Chapter 7
Context-Aware Recommender Systems

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Abstract  The importance of contextual information has been recognized by researchers and practitioners in many disciplines, including e-commerce personalization, information retrieval, ubiquitous and mobile computing, data mining, marketing, and management. While a substantial amount of research has already been performed in the area of recommender systems, most existing approaches focus on recommending the most relevant items to users without taking into account any additional contextual information, such as time, location, or the company of other people (e.g., for watching movies or dining out). In this chapter we argue that relevant contextual information does matter in recommender systems and that it is important to take this information into account when providing recommendations. We discuss the general notion of context and how it can be modeled in recommender systems. Furthermore, we introduce three different algorithmic paradigms – contextual pre-filtering, post-filtering, and modeling – for incorporating contextual information into the recommendation process, discuss the possibilities of combining several context-aware recommendation techniques into a single unifying approach, and provide a case study of one such combined approach. Finally, we present additional capabilities for context-aware recommenders and discuss important and promising directions for future research.
7.1 Introduction and Motivation

The majority of existing approaches to recommender systems focus on recommending the most relevant items to individual users and do not take into consideration any contextual information, such as time, place and the company of other people (e.g., for watching movies or dining out). In other words, traditionally recommender systems deal with applications having only two types of entities, users and items, and do not put them into a context when providing recommendations.

However, in many applications, such as recommending a vacation package, personalized content on a Web site, or a movie, it may not be sufficient to consider only users and items – it is also important to incorporate the contextual information into the recommendation process in order to recommend items to users under certain circumstances. For example, using the temporal context, a travel recommender system would provide a vacation recommendation in the winter that can be very different from the one in the summer. Similarly, in the case of personalized content delivery on a Web site, it is important to determine what content needs to be delivered (recommended) to a customer and when. More specifically, on weekdays a user might prefer to read world news when she logs on in the morning and the stock market report in the evening, and on weekends to read movie reviews and do shopping.

These observations are consistent with the findings in behavioral research on consumer decision making in marketing that have established that decision making, rather than being invariant, is contingent on the context of decision making. Therefore, accurate prediction of consumer preferences undoubtedly depends upon the degree to which the recommender system has incorporated the relevant contextual information into a recommendation method.

More recently, companies started incorporating some contextual information into their recommendation engines. For example, when selecting a song for the customer, Sourcetone interactive radio (www.sourcetone.com) takes into the consideration the current mood of the listener (the context) that she specified. In case of music recommenders, some of the contextual information, such as listener’s mood, may matter for providing better recommendations. However, it is still not clear if context matters for a broad range of other recommendation applications.

In this chapter we discuss the topic of context-aware recommender systems (CARS), address this and several other related questions, and demonstrate that, depending on the application domain and the available data, at least certain contextual information can be useful for providing better recommendations. We also propose three major approaches in which the contextual information can be incorporated into recommender systems, individually examine these three approaches, and also discuss how these three separate methods can be combined into one unified approach. Finally, the inclusion of the contextual information into the recommendation process presents opportunities for richer and more diverse interactions between the end-users and recommender systems. Therefore, in this chapter we also discuss novel flexible interaction capabilities in the form of the recommendation query language for context-aware recommender systems.