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A Destination Recommendation System for Virtual Worlds

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Abstract

This paper describes the design and training of a recommendation system that helps the user navigate in Second Life (SL), a massively multi-player online environment. Second Life allows users to create a virtual avatar and explore areas built by other users. However, unlike the real world, virtual attractions can be constructed within hours and previous ones often rapidly fall into disuse. Without recent information about the state of regions in the world, it is difficult to assist the user's searches in the virtual world. In this paper, we present a framework for leveraging recommendations about locations made by other users using a collaborative item-based filtering method in which locations are treated as items. Our system runs in real-time and presents the user with information via a virtual heads-up display (HUD).

Introduction

Second Life (SL) is a massively multi-player online user-constructed environment that allows users to construct and inhabit their own 3D world. The current population of SL users is 16 million, with a weekly user login activity reported in the vicinity of 0.5 million (Second Life 2009). The world of Second Life is laid out in a 2D space of locations, known as the SLGrid. The SLGrid is comprised of regions, with each region hosted on its own server and offering a fully featured 3D environment shaped by the user population. The game supports a number of personal modes of travel (walking, flying, teleporting) in addition to enabling users to create their own vehicles. Although Second Life offers 3D visualization, the keyword search mechanism offered by the SL user interface is fairly limited and more appropriate for searching text-based information sources. This motivates the need for a recommendation system that can suggest places to visit, personalized with the user's destination preferences. Analyzing users' destinations in virtual worlds offers a unique set of challenges:

- the lack of consistent geocoding information;
- the ability of users to teleport instantly to destinations;
- the lack of constraining lifestyle factors such as a need to sleep or go to work at a regular time.

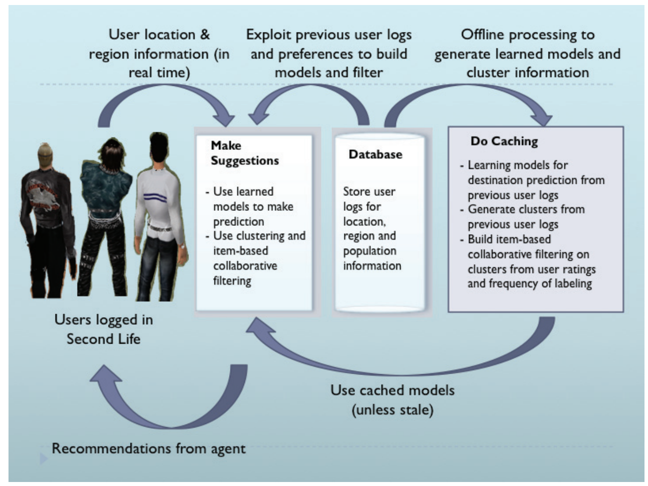

Figure 1: Application architecture

These challenges combined with the shifting nature of the SL landscape suggest that a regularly-updated, data-driven model is required.

Software System

To acquire data on users' travel patterns, we developed a custom tracker object using the Linden Scripting Language (LSL). Users carrying the object are periodically prompted to enter information describing their current location. The tracker object appears as an HUD that can be worn on the right or left of the avatar that monitors the user's current (x, y, z) location. Additionally the tracker estimates the local population density by counting the number of other users within 10m of the user. The operation of our tracker is described in (Shah, Bell, and Sukthankar 2009). Users have the option of marking a place as belonging to seven possible categories (artistic, camping, educational, entertainment, shopping, residential, other). Our GUI allows users to designate a location as belonging to multiple categories and enter additional descriptive tags through a text field. Users are also prompted to rate their interest in the location on a five star scale. The information is sent as a web request to the web server, where it is stored in a MySQL database. The data collection and recommendation can be performed

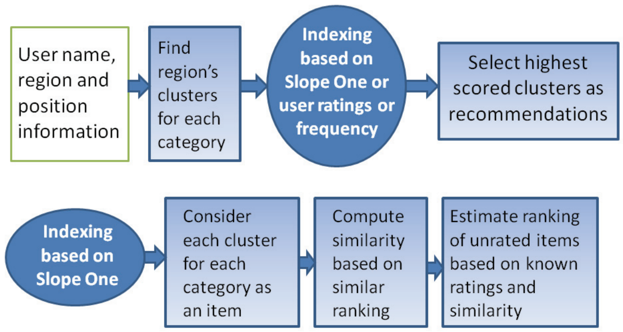

Figure 2: Item-based collaborative filtering

simultaneously for multiple users using our multi-threaded Java server application.

Our recommender system was implemented as a second custom object in the Linden Scripting Language (LSL), with the same monitoring properties as the tracking object but with a different HUD (heads-up display). Through the HUD, users can request and receive recommendations in the form of SLurls, an in-world analog of the hyperlink references used in WWW. When the user clicks on the SLurl link, he/she is teleported directly to that destination. To build a model of the user's preferences, we allow users to provide ratings for the SLurl. The user is also presented with an option to correct the labeling for the location if he/she thinks that the location does not fit the category. The overall architecture of the recommendation agent is shown in Figure 1.

Cluster-based Collaborative Filtering

We implemented an item-based collaborative filtering algorithm to generate SLurl recommendations. Raw labeled data points (x,y,z coordinates) were partitioned according to category using unsupervised k-means clustering (Euclidean distance minimization). Cluster centers (referred to as items here on) were indexed according to the average user-rating of the points. This ranking was used to make the first recommendation to new users without any rating history. After collecting some ratings from the user, we leverage them to make a more personalized recommendation based on item similarities and rating history by calculating a Slope One recommendation (Lemire and Maclachlan 2005) with the bipolar method. For the bipolar method, we consider both the likeness and dislikeness of the user to the other users' based on the ratings. In our system, likeness is defined as a rating of three or above on scale of five and dislikeness otherwise. Cluster centers in the same category are considered to be similar. The recommendation is returned to the request HUD as a SLurl. To capture user feedback, user can provide ratings on a five point scale for the link he/she has teleported to.

Our procedure for making the recommendation (shown in Figure 2) is as follows:

1. First, we smooth out the raw data, using k-NN to assign points to cluster centers. Each cluster center is calculated using a category-wise partition of the data.
2. Cluster centers are ranked in the order of the user rating after calculating the average score of the cluster.
3. In the case of no ratings, cluster centers are ranked by the frequency of the points that belong to each of the clusters.
4. The system responds to each request for recommendations by providing the next five suggestions in order of computed index, using one of the above two methods, such that the first three recommendations are from the same region and the last two from other regions.
5. Once we have some ratings from the user, we use the bipolar Slope One scheme to make a recommendation based on the similarity or dissimilarity of the user rating to other users that rated similar items similarly.
6. We consider items that belong to the same category as being the same and compute the likeness assuming that if the rating for the item was above the average rating for that user, it is liked, otherwise it is disliked.
7. The ratings for the user are then predicted from the average rating of the user and the similar user ratings for similar items, sorted on this rating. The recommendation changes as more user ratings become available.

Conclusion

This paper presents a recommendation system for helping users navigate in virtual worlds. To leverage research from web-based recommendation systems, we implemented a bipolar Slope One scheme to recommend locations to users. The user study (not reported here) showed that most users reported a positive user experience. While we only focused on the problem of destination recommendation, our framework that provides a rich user interface that is being used to explore the following directions as part of our ongoing research work: 1) creating social networks of users with similar interests; 2) supplementing SL data with information measures that describe the user's real-life interests. Many people use the internet to create a social presence, through blogs, avatars, and social networking sites; this presents an opportunity for researchers to collect rich user data from these interactions and research the problem of effectively creating a personalized and user-friendly experience.

Acknowledgments

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