# Collaborative Filtering - A Group Profiling Algorithm for Personalisation in a Spatial Recommender System

**Keywords:** Group profiling, Collaborative filtering, Recommender system

## Problem Statement

Spatial information overload has emerged as a new issue in the spatial context in recent years. To extracting meaningful information from large spatial datasets and portraying this on a map results in an efficient way to recommend map items to users. Such a recommender system can be built by monitoring user interactions with the system in order to generate user profiles. These profiles can then be used as a basis on which to recommend map content to users. A system has already been implemented to operate with individual user profiles and recommend items of spatial interest to the user (Ballatore et al. 2010). This paper presents an extension of this work and the development of a prototype which recommends spatial items based on group profiles using collaborative filtering techniques. Several other approaches to group profiling have also been studied and their relative strengths and weaknesses are discussed in this paper.

## Related Work

While Web personalisation and Web recommendation have been widely studied, comparably little research exists in this area within the Geographical Information System (GIS) domain (Albanese et al., 2004). Existing systems are diverse and generally specialised for a single domain. For instance, Hippie has been developed as a delivery service tool for museums which recommends contents based on user location (Oppermann et al. 1999) while COMPASS is a GIS recommendation system based on semantic groups (Weakliam et al. 2005). Similarly, PILGRIM is another relevant example which interprets proximity as a degree of user interest and uses this knowledge to generate web recommendations (Brunato and Battiti, 2003). Our previous system, Recomap, is a spatial recommendation system that incorporates user context to develop a novel algorithm for recommending personalised spatial content (Ballatore et al. 2010). The approach relies on implicit feedback analysis (Mac Aoidh et al., 2008; Weakliam et al. 2005). Recomap builds and updates individual user profiles by recording location, time and user interactions and makes recommendations at the map level. A time decay function is applied to reduce the relevance of previous older interests and more recent ones promptly become more prominent in the user profile. This paper builds upon this work in order to increase the performance of Recomap through the use of group profiling techniques. There are various solutions available to implement group profiling and choosing the best applicable theory is challenging and so this paper evaluates their strength and weakness.

## Group Profiling Techniques

Group profiling is widely used in traditional non-spatial application such as Amazon.com (Linden et al. 2003). Their approach is especially interesting due to the huge number of users and items involved. Existing algorithms focus either on similar users (*search-based methods* or *item-to-item collaborative filtering*) or similar items (*collaborative filtering* and *cluster models*). Recommendations are based on customers who are most similar to the current user. The high computation cost of this method is problematic, especially when the amount of customers and items is large. The solution could be to reduce the number of users who are taken into account when assigning similarity, but this means reducing the accuracy too.

An alternative approach is the cluster model which builds link between people (Ungar and Foster, 1998). By analyzing which group or cluster is the closest to the current user, recommendations can be

improved by taking the influence of the group profile into account. Several techniques exist to create those clusters, but they are usually complex so that for large amounts of data, dimensional reduction is necessary. A similar technique called search-based methods focuses on the link between actual items of interest (Sugiyama et al. 2004). The items of interest to a user are analysed and similar items are recommended. For a user who has many items of interest (such as a lot of purchases), the algorithm computes on a restricted amount of items in order to improve the speed of the approach; however this may reduce the quality.

A further approach is to utilise user behaviours as a method to determine similarity between users. This can be achieved through the categorisation of user behaviour patterns using Hidden Markov Models (Ypma and Heskes, 2003). Within this approach, user behaviour can be described as a succession of interactions with the browser in the form of a click stream. It is possible to use this data as a method for clustering users and determining similarity between user behaviours to form groups of users.

## Methodology and Results

Preliminary work has successfully implemented a collaborative filtering technique which mimics that developed by Amazon (Linden et al. 2003). The system architecture, shown in Figure 1, is based on the context management toolkit proposed by (Zimmermann et al. 2005). This toolkit integrates user modelling with context modelling in order to simplify the design of the architecture. The group profiling algorithm is implemented on the Process Layer which monitors the evolution of the user profile and interacts with other layers of the context toolkit. The current system is used to generate group profiles by clustering the individual user profiles which are built dynamically by implicitly monitoring user interactions such as mouse clicks and map navigation including zooming and panning, with the map interface that we have developed, as shown in Figure 2. The clustering approach is based on the Pearson similarity metric (Strehl et al. 2000), which has been widely adopted for such clustering tasks (Ungar and Foster, 1998). A case study, based on a map navigation assistant for users of a university campus was developed. The clustering technique was applied to various types of users such as students, lecturers and staff who can use the system to get recommendations accordingly. Initial results indicate that group profiles were successfully generated which match the semantic groups of users of the system. The next step is to ascertain how these group profiles affect the recommended map items returned to the user and if they improve the accuracy of such recommendations. One of the weaknesses of the approach is the computation time; however this can be overcome by running the algorithm offline. This approach will be appraised against other group profiling techniques which we will implement in order to gauge which is the most accurate to use in the GIS personalisation scenario.

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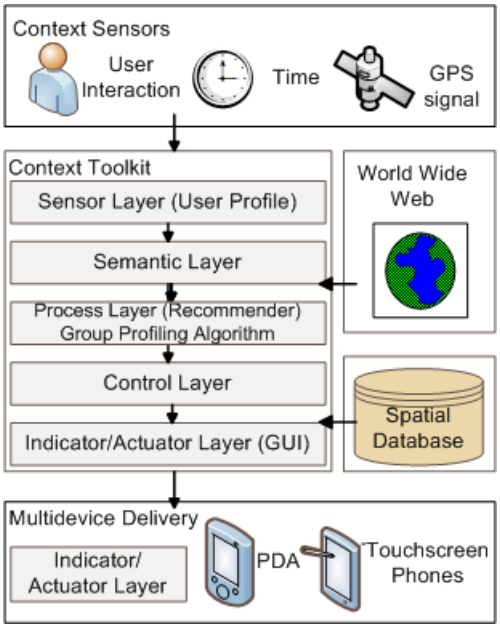


**Figure 1. System Architecture**

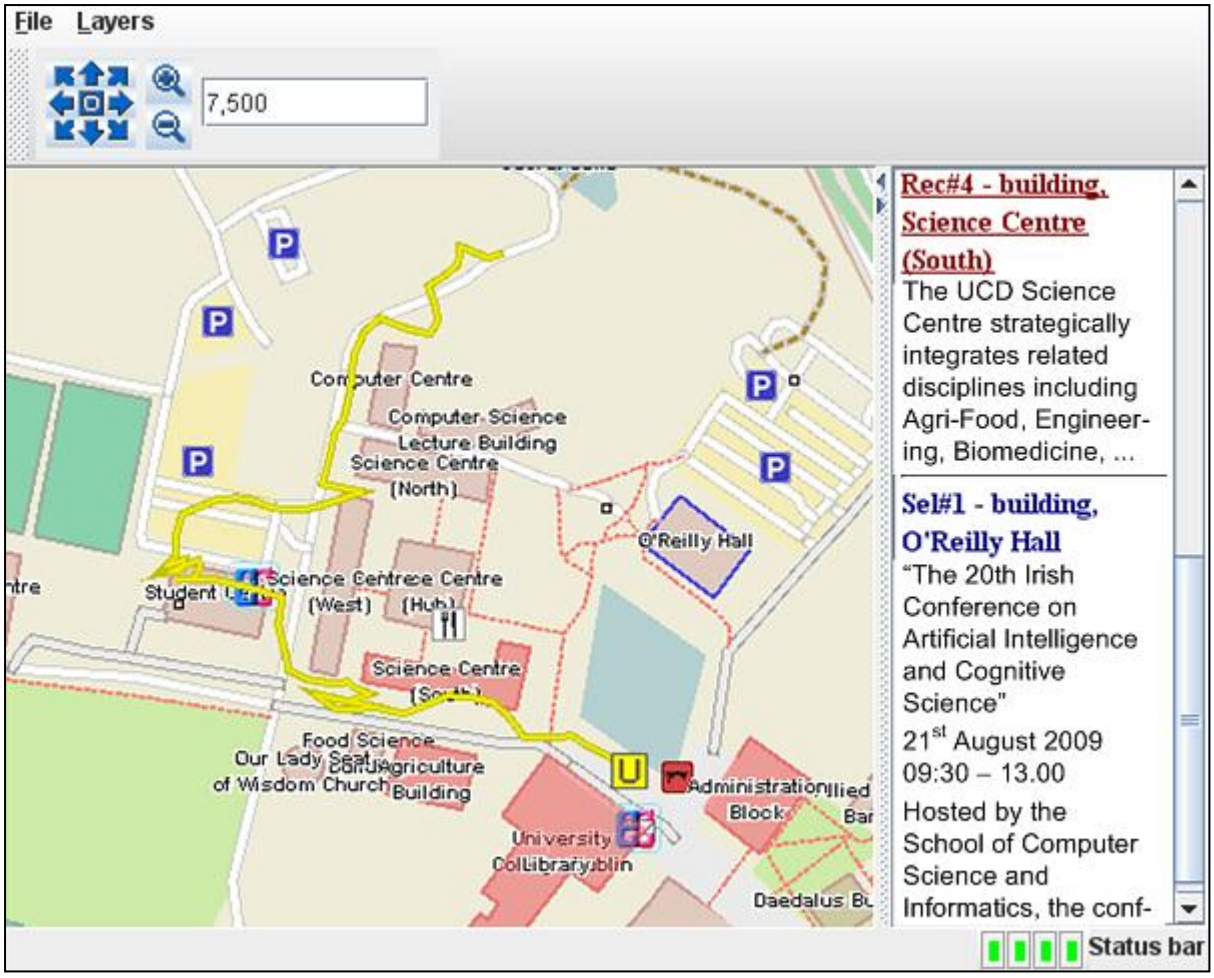


**Figure 2. The Map Interface showing some recommended buildings**