Context-Aware Recommender Systems: A Review of the Structure Research

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Abstract

Recommender systems are a branch of retrieval systems and information matching, which through identifying the interests and requires of the user, help the users achieve the desired information or service through a massive selection of choices. In recent years, the recommender systems apply describing information in the terms of the user, such as location, time, and task, in order to produce relevant and even customized recommendations. Recently, some companies began to utilize the context information in their search engines. For instance, when choosing a song for the customer, it attempts to include the current mood of the listener in the context of the suggestions that the user makes. Employing context information, in view of the system's access and ability to collect information from the user interface, it offers more precise and user-friendly content that, in addition to obtaining user satisfaction, will also lead to the development and promotion of the field of work and the concept known as context-aware recommender system. In particular, this paper explores the dimensions of research, work areas, architectures, and tools employed and the ability to create a structure that researchers have based on in this area.

Keywords: Recommender Systems, Context-Aware, Review

1. Introduction

From the beginning, data on web services has been increasingly escalating on sites, which has made information retrieval an important issue, and a concept called the recommender system. The system recommender is a system that offers the user favorite item. It's natural for user to talk about each item when choosing an item and suggest it to one item if they are satisfied.

A recommender system is, in fact, a strong mechanism for performing information refinement. Generally, these systems have become a popular technique for pruning large spaces that give users access to the best items they need. This technique is an integral part of commercial sites such as amazon, yahoo, and etc. [1].

Recommender systems can be divided into a common set of traditional and modern methods of recommender. Traditional or two-dimensional recommender systems exert these systems from a set of rankings, which are either explicitly obtained from the user or the system extracts them implicitly or inferred to calculate the ranking function R of two entities, the user's name and item object are used. The traditional referral systems are generally classified according to the following three techniques [2]:

In our opinion, content-centered filtering, in this method, first, the items that the user has given them an acceptable score is obtained. Then, in the list of all items, we look for samples that are similar to the user-rated points of view, and we recommend the most similar items to the user among them.

- Collaborative filtering. In this list of proposed items, users who are similar to the active user are satisfied with those items, thus this method focuses on finding similarity between users.

- Combined recommendation methods. In this method, to obtain better results, some advisory systems combine different techniques of collaborative filtering and content filtering. Applying combined methods, we can avoid some of the limitations and problems of the pure recommender systems.
- Along with traditional recommender techniques, a term called modern advocate has been created.

In this study, we divided the warm-up recommendations into five techniques [2]:

- In knowledge-based systems, this perceptual system, which utilizes the features that it provides, offers a number of recommendations to the operating system. That is, materials for the production of advice is the knowledge that the system has about the customer and the goods. In knowledge-based systems, knowledge can be applied in a variety of ways, like conventional algorithms in genetics, fuzzy, neural networks, etc., CBR or argumentation is the core of common knowledge analysis techniques Most of the issues that apply to users or items in the hierarchy of recommended systems. A set of labels and key words that the system has no idea of their meaning and these key words may be similar. Recommender systems with this refined technique implies on the systems that they employ according to a knowledge base, usually defined as a concept Figure.
- In domain-driven systems, the similarity between users is calculated by domain-dependent, and the local neighbors of each user are constructed with respect to domains. Thus, the values for the similarities are calculated and the nearest neighbor is sent to calculate the final similarity.
- Beta-based systems are peer-to-peer, non-centralized. Each node can connect itself to a group of other groups with similar interests and take recommendations from users of that group. Recommendations can be based on the history of each year. Decreasing the hot recommendations can solve the problem of scalability.
- Recommender systems based on the meta-language approach suggest an item to the user to provide descriptions in a language other than the language of the user. The meta-language advocate systems block the language and provide opportunities to search for sections, information, paper, or books in other languages.
- Context-aware recommender systems provide information about the user's environment. One can mention the spatial and temporal position that the system takes into account and offers in the process of proposing them. The text information is constantly changing and needs to be constantly updated. Today, this branch has received a lot of attention because it has significantly increased the quality of the predictions.

2. Context-aware recommender system

Recommender systems are aware of systems that try to function in accordance with their own personal preferences, user behaviors that are relevant to the context in which they are used. In this way, they offer any application that suits their personal preferences in recent years, recommendatory systems have used descriptions of the status and location of users, such as location, time, work, etc., for more relevant and personalized advice. From Dey's and Abowd's view, "any information that can used to identify an entity is known as the "Recommended Thinking System": identity, location, time, and activity. There are two levels of the definition, which include the primary and secondary fields. [3]

Primary context information			
Activity	Time	Location	Identity

Secondary context information			
User mood	------------	Friends list	Address

Figure 1) Levels of context information

Context information can be achieved in three ways:

- Explicitly, through referring directly to the user or source who has the field information and receive precise information, by asking questions or using other methods.
- Implicitly, using information or the environment, such as a change in user location that is received from a shared mobile operator. Time field information can also be obtained from tags when the transaction is created.
- Deducing the field, using statistical methods and extraction of information. For example, the age profile of an individual who uses a video site and has an account. It may not be explicitly stated for the system, but it can be reasonably gauged by looking at the videos seen with the user from his age.

On the other hand, the field-aware advisory systems, depending on the interference of the field information in the different sections of the recommended system are as shown in the following figure, to the following three cases [3]:

1) Before filtering context, in this case, context information is the main information provider of the system; i.e., the information field interferes with the collection of information, and after the collection of information, which is also included in the field information.

2) After filtering the context, in this case, the context information is ignored at the start of the process, and a set of rankings is generated exerting the next

recommendation system of all data. Then, the output of this section is affected by the context information for each user, and the output is obtained for each user.

Context-to-context modeling applies the preprocessing procedure itself. The Bottom and Ricky methods describe the pre-filter method as "initially, we will examine the items for a text property," which means looking for a feature that significantly changes the score of the items. In addition to, each such item, we generate two hypothetical items that indicate with their textual properties. Therefore, the main idea of the algorithm is to find a textual feature for item classification.
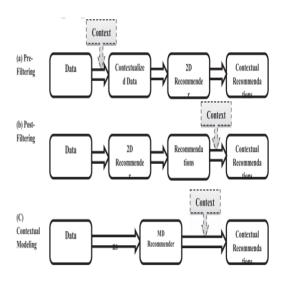

Figure 2) How to interfere with context information in the proposed process in the traditional recommender system

3. Research Methodology

In order to analyze the research done in the field of " context-aware recommender system," we reviewed the articles of the journals and usage in the four digitized libraries:

- ACM Digital library

- IEEE Explore

- ScienceDirect

- SpringerLink

However, the literature review was carefully analyzed based on keywords like "recommender systems", "context-aware", which were collected from among roughly 12349 articles studied, that, due to lack of relevance to the research process, were later eliminated and 165 articles were selected in the period between 2004 by 2017. Meanwhile, it was decided to narrow down the research by focusing the criteria for selection of articles focusing on context-aware with the recommender system. In order to investigate the articles, according to the research objectives, based on Fig. 1, the following steps to categorize base on this classification framework were applied:

presence of the two keywords "recommender system" and "context-aware" in online databases.
The first category of search in accordance with the dimension examined.
The secondary category of research in accordance with the technique recommended with the public.
Third category of research in accordance with the topic in the field of context-aware in the recommend systems.
The fourth category of research according to the method exerted in the recommender systems.
The fifth category of research in accordance with the architecture employed in the recommender systems.
Evaluation of classification results according to the intended purposes.

Regarding the issues outlined in Figure 1, the different areas of the recommender systems, the wide usage recommender technique, the subject matter of the recommender systems, the method applied in the recommended systems handled on the abstract architecture of context-aware recommended systems is drawn based on 165 selected articles. Based on relevant literature review on context-aware architecture, we present general abstract layer architecture of context-aware recommender systems.

4. Reviewing the research from the perspective of the next review

In order to better investigate the research in the field of context-aware on recommender systems, of the three perspectives for presenting combinational methods, presenting new ideas and applying existing methods in the field of applied applications have been exerted.

4.1. Recent research on applied applications

The overall objective of our research was a study on the design of a recommender system for a well-informed tourist destination. In other words, the purpose of this research was to design and implement a well-known field recommender system. The system consists of sections such as databases, model management, data management and user interfaces, which the user exerts to transfer their conditions through the user interface to the system, and the system the model and according to the user's conditions among the items in the database, which offers the most suitable option. The results show that the standards and parameters of residences are expanded to the extent possible to distinguish between residential locations more than before [4], in a research entitled "Knowledge Based, Mobile Awareness recommender System for Movie Presentation." In this research, a suggested system in the field of leisure and pastime, in particular the representation of the field of theater in Marca, Spain called RecomMetz, with acceptable results is considered. The propositional system is based on semantic web technology. The ontology domain was primarily developed to serve the metric semantic similarity to the concept of "packages of single items." Additionally, the location, population and time were considered as three different types of text or field information in RecomMetz. In short, it has some unique features: (1) the recommended cases are a composite structure (cinema + film + time view), (2) integration of time and crowd factors into a conscious field model, (3) execution a field-based ontology modeling; and (4) the development of a multi-platform mobile user interface intended to leverage hardware capabilities (sensors) from mobile devices. The results of the survey display that the efficiency and effectiveness of the

recommended tool in both scenarios are cold start and the other scenario without starting to cool [5]. In a study entitled "Exploring the Program of Informative Transport Network Plans," classifying applications that are aware of the field of usage in transportation networks are studied. A three-dimensional classification framework, including the environment, system, and software, provided a background of awareness. This framework can be checked with checking the transportation systems aware of the available text for each dimension, which in turn consists of some specific parameters [6].
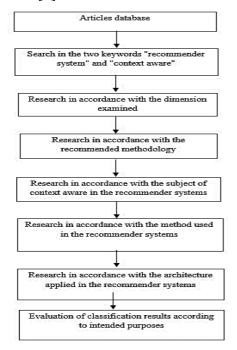

Figure 3) Pattern analysis of article on the recommender System in the field of context-awareness

4.2. Research on the implementation of combined methods

This section focuses on combined methods, which can be used to better understand the research employed in the context-aware recommender system; for instance, inclusion of a research entitled "Based on shared filtering features for the healthcare provider's recommendation system, context-aware." Given the problems that have occurred in the electronic health record due to traditional strategies, the strategies of the context-aware recommended systems are introduced a new filter strategy, focusing on the properties that are specified with the items and users

employed. The preliminary test with real users has proven that this approach is better than the case satisfying consumers is recommended. Therefore, special benefits among users are evident with concerns about the provision of specific health [7].

In a study titled "Data Correctness Tracking in Cloud Computing: A Conscious Substance and Motivational Credit Mechanism," the issue of protection from internal attacks for the advancement of data diversity has been raised in cloud computing. A new knowledge-based structure and an incentive-based credential mechanism called CCRM were called. In CCRM, innovative methods, including data categorization, field measurement technology (content), a security relationship assessment model, and a method based on incentive schemes called Vickrey-Clarke-Groves (VCG) are applied. As The next generation of promising computing patterns, Mobile Cloud Computing (MCC) enables large-scale collection and large data processing of private and personal information. However, cost analysis shows that communication is the complexity of linear CCRM computing, and simulation results indicate superior CCRM performance compared to existing credibility mechanisms under internal and external attacks [8]. In a study titled "Managing Uncertainty in Mobile Law-based Context Aware," the focus is on recommender Systems. In mobile-aware context-aware systems, often acquired data from hardware measurements (e.g. GPS), objective measurements (such as Google's APIs detectable activity activity) or directly with users. Nevertheless, interaction with the uncertainty about such data is unavoidable, and serves as a task for the provision of a modeling and process mechanism. In this research, the full approach to dealing with the types of uncertainty existing in mobile-based systems are discussed. Therefore, with considering and combining algebraic factors and possible interpretations based on a rule-based model and parametric operation of time as a comprehensive tool for modeling the action to create a conscious background in telephone systems. The results obtained from the idea show the preparation of the proposed methods

[9]. In another research, a combination of methods to improve the recommender system's in the context-aware on pay-back system has been proposed. In this structure, two methods of deep monitoring without supervision and PCA have been used to extract the hidden field from the data collected in the mobile device. The suggested methodology presented is the hybrid method which integrates both explicit and contextual features. In a study titled "Assessing the Impact of Aggressive Gaming on User's Experience from a Well-Informed Promoter or Recommended System for Android Phones," the scenario for a well-known restaurant background has been applied to Android phones. Two examples of options are designed to achieve aggressive gaming: announce an element and a notification-based solution. In addition, the mobile user interface includes an embodiment of recommendations and allows the user to provide conditions for feedback. The method was examined in a survey among users with proportional results on utility and effectiveness. Also, the results showed that users preferred the solution based on user feedback [10].

4.3. Recent researches

Overall, limited research has also been carried out on providing new ideas in well-known field context-aware recommender systems, which can used for such as similarity algorithms, often as collaborative-based filtering techniques for memory, one of the most successful methods. At this point, in recommended systems, when clear ratings are available, the similarity is usually defined using similarity functions, such as the Pearson correlation coefficient, cosine similarity, or the mean difference. These assumptions of similarity metrics are symmetric. So, two examples of users have an impact on each other in introducing new items. In a study titled, "Weight Similarity Scheme for Lifelike Scalability Based on User-Friendly Filtering," in addition to introducing new weight designs that allow us to engage with new features to find similarities between users, the authors recommend weighting schemes, transform the symmetrical similarity to asymmetric similarity with taking into account the number of votes given by users on unusual items. Attention is drawn to accruals of users' habit effects on points rated by measuring the proximity of the number of repetitions for each rate on common rating items. Nevertheless, experiments were performed on two sets of data and compared with other similarity criteria. The results showed that adding weight plans for traditional similarity measures significantly improved the results of the traditional similarity criteria [11]. In a study titled "A Creator of Artificial Data for Assessing Recommender Systems Informed Field," it has been attempting to provide a data creator for the context-aware recommender system based on the Java structure. The creator attempts to provide features such as flexible definition of user schema, user profiles, types of items, and so on. The features to analyze existing data are the basic basis for generating artificial data and automatic mapping support between item layouts and Java classes [12]. In a study titled "Providing an Intelligent Field Advisor System for Cloud Forecasting and Internet Services" through well-known background-based context-aware recommender systems, both user-side and service-side, to achieve superior service quality, are used for prediction. On the user's side, applying geographic information as a field for users, and the identification of similar neighbors for each user is based on the similarity of the underlying context. On the service side, use this information as a dependency on the service field, including company affiliation and country affiliation [13]. In a study entitled "Improving Argumentative Systems Based on Compatible Field Selection Criteria," comparative metrics are a constant component, or if they exist, which focus on multi-criteria user configurations. Consequently, reasoning recommendations becomes important. In other words, the benchmark used to make a recommendation should be part of this explanation. Our proposal introduces a greater clarity on the aspect, which, as the formula presented here, allows the user, through a conditional-priority clause, to choose comparative criteria for the important and specific benefits of the recommended process.

In this regard, in the present research, we propose a strategy for determining how to choose using the comparative argument of the most appropriate user-friendly settings on performing the conditional expression of the result [14].
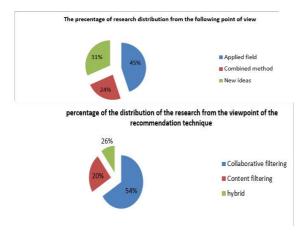
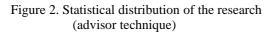## 5- A survey of the statistical distribution of the research

In order to analyze the different dimensions of research in foreign subjects, according to the initial division, a survey of the distribution on articles is performed. As mentioned, the research papers are divided into three subgroups:

Future research on applied applications
Research carried out on the implementation of combined methods.
Recent research on new ideas

Figure 2. Statistical distribution of the research (advisor technique)

The review was organized according to most research in this field which devoted to demographic aspects and user activities.
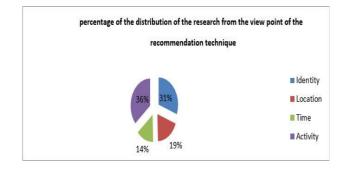

Figure 1. Statistical distribution of the research (dimensions)

The results of Figure 1 depict that most of the research done in order to apply the context-aware-based on recommender system in a particular industry. Generally, most of the research in this area focuses on the aspect of collaborative filtering, especially with regard to user activities and their demographic features.
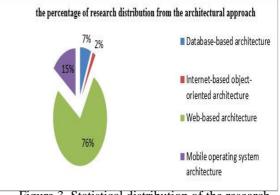

Figure 3. Statistical distribution of the research (informed background)

The review introduced the most research in this field of web-based architecture has implemented, especially in the field of applied.

Figure 4. Statistical distribution of the research (architectural viewpoint)

We briefly review the basic concepts that are useful in the study of recommender systems. As illustrated, the figure below demonstrated the distribution of articles with various tools.

The results obtained from the figure are:

As pointed on, there are 54 articles that refer to statistical methods such as ANOVA, T-test, scoring matrix, and regression only to investigate the time and domain factors affecting the application field on context-aware in the recommender system.
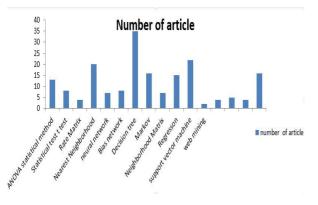
Figure 5. statistical distribution of the research
(instrument used in the research)

In general, the usage of more than 70 research projects from different data mining methods, such as decision trees, closest neighbors, clustering of association networks, especially in user activity factors, depicts to the significant of data mining techniques in the field of context-aware recommender systems

As discussed in distribution of papers in various industries, especially the assignment of 57% of articles in mobile phone services, social networking and electronic commerce, indicates more attention to business discussion and social issues, while ease of access to transactional data and the amount of these data for better analysis of the point created.
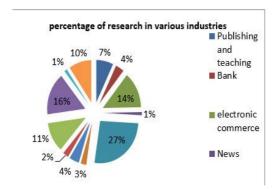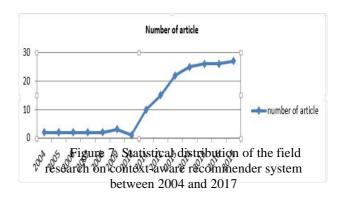

Figure 6. [1] De Pessemier, T., Dooms, S., & Martens, L. (2014). Context-aware recommendations through context and activity recognition in a mobile environment.

In this section a brief review is introduced for a better understanding of our proposal and different related works about describing to clarify the importance of this topic in recommender systems. As can be seen, the distribution of published articles in the context

of the well-known context-aware recommender system is illustrated below. Furthermore, the evidence indicates the extent of research fulfilment and the growing trend of these papers over the years from 2004 to 2017.

Figure 7. Statistical distribution of the field research on context-aware recommender system between 2004 and 2017

6. Conclusion

As mentioned in this paper, most of the research has presented on distribution of context-aware recommender systems in the fields of e-commerce, mobile services and travel. The application of participatory filtering is based on the user's demographic characteristics and properties architectures are the main aspects of the operating system. Therefore, it is concluded that most commonly employed tools are the usage of scoring matrices, learning machines, decision tree and semantic web to provide context-aware which oriented on recommender systems. As part of our work, we finally plan to perform analysis in the form of user studies, which will allow for both an evaluation of our approach's applicability as well as an analysis of the result sets from an expert user perspective.

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