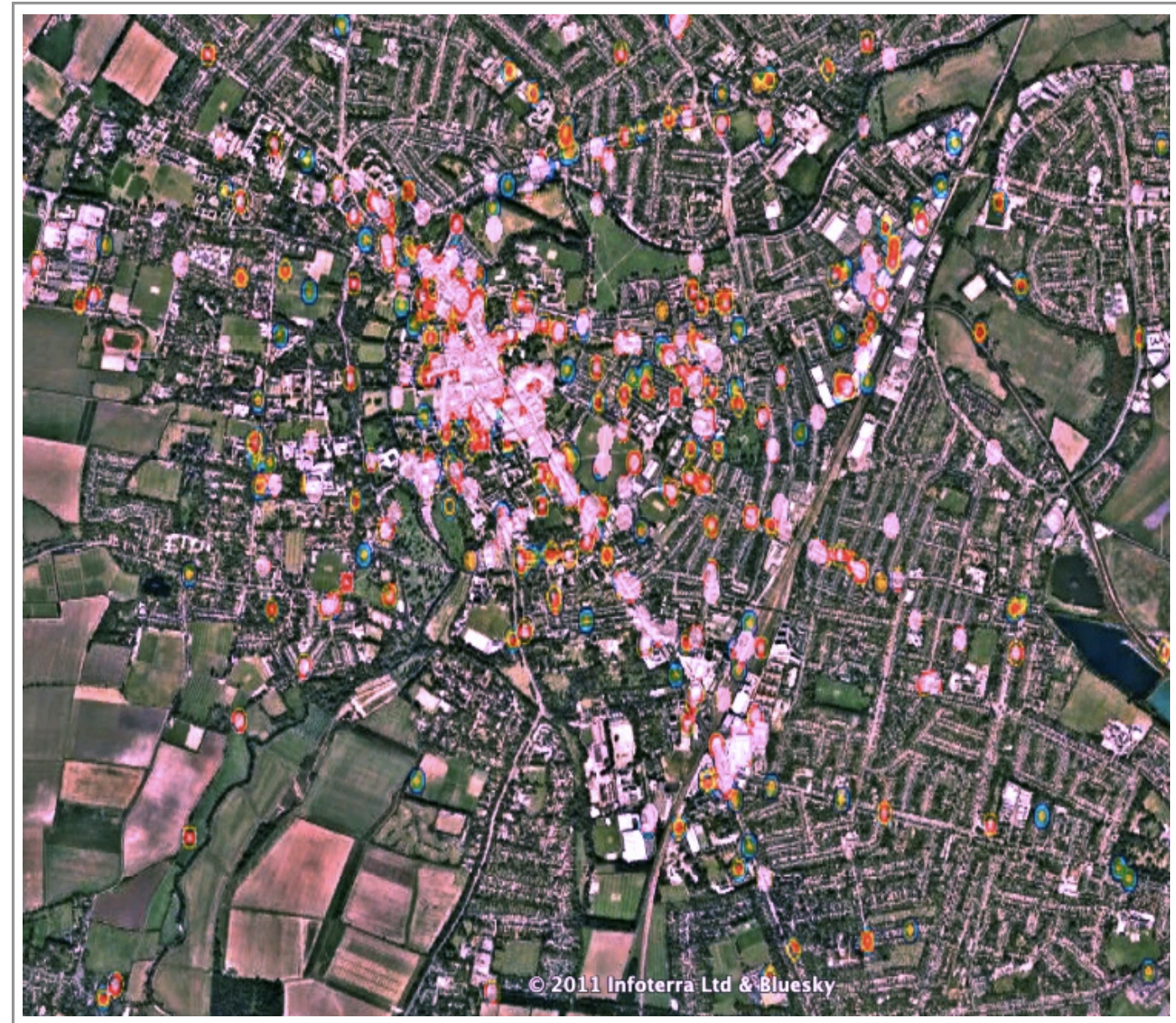
Checkins heatmap

Cardiff



2km

Cambridge



2km

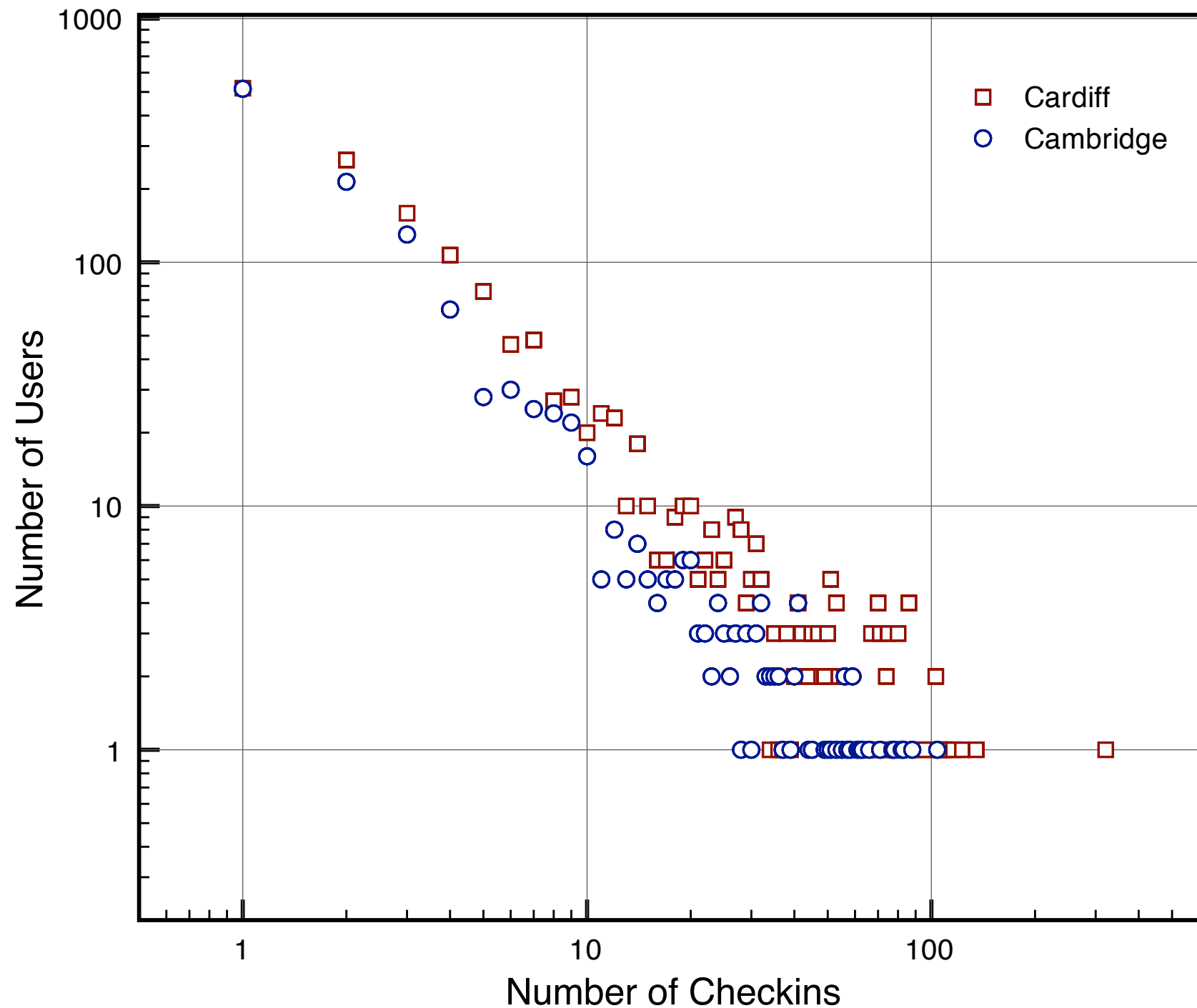
most  fewest

Areas of analysis

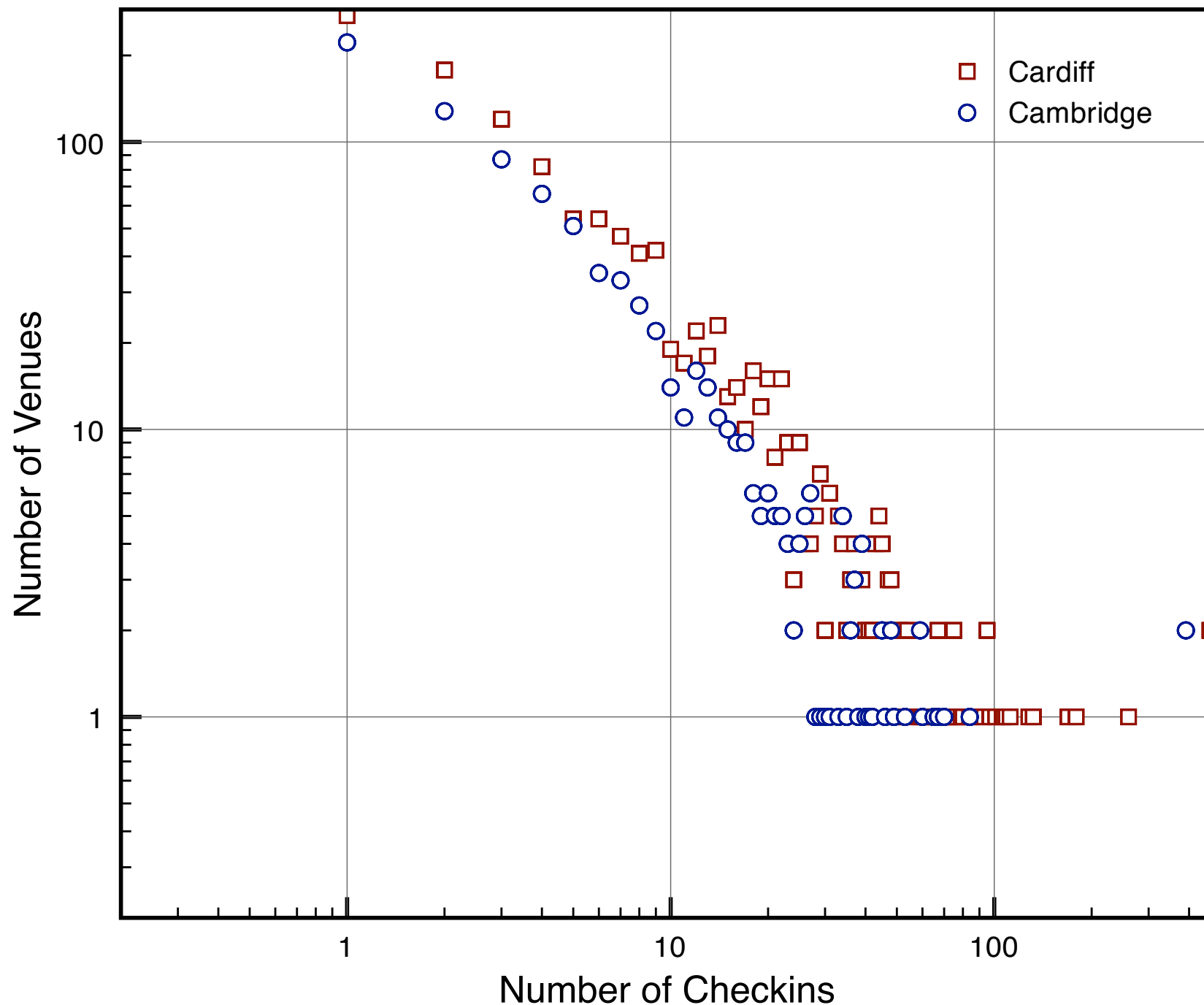
- User activity and venue popularity
- Inter-checkin time and distance
- Co-located checkins
- Checkin patterns

User activity and venue
popularity

User activity



Venue popularity



- Small **minority** of **very-popular** venues
- Most-popular tend to be transport hubs
- A large number of venues with very few checkins
- Usually “Home” venues

**Inter-checkin time and
distance**

Inter-checkin time and jump distance

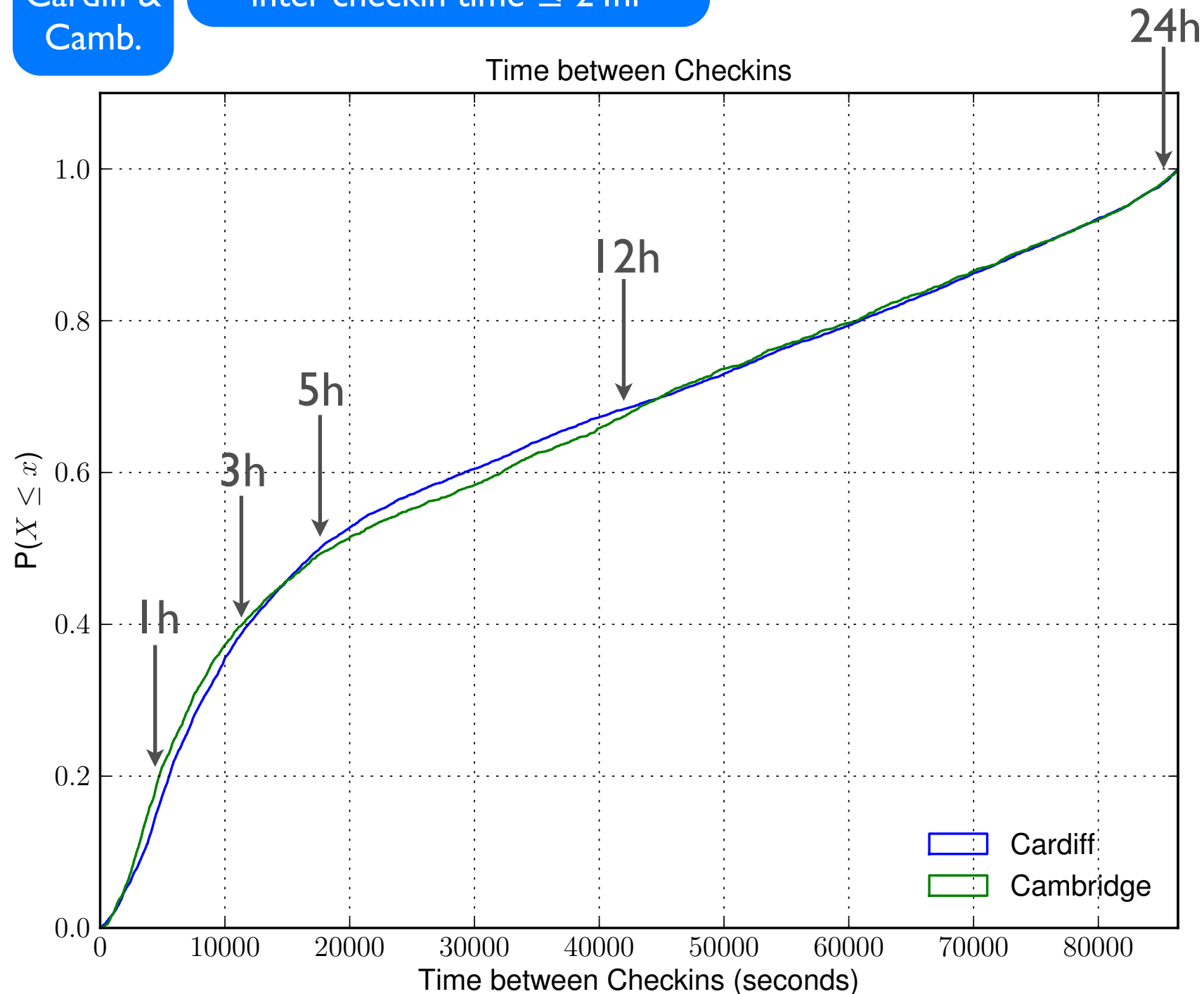
- **Jump distance:**
 - (or: “inter-checkin distance”)
 - distance between two consecutive checkins
- **Inter-checkin time:**
 - time between two consecutive checkins
 - staying time + travel time



Inter-checkin time

Cardiff &
Camb.

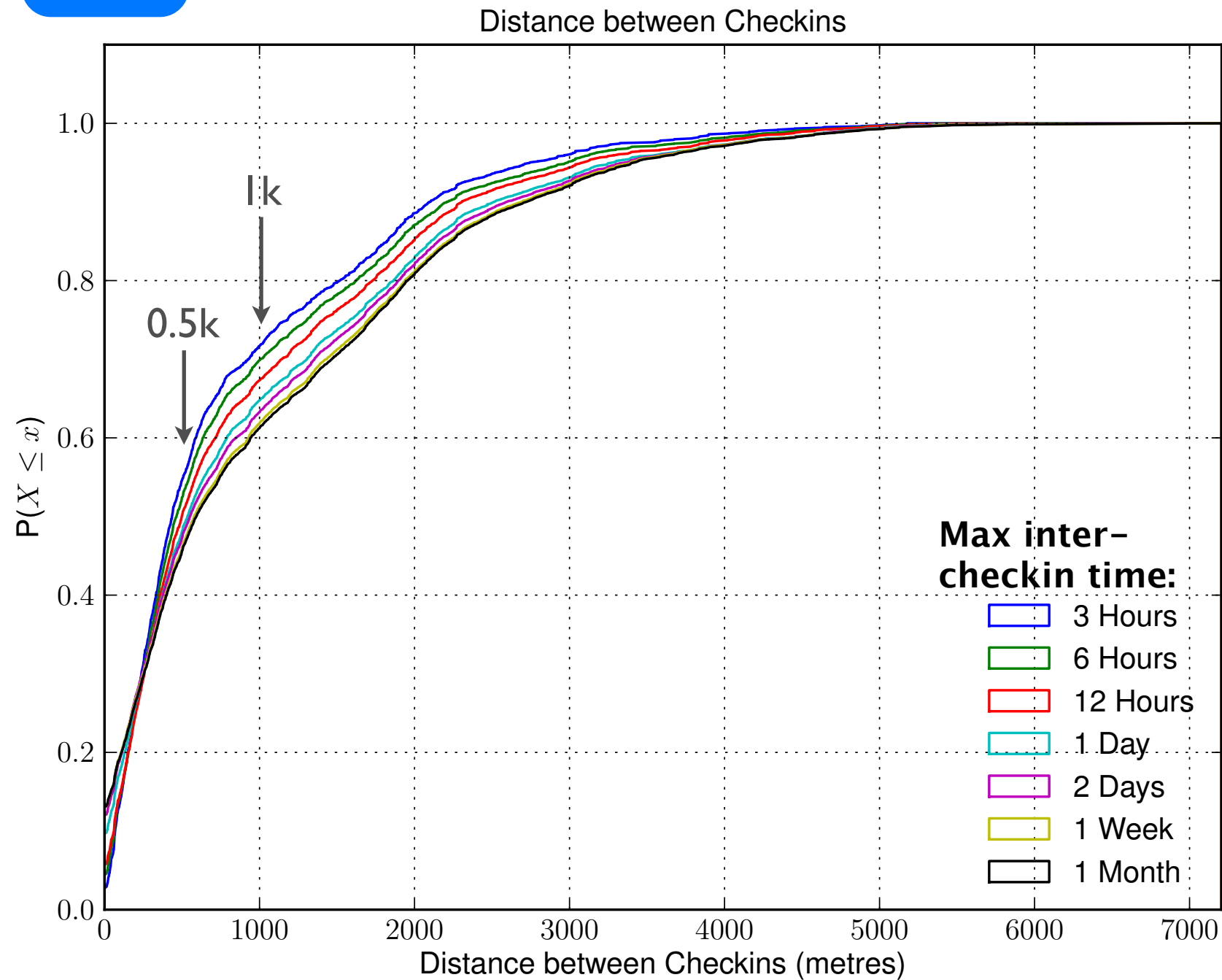
inter-checkin time $\leq 24\text{hr}$



- 50% of consecutive checkins within five hours
- 20% of consecutive checkins within one hour

Jump distance

Cardiff



Cardiff:

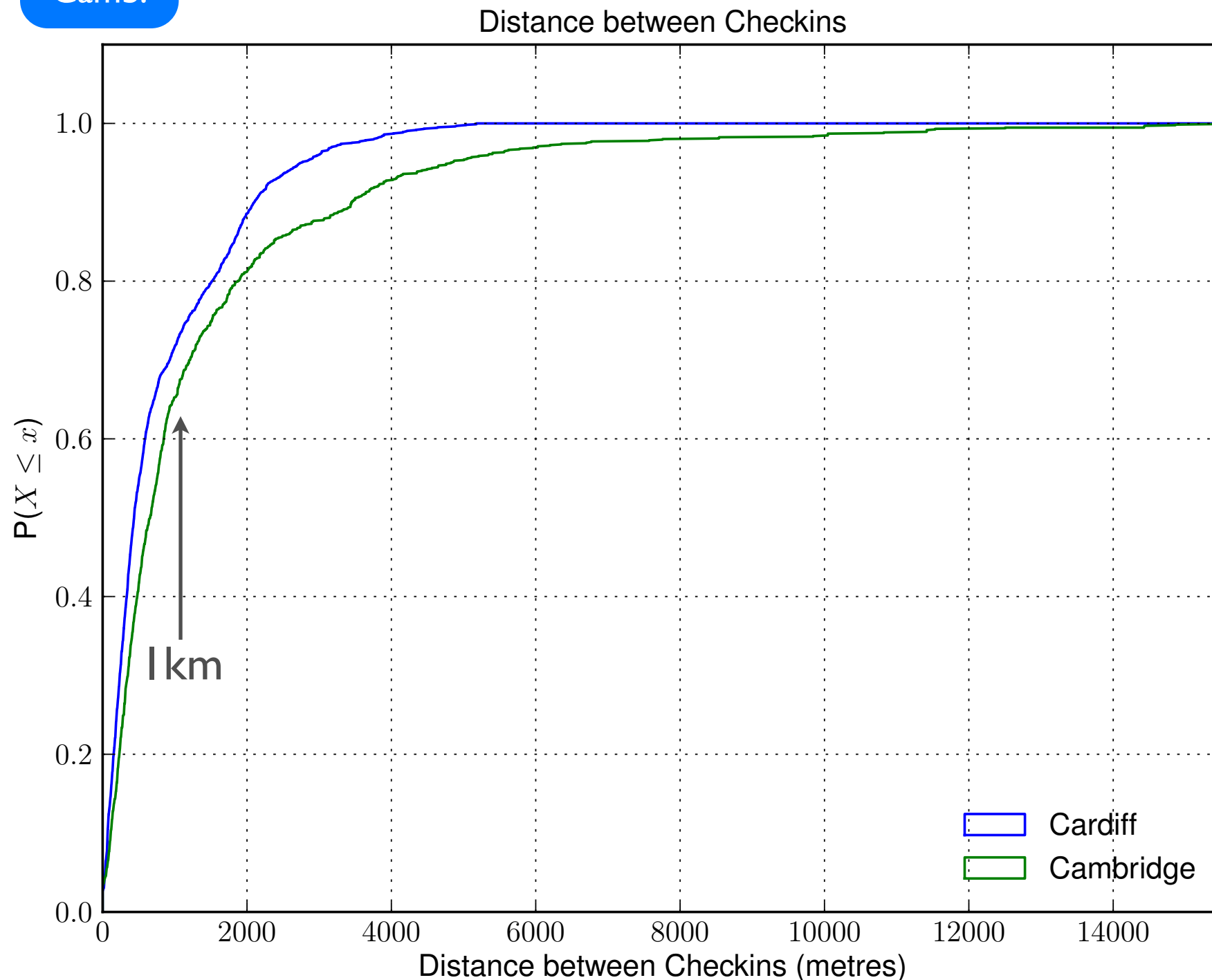
- 60% to 70% of consecutive checkins within 1km
- 48% to 55% of consecutive checkins within 0.5km

(...depending on max inter-checkin time)

Jump distance

Cardiff &
Camb.

inter-checkin time ≤ 3 hr



- For consecutive checkins within three hours...
 - Cardiff: 75% of jumps less than 1km
 - Camb.: 66% of jumps less than 1km
- On average, Cambridge users travel farther between checkins

Co-located checkins

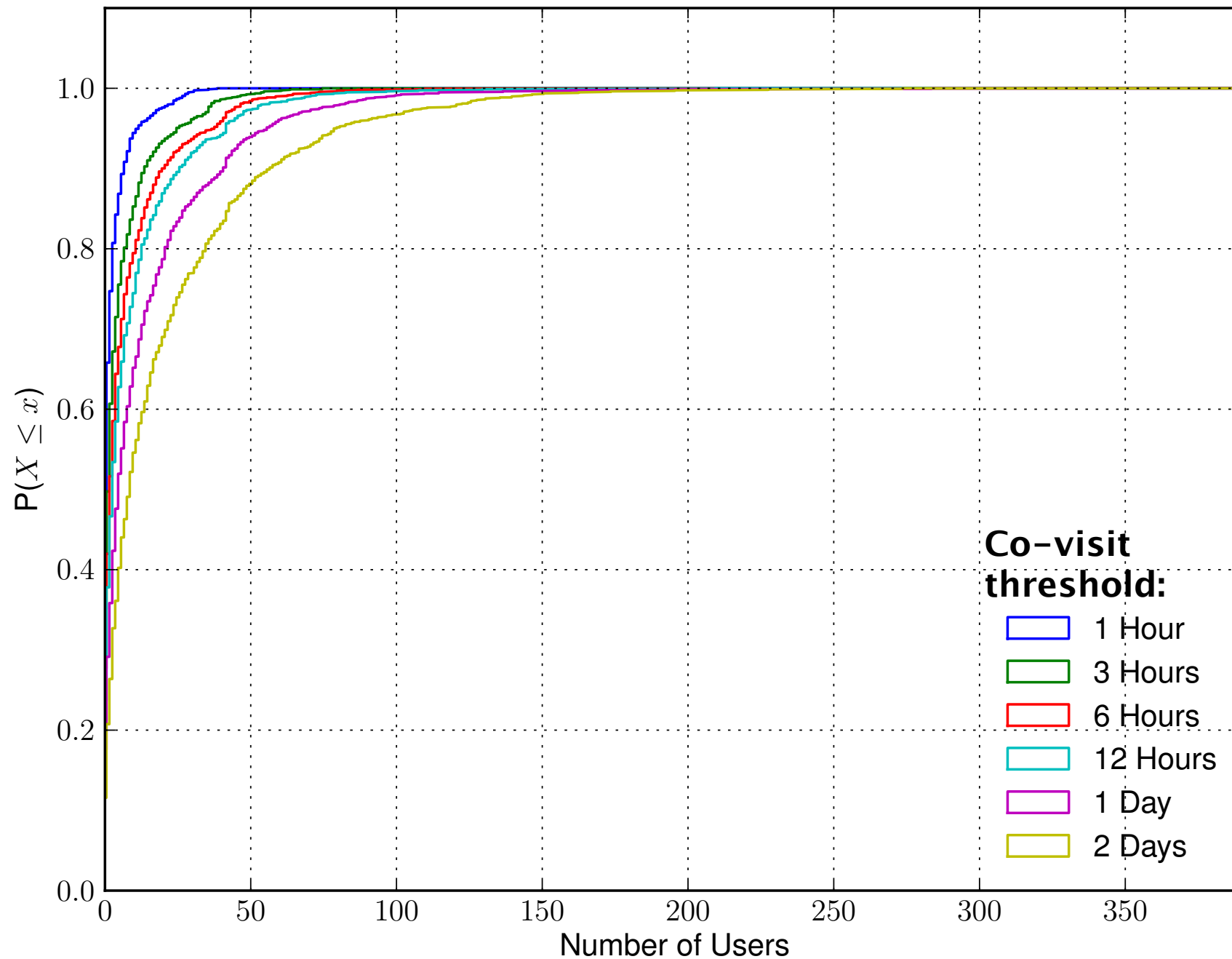
Co-visiting behaviour

- The **co-visiting** patterns of users:
 - Two users checking in at the **same venue** within one hour of each other are said to have “**co-visited**”
 - Other **co-visit thresholds** can be chosen
- How many users ‘*meet*’ in this way?
- Does **friendship** influence **co-visiting behaviour**?

Number of co-visitors

Cardiff

Number of Unique Users with Co-located Checkins (per User)



At a **co-visit threshold of one hour**:

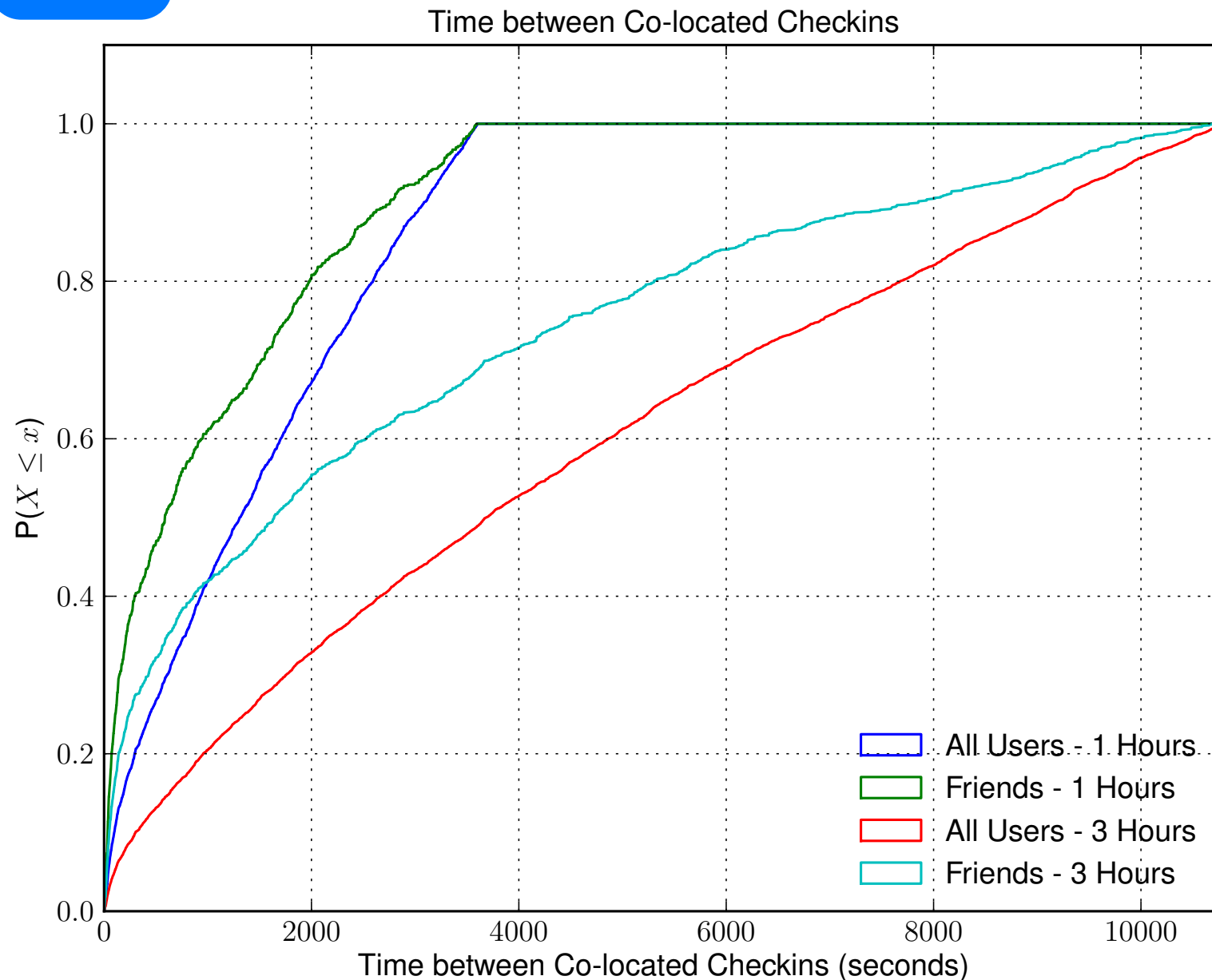
10% of users co-visited with more than 10 different people

35% of users co-visited with at least one other person

The most people a user met is 35

Time between co-visits: friends vs. non-friends

Cardiff



In Cardiff...

average time between co-visits in a **one-hour** threshold...

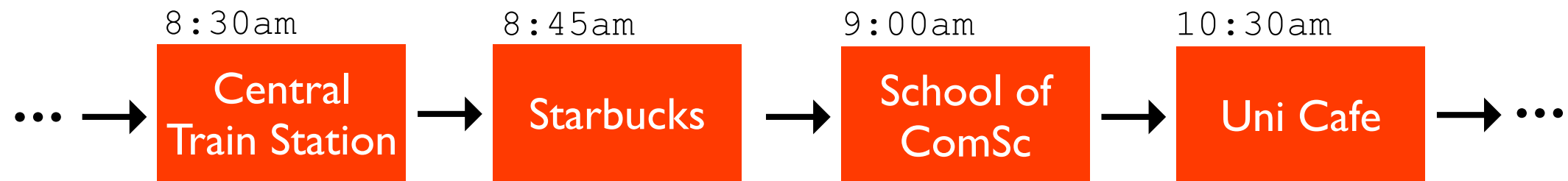
between friends: 8.3 mins
between any users: 18.2 mins

average time between co-visits in a **three-hour** threshold...

between friends: 27 mins
between any users: 63 mins

Checkin patterns

Sequence analysis



- Can we find repeated patterns of checkins?
- Look at n-grams frequencies...

example string:

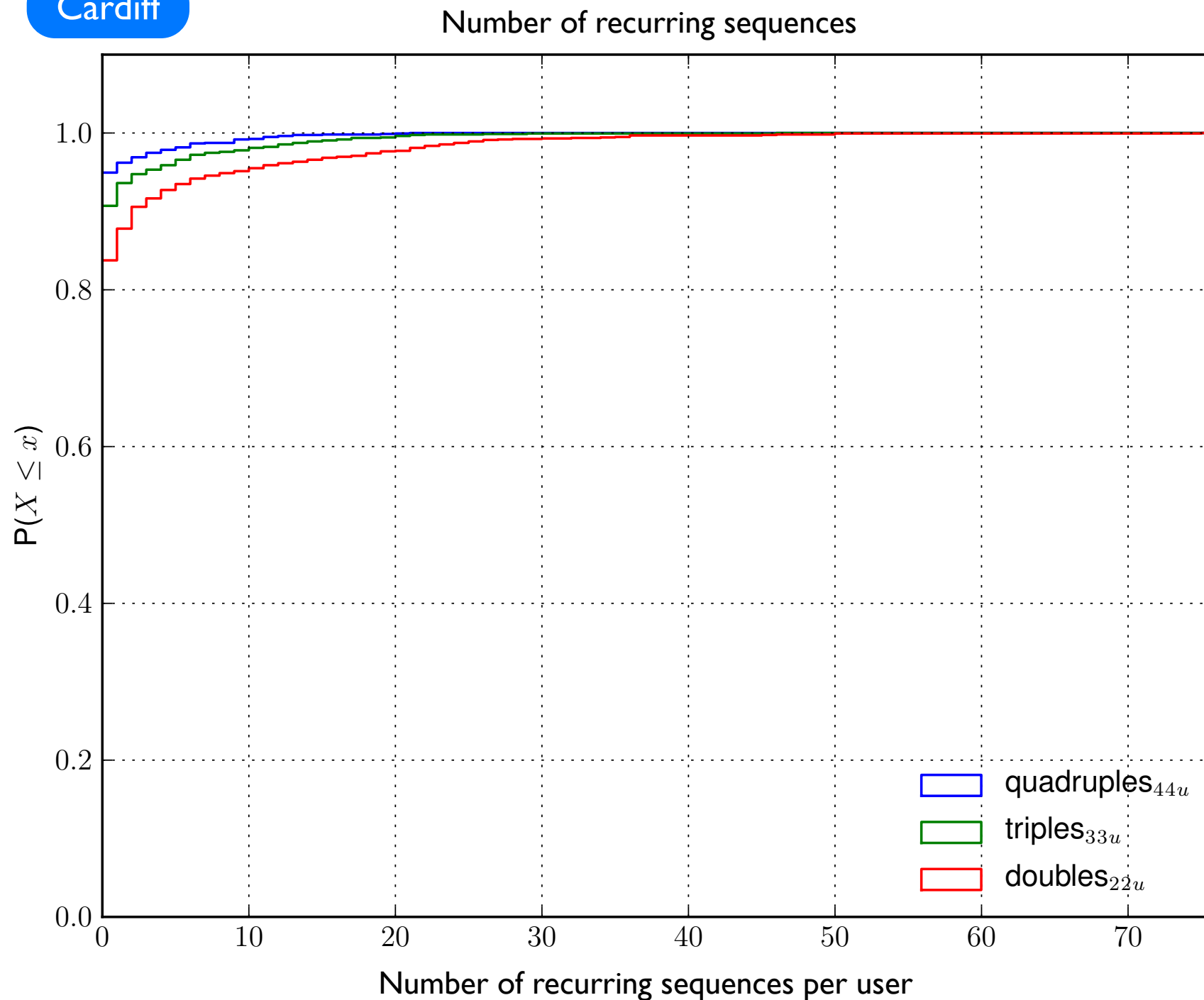
A-B-C-D-A-B-C-C-A-B-C

3-grams

sequence	count (#repeats)
ABC	3
BCD	1
CDA	1
BCC	1
CCA	1
CAB	1
DAB	1

Recurring sequences per user

Cardiff



2-grams:

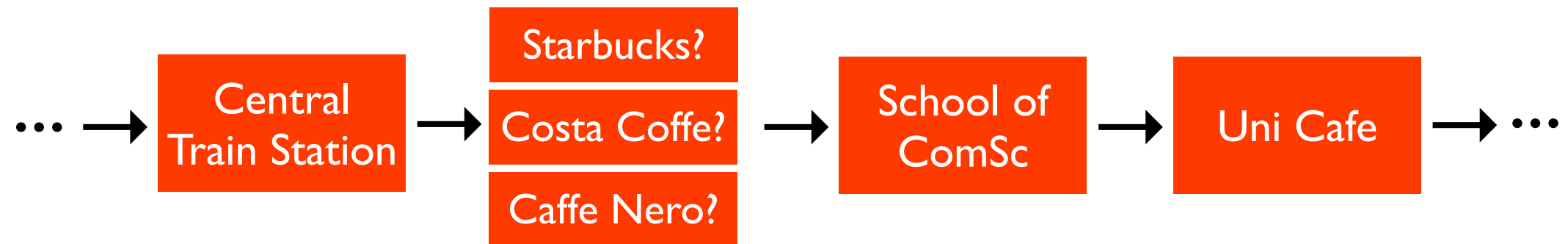
- 84% of users with no recurring sequences
- 10% of users had between one and five recurring sequences
- 6% of users had more than five recurring sequences

3-grams:

- 90% of users with no recurring sequences
- 6% of users had between one and five recurring sequences
- 4% of users had more than five recurring sequences

Fuzzy sequences

- Allow different intermediate venues



- Allow **up to** n intermediate venues when matching a pattern
- Similar to regular expression matching...

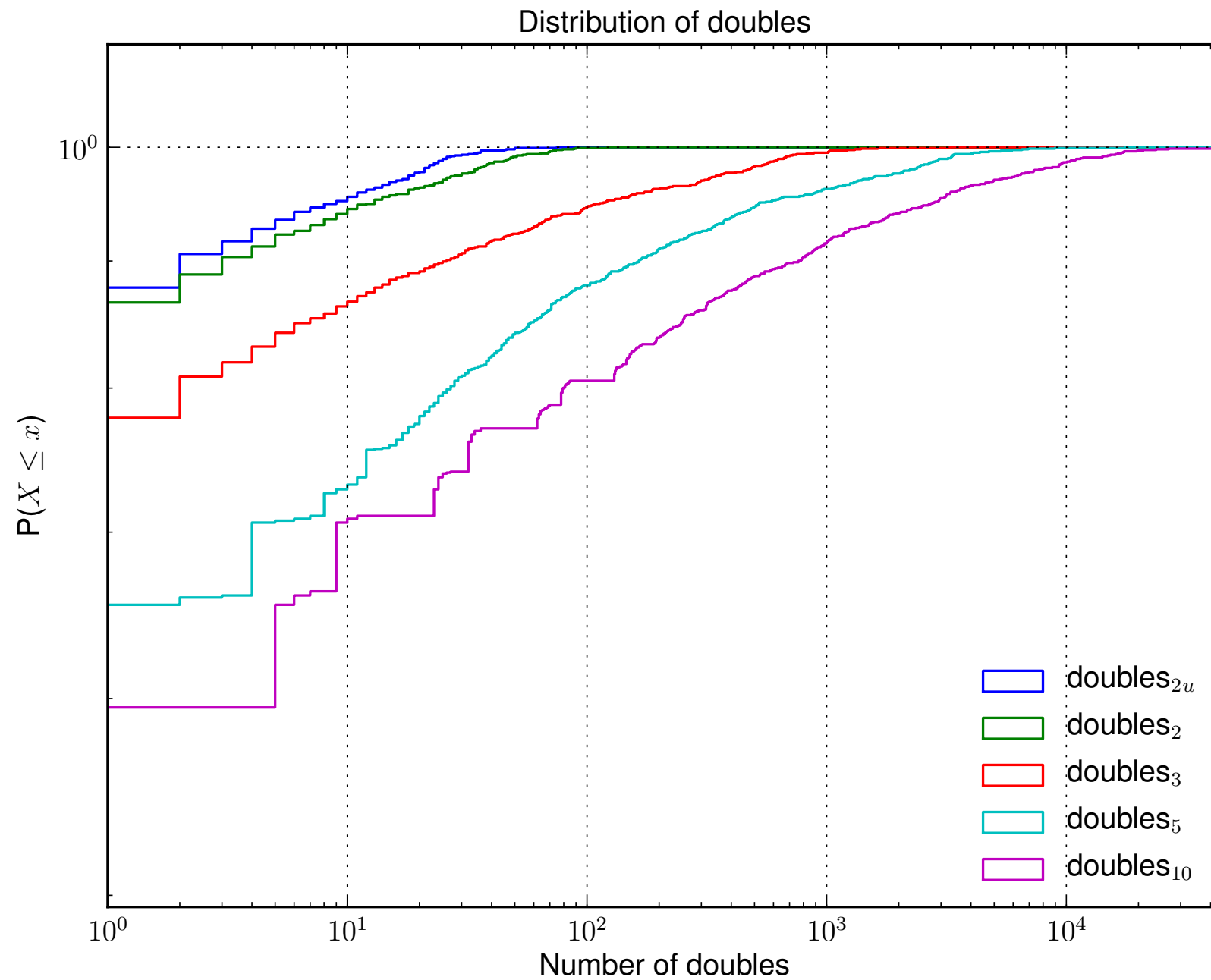
A-B-C-D-A-B-C-C-A-B-C

Pattern:

$C * \{0, 2\} A$

... has two matches

Distinct fuzzy sequences per user



Summary

- Users tend to make frequent and regular checkins to a limited number of venues
- A small subset of users show repeated sequences of checkins
- The type of venue affects regularity:
 - Home and Work venues are very regular; Outdoors venues are less regular
- Movement of friends influences co-visit behaviour
- City-specific characteristics affects user behaviours
 - Temporal behaviour is universal, but jump distance affected by geography?

Ongoing and future research

- Individual checkin patterns: regularity, predictability, heterogeneity
- Influence of friendship on co-visiting behaviour -- causality or commonality?
- Relationship between personality traits and visiting behaviour

Thanks for listening!

Questions?

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