Request Driven Social Sensing (Demonstration)

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ABSTRACT

Using a scenario of collecting weather data, we present a simulation of a crowdsourcing system for social sensing using mobile sensors, driven by the requests of other users. Users control how and when their mobile sensors are used, and may exhibit cooperative and non–cooperative behaviour. To facilitate social sensing, our system includes an implementation of intelligent data aggregation. The simulator allows the analysis of user control, selfish behaviour, and data aggregation in a realistic setting.

Categories and Subject Descriptors

Artificial intelligence [**Distributed artificial intelligence**]: Multi-agent systems; Networks [**Network algorithms**]: Network control algorithms; Modeling and simulation [**Simulation types and techniques**]: Agent / discrete models

General Terms

Algorithms, Experimentation

Keywords

simulation; crowd-sensing; crowdsourcing; norms; self interested agents; reciprocation; game theory; data aggregation

1. INTRODUCTION

Crowdsourcing systems leverage people's efforts to perform tasks. Crowdsensing is a type of crowdsourcing focusing on collecting, aggregating and analysing large amounts of data through mobile devices [2], for example about our environment. High spatial resolution is difficult to obtain through traditional stationary weather stations because these are very expensive. The advantage of crowdsensing over traditional environmental monitoring approaches is that data with higher spatial resolution can be obtained through a dense network of people.

Crowdsensing is useful for cases where high resolution environmental data is required for making better decisions. For example, in the case of extreme rainfall, crowdsourced rainfall sensors people carry with them, or photographic flooding reports taken with cellphones provide valuable warnings and damage reports.

Unfortunately, current crowdsensing systems have some associated problems. In particular, systems [1, 3] do not let users control how their resources are used and do not regard enough the problem of selfish users to cooperate.

Thus, in this paper we propose a solution and simulate it. In our system we focus on a case study where users issue and serve requests for rain data. Lane et al. [4], distinguish between opportunistic and participatory crowdsensing, respectively denoting systems where users do not directly participate and where the user must perform an action. Our simulated solution focuses on participatory crowdsensing, and addresses challenges by doing the following. 1) Take advantage of an intelligent mobile crowdsensing network to collect, process, and transfer data. 2) Allowing users to flexibly control the usage of their resources. 3) Modeling the cooperative and non-cooperative behaviour of users, allowing the system as a whole to be tested under realistic conditions.

2. SYSTEM COMPONENTS

In this section we describe the control-flow of a single agent in an application example of crowdsourced mobile rain sensors for rainfall monitoring. Each user has a sensing device for requesting, gathering and sending rain data. Here we exemplify the close relationships between the governance of resource usage, modelling of human cooperation and aggregation of data in Figure 1, for a single data request and the accompanying description:

1) The sensing device receives a request from another user to provide rainfall sensing data in the area. 2) The device accepts or rejects the request based on its use policy. 3) When the user's device accepts the request to provide data, it forms a cluster with nearby users that have also accepted a request for rain data in the same area. The users' devices in the cluster collectively decide which one of them senses the rainfall condition. The data aggregation function of [5] is used in our system to collect and transfer information efficiently to the required users. If the user's device is chosen to gather the data, the user is notified to turn their sensor on. 4) We model participatory sensing and the decision of the user to provide good data or sabotage the rain sensing (e.g. holding the sensor wrong), or even abandon the request and provide no data at all. Their decision is dependent on their past interactions with the requestor and on their personal character. 5) Providing rain data is only useful if it can be sent to the requestor, so the data aggregation component on the device selects an appropriate delivery method.

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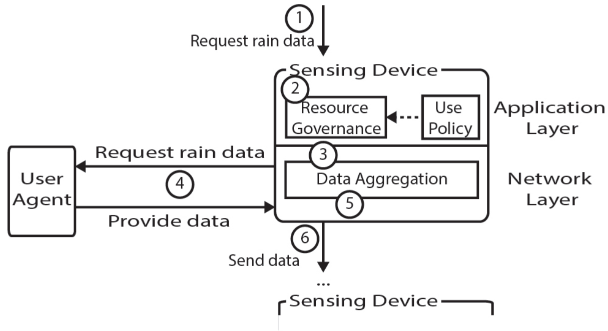

Figure 1: A user in the simulation is modelled as an agent that possesses an intelligent sensing device.

When speed is not important, the device uses other users to form an ad-hoc network, thus crowdsourcing the data transmission and saving energy, at other times when speed is important GSM is used. 6) Finally the data aggregation component sends the data, which will eventually be received by the requestor.

3. DEMONSTRATION

Our crowdsensing simulation integrates the intelligent behaviour of users and their mobile sensing device, where each behavioural aspect is visualised. The demonstrator simulates and visualises the crowdsensing system as follows.

A request for data is issued from a user (on the map) to a location on the map and served by the users at that location. We enable the editing of use policies, that govern which request a user's sensing device accepts, through the GUI as the simulation is running. On a separate screen, we also visualise a map of the users who have accepted the request.

We visualise the networking (Figure 2) with figures of people denoting sensing devices. Clusters of sensing devices that have accepted a request to gather rain data, where only one member of the cluster will do this, are visualised as adjacent people with the same colour. Each sensing device that has chosen to form an ad-hoc network with neighbours, either to send data that has been gathered or to forward data, has lines to other sensing devices, whilst those who use GSM communication do not.

When a user gathers good or bad data, or decides not to gather data at all, we visualise these behaviours respectively denoting them with green, red or orange lines from the user providing (or not providing) the data to the user that requested it. Thus, the key behavioural parts of the system are visualised and we provide a means to test and change the system on the fly with use policy editing.

4. RESULTS

We have constructed a simulator of a new request driven social sensing crowdsourcing system, which incorporates checking use policies against requests, modeling strategic behaviour of self-interested users and smart network selection. This tool allows checking the influence of each of these component's functionality on the total system performance, defining performance as the number of requests per time unit that are satisfied to a certain extent and measuring it. We can also test the relationship between user behaviour and what is specified in their use policy and requests. This simulation platform can further be used for answering research questions for social sensing. For example, given a population of users with certain behaviour and use policies, how will they behave as time progresses and influence the network performance?

Figure 2: Visualisation of data aggregation. Lines between users (not to scale) indicate data aggregation, adjacent users with the same colour indicate a cluster where only one in that cluster is providing data. Rainclouds are indicated with blue and black squares. Map taken from ©OpenStreetMap.

Our crowdsensing system focuses on rain data but can also be applied to many other scenarios, such as photographic weather reports, file sharing or personal tasks (such as Amazon's Mechanical Turk). To summarize, we have both demonstrated a new approach to crowdsourcing and built a platform for further analysis of this approach.

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5. REFERENCES

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