Proactive information retrieval by monitoring eye movements

Samuel Kaski
Laboratory of Computer and Information Science
Helsinki University of Technology
P.O. Box 5400, FI-02015 TKK, Finland
E-mail: samuel.kaski@hut.fi

Abstract. A long term goal in user modeling for improving human-computer interaction is to understand the user's intent based on her monitored actions. We are developing an information retrieval system where the task is to predict relevance for new documents, given judgments on old ones. By monitoring the user's eye movements and inferring implicit feedback from them we reduce the amount of tedious ranking of retrieved documents, called relevance feedback in standard information retrieval. Relevance is inferred with machine learning methods, trained on eye movement patterns measured in settings where relevance is known. Noise in the predictions is compensated for by fusing the eye movements with other information about the user's preferences. The goal is to make the information retrieval system proactive, that is, capable of anticipating the user's interests.

For more information see `http://www.cis.hut.fi/projects/mi/prima`

Project PRIMA. We started the work by feasibility studies aimed at finding whether relevance can be predicted to any extent based on eye movements. We measured eye movement data in controlled settings where relevance was known, and used machine learning models to learn predictors from the resulting database. If they are capable of predicting better than naive models, there is information about relevance in the eye movement signals.

An exploratory study [3] already showed that this is the case, and later [5] we developed discriminative Hidden Markov Models for this task. As a side-branch of this work, we studied discriminative generative models [6] further, and developed new Expectation Maximization-type algorithms for optimizing discriminative models [4].

It turned out, however, that although eye movements carry information about relevance, they are very noisy. Prediction based on them may not be accurate enough for practical purposes, and we started to investigate how much could be gained by combining eye movement information with other available knowledge. One well-studied source is collaborative filtering, that is, generalization of relevance over similar-minded users. We developed a new two-way probabilistic grouping model [8] to generalize over both users and documents to predict relevance. Finally the two predictions, based on collaborative filtering and eye movements, were combined by a probablistic Diriclet mixture model. The results were better that with either method alone [2].

The very promising results are expected to still improve when text content-based predictions are combined into the model. Simple document models are not sufficient for this task [7], however, because there typically is only little data about relevance for any given user available. New methods are needed here.

Finally, our research consortium has studied what kind of proactivity would be useful in information retrieval [1]. When predictions produced by the models discussed above are plugged into such a system, the hope is to have proactive information retrieval systems that learn from observing the user, instead of always having to be led by hand as current information retrieval systems.

Acknowledgements. The project is funded by the Academy of Finland, decision number 122209, and by the IST Programme of the European Community, under the PASCAL Network of Excellence, IST-2002-506778. This publication only reflects the author's views. The author would like to thank all other people in the PRIMA project and acknowledge that access rights to the data sets and other materials produced in the PRIMA project are restricted due to other commitments.

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