Notes Recommendation e-Book System

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***Abstract* - Nowadays there are many teachers and students accessing e-Book through digital devices. For students, books are the main entity in teaching and learning activities. Not only adults but also children have been introduced with Digital Books. Most of the eBook readers allow to add notes; however, they do not allow to search or sort, these notes. This paper provides Notes Recommendation e-Book System which allows a user to write, search, filter and recommend notes. We used a collaborative filtering technique based on subject, user preference, and credibility.**

Keywords - Digital Reader, Note classification, Collaborative filtering method, user preferences, credibility.

I. INTRODUCTION

The reliance on eBook technology has increased as a new way of educational technology. It provides students and teachers with a flexible platform in accessing their course material anytime and anywhere with rich media and interactivity. There are a lot of features for eBook which could be used for improving eBook browsing such as bookmark, highlight text and add notes. Some platforms allow students to follow each other's notes such as bookshelf of VitalSource [1]. It allows students to subscribe to their friends' notes and view their notes in a single list. However, this list is not ordered as what is more related to the topic or useful for readers.

eBook readers were introduced by poplar companies such as Amazon, Barnes and Nobel and Apple. Kindle, Kobo and Barnes, iPhone and Android eBook reader, and Noble Nook are some examples [2] [3]. Many publications of eBooks has been published for chemistry, biology, physics, computer science, and other disciplines [4]. Accordingly, the launch of innovations such as Digital Readers and eReaders based on software, hardware, and infrastructure resources [5] provides an opportunity to implement new business models [6].

Recommendation systems use filtering methods, machine learning techniques, and prediction algorithms to predict readers concern on some notes among a huge number of accessible notes. The Collaborative Filtering (CF) systems [7] [8] [9],[10] [11] deals with reader profiles and keep reader rating. The disadvantage of ratings is that when references are taken as votes, there is no grantee that it is a positive vote [10]. CF almost provides unforeseen recommendations because of the dependence on reader similarity rather than on note similarity [11]. It employs the resemblance between reader profiles to figure out which one matches the current reader [8]. Although most of the CF relies on ratings from readers; they do not consider readers' credibility. The challenge is when uncertain readers recommend bad notes; consequently, it forces the recommendation system to provide a false note.

This paper presents a Notes Recommendation e-Book System (NRBS) that not only considers like-minded readers but also readers' reliabilities. NRBS can provide different notes based on reader's profiles. NRBS allows instructors around the world to improve the reading experience for students and leading them to have higher engagement with their textbook. This should increase students' confidence about required topics.

This paper is organized as follows. In section 2, we describe filtering methods and recommendation systems. Section 3 presents NRBS framework and its methodology. In section 4, we show the conducted experiment and results. Finally, in section 5, we discuss pending problems and suggest future projects.

II. FILTERING NOTES METHODOLOGY

A recommendation system is a software which can use machine learning methods or other filtering methods to record preferences of readers and build some recommendations. There are many companies adopted recommender systems for their application such as Netflix [12], and Amazon [7]. Netflix is a company for video rental and streaming service. In 2006, it started to build a recommendation agent to improve recommendations to their members. The tremendous number of both videos and members was the reason that caused Netflix to build a recommender system. The company personalizes its homepage to include groups of videos arranged in bars and ordered according to the preferences of the members. Amazon also created recommendation algorithms to

personalize the content of its Webpage for each consumer [13]. The methods used in recommendation systems are regularly classified based on CF which contains three items: reader preferences representation, credibility of notes, and personalized notation-panel for a reader.

A. Reader Preferences Representation

Suppose that an e-Book C contains m pages: $C = \{C_k\}_{k=1}^{m}$, and each page C_k has n notations

$$C_k = \{d_{ki} \mid i = 1,..., n\} \tag{1}$$

Therefore, the book could be represented as $m \times n$ -tuple,

$$\begin{bmatrix} d_{11} & .. & d_{1n} \\ : & d_{ij} & : \\ d_{m1} & .. & d_{mn} \end{bmatrix} \tag{2}$$

Where d_{ij} represents the j[th] note in the i[th] page. Consequently, the following Φ_k ($m \times n$ -tuple) represents the reader's degree of interest for all notes for a reader u_k.

$$\Phi_k = \begin{bmatrix} \phi^k{}_{11} & .. & \phi^k{}_{1n} \\ : & \phi^k{}_{ij} & : \\ \phi^k{}_{m1} & .. & \phi^k{}_{mn} \end{bmatrix} \tag{3}$$

Where

$$\phi^k{}_{ij} = \frac{f(u_k, c_{ij})}{\sum_{i=1}^{n}\sum_{j=1}^{m} f(u_k, c_{ij})} \tag{4}$$

$$\sum_{i=1}^{n}\sum_{j=1}^{m} \phi^k{}_{ij} = 1$$

Where $f(u_k, c_{ij})$ represents the frequency number, when a reader u_k read a note c_{ij}.

B. Credibility of Notes

In case a reader just selects notes but did not like any of them, a credibility matrix overcomes this issue. The matrix represents the interesting notes based on readers' preferences. Accordingly, we can define the credibility matrix of the reader as follows:

$$\Delta_k = \begin{bmatrix} \lambda^k{}_{11} & .. & \lambda^k{}_{1n} \\ : & \lambda^k{}_{ij} & : \\ \lambda^k{}_{m1} & .. & \lambda^k{}_{mn} \end{bmatrix} \tag{5}$$

Where, $\lambda^k{}_{ij} = \dfrac{S(u_k, c_{ij})}{\sum_{i=1}^{n}\sum_{j=1}^{m} S(u_k, c_{ij})}$, and

$$\sum_{i=1}^{n}\sum_{j=1}^{m} \lambda^k{}_{ij} = 1$$

Where $S(u_k, c_{ij})$ represents the frequency number when reader u_k likes the note c_{ij}.

Accordingly, we can compute the credibility $D(u_k, C_j)$ for reader u_k at each page C_i as follows:

$$D(u_k, C_j) = \sum_{l=1}^{n} \lambda^k{}_{jl} \tag{6}$$

$$\Omega_k = \Theta_k + \Delta_k = \begin{bmatrix} \omega^k{}_{11} & .. & \omega^k{}_{1n} \\ : & \omega^k{}_{ij} & : \\ \omega^k{}_{m1} & .. & \omega^k{}_{mn} \end{bmatrix}, \tag{7}$$

Where, $\omega^k{}_{ij} = \phi^k{}_{ij} + \lambda^k{}_{ij}, i = 1,..., n \;\&\; j = 1,..., m$

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Based on formula (7), we can define an interested set Ψ_i^k for each page C_i for each reader u_k:

$$\Psi_i^k = \{\omega^k{}_i \mid i = 1,..., n\} \tag{8}$$

Accordingly, we can compute the interested of the reader u_k for each page C_i:

$$I(u_k, C_j) = \sum_{l=1}^{n} \Psi^k{}_{jl} \tag{9}$$

C. Personalized Notation-Panel

To create a notation-panel for a reader u_k, we determine the order of the notes, and then rearrange the content of every note. To determine the order of the notes, we sort as descending order the set $C = \{C_k\}_{k=1}^{m}$ based on the value $Z(U^k, C_j)$ in formula (11). Each note is represented by a

set $C_j = \{d_f^k \mid f = 1,...,n\}$. Where d_f^k presents the frequency of note d_f , which belongs to note C_j for a reader u_k :

$$d_f^k = \frac{1}{3}\left(\frac{n_f}{F_{\max} \times N} + Z(U^k, C_j) + I(u_k, C_j)\right) \quad (10)$$

Where n_f represents the maximum number of notes in which a note had been selected, N represents the total number of notes, and $F_{\max}$ represents the maximum number of notes in which a note had been selected, and $I(u_k, C_j)$ represents the interested of the reader u_k for each note C_i represent sum of reader interested on note v:

$$F_{\max} = \underset{v=1,...,n}{Max}\{n_f\} \quad (11)$$

III. Notes Recommendation E-Book System

The recommendation of the notes is built based on formula from (1) till (11). NRBS framework consists of an e-Book reader interface, a reader profile, notes database, and a filtering engine. Generally, a course includes resources such as text, images, and multimedia. Readers use these resources to participate in various activities. However, it is very difficult for users to monitor and analyze all the activities of all the readers. Therefore, we need an automatic way to track a reader's browsing behavior and adapt the next appropriate presentation.

We need to design an adaptive algorithm that combines adaptability with reader-driven software [14] [15] [16] [17] [18] [19]. The proposed system can analyze the reader's behavior during a reader-driven stage, and evaluate the granularity level of note materials (the degree of specificity of information contained in a note) [20]. This will allow adapting the next presentation and also updating the domain model.

As shown in Figure 1, a reader can use the reader interface to add sticky notes to his eBook pages. Therefore, the reader can navigate to the required page to add note, and then click the Notes tool and select the color or font for his note. The note will not be saved in the Note database unless the reader clicks the button "add a note". The note appears in the eBook page and in the note list as well.

Modeling the semantics of individual notations is important because the number of notes that will be published each day on the e-Book will continue growing when the publisher adopts e-Book as a textbook. Thus, students and teachers need support to benefit from notations streams. Figure 1 shows three components of NRBS: e-book user interface, system database, and a filtering engine. These components are described in the following subsections.

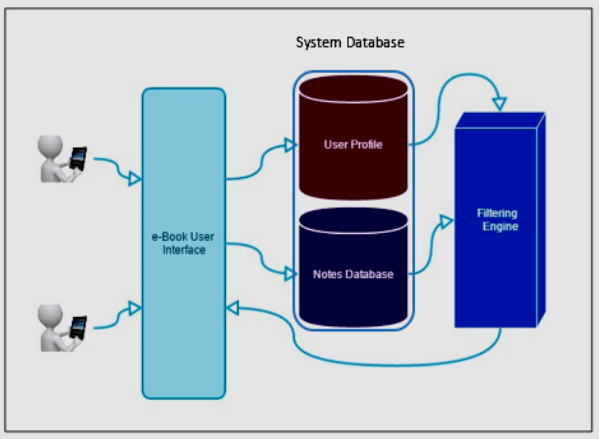

Figure 1 NRBS Components

A. E-book User Interface

The interface is responsible for orchestrating communication between Digital Reader and e-book. It is accomplished by extensive code optimization using HTML5 and other scripts. It appears in the e-book menu and shows some notes sorted by a filtering engine. Moreover, it contains a process of control to communicate with other components and show notation-panel. The reader interface is in charge of acquiring knowledge about readers - such as their learning profiles and learning objectives. It allows readers to navigate and browse the contents of the Digital Reader.

B. Filtering Engine

When readers use the system for the first time; the reader interface encourages them to fill out short questionnaires to determine a user profile by asking for name, password, sex, age, and interests (expertise and projects). This basic information is stored in the database. The filtering engine uses user profiles and the methodology of creating a personalized notation-panel for a reader to filter notes and create the sorting list.

C. Plug-in Reader Interface Implantation

A prototype of a portable Digital Reader is built based on the Calibre framework Version: 3.16.0. It is a powerful and easy to use e-book manager. As we mentioned before, we created an automatic filtering for the notes driven by the filtering engine. This pattern takes into consideration the following conditions: the reader model (the learner's goals, user profile, behavior, and preferences). The current version of Digital Reader is built in HTML5 and operates under Windows 10. Figure 2 shows an interaction example for the first version.

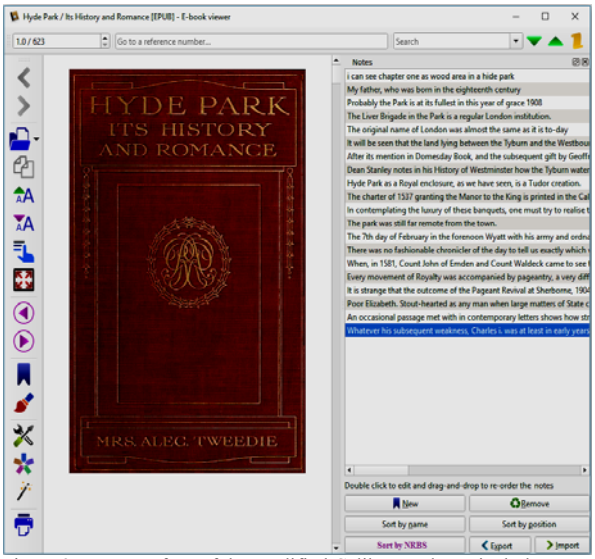

Figure 2 User Interface of the modified Calibre reader to include Notes recommendation e-Book system Diagram

IV. Experimentation and Results

The purpose of this study was to investigate the readers' preferences on page and content design of Digital Reader and conduct a usability testing. This test provides quantitative and qualitative data from real readers performing real tasks with a product. Usability professionals can evaluate some aspects of accessibility by using standard usability testing protocols, with a few modifications for including participants with disabilities. Twenty readers' responses are obtained from students from different faculties at a university. The respondents are 8 males and 12 females (n=20), all of them are undergraduate students. Results of the study shows that navigation design greatly affects the overall ease of use of e-books notes. An online survey was conducted, and 10 questionnaires were returned. Table 1 and Figure 3 shows that the respondents prefer the criteria of the design of the note recommendation system NRBS.

The results from Table 1 and Figure 3 show that the majority of the participants consider the usefulness of using NRBS with 89%. The most favored feature was using the filtering engine with 91%. The high preference with this feature can be explained by the engine ability which allowed completing task rapidly and reduced frustration. There was some agreement between the participants' impression on enjoyment (experience with NRBS), the benefit of Cross-referencing between index pages and between NRBS notes with 89%, 89% and 88% respectively. Participants also concurred on note features consideration and NRBS notes to match their needs with 87%. Although most of the participants showed high preference of the value of NRBS, some of them reported less favored preference with conformance of the filtering notes 17%, and reliability of NRBS notes 18%. Additionally, 19% of the participants questioned the NRBS ability to convince the reader.

TABLE 1 CRITERA FOR TESTING NRBS

Question	Criteria	Preferences
Q1	Reliability of NRBS notes' navigation	82%
Q2	NRBS is a comfort for filtering notes	83%
Q3	The Cross-referencing between NRBS notes is considerable	88%
Q4	Note features are considerable	87%
Q5	Cross-referencing between index pages is helpful	89%
Q6	NRBS recommendation notes are matching our needs	87%
Q7	A filtering proposed engine's ability to quickly accomplish his task without frustration.	91%
Q8	How much a reader enjoys using NRBS	89%
Q9	NRBS ability to convince the reader.	81%
Q10	Overall evaluation	89%

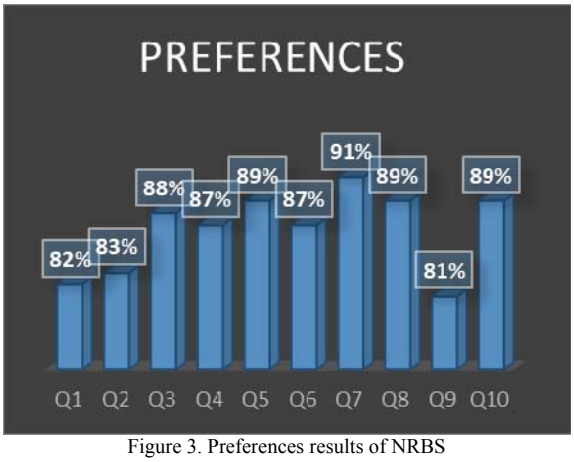

Figure 3. Preferences results of NRBS

V. Conclusion

This paper presented NRBS which was developed using HTML5. It highlighted the potential benefits of e-book filtering such as adaptive assets based on the reader's learning. A Framework was described for the proposed e-book interoperability. The methods used in recommendation systems are regularly classified based on CF which contains three items: credibility of notes, reader similarity algorithm, and personalized notation-panel for a reader. The findings of the study conducted to test the navigation and usability of the proposed system indicated that the students preferred NRBS which had clarity, simple navigation and overall ease of use.

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