# Chapter 5

# Context–Aware Recommender Systems in Vehicular Networks and Other Mobile Domains

**Wolfgang Woerndl**
*Technische Universitaet Muenchen, Germany*

**Michele Brocco**
*Technische Universitaet Muenchen, Germany*

**Robert Eigner**
*Technische Universitaet Muenchen, Germany*

## ABSTRACT

*We give an overview of ideas for integrating context in recommender systems in general and specifically in various mobile application domains. Our main case study is an approach for vehicular ad-hoc networks (VANETs). The system recommends gas stations based on driver preferences, ratings of other users and context information such as the current location and fuel level of a car. We explain the main design issues behind our recommender. Our approach first filters items based on preferences and context, and then takes ratings of other users and additional information into account, which can be relayed from car to car in a VANET. We also outline other mobile scenarios for contextualized recommender systems: a system for recommending mobile applications based on user context, an approach to find relevant resources in mobile semantic personal information management, and a decentralized recommender system for personal digital assistants (PDAs) that has been successfully applied in a real world mobile city guide.*

## 1. INTRODUCTION

The ever-growing networking of devices and services lead to an increasing availability of

information not only in desktop computing settings, but also in pervasive domains. The sheer volume of available data makes it more and more difficult for users in general to find and access relevant information. Personalization of content is a technique to reduce the omnipresent

information overload by customizing information according to user needs and preferences. Often, recommender systems using collaborative or content-based filtering are applied. Another promising and possibly complementary approach is to utilize context. This is especially true in mobile settings. For example, a user travelling in a car needs access to the current traffic situation on her route, the weather report at her destination or a recommendation for restaurants, gas stations or other points-of-interests (POIs) in her vicinity. So, the main characteristic of the mobile application domain is the availability of context information and it is evident to exploit this information for user assistance. This applies to car-to-car networking, for example, where recent efforts make it possible to detect and exchange warnings about hazardous road conditions among other pieces of information. These vehicular ad-hoc networks (VANETs) can also serve as an infrastructure for driver information systems. Thus, input data for context-aware recommender systems can be obtained by exchanging data over the network with other cars or access points and can be used to tailor the recommendations.

As the integration of context into recommender systems has not been investigated thoroughly up to now (Anand & Mobasher, 2005), it is the overall goal of this work is to investigate context-awareness in personalization and recommender systems in mobile scenarios. Its use is illustrated by presenting a context-aware gas station recommender in VANETs and other mobile and context-aware recommender systems. The rest of this article is organized as follows. First, we give some background on what context is and how it can be modeled, and introduce recommender systems in Section 2. We also discuss some general ideas to contextualize recommenders. In 3 we present our gas station recommender system for VANETs in detail. The approach uses a hybrid, multidimensional recommender system which takes contextual information in addition to user ratings and item metadata into account, most

notably the current fuel level. In Section 4, we outline some other mobile application scenarios for context-aware recommender systems we are currently working on. Finally, we conclude with a short summary and outlook.

## 2. INTEGRATING CONTEXT INTO RECOMMENDER SYSTEMS

In this section we provide some background on context and recommender systems, present some ideas to integrate context into recommender systems and outline selected related work.

### 2.1 Context: Definition and Model

Recommender and personalization systems are often not tailored towards the context of users, i.e. they return the same results regardless of the current situation of the user. One of the reasons is that it is first of all hard to arrive at a consensus of what defines context and how to model it (Anand & Mobasher, 2005). In our work we follow the context definition by Dey, Salber & Abowd (2001): Context is "any information that can be used to characterize the situation of entities (i.e. whether a person, place or subject) that are considered relevant to the interaction between a user and an application, including the user and the application themselves" (p. 11). This means, context is very dynamic and transient. For example in our mobile domain, a context model could include location, movement, lighting condition or current availability of network bandwidth of mobile devices. Which context attributes are actually modeled and used in systems is largely dependent on the requirements of the application domains. In comparison to (user) context, a user model (or user profile) that is used in most personalization systems is rather static and somewhat longer lasting and includes demographic data or user preferences or interests, for example.

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