Literature survey on user action interpretation and content recommendation

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***Abstract* - Today, millions of user interacts with the search engines to get acquainted with the latest trends. System requires timely updates to ensure that the users get up to date news or advertisements. Instead of digging for a linked search, the system must provide a recommender system which provides with a column of articles related to the users' search. This can lead to online content optimization. User interaction plays a key role in optimising the contents of a website. User profiles can be created with the adaptive web pages displaying the recommended contents based on feedbacks. It is impossible to capture all the contents and display according to the user's need and thus challenges come across. Personalised web portal services need to be taken a deeper look for content optimization. User Interactions should be managed and applied to the web portals using recommendation models. Recommendation models prove to be significant in online content optimization. The results of an adaptive system are carried out on real user traffic.**

***Index Terms* - Content optimization, recommendation models, personalized systems, action interpretation, user segmentation**

I. INTRODUCTION

Web users are intended to query the web portals for their convenience. They issue queries, click on some of the links, visit advertisements, read pages, modify the query and perform some actions. Web users do not like to waste time on a single web page. Their tendency is to get maximum information in less number of clicks. Web Systems should identify the most attractive trend and display in order to grab user's attention and manage them on an on-going basis.

Whenever a web portal is visited, there exist different modules on a web page for example Today's alerts, Top trending news, favourite deals etc. For example, 'The Times of India' provides with top news and is one of the most running news website in India. Figure 1 illustrates the contents of the website and gives a glance of Home Page. Numerous links have been provided to the user to navigate through the world class news. Different modules interact and provide the digital content. However, this page suffers from a cold-start problem [2].

Figure 1 Snapshot of homepage of a news website (The Times of India)

Figure 2 gives a brief idea about a personalized web system developed with the help of Users' interaction and feedback. Fig. 2 shows Home Page of amazon.in shopping portal where a particular user is logged on to the website sees different modules. When a user is logged in to the system, it offers various deals to the user in the 'Today's Deal' module. Based on the user's previous orders, it provides with certain recommendations (books) which can be seen in the figure. There are links for Gift cards,

categories, viewing the carts, wish list and others. The user profile shows the interests of the user which came through user interactions and the content can be seen optimized as per the user's requirements.

Figure 2 snapshot of amazon.in homepage with user login shows deals and recommendations

Personalized systems require adapting to the users by gathering and storing information about users, analysing their actions and delivering the right content to the users. Traditional personalized systems can be categorized into two parts: content based filtering and collaborative filtering [1][3][4][5]. The former is specific to a user and is based on the content items previously rated by the users. The disadvantage is that the contents recommended other than the previous ones can be limited.

Collaborative filtering is one the most widely used and successful techniques. In this technique, multiple users' interactions are recorded and the commonality is found, based on this the links are displayed according to the users' preferences which is common to all. The recommendation systems although processes content optimization still face some of the critical challenges [1]. Large numbers of users are attracted to a web portal where they perform browsing, navigating and clicking of links. This becomes a challenge to incorporate all the feeds in real-time. Also personalized systems offers a highly attractive content to the user divided into different groups, it becomes difficult to maintain different user segments and needs accurate understanding of the user actions.

An online learning framework, parallel-serving-buckets, is introduced which to model the user actions for a better recommendation system [1]. It is a dedicated model working on click-through-rate (CTR) for each content item. It uses divide and conquer strategy to identify the users' group.

The key factors taken into account for content optimization using recommendation models are:

- Introduction of an online learning framework for content recommendation in real time
- To build a behaviour-driven user segmentation which gives higher engagement of the user actions

Couple of previous studies describe the solution for content optimization using historic user behaviour. Adaptive personalization systems have been introduced by Billsus and Pazani [6]. YouNews [7] is an adaptive news website which customizes according to the user's interest. Some of the researchers also discussed on behaviour models based on controlled user studies [8][9].

II. Online Learning Framework for Content Recommendation

Recommendation models refer to optimizing the content presented to the user on web portal. Optimized contents can be measured over a metric (CTR). Manually working, we can rank the links, web pages and ten recommend top rank pages to the users but this requires high human efforts. Therefore, a recommender system can be designed to achieve optimized content automatically. It has three critical characteristics:

- Online Learning: Attracting a large number of users to the system and analysing their clicks and views and update the recommendation models
- Per-Item model: Dedicated model is assigned to each user's content so as to present the top ranked ones estimated by CTR.
- Personalization: Divide and conquer strategy to customize the contents where users are divided into different groups and their contents are made common relevant to the same group users.

Characteristics Overview

Online learning uses a random learning bucket for exploration purposes. For a given time interval, the clicks and views are updated in the bucket at the end. The updated model is applied to the item in the serving bucket by ranking sources for the next time interval. Random learning bucket is used to estimate CTR for each item based on user's feedback [1]. In per-item model, estimated most popular (EMP) is used [1]. A brief idea about EMP can be found in [10].

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User Segmentation

User Segmentation-based approach is followed in personalizing a web system using online content optimization. Segments of users are created where each segment will serve a dedicated recommendation model. Priori Segmentation [11] is used to form homogenous groups of users. User segmentation provides with simplicity and reliability for real-world recommender systems.

Challenges

The equations are an exception to the prescribed specifications of this template. There are certain challenges in the online learning approach based on user segmentation. Some of them are critical which are stated as below:

- Dividing users into different groups/segments [1]
- Utilization of the feedbacks and user action interpretation into each user group [1]

III. User Action Interpretation

Action interpretation can be done using user segmentation which uses historical click information. More accurate interpretation of user's action can improve online learning made through clicks and views [1]. Users can be categorized based on their features namely explicit and implicit. The most straightforward approach is to group the users based on their explicit static features but this ignores the implicit feature which better reflects user interests. There are different clustering techniques, one of them is given below

Segmentation by Demographic Information

It has been observed that people of same age group and gender tend to search for the similar kind of information. Age, gender, location are some of the demographic features which can be seen in the following table.

Table 1 User Segmentation based on demographic features

Segment No.	**Demographic Features**		
	Age	**Gender**	**Location**
1	10-20	Male	Mumbai
2	20-30	Male	Mumbai
3	10-20	Female	Mumbai
4	20-30	Female	Mumbai
5	10-20	Male	Pune
6	20-30	Male	Pune
7	10-20	Female	Pune
8	20-30	Female	Pune

IV. Conclusion

Personalized and adaptive web system can be developed using content recommendation system with online learning framework. Personalized system focuses on optimizing the content according to the user's click history and views. Click through rate gives the efficient way to learn the visited links for a candidate. User segmentation plays a key role in grouping the users under an interest.

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