Incentivising Crowdsourced Parking Solutions

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Abstract. The problem of finding parking slots imposes both societal and infrastructural issues in modern cities. It is a daily hurdle that affects millions of people, but existing approaches fail to solve this conundrum. Thus, there is an urgent demand for reputable, motivated, and replicable solutions that can be used by cities of any size. We are proposing an experiment to analyse the interplay between incentive mechanisms, user participation, and the truthfulness of reports. For that, we are developing the "wePark application" based on concepts of crowd sourcing and social regulation. As a differential, we are examining alternative methods to motivate adoption, such as reciprocity, reputation, altruism, and money. In this paper, we analyse the requirements of the solution, propose a development test bed, and an experimental environment for this study.

1 Introduction

The problem of finding free parking imposes both (a) social issues, due to the annoyance caused to citizens, and (b) traffic infrastructure impact. For instance, [10] reports that around 40 % of traffic in New York is generated by cars searching for parking spaces. Different approaches have been proposed such as the SFpark [6] in San Francisco, which provides centrally controlled "parking sensors" to identify free parking in real-time. However, even with the large budget of this project, only a small part of San Francisco is covered. Meanwhile the advent of commonly available smartphones, with GPS and online capability, allows for citizens to fulfill the role of *sensor*, should the proper motivation exist for them to provide such information. Google released an Android application called *Open Spot* [3], which allow users to report and find free parking spaces. However, this proposal failed because people did not correctly report enough free parking spaces [7]. This scenario reinforces the demand for reputable, motivated, and replicable solutions that can be used by cities anywhere.

However, there is a lack of understanding on how to engineer a working solution applying participatory sensing [4] approaches for this problem. We hypothesise that it will require a balance between crowd sourcing, reputation models, and incentive mechanisms. We propose an experiment based on a mobile application (to collect data) being use in a controllable environment, and analytic

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models to analyse social behaviour and reputation parameters. We want to better understand the influence of motivation mechanisms, social behaviour, and social interactions in this problem domain. In specific, we aim to address two research questions: (i) how to incentivise citizen participation in such projects, and (ii) how to model and understand individual behaviour whilst utilising these systems?

To that end, we are developing the "wePark application" for reporting and finding parking spaces in a specific area. The solution works based on crowd sourcing concepts and allows for participants to provide feedback on others' reports, providing an interface for social networking. As a differential, we are promoting alternative methods to incentivise adoption, such as reciprocity, reputation, altruism and money. Moreover, we are focusing on the development of reputation models, trying to identify and filter misleading reports, which will help to promote credibility and usage.

We intend to validate this approach in a "Living Campus Experiment" along with the UFGRS campus. That is, we want to create the infrastructure of Smart City technologies to transform the campus in a living lab, integrating mobile computing resources, open services, and advanced Analytic Models similar to the proposal in [5], previously conceptualised by IBM Research. This setup provides a unique resource for joint research, allowing the development of meaningful field tests and fast turn around.

This paper is structure as follows. Section 2 provides an overview of related research and the prior art. Section 3 present the "wePark Application" as a tool to conduce our research. Section 4 concludes with the expected results and analysis.

2 Background

There are a number of research projects in the domain of crowdsourcing to find a suitable incentive model in order to attract participation, such as the ones described in [1,9]. Nonetheless, it is an ongoing research topic and very much domain dependent. Yan et al. [11] propose a market-based approach for traffic, where people who are leaving their parking space can sell information about its location to people in need of a parking space. However, this must be done in advance, and drivers must know when they are leaving, or arriving, to sell or buy a parking space, respectively.

A more general approach, that is also more similar to the approach taken by Google's *Open Spot* and similar commercial Apps, is proposed by Chen et al. [2]: participation itself is the incentive mechanism. However, they propose a number of improvements over commercial apps in order to make the user's experience better, and thus more likely to use the service. Nevertheless, their evaluation is simulation-based, so it is unclear whether this is truly sufficient.

Tokarchuk et al. [9] have categorised the motivations of people participating in crowdsourcing activities as follows:

- Reciprocity and expectancy
- Reputation
- Altruism
- Self-esteem and learning
- Fun and personal enjoyment
- Implicit promise of future monetary rewards
- Money

Other references provide slightly different lists, but in general agree. Not all these motivational methods are available to different applications, and even when available, may be more, or less, effective. It may also not always be obvious what incentive works. For instance, the *Old Weather project* [8] found that they could motivate people by giving them a story to read, thus motivating participants with personal enjoyment: something they were not expecting in a serious Citizen Science project.

One way of motivating people to report free parking spaces is to improve the functioning of the app, thus lowering the "cost" of reporting while simultaneously increasing the utility of the provided information. This is similar to the proposed in Chen et al. [2]. Alternatively, Yan et al. [11] proposes to provide a monetary incentive. Nevertheless, these have not been tested in an real-world experiment leaving a gap for experimentation.

In our project, we hypothesise that the main motivating factors for reporting parking spaces are: *reciprocity*, *reputation*, *altruism*, and *money*. Altruism and reciprocity seem straightforward: people are reporting parking spaces out of sympathy for others, or by installing the app they intend to use it to search for parking spaces when they are in need, and hope others will be reporting them (reciprocating). This also seems to be the main reason *Open Spot* and similar programs failed: these motivating factors were not enough. Nor was Google's reputation incentive, by awarding so-called Karma points for reporting free parking spaces.

Therefore, we propose an experiment to put this to the test in a controlled environment, in order to discover what can incentivise participation.

3 Proposal

In order to conduce this experiment, we are proposing to research and develop the *wePark application* and analytic models to understand social behaviour and reputation parameters. This environment will develop upon the concepts of Citizen Participation, Social Networking and Community Engagement.

The architecture of this framework is depicted in Fig. 1. The application will run as a crowd sourcing solution, allowing for end-users to: (i) easily report free parking spaces, and; (ii) search for a parking space nearby or at a distant location (related to his programmed trip). In addition, the back-end solution will implement the algorithms that provide the intelligence to the system, such as reputation ranking, filtering of parking places reported by, and to, different users, clustering of reports to avoid reporting the same spot multiple times, and

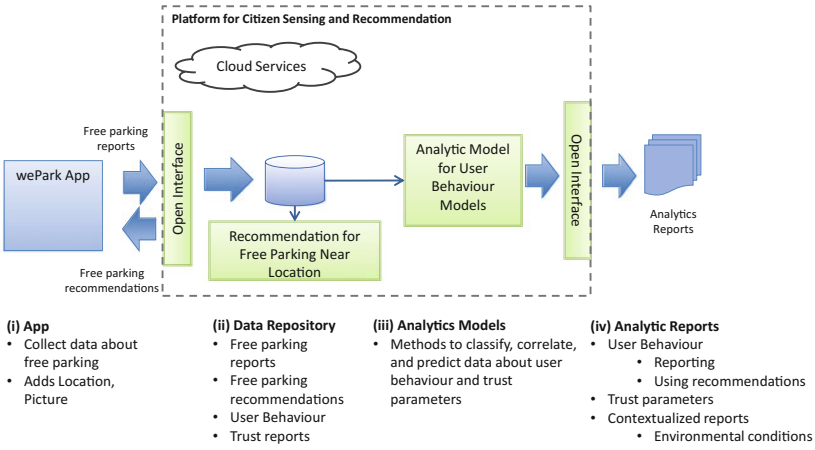

Fig. 1. Architecture for the wePark experimental framework

other possible processes for improving the functioning of the system. We will test how this intelligence can be used to ensure the social balance, by detecting and eliminating misleading information and erratic behaviour.

We intend to use the "wePark application" to gather data on users' behaviour and improve the application incrementally. This data set will provide insight into how similar crowd sourcing applications could be used for dissemination of other traffic information, such as the location of traffic jams. The advantage of this approach is that there is very little known about user behaviour in such situations. We start from the principle that for some crowd sourcing applications the intrinsic incentives are enough to be successful, while others require external incentives to be added, such as credit systems. Similarly, whether users' reports are truthful depends on many different factors, which are largely unknown in the traffic environment.

The app will be integrated with route planner software, and the initial iteration will have the following functionality:

- One-click reporting: if the user clicks the report button, it will report a free parking space at the user's current GPS coordinates, and at the current time.
- Automatic parking space display: any reported parking spaces that are near the route's destination will be displayed on the map. These will be colour coded according to the time they were reported. The map can be browsed through as well.

Figure 2 depicts the screenshot of a prototype. The features being introduced in this application provide improved functionality over other solution, making it easier to report parking spaces, as well as incorporating them into the navigation software. We purposefully do not propose to use any other incentives, such as Google's *Karma points*, or monetary incentives for reporting a parking space.

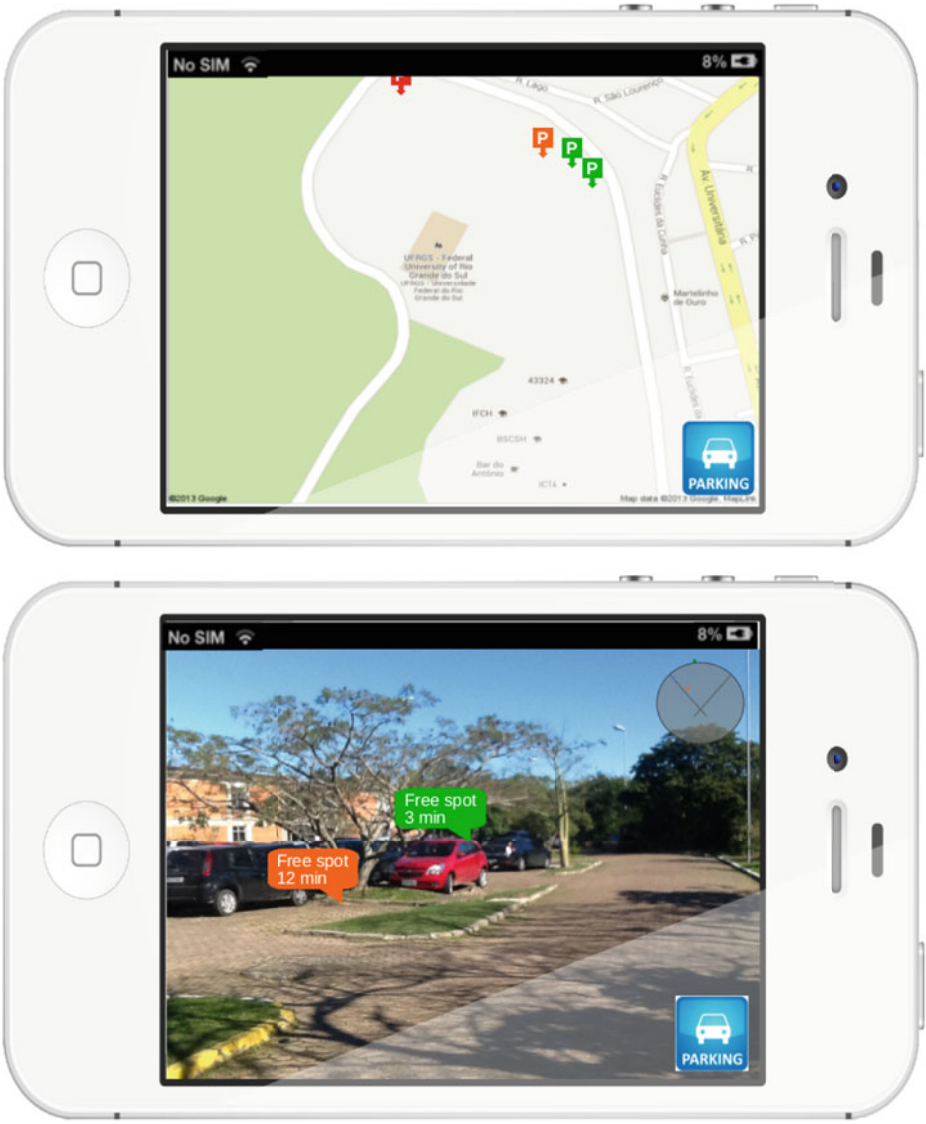

Fig. 2. Prototype wePark application

We also do not intend to punish malicious users in any way, because we are particularly interested in how the app is used.

3.1 Trial Setup

The user trial will follow students and university employees on the UFRGS Campus do Vale in Porto Alegre, Brazil. The main advantage of deploying this in

the Living Campus context is because it is a restricted environment in which a controlled user experiment can be conducted. After monitoring users' participation throughout a month we will ask them about their experience with the app, and compare this with the collected data. This will serve as input for a next iteration, in which incentive mechanisms can be added, we can sanction malicious users or improve the app in other ways.

While we do not know for sure how many users we will include in the trial, the aim is to reach as many commuters as possible in order to have a sufficient group for accurately reporting parking spaces on the campus. We will initially distribute it among CS students and professors, but make it available for download and do some advertising of the app on the campus to disseminate information about it.

We realize that a university campus has a different demographic to the city as a whole and any conclusions we draw will have to be confirmed in a larger population. Nevertheless, as an initial field trial environment, the advantages of a small area with a large number of drivers who are easily contacted outweigh this disadvantage.

3.2 Collected Data

The data being collected consists of usage data, as well as answers to a questionnaire. The usage data will record how often, when, and where participants report parking spaces, or open the app to search for a parking space. We will also collect a user's route when using the app, and can match this to either successfully finding a parking space, or driving past spaces that have been reported as free. The questionnaire will ask for the user's subjective opinion on their use of the app, with questions such as: "are you pleased with your usage of the report function?", "what are the main reasons for not reporting a parking space?" and "did you ever falsely report a parking space? If so, why?" to discover what might better motivate users to truthfully report parking spaces. Similar questions will serve to discover if users are pleased with the experience of finding a parking space with the app, and what can be done to make it better.

The usage data will then be coupled with questionnaire answers to discover usage profiles, which we will classify, roughly, according to what motivates the participants. We can then improve the app with further incentives to reinforce these motivations. The improved app will be tested in a second iteration of the experiment, thus allowing us to test specific hypotheses about the motivations of users and how to incentivise participation in a collaborative software.

4 Conclusion

In this paper we analysed the requirements of a solution for the free parking problem by studying the interplay between incentive mechanisms, user participation and the truthfulness of reports. We are developing wePark, a proof-of-concept solution for reporting and finding parking spaces, which provides the

data collecting capabilities in our platform. As a differential, we are promoting alternative methods to incentivise adoption, such as reciprocity, reputation, altruism and money. The empirical experiment that we propose is designed to answer the following two questions: (i) how to incentivise citizen participation in such projects, and (ii) how to model and understand individual behaviour whilst utilising these systems. We presented a prototype proposal and discussed some design decisions, such as provided advanced end-user experience, not creating any monetary incentives, and implementing on-line surveys to model user profiles. We will be applying this solution in a "Living Campus" experiment at UFRGS, collect data, and apply analytic models to analyse how user behaviour and social interaction impacts the utilisation of this solution. Our objective is to engineer a working solution applying participatory sensing approaches, and make it work based on the balance between crowd sourcing, reputation models, and incentive mechanisms.

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