NPS2001C: Matrix Unplugged:Using Computer for Real-World Problems [2320]

GROUP PROJECT MILESTONE 1

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FlushFinder: Find My iPhone? More Like Find My Toilet

I. Problem Statement

The public toilet experience is a “shitty” one. Finding the nearest public toilet — let alone an unsoiled one — continues to be a gripe many may not necessarily articulate, but instead often tolerate. Way-finding platforms like Google and Apple Maps have failed to provide specific information about toilets. Notably, details surrounding the availability of amenities like nursing rooms, disability-friendly toilets, and washrooms with bidets practically remain scarce on existing platforms. As a result, the quality of one’s toilet experience is often left to chance, an unwarranted gamble usually ending in a subpar, undesirable — *shitty* — visit.

II. *FlushFinder*

When nature calls, *FlushFinder* answers; it is a tool for locating and navigating to different lavatories while aggregating useful information like accessibility and amenity features. Based on four broad attributes: closeness, cleanliness, aesthetics and amenities, the app furnishes a list of recommended toilets that users will be able to choose from and then, follow a generated route to their specified choice. Updating these metrics in real-time, users leaving the toilet can reciprocally review and rate the toilets they have used, providing scores and written notes for other users’ reference.

III. Algorithm

Item-Based Collaborative Filtering (IBCF)

We can use IBCF to recommend toilets to a user, based on the similarity of their attributes and characteristics. This system enables personalised toilet recommendations that are tailored to each user’s preferences and past interactions. The flowchart below provides a schematic of what IBCF would do in the context of *FlushFinder*.

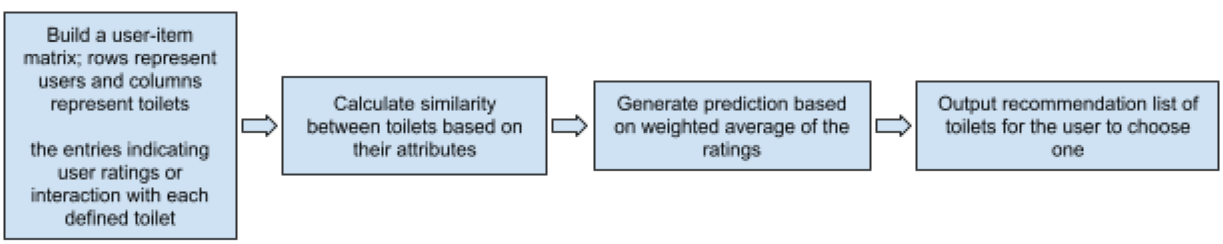

Figure 1: the IBCF used in *FlushFinder*

It is not hard to understand IBCF. Its mechanism can be split into two subtasks: 1) calculating similarity and 2) calculating prediction/recommendation. Rather than turning to commonly used, complex formulas like Cosine-similarity for calculating step (1), we will use a simple and efficient approach called Slope One that ‘recommends items to users based on the average difference in preferences of items’ (Lemire and Maclachlan, 2007). These two blogs (Renata, 2010) and (Pinela, 2017) explain the Slope One model clearly. For step (2), we merely need to apply the IBCF formula that is:

$$score(u,i) = \frac{\sum_j^I similarity(i,j)(r_{(u,j)} - \bar{r}_j)}{\sum_j^I similarity(i,j)} + \bar{r}_i$$

Figure 2: Formula of the IBCF predictive algorithm

Explaining this equation from a computational-thinking approach will make it easy to understand. We can break down the equation into its components to clarify its function (decomposition), and explain the inputs (u, i, j, r) and its output — a matrix of scores that recommends the top-scored toilets to users (abstraction). These two blogs (Qutbuddin, 2020) and (Chiang, 2021), which explain the IBCF formula in greater detail, can be used as an educational resource for our presentation. Finding and implementing code for IBCF is also relatively fuss-free. This open-source GitHub project is a pre-made movie item-based model recommendation system which we can adapt to our context. This code written in R is a more general IBCF model with relevant # explanatory notes that we can also tweak to suit our application. Overall, IBCF is a promising algorithm to use in *FlushFinder*.

Dijkstra' Algorithm (*Dijkstra*)

After the user is recommended a list of toilets and chooses one particular toilet to go to, we will employ *Dijkstra* to calculate the shortest routes from the starting position to the nearest toilet, analysing the network of paths, roads, and walkways from the OpenStreetMap, an open-source database, to provide real-time navigation guidance. *Dijkstra* is widely known to be the foundation of most map applications such as Google Maps (Kim, 2019). It is also well documented, with many resources on the algorithm present online. Case in point; an hour-long YouTube video by Stephano Dev, where he goes through an example of implementing *Dijkstra* using Javascript and several Application Programming Interfaces (APIs) to emulate a map application. Numerous codes of *Dijkstra* are present on GitHub with in-depth explanations. *Dijkstra* is therefore the most crucial algorithm which builds the foundation of finding the shortest pathways to the nearest toilet, based on our user's preferences.

User demographics

Our demographic is primarily individuals who own smartphones and thus have access to the mobile app market. The circumstances of the app are obvious: whenever a user wishes to find the nearest toilet that fits their preferences, *FlushFinder* gets the job done. However, *FlushFinder* intends to cater to distinct groups within the broader demographic that frequently face challenges in finding suitable restroom facilities. Firstly, nursing mothers often struggle to find clean and private spaces for expressing milk when outside their homes (CNA, 2018). The lack of readily available information leads many to resort to unsanitary public restrooms, compromising their comfort and health. Secondly, using a bidet is a religious requirement or a preferred hygiene practice by many Singaporeans. There are existing attempts to catalogue and provide this information, such as @toiletswithabidetsg on Instagram (AsiaOne, 2023) amongst others, however, there is no one central provider of online information that users can turn to should they want to use a toilet with a bidet. Lastly, while accessible toilets are increasingly common in Singapore, their adequacy varies significantly due to the diverse needs of individuals with disabilities, especially concerning space for personal motorised vehicles. Older facilities often fall short of accommodating these larger requirements, a gap only newer restrooms have started to fill (Rashith, 2019). *FlushFinder* streamlines finding nearby nursing rooms, facilities catering to personal and religious needs and accessible restrooms for those with disabilities, enhancing comfort and safety for all users.

Foreseeable issues

Ensuring data accuracy and reliability pose a challenge for restroom-finding apps, as user-contributed details regarding amenities, cleanliness, and accessibility features may not always be accurate, leading to potentially misleading information. Also, the app may face unequal coverage issues, particularly in less populated or technologically accessible areas, and with newly built toilets which have not been widely reviewed yet. Privacy concerns also arise, as using a restroom is inherently private, and users may be hesitant to share location data or personal preferences. Furthermore, regulatory compliance must be considered, as collecting and sharing restroom data involves navigating legally grey zones, especially given that some toilets are in semi-private spaces like malls.

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