Chapter 6

Learning Adaptive Behaviour

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Abstract

This chapter demonstrates the use of machine learning techniques in adaptive hypermedia systems. A generic machine learning scenario is described and related to an abstract definition of interactive software systems and adaptive hypermedia systems. In the main part of the chapter, numerous recent systems and employed techniques are described. The most important learning methods are introduced by examples, and their applicability in adaptive hypermedia is discussed. The chapter concludes with a comparison of all approaches one might consider when applying machine learning in adaptive hypermedia systems.

Introduction

With growing data, and number and diversity of users, complexity of human computer interaction still increases. Accordingly, modern (software) systems should adapt to the user: instead of being adaptable by the user (customisation already requires the user to have sufficient domain knowledge), adaptive systems adapt themselves to the unacquainted or inexperienced user. This can be explained by simple everyday examples:

- *Experts and expert systems:* Help text is verbalised using a vocabulary and a level of detail that corresponds to the user's knowledge of the domain. A human expert — like a physician — is adaptive: a physician will recognise a patient's interest and knowledge during a dialog, and choose his terminology accordingly by giving full particulars only to the interested. Recent adaptive systems for information retrieval (IR), adaptive help systems, or adaptive expert and presentation systems in information space include a user-centred tailoring process.

- *Teachers and educational systems:* Early tutoring systems or educational systems offered the same course contents using the same presentation and didactic method to all students. If a teacher observes that a certain degree of abstractness will overstrain a student's learning capacity, the teacher adapts his didactic method, and starts with an illustrative example and restrains from referring to confusing details. Recent adaptive educational hypermedia systems account for user preferences, skills, and interests to enhance knowledge acquisition in a personalised computer-supported teaching environment.

Accordingly, one would like to make intelligent hypermedia systems behave proactively and adaptively which requires the system to learn about the user.

Learning and Adapting

To behave adaptively, one needs to be able to recognise a user's needs or preferences and then change an internal model of the user. This section introduces the general machine learning problem and relates it to the problem of learning adaptive behaviour, especially in the context of adaptive hypermedia.

Machine Learning

Machine learning has been defined in many different ways, all of which can closely be related to several aspects of adaptive systems. To begin, machine learning shall enable a system to solve a certain (or a similar) problem better the next time. In this context, an adaptive hypermedia system should give increasingly better recommendations with respect to a user's needs. A machine learning algorithm incrementally improves by learning from experience. Again, in the context of adaptive systems, an intelligent system shall observe the user and continuously adapt itself to the user. A learning algorithm **A** induces a hypothesis h which shall approximate the target function **t** based upon m examples in a sample **s**. Each observation x is labelled by a teacher signal $\mathbf{t}(x)$. The sample **s** is assumed to be the result of a random choice function S, which picks correctly labelled examples from the universe U. This can be illustrated by an abstract learning algorithm architecture as in Figure 1.

Learning may involve background knowledge Σ containing a theory of the domain and definitions of supporting concepts. The target function is approximated using a search

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