ParkJam: Crowdsourcing Parking Availability Information with Linked Data (Demo)⋆

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Abstract. This demo shows a mobile Android app that uses openly available geographic data and crowdsources parking availability information, in order to let its users conveniently find parking when coming to work or driving into town. The application builds on Linked Data, and publishes the crowdsourced parking availability data openly as well. Further, it integrates additional related data sources, such as events and services, to provide rich value-adding features that will act as an incentive for users to adopt the app.

1   Motivation

Managing parking in congested areas is a well-recognized problem. In the modern car-oriented world, many will experience difficulties finding parking places when driving to work or into a congested city, as discussed in [1], and drivers cruising in search of available parking can make up over 8% of total traffic in urban areas. In [1], Shoup discusses the effects of free parking, and suggests that parking spaces should be dynamically priced at a level that would result in about 85% utilization, with many benefits beside the improved availability. He acknowledges, however, that there are mainly political obstacles to charging for parking, and strong resistance to putting a price on previously free parking.

Another approach to managing parking is to aim at improving the efficiency of the use of existing spaces, by informing drivers about available spaces, and by guiding them to alternate car parks. In some cases this is done with manually-placed "Car Park Full" signs; in better-equipped areas there are electronic systems in place. [2], a study published in 1993, reported how a real-time parking information system improved parking situation in Nottingham, England; and [3] studied the benefits of electronic parking information displays in Japan.

Fig. 1. Parking sign

The figure on the right sketches a typical electronic display that shows the status of the main car parks in some town. The data displayed on such signs can easily be published online, so a user can then conveniently check it on the Web or in a mobile app. SFpark, provided by the city of San Francisco, with real-time data on a number of car parks and on-street parking areas there, is an example of such an app.
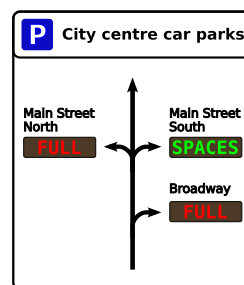

⋆ The name of the app, "ParkJam", may change when the app is released publicly, which is expected to happen before the conference. More information can be found at `http://parking.kmi.open.ac.uk`

Still, only a minority of car parks are monitored by electronic systems. With the growing popularity and affordability of internet-enabled smartphones, and with the wealth of data available online, especially in linked data, we can now take a step to address the parking problem in an inexpensive and efficient manner, by crowdsourcing parking availability information from drivers.

Much data about the location of car parks is available in the LinkedGeoData project, a Linked Data view on the geographical database of Open Street Map,[1] a global open collaborative mapping website. While little data on the up-to-date availability of car parks is publicly accessible online, a mobile app can make it effortless for users to contribute pieces of data (e.g. "this car park is full").

This demo presents such a mobile app, PARKJAM, in development for the Android smartphone operating system. The research focus of the PARKJAM project is 1) on crowdsourcing near-real-time data, 2) on publishing such near-real-time data as Linked Open Data, and 3) on combining and using various semantic data sources and services in a mobile app. For crowdsourcing, we especially investigate how semantic data formats and the parking use case bear on the challenges listed in [4]: *How to recruit and retain users? What contributions can users make? How to combine user contributions to solve the target problem? How to evaluate users and their contributions?* Publishing near-real-time semantic data is closely related to work on semantic sensors [5], and we look into how the app, or its users, can be seen as sensors. Finally, the last aspect looks into the wider interplay of mobile client environments with the Web architecture and the access patterns for graph-structured semantic data.

2 ParkJam App Description

As shown in the screenshot in Figure 2, the app is built around a map view that shows car parks located in the zoomed-in area, which by default follows the user's location. The app can show the availability status of the car parks, and notify the user if the availability of a watched car park changes; this will also be done with text-to-speech voice notifications, especially desirable when driving.

In a separate view, the app shows any available detailed information about the car park, such as its opening hours and pricing. Where information about car parks is missing, PARKJAM users can add it, and the system will feed it back to Open Street Map.

The app allows its users to explicitly submit availability information of the currently selected car park. Additionally, to minimize the need for users to do anything, the app may also monitor conspicuous actions that imply something about availability of car parks: if a user enters a car park and quickly parks there, it is likely the car park has places available, whereas if a user drives around a car park and then moves on to another one, the first one is likely to be full.

All submissions from the users are aggregated to provide an up-to-date availability estimate for each car park. The aggregation formula must take into account the aging of information (it is seldom relevant that a car park was full six hours ago) and noisy data (submissions that look erroneous or malicious). In

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[1] `http://linkedgeodata.org/`, `http://www.openstreetmap.org/`

effect, the app crowdsources the creation and maintenance of parking location and availability data. The aggregate results are published as linked open data, to enable other third-party mashups and applications.

While the focus of PARKJAM is to engage drivers, and to crowdsource parking availability data from them, we also recognize the usefulness of authoritative data sources, such as car park operators, who are encouraged to register with the app and submit their data. Any user, but especially an authoritative data provider, can make their car park availability submissions public (as a so-called "User's Data Source" — UDS); PARKJAM then uses social features described below to recognize and promote authoritative sources of availability data.

Firstly, the detailed information view of a car park lists the applicable Users' Data Sources, and the user may select one(s) to trust, based on the name and other information — we recommend that authoritative sources include a phone number where users may confirm the UDS is indeed official. Reliable data sources from car park operators are likely to be trusted by many users, and such sources can be highlighted in the app to simplify discovery by new users; the app can even automatically give stronger weight to submissions from users recognized as reliable for the given car park.

Fig. 2. PARKJAM Screenshot

Secondly, the app can generate a QR Code (a 2D barcode easily readable by smartphones) for a user's UDS, which the user (a car park operator) may print out and display, for instance, at the entrance to its car parks, or on Pay-and-Display machines, where drivers can scan them and readily accept as trusted.

Publishing their UDSs can also be meaningful for ordinary users/drivers. For example, a user may publish their submissions for the benefit of colleagues who happen to drive to work somewhat later, and who will be happy to know from the user what car parks are already full. As the general aggregation algorithm cannot judge a car park to be completely full after just one driver says so (partly because that would make the data prone to manipulation), marking a colleague's data source as trusted will allow a user to see the estimate of "full" early, while others may still see the car park as "nearly full".

Further, PARKJAM integrates additional related data sources, such as events and services, to provide value-adding features that act as incentives for users to adopt the app. Where data is available, the detailed information view of a car park can show nearby events (which may affect parking situation in the area), and services associated with the car park, such as advance booking. These services, discovered from the registry iServe [6], will be invokable directly from the app, using the Semantic Web Service invocation engine OmniVoke [7].
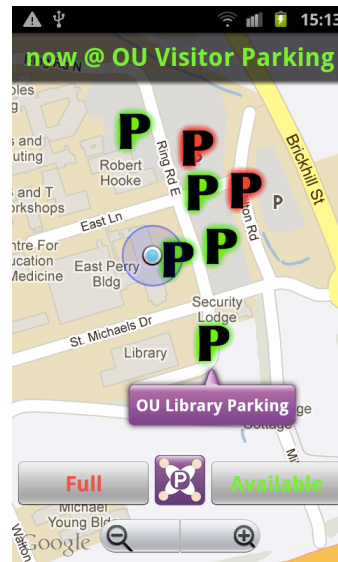
3 Related Apps

There are many mobile apps that help with parking, too many to list here. We discuss two selected apps to show the novelty of our approach.

SFPARK (`sfpark.org`) tracks the real-time availability status of on-street parking and parking garages in selected areas of San Francisco. Provided directly by the municipal transportation agency, the app has rich and highly-accurate data (also available to third-party developers), albeit only for a limited set of locations.

Another important app, PARKOPEDIA (`parkopedia.com`), uses free public data and data licensed from third parties, including availability information for a small number of car parks, and even a direct booking interface for some car parks, hard-wired as the only supported type of service. PARKOPEDIA users may submit information about car parks, with a manual review process for the submissions. The app is described as "think Wikipedia... but for parking!", but it is in fact a closed data silo — it does not make the user-submitted data freely and openly available, except through commercial licensing.

In contrast, PARKJAM focuses on crowdsourcing of parking availability data from its users, which can be applied globally (but with a somewhat lower data quality), compared to the use of expensive sensor infrastructure in selected car parks in SFPARK and PARKOPEDIA; and on integration with sources of data on nearby businesses and services, particularly including generic service invocation.

4 Demo contents

The demo starts with hands-on use of the application, on an emulator and on a smartphone device. It simulates a user driving to work at the campus of The Open University, with its 13 car parks, some of which are shown in Figure 2. The user receives up-to-date estimates of car park availability and makes decisions on which car park to go to; then on the campus, the user submits information about car parks filling up.

Then, the demo proceeds to show additional features of the app: show detailed information about a car park, including dynamically discovered nearby events and relevant services associated with the car park, such as advance booking. Further, we show how a car park operator can publish its Users' Data Source (UDS), and how users can find it using a QR code, or using the listing in the detailed information view. The demo highlights the effect that marking a UDS as trusted can have on the estimate of car park availability.

Finally, for interested viewers, we are prepared to show the behind-the-scenes workings of the system: the ontologies and the data sources, including how we integrate them; the architecture of the system, and the APIs and interactions between the mobile app and the back-end system.

5 Conclusions and Future Work

This demo shows PARKJAM, an Android app that uses openly available geographic data and crowdsources parking availability information, in order to let

its users conveniently find parking when coming to work or driving into town. The application builds on Linked Data (combining several data sources), and publishes the crowdsourced parking availability data openly as well.

As a crowdsourcing application, PARKJAM must recruit users: capture their interest and give them incentives to use the app, and to submit data about car parks and their availability. The core value of the application is clear (users will spend less time looking for a parking space) but it depends on the quality and quantity of the user-submitted data. Therefore, user incentives will be a significant part of future work.

Currently, the project addresses user incentives along two axes: 1) the simplicity and efficiency of the user interface, which makes it effortless for users to submit the data that they know is valuable, while they already have the interface in front of them because they use it to look up parking availability; and 2) the added value of showing nearby events, services and businesses related to car parks. PARKJAM can further integrate a number of data sources with relation to parking, such as the locations of businesses in the area, traffic and weather conditions, and even statistical information on car-related crime. By combining parking location data with business and service directories, the app can for example help the users select a car park that is near a desired business or other place of interest.

Acknowledgements

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