Preliminary Results of a Spatial Analysis of Dublin City's Bike Rental Scheme

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1. Introduction

We present some initial observations on the usage and flow patterns of the DublinBikes (DB) bicycle rental scheme across Dublin city. In September 2009 Dublin City in conjunction with outdoor advertising company JC Decaux made 450 bicycles publicly available from 40 locations around the city in a scheme called DublinBikes (DB). Cycling, as a commuting mode forms an important part of the Irish Government's Transport policy for Ireland up to 2020 stating that "*a culture of cycling will be developed by 2020 to envisage around 160,000 people cycling for their daily commute, up from 35, 000 in 2006* " (DOT, 2009). We follow Froehlich et al (2008) who find usage patterns from these bike rental schemes can "*infer cultural and geographical aspects of the city and predict future bike station usage behaviour*" when combined with geographical information and local knowledge. Data captured on DB and presented in this paper covers the period of September 20th 2009 to February 15th 2010 inclusive.

1.1 Data Capture and Experimental Setup

There are 40 DB terminals or stations in Dublin with 450 DB bicycles available at full availability. Each DB terminal has between 15 and 25 spaces. Real time information (in XML format) is available from http://www.dublinbikes.ie on each DB terminal including information on the number of bikes available and the number of parking spaces currently available. We do not have access to the individual movements of DB bikes from checkout terminal to return terminal. The DB network is not fully self-supervising. In a self-supervising network some DB stations would suffer from unbalanced checkouts and returns of bikes. Some load balancing is performed by DB staff moving bikes between stations. An assumption in our work is that the forced load balancing only happens sporadically and consequently does not significantly bias our statistical results. The frequencies of bike checkouts and returns correspond to a terminal being characterised as "busy" or "not busy" (Froehlich et al, 2008). We use the OpenStreetMap database for Dublin to provide us with access to spatial data on locations of bus stops, train and metro stations, and other aspects of Dublin's transportation infrastructure.

2. Discussion of current results

The spatial layout of a city has an obvious influence on the movement patterns and social behaviours found within (Froehlich et al, 2008). Transportation systems providing good access to all transportation modes have a positive influence on movement patterns in a city (Brons et al, 2009). There are subtle differences between the patterns of bike checkouts and returns for all of the 40 stations. Currie (2009) outlines some reasons for these including social needs, population density, and public transportation service level.

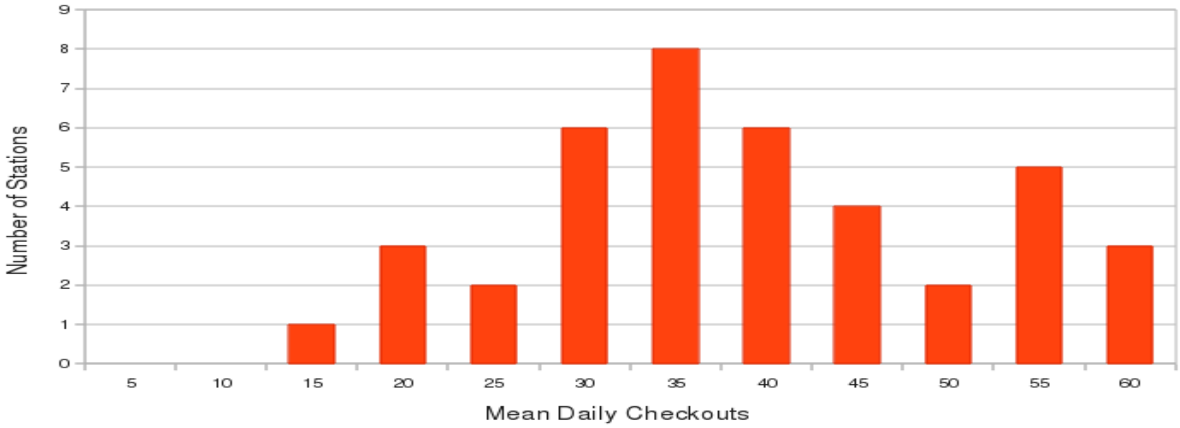

Figure 1. Distribution of mean daily checkouts for all DB station terminals

Figure 1 shows a frequency distribution of the mean number of checkouts per day for all DB terminals over the entire observation period. Three clusters of stations are immediately apparent – stations with a daily checkout mean of less than 25, stations with mean daily checkouts of between 25 and 45, and finally stations with mean daily checkouts of between 45 and 60 checkouts.

Figure 2. Location of all 40 DB terminals. Larger circles indicate busier DB terminals. OpenStreetMap for Dublin is used as the base map

Figure 2 shows the location of all 40 DB terminals. The largest circles indicate the location of the busiest terminals (combining checkouts and returns) while smallest circles indicate the location of the quietest terminals in terms of checkouts and returns of bikes. There is no obvious spatial clustering of the busiest terminals but attention is drawn to the three busy terminals at the southern portion of the map. These are located on a very busy orbital transport route in the city known as the “canal route”. There is a higher concentration of terminals with low frequencies of checkouts and returns in the northern part of the city.

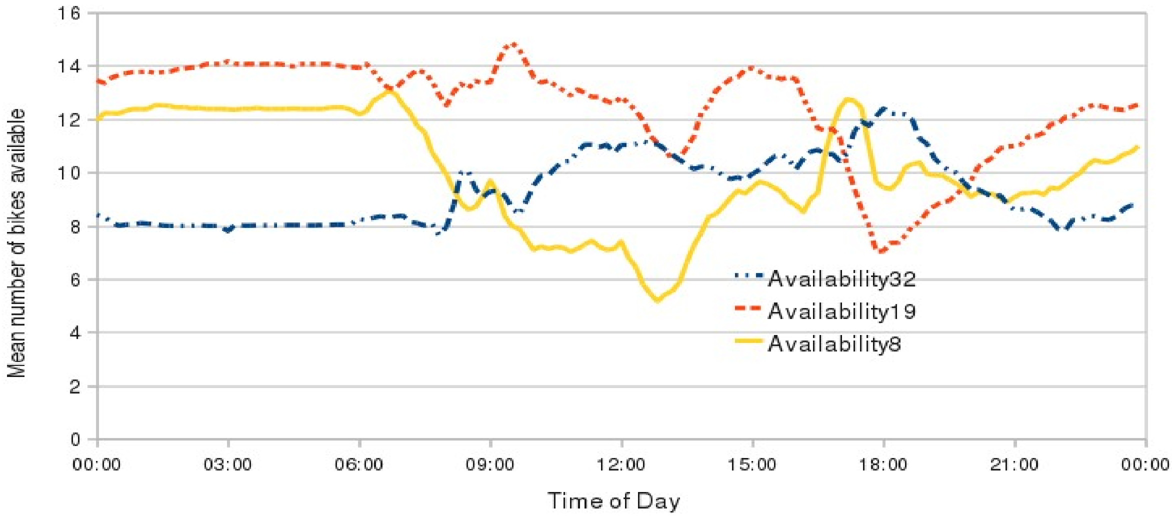

Figure 3. Time-series plot of the mean number of bikes available at the three busiest stations in the DB network

Figure 3 shows the mean number of bikes available at the three busiest stations in the DB network for all weekdays over the observation. Station 8 (denoted as Availability8) shows low availability during the working day. This could be linked to its location at a busy pedestrian bridge over the River Liffey beside the international financial center. Station 32 shows increasing availability of DB over the day. This DB terminal is beside Pearse Street mainline and commuter train station. This could indicate that people are using DB to move from other locations and park their bikes at Station 8 to possibly link to public train transport. Finally Station 19 is located in the suburbs. The dramatic decrease in availability at evening rush hour could indicate the movement of people away from this location as businesses close for the evening in this area.

Table 1 below shows statistics from a selected number of stations. These stations were chosen from the 40 stations for the purposes of illustrating the different characteristics for stations during the week and at weekends. For each station their mean daily checkouts from weekdays (CKWeek) and weekends (CKWend) are shown. The overall ranking of all stations based on CKWeek is shown in the column Pweek while the overall ranking of all stations based on CKWend is shown in column Pwend. The column Diff indicates if a particular station changes overall ranking from weekday to weekend. For example the first row (Pearse Station) is the busiest bike terminal (ranked 1st) on weekdays with 49.67 checkouts per day but is only the 11th busiest overall at the weekend. The Diff column is -10 indicating a drop of 10 in overall ranking from weekday to weekend and consequently a drop in mean checkouts relative to all other stations. Some important observations can be made from the table above. The four busiest stations (32,8,19,5) during the week lose four or more rankings in overall mean checkouts at weekends. The most dramatic set of changes is for stations (20,25,22) dropping very significantly in overall ranking. When one looks at the locations of these stations they are within key office and business areas of Dublin city. It is no surprise to see the usage of DB terminals in these locations decrease at weekends when these areas become dramatically quieter. Stations (40,10,24) display the opposite effect with dramatic increases in overall ranking at weekends. These stations are located close to key shopping areas and leisure facilities in the city which naturally see a large increase in visitors at weekend. It is worth noting that station 15 is placed bottom of both the weekday and weekend ranking which is possibly due to its isolated location in the north inner city and close proximity to a high frequency bus corridor.

Table 1. Comparison of mean checkouts for selected stations during weekdays and weekends

StationID	Pweek	CKWeek	Pwend	CKWend	Diff
32 (Pearse)	1	49.67	11	9.35	-10
8 (Custom Hse)	2	46.39	6	11.00	-4
19 (Herbert)	3	43.59	7	10.21	-4
5 (Charlemont)	4	43.21	12	9.30	-8
11 (Earlsfort)	10	38.01	36	3.15	-26
20 (James St. East)	11	38.00	37	2.98	-26
25 (Merrion Sq East)	13	35.55	26	5.47	-13
22 (Townsend Street)	18	29.72	30	4.63	-12
40 (Jervis Street)	23	26.25	9	9.86	+14
10 (Dame Street)	29	23.93	15	7.38	+14
24 (Cathal Brugha)	33	21.67	22	5.67	+11
15 (Hardwicke)	40	9.82	40	1.81	0

3. Discussion and Future Work

Initial analysis of the checkout and return statistics for each terminal appear to loosely support the findings of Martens (2004) who showed that in the Netherlands the closer bike parking stands and facilities were to bus/railway station entrances/exits the higher the use of bicycles as part of the access or exit trip to the station. During weekdays three of the busiest 5 stations (Four Courts, Pearse, Charlemont) are within 400 meters of either stations on the LUAS metro system or mainline/sub-urban train stations. However this changes at weekends where the 5 busiest stations are located with 400 meters of shopping centers and key shopping areas. Martens (2007) concludes that "bicycle usage in trips to and from public transportation and leisure facilities can be promoted simply by providing more sufficient and attractive bicycle parking facilities". At the time of writing 1,500,000 records are currently stored in the PostGIS database for the DB activity data. The analysis above has shown that there are patterns developing at a station level – the checkout and check-in of bikes and at the network level where stations close to major transportation locations are busier than those further away. Some initial patterns are developing where DB terminals are close to bus stops where the service level frequency of buses is high. The database of DB information is time-series data and we are currently investigating methods for similar time-series pattern retrieval. We have looked at usage patterns in DB by clustering DB terminals into geographically relevant groups – DB terminals: near train stations, within 300 meter walking distance of each other, at major street intersections. DB terminals without explicit geographical relationships such as proximity may exhibit similar time-series patterns. Quantifying how similar the time-series for non-geographically adjacent stations are may give us an insight into other aspects of the characteristics of the DB bike flows. Given the high dimensionality of the DB time series it may be necessary to reduce the dimensionality of the time-series for each DB terminal before attempting to perform a similarity search.

References

Benenson, Itzhak and Martens, Karel and Birfir, Slava. **PARKAGENT: An agent-based model of parking in the city**, Computers, Environment and Urban Systems, Vol 32(6), GeoComputation: Modeling with spatial agents, November 2008, Pages 431-439

Brons, Martijn and Givoni, Moshe and Rietveld, Piet. **Access to railway stations and its potential in increasing rail use**, Transportation Research Part A: Vol 43(2),2009, pp 136-149

Currie, Graham. **Quantifying spatial gaps in public transport supply based on social needs**, Journal of Transport Geography, In Press, Corrected Proof, Available online 2 May 2009

DOT, **SmarterTravel: Ireland's First National Cycle Policy Framework**. Department of Transport, Kildare Street, Dublin 2. Ireland. April 2009. Report available online at www.smartertravel.ie/

Froehlich, J., Neumann, J., and Oliver, N. (2009) **Sensing and Predicting the Pulse of the City through Shared Bicycling** Twenty-First International Joint Conference on Artificial Intelligence (IJCAI-09), Pasadena, California, USA, July 11 - 17, 2009.

Martens, Karel. **The bicycle as a feedering mode: experiences from three European countries**, Transportation Research Part D: Transport and Environment, Vol 9(4), July 2004, pp 281-294

Martens, Karel. **Promoting bike-and-ride: The Dutch experience**, Transportation Research Part A: Policy and Practice, Volume 41, Issue 4, May 2007, Pages 326-338

Biography

Peter Mooney is a postdoctoral researcher at the Dept of Computer Science and a Data Manager at the Environmental Protection Agency. Padraig Corcoran completed a B.Sc. in Computer Science and Software Engineering and a Ph.D. in Computer Science in 2004 and 2008 respectively. He is currently working as a lecturer and researcher in the department of Computer Science at the National University of Ireland Maynooth. Adam Winstanley gained MSc and PhD degrees in Computer Science in 1987 and 1991 respectively. Currently, he is Senior Lecturer and Head of Department of Computer Science and Senior Research Associate of the National Centre for Geocomputation (NCG) at NUI Maynooth. He is a Co-PI of the LBS strand of the STRAT-AG project at NCG.