Multilingual vs. Monolingual User Models for Personalized Multilingual Information Retrieval

M. Rami Ghorab, Séamus Lawless, Alexander O'Connor, Dong Zhou, and Vincent Wade

Centre for Next Generation Localisation, Knowledge & Data Engineering Group, School of Computer Science & Statistics, Trinity College Dublin, Ireland
{ghorabm,seamus.lawless,alex.oconnor,vincent.wade}@css.tcd.ie, dongzhou1979@hotmail.com

Abstract. This paper demonstrates that a user of multilingual search has different interests depending on the language used, and that the user model should reflect this. To demonstrate this phenomenon, the paper proposes and evaluates a set of result re-ranking algorithms based on various user model representations.

Keywords: User Modeling, Personalization, Multilingual Web Search.

1 Introduction

Today's Web is becoming increasingly multilingual, and users are increasingly faced with the challenge of finding documents which resolve their information needs in collections of different languages. Multilingual Information Retrieval (MIR) has been well studied [1], but many unexplored questions remain about modeling users interests for Personalized MIR (PMIR). User modeling for personalized search has been studied, but only on a monolingual level [2]. Taking multilinguality into consideration should change the way user information is modeled to improve PMIR.

This research argues that users' search behavior is influenced by language; this depends on the combination of their language capabilities, and the availability of content in various languages. For example, a user may use a certain language when searching for certain types of content (e.g. native language to search for news), yet use another language when searching for other types (e.g. English to search for technical content). Furthermore, a user may click on results of certain languages depending on the type of information sought. This behavior suggests that a user may have multiple personas (facets) in Web search. In support of this argument, this paper proposes and compares multilingual vs. monolingual approaches to adapt search results in PMIR. This involves evaluating a set of result re-ranking algorithms combined with various representations of the user's interests in both multilingual and monolingual form. The evaluation showed that maintaining user models that account for multilinguality, can achieve significant improvements in retrieval effectiveness.

S. Carberry et al. (Eds.): UMAP 2013, LNCS 7899, pp. 356–358, 2013.

2 Proposed Multilingual vs. Monolingual Approaches

In the experiments reported in this paper, three methods were used to maintain the terms (keywords) which represent the user's search interests:

1. *Multilingual User Model:* the model consists of multiple language groups, where each group holds clusters of interest terms that correspond to a language.
2. *Single-Language Fragment of Multilingual User Model:* this model comprises only one selected language group from the previous model (a pivot/preferred language that is specified by the user). The purpose of this is to indirectly examine whether there is a redundancy between the interests maintained in different languages.
3. *Monolingual User Model:* all interest terms from all the groups are translated to the user's preferred language and maintained together in one group.

In MIR, result lists are retrieved from multiple languages and then merged into a single list. The baseline system in this paper merged the lists using round robin. In order to evaluate and compare the contribution of the abovementioned user models to PMIR, they were used as the basis for the following re-ranking algorithms:

1. *Separate re-ranking based on multilingual user model:* each result list was separately re-ranked in its original language against the interests of the corresponding language group in the user model; the lists were then merged using round robin.
2. *Re-ranking based on similarity score with multilingual user model:* each result was given a score based on its textual similarity (cosine similarity) with the interest terms of the corresponding language group in the user model. All the results from all the lists were then put together and sorted based on their similarity score.
3. *Re-ranking based on similarity score with a single fragment of the user model:* all the results from all the lists were put together and translated to the user's preferred language, and then they were given scores based on their similarity with only the interest terms of the preferred-language-fragment of the multilingual user model.
4. *Re-ranking based on similarity score with the monolingual user model:* all the results from all the lists were put together and translated to the user's preferred language, and then they were given scores based on their similarity with the interest terms of the combined monolingual user model.

3 Evaluation

The experiment involved the participation of 26 users of different linguistic backgrounds and language capabilities. The multilingual Web search system provided results from 3 languages: English, French, and German. The experiment comprised 2 phases. In the first phase, each user was asked to choose a search topic (task). When a query was submitted, the baseline system returned a merged result list containing 30 results obtained from the 3 languages. The system logged user interactions. In the second phase, the last submitted query by the user was reserved for testing. The remaining queries, along with their associated clicked results, were used to construct the user models. Each test query was then automatically submitted to the search system multiple times so that a result list is generated for each of the aforementioned algorithms. Each user was presented with the last query they submitted in the task in

the first phase along with the pool of generated results, and was asked to judge the relevance of each result on a 4-point scale. A total of 540 results were judged, corresponding to 18 test queries (in multiple languages). The precision of the result lists was evaluated using Normalized Discounted Cumulative Gain (NDCG). Table 1 reports the mean improvement percentages over the baseline, computed at different list positions (improvements highlighted in **bold are statistically significant** using T-test with p=0.05). The results show that the second algorithm achieved the highest improvements (up to 38%). Furthermore, the results show that the first and second algorithms, which were based on the multilingual user model representation, outperformed their monolingual; this supports the main argument presented in this paper. Although it may seem intuitive that an approach that handles all the user's interests together should be more representative of the user, the results suggest that this is not the case; this is perhaps due to translation in-accuracies introduced when combining the interest terms into a monolingual model. Based on the T-test, the results show that the third and fourth algorithms did not consistently achieve improvements. Finally, the difference between the results of the second and third algorithms suggests that the different fragments of the multilingual user model do not hold redundant information.

Table 1. Mean NDCG improvements at various ranks

List Position	1.Multi-UM: Separate Re-ranking	2.Multi-UM: Re-ranking on sim.	3.Single-Frag.-UM: Re-ranking on sim.	4.Mono-UM: Re-ranking on sim.
NDCG@3	**26.38%**	**38.41%**	33.7%	**28.36%**
NDCG@5	**22.8%**	**32.14%**	21.1%	17.91%
NDCG@7	**17.82%**	**28.6%**	15.36%	15.74%
NDCG@10	**13.42%**	**18.9%**	12.29%	13.18%

4 Conclusion

This paper has shown that users have language-dependent search interests in MIR and that user models should reflect this. To verify this, a set of re-ranking algorithms were evaluated based on various user model representations. The results support the argument that systems should maintain multilingual user models. The results also suggest that even if a user only speaks one language, a multilingual search system may exhibit different interests for them in different languages, based on browsed documents.

Acknowledgements. This research is supported by the Science Foundation Ireland (grant 07/CE/I1142) as part of the Centre for Next Generation Localisation (www.cngl.ie) at Trinity College, Dublin.

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