HUMAN BEHAVIOR AS AN ASPECT FOR CONTEXT INFERENCE

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Abstract. Context-aware information retrieval received a significant amount of attention last years. This paper addresses some of the challenges in context acquisition. It is focused on results which we achieved with a method for context inference. Our method is based on machine learning principles. We observe behaviour of individual user and virtual communities of similar users. We work with contextual information such as location, time or weather in the domain of news recommending. We discuss the role of user behaviour and its significant impact on the actual information need, which directly influences information retrieval or recommendation process. In experiments we demonstrate the impact of inferred context on the recommendation process and its precision and recall. We sum up our effort for improving context-aware recommendation in discussions to achieved results.

1. Introduction

The availability of contextual information through mobile devices leads to spread of advanced methods for satisfying user needs such as personalized recommendation or adaptive navigation. The context is understood as a set of conditions describing the user and her state in the environment. However, complex environment surrounding the user is poorly described and contextual information is difficult to acquire in some cases. For instance, we are able to obtain location for a user whose mobile device is capable of receiving GPS signal. On the other hand, the same user might disallow the device to retrieve geolocation due to various reasons (privacy issues, battery consumption). Thus we want to solve this problem and infer the context implicitly by mining it from available data.

Our aim is based on the cognitive psychology and research [2] which observed the effort of human being to recognize emotions of another human. Humans use various contextual information to recognize the facial expression and classify it. We reproduced this observation and managed to infer the context using other contextual information. In our

method for context inference we analyse behaviour of several users and we recognize virtual communities by behavioural similarities of users. Knowing communities of similar users allows to infer the context where it is missing.

Many recommender systems use context as a source for mining the interest of users [3]. However context-aware recommender systems are often based on different technique due to poor performance [4] of purely context based recommender systems. We recognized that huge sparsity in contextual information could be one reason why are not context-based systems successful. We identified that by reducing the sparsity we should be able to increase the precision.

2.   Human behavior influenced by context

The context is typically understood as a set of conditions describing a user and her state in the environment. The context is always present when user makes decisions. For instance, context could be weather, time (and its derivations like day of week or part of day), mood, location etc. We observed the impact of the context on user behavior by simple news reading analysis. User behavior, which we reference as a set of actions is influenced by a set of conditions. By action in the news reading domain, we understand clicks. Each click has its attributes such as timestamp, target article and user identifier. Using these actions and associated contextual information we discover rules which could be applied to predict user behavior.

We work with the dataset of user actions and articles from the news portal SME.sk. We are working with real users and articles which are published every day. Every day around 250 new articles are added. These articles are read by roughly 40 thousands readers, what generates around 80 thousands clicks per day (displayed articles only).

From the user and her actions, we continue to research the group of users and their actions. Not only individual user has behavioral patterns. We know that also behavior of the masses emerges into pattern. Analyses of the news reading during a year showed that readers are influenced by the context of time.

Improvement of the behaviour prediction of SME.sk readers and users in general is one of our key contributions of this work. Behaviour of the mass or isolated group could be influenced by individuals in the group. There are always authorities or hubs in the group who are leading the behaviour of the rest of the group [6]. Our generic approach could work with any type of action taken by the user. What we do is add contextual information to every action which already contains user identifier and subject identifier.

Some actions of users correlate in the consideration of the context. This effect is very important for the context inference. Our intent is to find similar users according to their behaviour. We propose to discover the user similarity by searching the similarities using vectors of represented user actions. We propose the way of calculating similarity to support different weights of context components. Weighting the components could be useful in experimentation where we could identify different relevance of context factors [5] and reduce ineligible noise of unnecessary context factors.

Real world employment of our approach does not require weights because ineligible noise is eliminated automatically by searching for similar users and thus reducing the complexity of the data.

3. Results of experiments

We conducted this experiment as inference of visible context. Firstly, we deleted this information and in the next step we used our method to infer it. Then we compared original information with the inferred one. Observed results are shown in the Table 1. We present relative error calculated as deviance from the original data. All numeric and nominal attributes are normalized using interval < 0; 1 >. We also made the calculation of precision and recall where we took predicted attributes as retrieved items and original attributes as relevant items. Matching items have to fulfil the condition of maximal allowed error.

Experiments are grouped by the superclass of the context type. We discuss the context of place (whether user is at home, at work or out). Context of time specifies when the user performed some action (relative to minute of hour, hour of day, day of week etc.). Geo-location consists of city, country and GPS coordinates. Context of content (category and section of news classification system for SME.sk (around 400 categories)). This experiment shows that our method is more successful in the inference of specific context types (see Table 1). However, this could be applied only in our case of news reading where the content and geo-location have higher impact on the user interest and behaviour. Do not add any page numbering to your paper other than the one predefined in this template as the final numbering will be provided by proceedings editor. Similarly, avoid the use of references using page numbers.

Table 1. Results of the context inference.

context	Relative error	recall	Precision	f-measure
Place	0.118	31%	57%	40%
Time	0.096	40%	73%	51%
geolocation	0.082	50%	96%	66%
Content	0.031	58%	94%	72%

Secondly we incorporated our context inference into process of recommendation. In our specific case we worked only with the prediction model (see Table 2).

Table 2. Results of the behavior prediction.

Contextual information	recall	precision	f-measure
Original	41%	64%	50%
Enriched	50%	79%	61%

4. Discussion and conclusions

In this paper we proposed the method for context inference which is based on the effect of correlation in user behaviour. Our method helps to semantically enrich data and fills the gap which is caused by unavailability of certain context for certain users. We showed that by context inference we enriched the process of recommendation. Secondly, we showed that we are capable of inferring contextual information correctly by using fabricated inference of original context components. Finally, we showed that using inferred context positively influences the results of user behaviour prediction. Predicting behaviour considerably improves information retrieval or recommendation since behaviour has profound ef-

fects on the information need. Our approach combines more techniques available in data mining to infer context which is not directly available for users. We decided not to use standard association rules mining because it seriously hinders by discretized values.

We work with continuous values instead of nominal or discretized. We showed how this approach is designed and what is the precision in the domain of news. In the future work we plan to integrate our method for contextual information inference into the existing recommender system [7] to research the impact on the quality of recommender system. We also plan to demonstrate our method in utilization for different domains where we are able to work with different context types and prove its generic nature. We also want to move start working with other user attributes which could be understood as context. We want to use age, gender or other demographic attributes and infer these attributes if necessary.

References

to other papers publishing the results that are summarized here

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