

Integrating new, emerging and traditional sources of data to produce time-specific gridded population maps



Samantha Cockings, David Martin

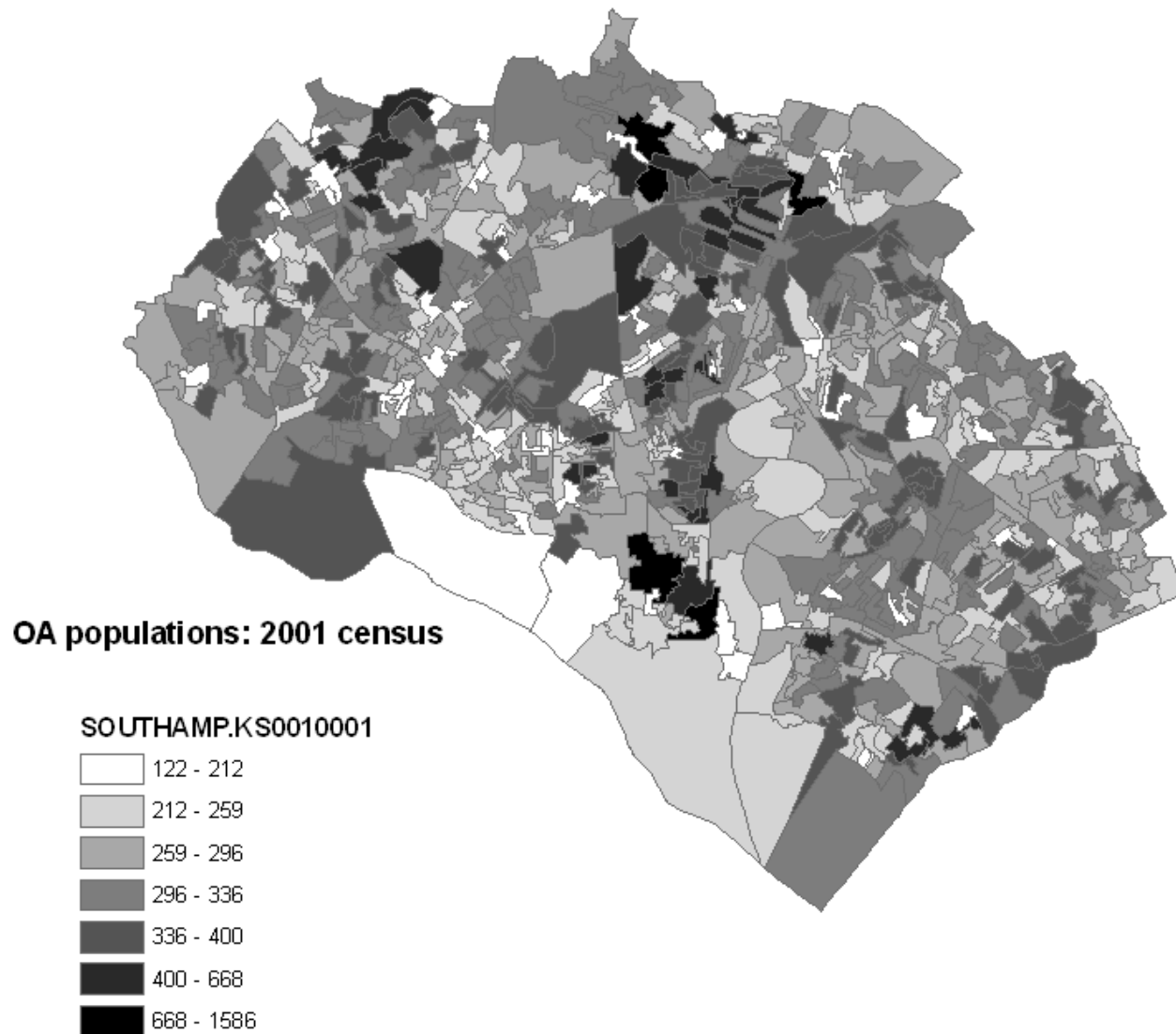
EFGS, Dublin, 3 Nov 2017

Why do we need space-time specific population estimates?

- For decision-making, planning and policy formulation in many sectors
 - E.g. emergency planning/response, health, national security
- How many people in specific places and specific times?
- How this varies by time e.g. hourly, daily, weekly, seasonal, one-off events/scenarios
- Ideally, retrospective and (near) real-time
- Census data inadequate (even with recent improvements in workplace, daytime populations etc)
 - Static, residential-based, every 10 years

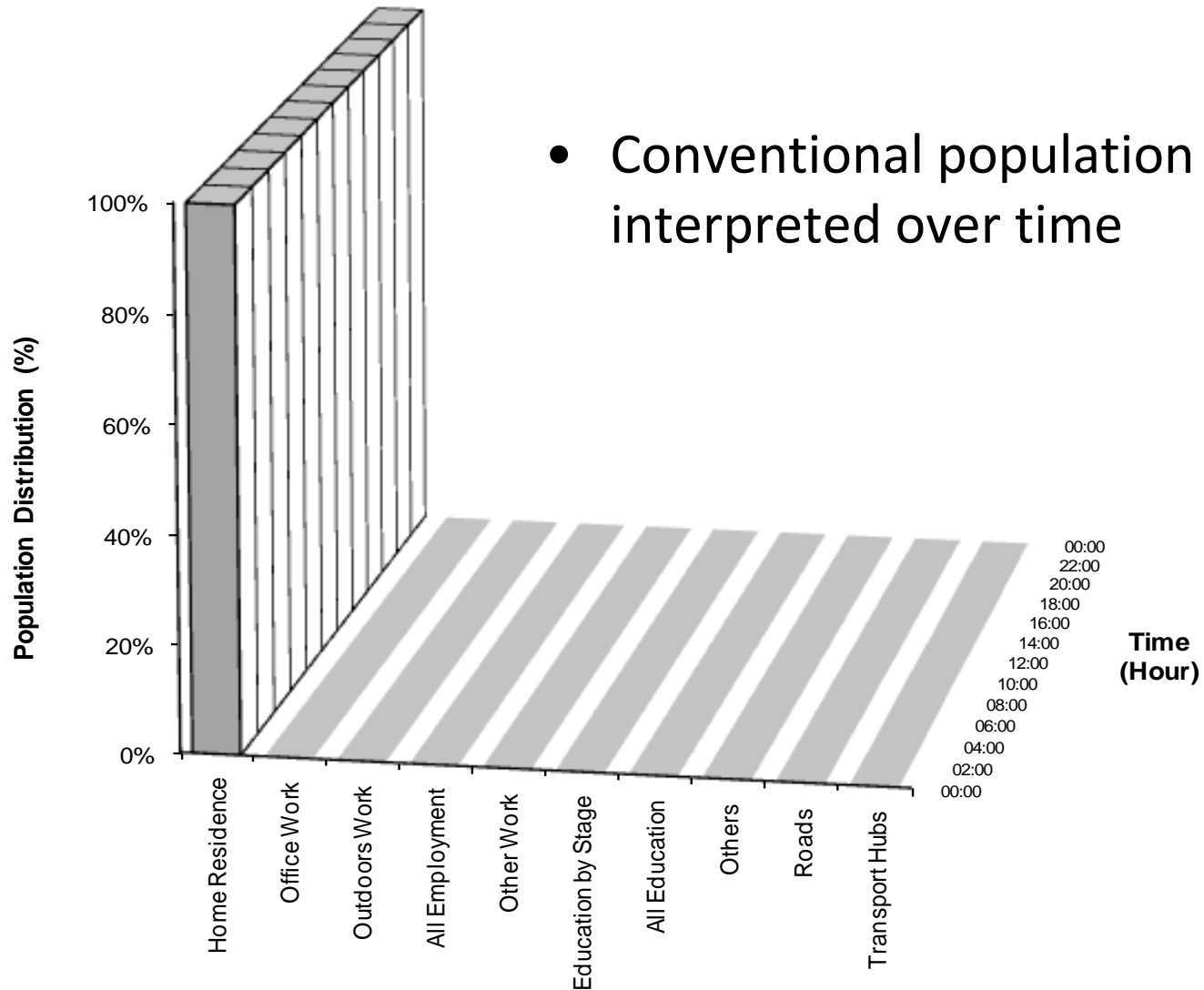
The problem ...

A typical small area population map

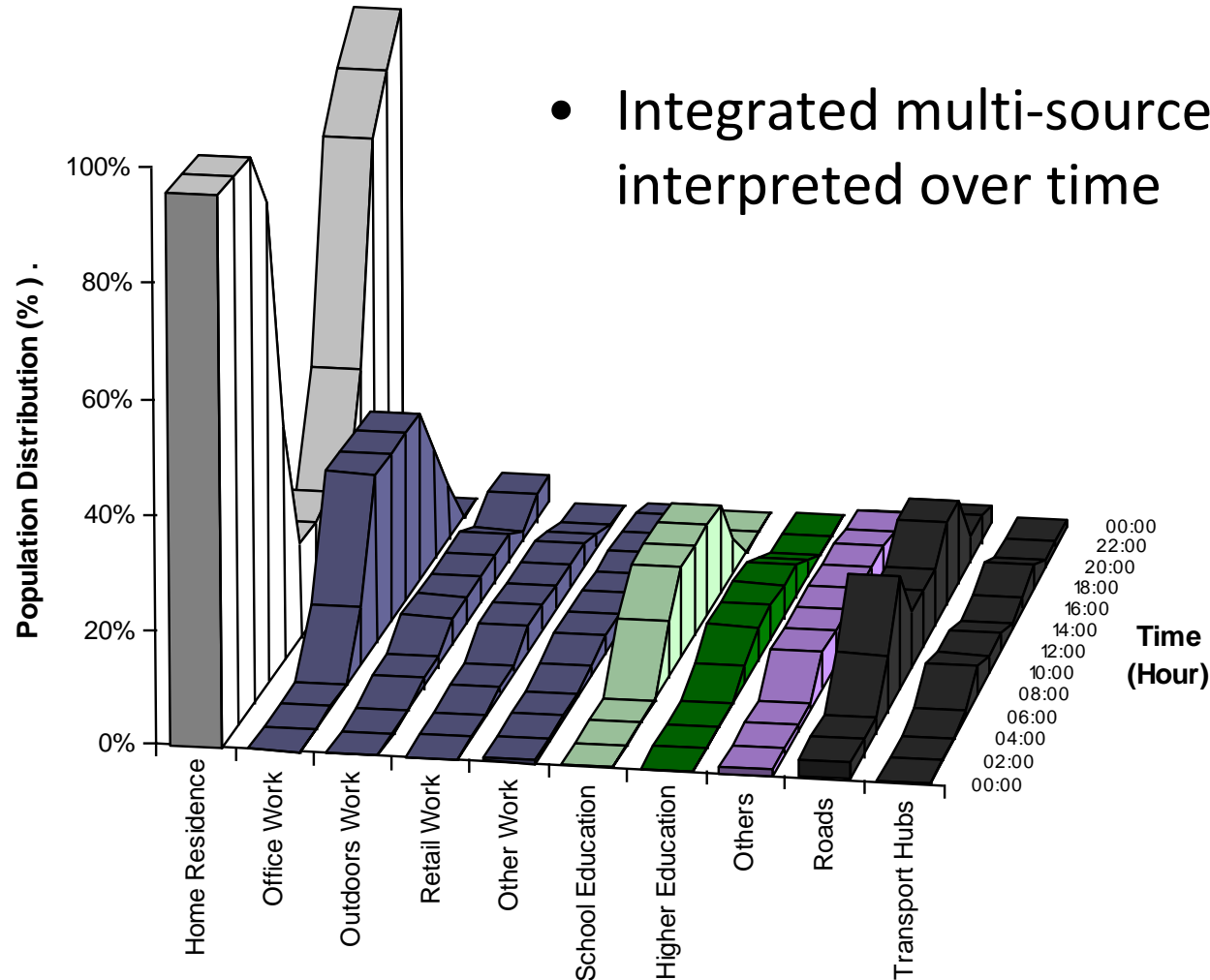




Inadequate spatio-temporal resolution



Required spatio-temporal resolution







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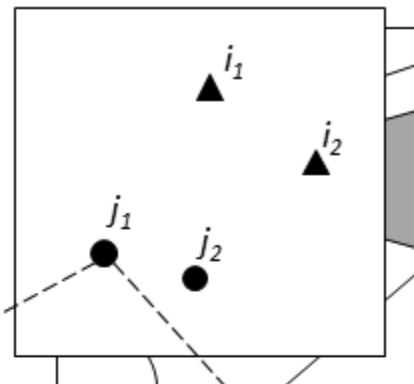
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Previous Population247 research

- ESRC Population24/7 project, 2009-2011
 - Spatiotemporal population estimates – by time of day, week, term, season, etc.
 - General approach/framework
 - Software: SurfaceBuilder247 (.NET)
 - Sample outputs
- Various related PhD / University of Southampton projects
 - population exposure to hazards e.g. flooding, radiation

Locations
(origins and destinations)

Spatial domain



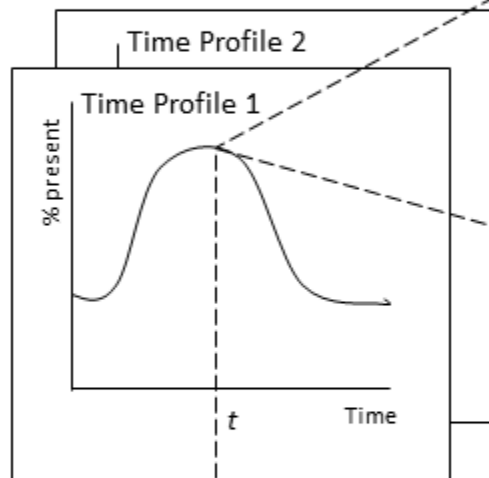
Background features

Background

Magnitudes

Time profiles

Temporal domain



Attribute domain

Origins			
	PR_{c1}	PR_{c2}	...
i_1	100	20	...
i_2	80	150	...

Destinations					
	PNR_{c1}	PNR_{c2}	$TProf$	W	...
j_1	250	50	1	10	...
j_2	100	25	2	5	...

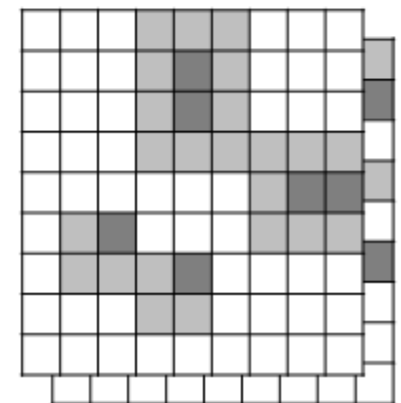
Data
system

Analysis
system

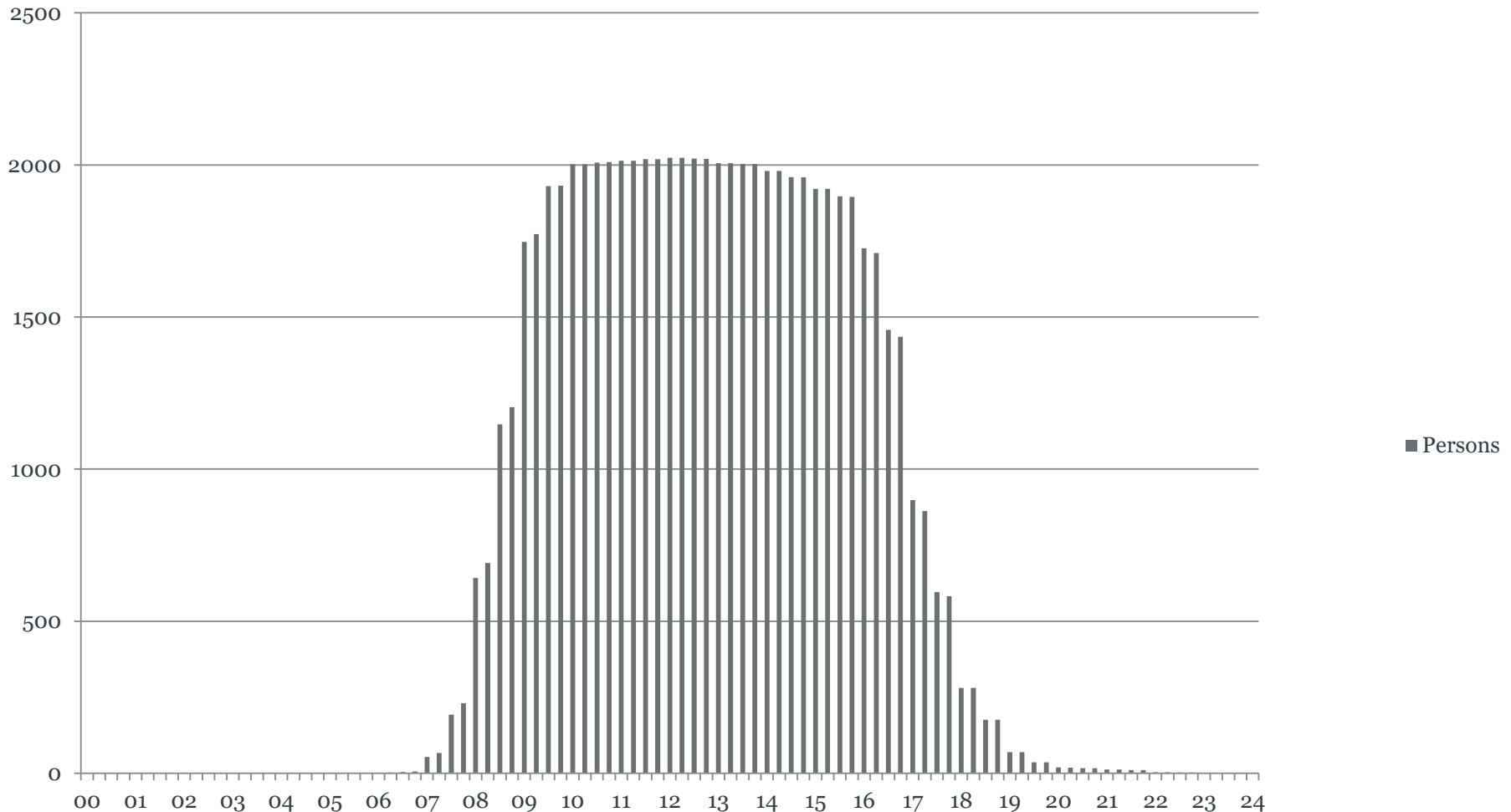
Query
(space-time-attribute)

Modelled
output

Mapped
representation



University of Southampton travel survey: respondents on campus, 15 minute intervals



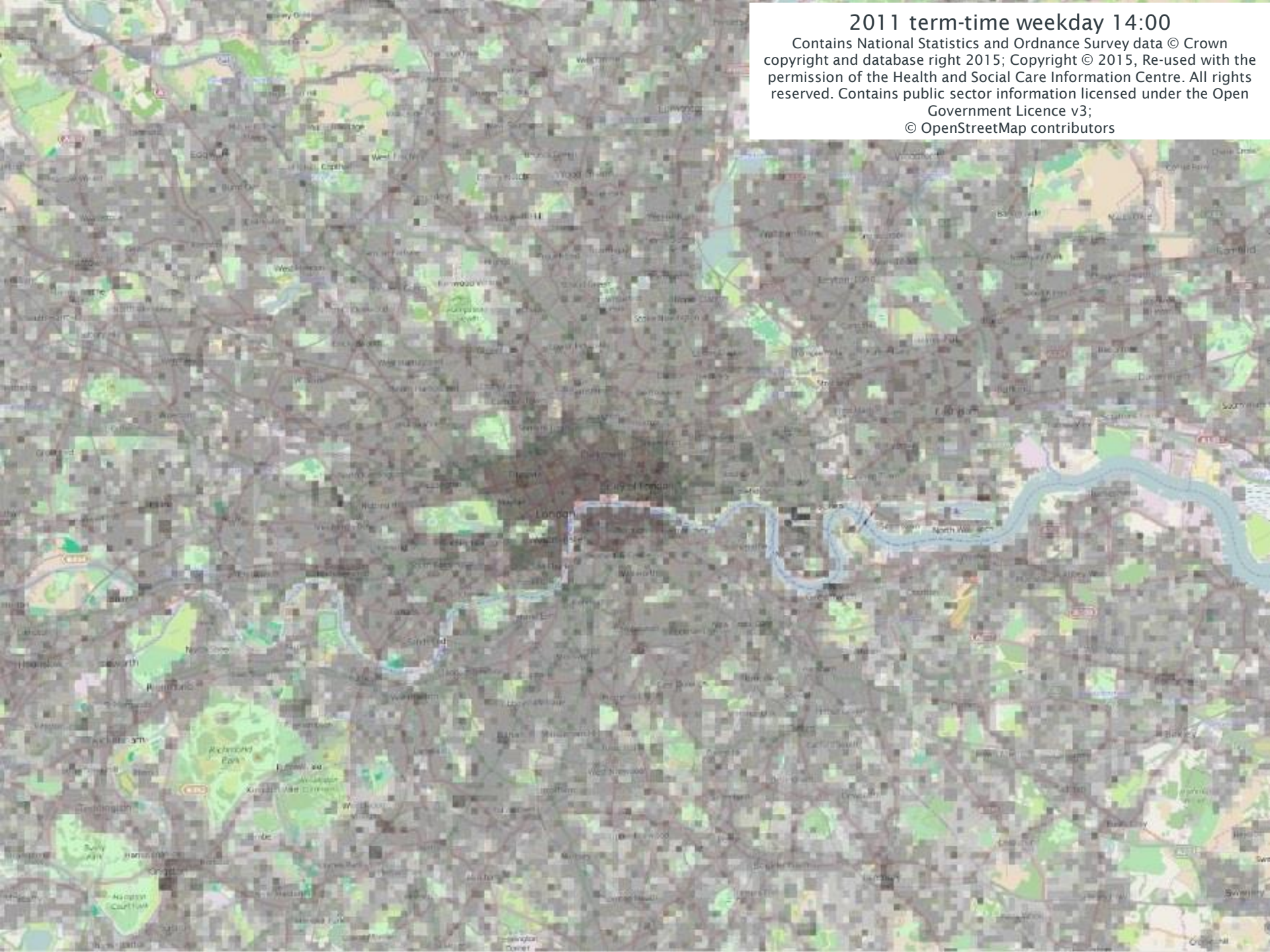
2011 term-time weekday 02:00

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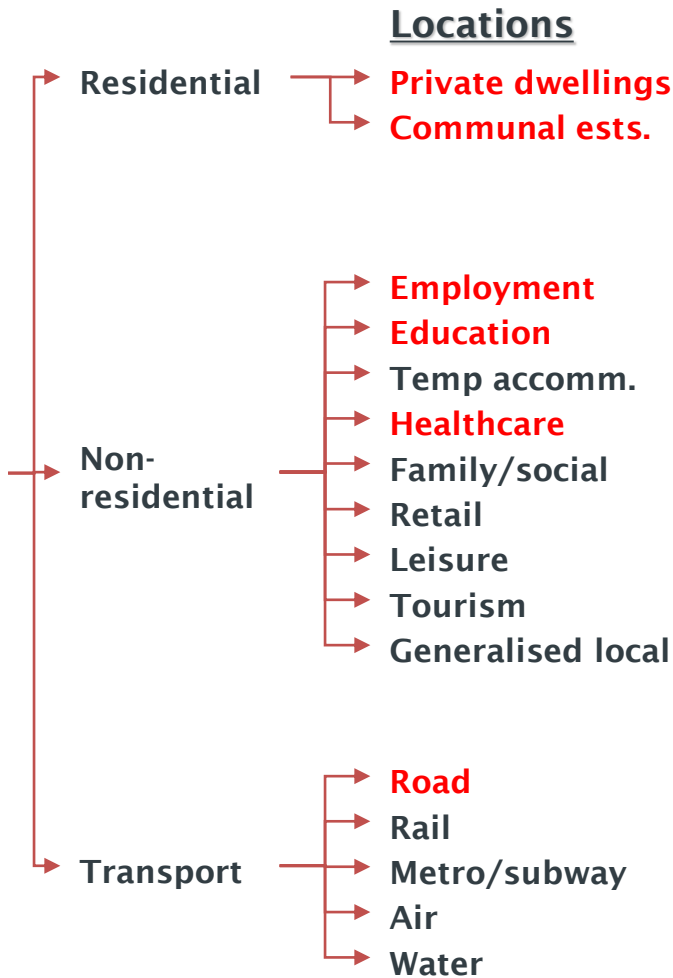


2011 term-time weekday 14:00

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**Total
population
+/-
external
visitors**



Data Sources

- Census, Mid-Year Population Estimates (MYEs)
- Census, Mid-Year Population Estimates (MYEs)
- Census, Annual Business Inquiry, QLFS
- EduBase, DCSF school performance tables, HESA
- VisitBritain, Annual Business Inquiry
- Hospital Episode Statistics
- VisitBritain
- Annual Business Inquiry, commercial sources
- ALVA Visitor Statistics, DCMS
- ALVA Visitor Statistics, DCMS
-
- DfT Road Statistics, Annual Average Daily Flow
- National Rail station usage data
- DfT Light Rail Statistics, TfL Tube customer metrics
- CAA UK Airport Statistics
- DfT Sea Passenger Statistics , London River Services

Acronyms: **QLFS** Quarterly Labour Force; **DCSF** Department for Children, Schools and Families; **HESA** Higher Education Statistics Agency; Survey; **DCMS** Department for Culture, Media and Sport; **ALVA** Association for Leading Visitor Attractions; **DfT** Department for Transport; **TfL** Transport for London; **CAA** Civil Aviation Authority

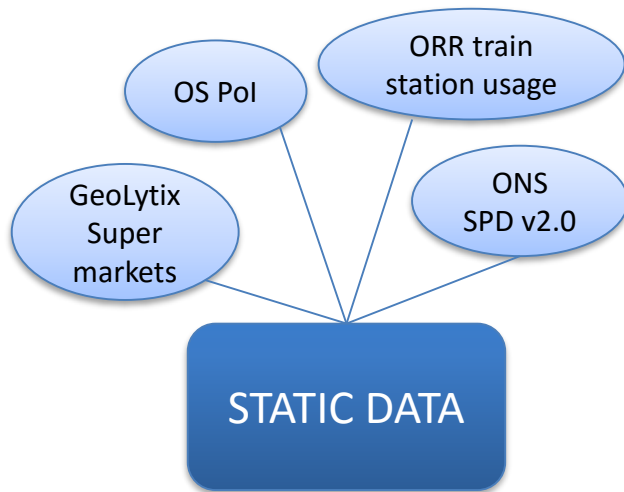
Population247 Near Real Time Project (Pop247NRT)

- ESRC New and Emerging Forms of Data Policy Demonstrator Project (Feb 17-Feb 18)
 - Integration of new, emerging and existing datasets
 - Enhanced spatiotemporal population estimates for improved decision-making and policy formulation
 - “Nearer to real-time” estimates
- Partners
 - Public Health England
 - Defence, Science and Technology Laboratory
 - Health and Safety Executive

New sources/signals/proxies for more dynamic/less routine activities ... e.g.

- **Retail** – supermarkets, retail centres, high streets
- **Leisure** – tourist sites, leisure activities, sports events
- **Transport** – transport hubs e.g. airports, train stations
- **One-off/unusual events** – festivals, Bank Holidays

New and emerging forms of data



ORR Train Station Usage data

estimates-of-station-usage-2015-16.xlsx - Microsoft Excel

FileHomeInsertPage LayoutFormulasDataReviewViewDeveloperLearningGuideAcrobatTeam

CutCopyFormat Painter

Clipboard

Calibri11

B

I

U

Wrap Text

Merge & Center

General

%

0.00

0.00

Conditional Formatting

Format as Table

Normal 4 2

Normal 4 3

Normal 4 4

Normal 4 5

Normal 1; Stat...

Normal 1; Stat...

Normal 1; Fog...

Normal 1; Fog...

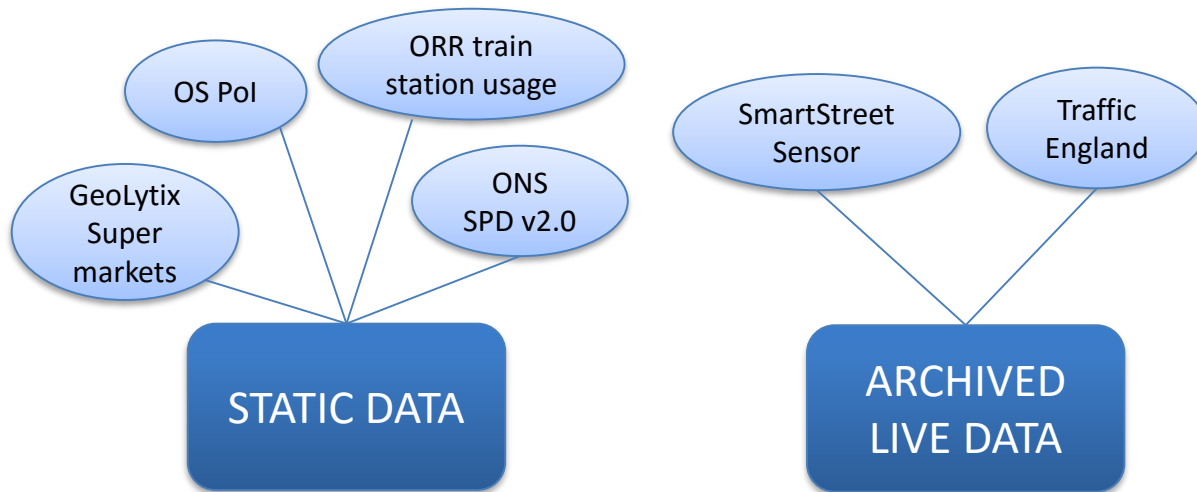
Styles

A2088

5922

	A	B	C	Q	R	S	T	U	V	W	X	Y	Z
	NLC	TLC	Station Name	Entries_Full	Entries_Reduced	Entries_Season	Entries_Total	Exits_Full	Exits_Reduced	Exits_Season	Exits_Total	1516 Entries & Exits	Estimated absolute change in Usage due to 2015/16 London Travelcard Methodology
1													
2080	1453	SOK	South Kenton	68,553	122,130	105,145	295,828	68,553	122,130	105,145	295,828	591,656	166,259
2081	5292	SMO	South Merton	20,121	18,245	31,542	69,908	20,121	18,245	31,542	69,908	139,816	-56,511
2082	8142	SOM	South Milford	24,559	18,787	25,883	69,229	24,559	18,787	25,883	69,229	138,458	-
2083	3057	SRU	South Ruislip	45,963	37,930	33,459	117,352	45,963	37,930	33,459	117,352	234,704	37,858
2084	7404	STO	South Tottenham	112,416	197,700	379,768	689,884	112,416	197,700	379,768	689,884	1,379,768	326,352
2085	1949	SWS	South Wigston	13,599	9,475	14,355	37,429	13,599	9,475	14,355	37,429	74,858	-1
2086	6892	SOF	South Woodham Ferrers	49,021	43,850	192,715	285,586	49,021	43,850	192,715	285,586	571,172	-838
2087	3187	STL	Southall	274,015	479,966	641,600	1,395,581	274,015	479,966	641,600	1,395,581	2,791,162	451,470
2088	5922	SOA	Southampton Airport (Parkway)	288,364	335,622	285,730	909,716	288,364	335,622	285,730	909,716	1,819,432	-165
2089	5932	SOU	Southampton Central	825,380	1,655,155	699,311	3,179,846	825,380	1,655,155	699,311	3,179,846	6,359,692	-1,194
2090	5263	SOB	Southbourne	21,366	43,614	47,970	112,950	21,366	43,614	47,970	112,950	225,900	2
2091	6947	SBU	Southbury	101,116	185,126	130,752	416,994	101,116	185,126	130,752	416,994	833,988	20,779
2092	5339	SEE	Southease	2,633	5,842	508	8,983	2,633	5,842	508	8,983	17,966	9
2093	4787	SIA	Southend Airport	73,833	108,288	30,459	212,580	73,833	108,288	30,459	212,580	425,160	7,052
2094	7456	SOC	Southend Central	347,863	506,775	691,515	1,546,153	347,863	506,775	691,515	1,546,153	3,092,306	-177,586
2095	7457	SOE	Southend East	198,090	288,582	393,782	880,454	198,090	288,582	393,782	880,454	1,760,908	-101,126
2096	7420	SOV	Southend Victoria	161,931	235,906	321,903	719,740	161,931	235,906	321,903	719,740	1,439,480	-82,667
2097	6890	SMN	Southminster	13,816	18,538	43,617	75,971	13,816	18,538	43,617	75,971	151,942	-1
2098	2262	SOP	Southport	284,234	1,422,538	366,760	2,073,532	284,234	1,422,538	366,760	2,073,532	4,147,064	-
2099	5286	SWK	Southwick	42,232	92,567	46,237	181,036	42,232	92,567	46,237	181,036	362,072	-1
2100	8527	SOW	Sowerby Bridge	77,723	63,130	55,030	195,883	77,723	63,130	55,030	195,883	391,766	-
2101	6388	SPA	Spalding	25,332	54,415	12,951	92,698	25,332	54,415	12,951	92,698	185,396	-1
2102	8836	SBR	Spean Bridge	2,409	1,257	-	3,666	2,409	1,257	-	3,666	7,332	-
2103	2199	SPI	Spital	95,684	82,370	56,821	234,875	95,684	82,370	56,821	234,875	469,750	-

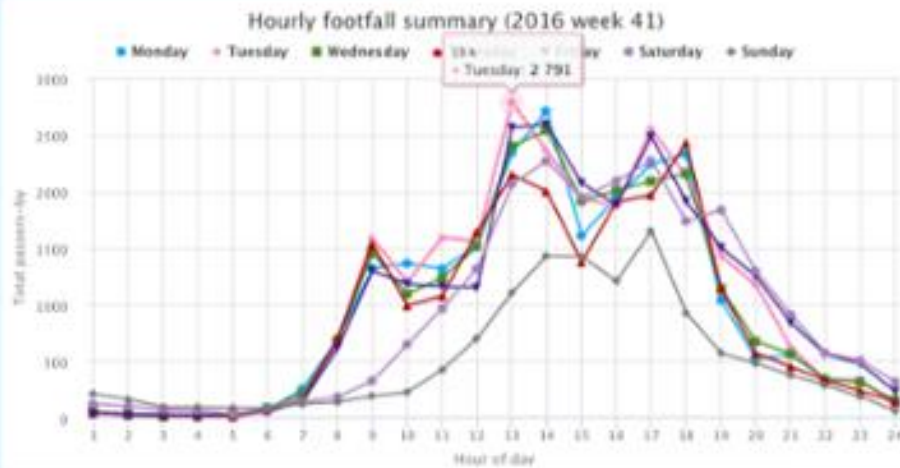
New and emerging forms of data



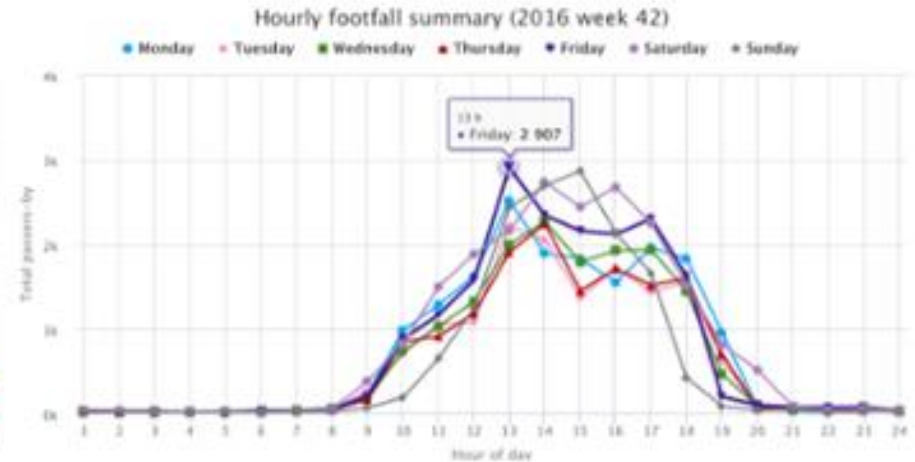
Footfall data

(SmartStreetSensor project, LDC/CDRC)

High Street, Sheffield S1 2GB
7.1% Vacancy



Pinstone Street, Sheffield S1 2HJ
20.4% Vacancy

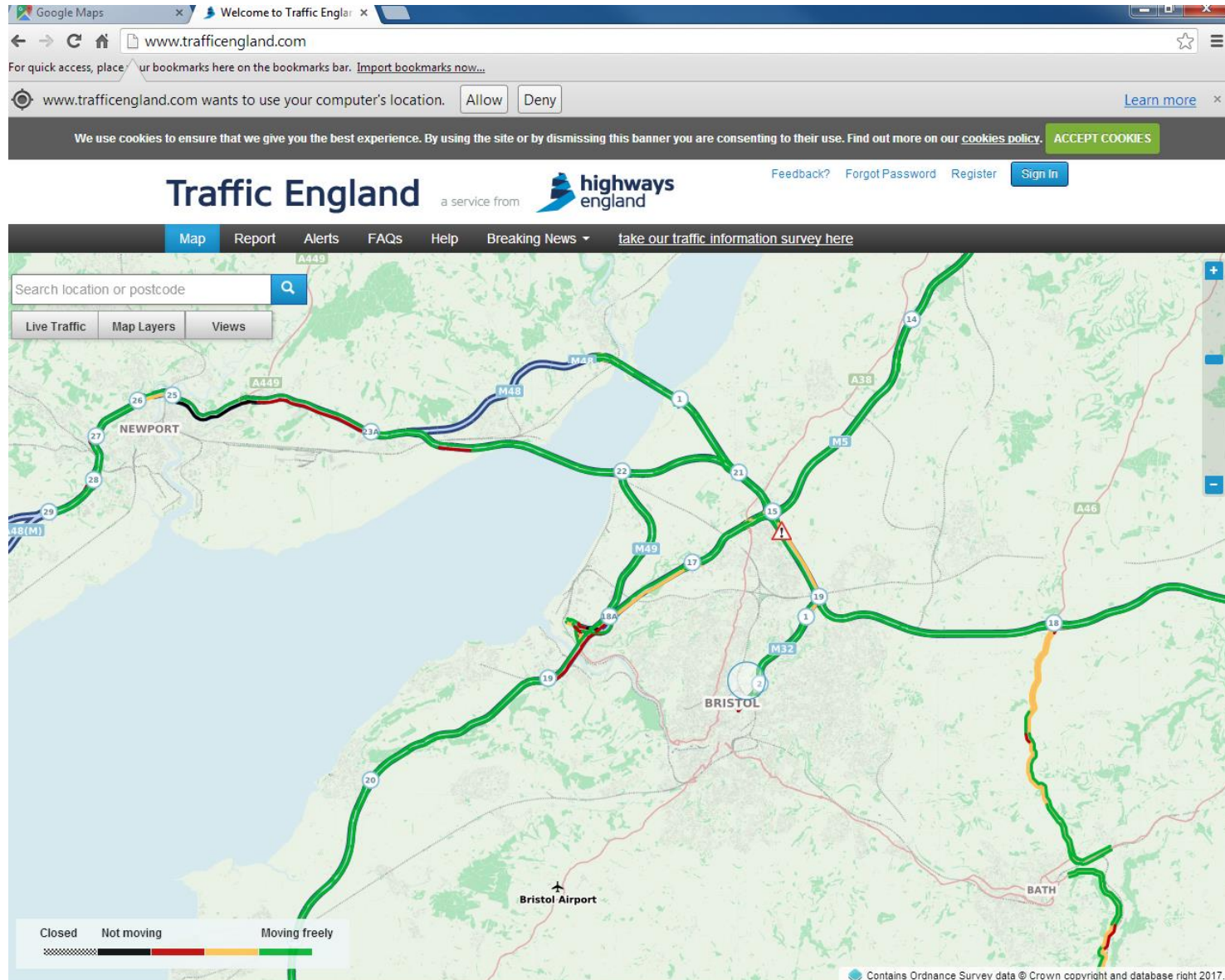


Sheffield City Centre Vacancy = 14.0%

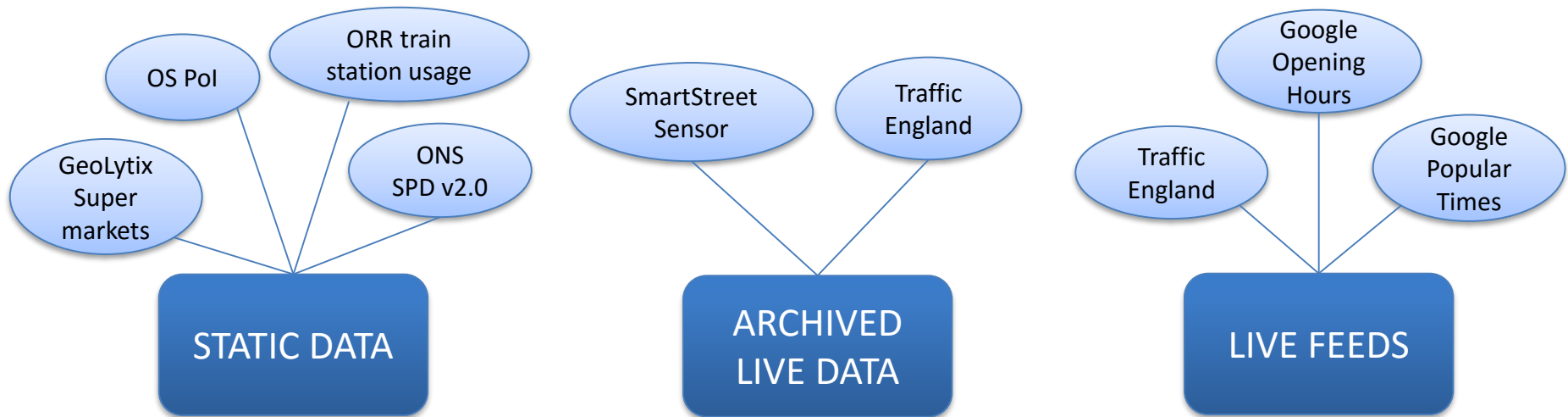
© Local Data Company

Source: <http://blog.localdatacompany.com/off-to-a-flying-start-the-first-smartstreetsensor-partner-forum>

Traffic England data




New and emerging forms of data



Google Places – Opening Hours data

Marks & Spencer Hedge End, Hed



Marks & Spencer Hedge End

4.1 ★★★★★ · 182 reviews · ££

Department Store

Directions

★

NEARBY

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SAVE

📍

Tollbar Way, Hedge End, Southampton SO30 2UH

🌐

marksandspencer.com

☎

01489 798844

🕒

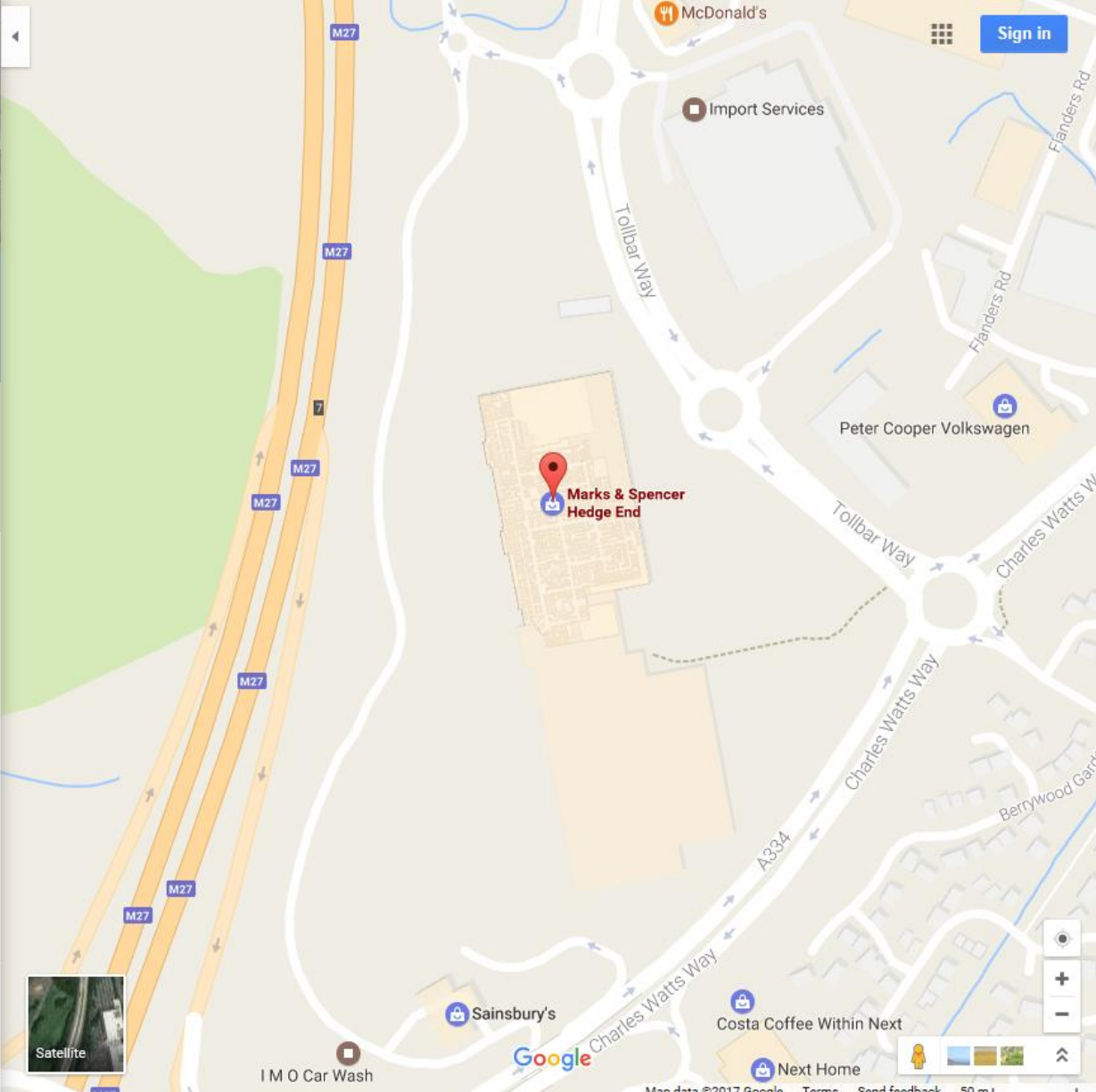
Tuesday	9am–9pm
Wednesday	9am–9pm
Thursday	9am–9pm
Friday	9am–9pm
Saturday	8am–9pm
Sunday	9:30am–4pm
Monday	9am–7pm
(International Workers' Day/Early May Bank Holiday)	Holiday hours

✎

Suggest an edit

Popular times

Mondays ▾



Sign in

McDonald's

Import Services

Peter Cooper Volkswagen

Marks & Spencer Hedge End

Sainsbury's

Costa Coffee Within Next

Next Home

I M O Car Wash

Map data ©2017 Google


Terms

Send feedback

50 m

Google Places – Popular Times data

Marks & Spencer Hedge End, Hed



Marks & Spencer Hedge End

4.1 ★★★★★ · 182 reviews · ££

Department Store

Directions

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Open now: 9am–9pm

Suggest an edit


Popular times Tuesdays

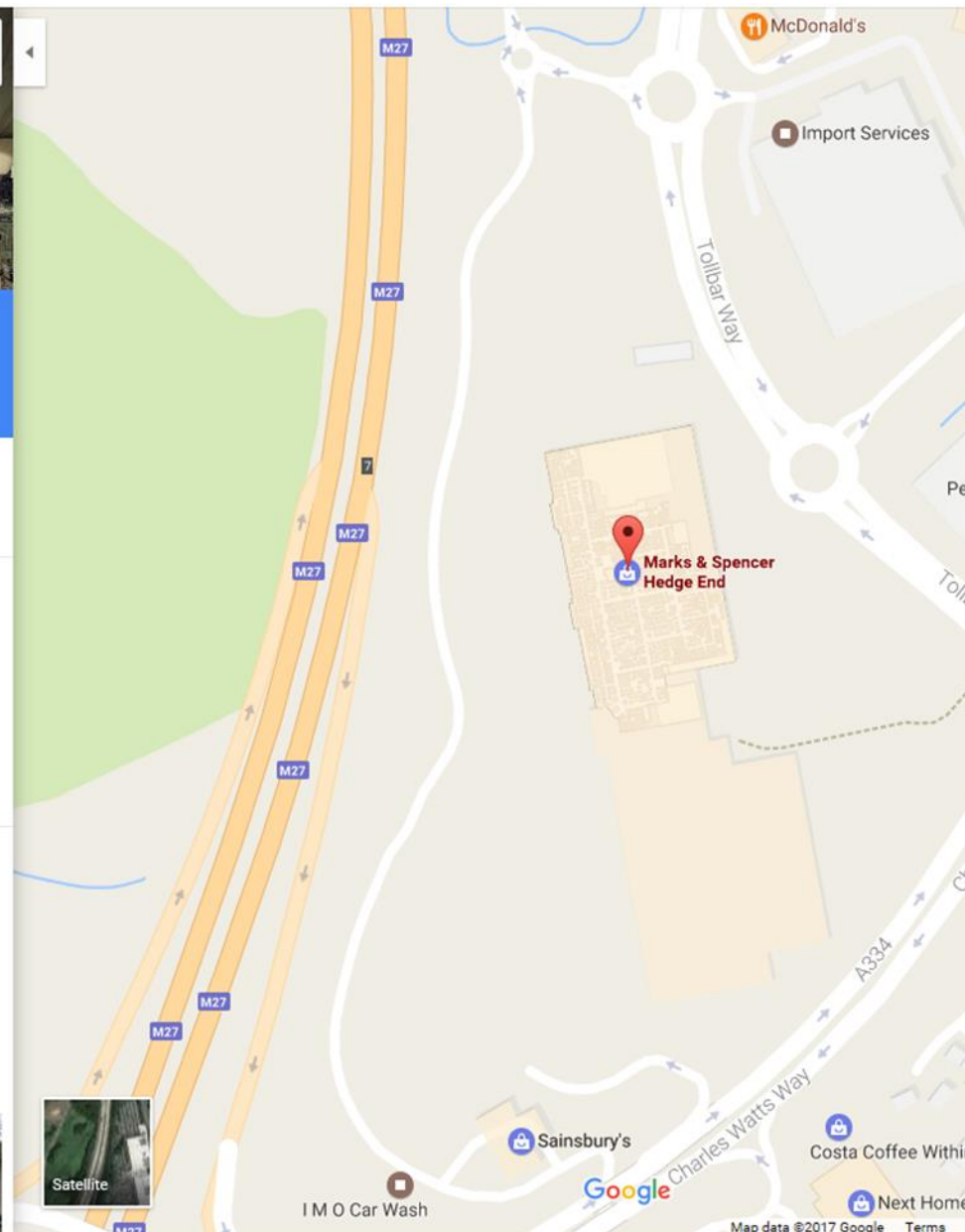
LIVE

Busier than usual



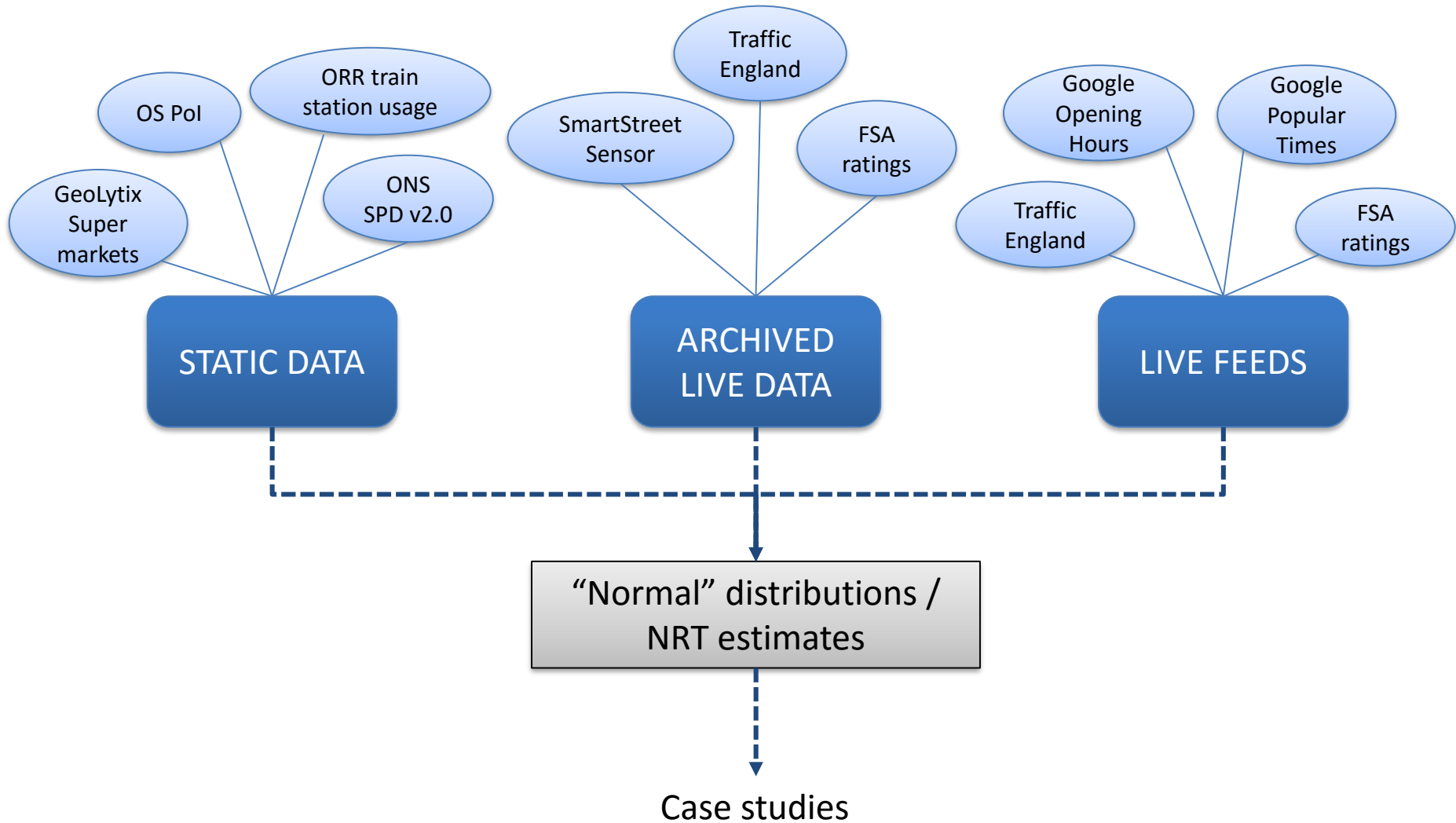
Time	Popularity
6a	Low
9a	Low
12p	Medium
3p	High
6p	Medium
9p	Low





A map view of the Marks & Spencer Hedge End location. The map shows the store's location marked with a red pin and a blue location icon. The store is situated on Tollbar Way, Hedge End, Southampton SO30 2UH. The map displays the surrounding area, including the M27 motorway, the A334 road, and nearby businesses such as McDonald's, Import Services, Sainsbury's, Costa Coffee, and Next Home. The map also shows the Charles Watts Way and the I M O Car Wash. The map data is attributed to Google, 2017.

New and emerging forms of data



Key opportunities and challenges

- Population247 is an extensible framework for time-specific population modelling
- New and emerging forms of data are providing new insights and opportunities
- A key challenge is whether new data should replace, augment or calibrate existing ones
- Pop247NRT: finalise data processing, implement case studies, stakeholder workshop

Acknowledgements

- Economic and Social Research Council Awards
ES/G031304/1, ES/P010768/1
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- Alan Smith, Becky Martin (past PhD
researchers)

Contacts

Email: s.cockings@soton.ac.uk

Twitter: @SamCGeog

Population24/7 in a slide...

- Assemble multi-source data library of locations, populations and time profiles
- Transfer total population from origins locations to cells in output grid
- Principal loop is of destinations, identifying population required at specific target time
- Some population remains at origins; some transfers to destinations; some allocated into background (in transit), local dispersion applied
- All processing repeated per population subgroup