Exploiting plans, ontologies and constraints in a matchmaker model

Ọdẹ́túnjí. A. Ọdẹ́jọbí and Richard J. Wallace
Cork Constraint Computation Centre
University College Cork
Cork, Ireland

Abstract

This paper describes ongoing research on integrating planning, constraint-based modelling and product ontology in the development of a matchmaker system. Planning is used to model the Human Computer Interaction (HCI) to support customer-system interaction.

Introduction

Our ongoing matchmaker project (Freuder and Wallace 2002) has thrown up a number of interesting research challenges. The goal of the project is to develop a system that could assist a customer in matching a product to his/her preferences. A common scenario is online shopping where a product is described using technical jargon and the customer is expected to determine the product's suitability. In the mobile phone product specification for example, technical terms such as *mega-pixel*, *anti-blur*, *roaming*, *blue tooth*, *battery life* are used to describe the product's functionally. However, customers who have little or no technical knowledge of the product will find it difficult to relate these terms to how the product will serve their specific needs. For example, a customer may be able to state that s/he wants a camera to allow him/her to take a photograph that can be expanded by twice the original size without losing quality. But s/he may not be able to relate this requirement to the concept of camera resolution described using *mega-pixels* (Wallace 2002).

There are three important challenges for user-computer interaction in this domain:

- expressing product features and attributes in a form that matches a customer's perception or conception of its preference value;
- matching the customer's intention to computer interface actions;
- giving the customer the ability to control the selection process, including undoing previous actions.

To meet these challenges, a matchmaker must be able to manage a variety of different coherent interactions between the buying (human) and selling (intelligent software) agents. The goal is to model the HCI in a way that will reduce the potential mismatch between the product's properties and customer's preference or expected preference. We hope to address these challenges by exploiting planning and scheduling, constraint modelling and product ontology techniques within a well integrated modelling framework (Mylonas et al. 2008; Fox and Long 2003).

In this work, we attempt to extend the (Freuder and Wallace 2002) model by addressing two inherent shortcomings. The first is that the model assumes that customers understand the technical terms used for describing products well enough to be able to relate these features to their preference. The second is that the model does not explicitly specify the mode of interaction. We address these shortcomings by using a design product ontology and a Human Computer Interaction (HCI) module that exploits a planning and scheduling approach. Our goal is to build on the original CSP-based model, by using it as the core reasoning component and incorporating an HCI and ontology framework to improve its decision accuracy.

System architecture

The overview of our Matchmaker system is shown in Figure 1. The GUI and HCI modules model the interaction between the seller and customer agents using a plan-based approach. The product technical details and ontology servers contain a technical description of the product domain and the taxonomy of the ontology defined over that domain, respectively. The CSP solver implements the reasoning processes in the Matchmaker. The scheduling function assigns resource to UI activity by ordering the actions at each level of product selection. The planning component decides what activity should be scheduled.

The purpose of the ontology module is: (i) to allow the system to combine combinatorial inference with user interaction using terms that the user is familiar with, (ii) to facilitate a benefits-centered, rather that a feature-centered, approach to product selection. The ontology module contains an ontology of products, and therefore includes concepts relevant to the description of the characteristics and usage of a particular set of products.

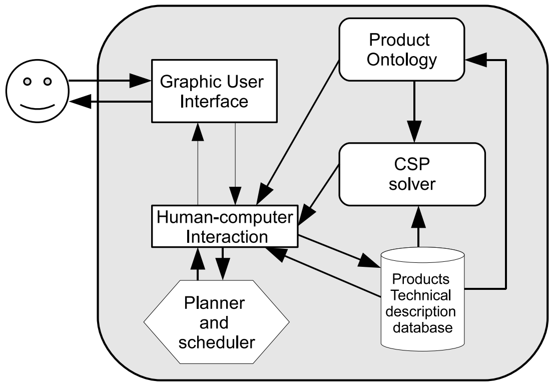

Figure 1: Overview of the Matchmaker system

Planning and scheduling module

The planning module has the dual function of guiding the current user-system interaction and organising past interactions to form a 'contrived' plan. The latter should provide a relevant context for the user based on previous selections (of activities, features, products, etc.) and support efficient retracing.

A plan is implemented as a dialog between the customer and the HCI module, and the goal of the dialogue is the selection of an article to be purchased. The domain of our problem has three active entities: (i) the customer, (ii) the HCI, (iii) the article to be purchased. As in classical planning, the task is to generate a sequence of actions which, when applied to an initial state, allows the matchmaker to reach a final state. The final state in this case is associated with the recommendation of an acceptable product to a customer and the initial state is associated with the constraints on the functionalities and features of the products. This process is guided by the ontology-based constraints.

The planning module is motivated by the need to improve on the "suggestion strategies" of the original (Freuder and Wallace 2002) model. In (Freuder and Wallace 2002), the 'engine' for the procedure was the constraint solver deducing products to select, given the constraints posted in response to user-critiques. The planner seeks to extend this approach by a more precise and extensive definition of states and goals. It also provides a facility for backtracking through the event history component.

A plan P in this context is defined by the three-tuple: $P =< A, I, G >$, where A is a set of actions, and I a set of feature values that establishes an ordering over A, given an initial state. G is a set of goals that can be viewed as a set of non-committing link of actions over the problem space. This ensures that different UI actions introduced for different subgoals will not interfere with each other. The plan can be decomposed into sub-plans that achieve the individual component goals, g, of the task being modelled. The plan database consists of several loosely coupled sub-plans. Each sub-plan is expected to achieve a well defined task, that is, elicit a preference corresponding to a technical feature of a product. The overall plan is then combined to form a solution to the problem by aggregating the computed preference and executing a function, $R(F)$, which maximises some predefined conditions. A method by which sub-plans can be combined to form a complete plan is provided in (Coles et al. 2007).

The planning module is designed as an hierarchical planner and follows a top-down procedure. The general plan is first obtained and then refined, iteratively, until a more specific plan is generated. This approach is adopted because its structure is similar to the ontology we are developing. The planner module, therefore, contains a sequence of actions where every action models a query-response pair corresponding to a feature-preference space. The domain for the plan is expected to be extracted from the ontology.

In the scheduling aspect, interval variables are used to model tasks, logical variables models mutual dependence and product domain ontology are modelled by product classification. We hope to use soft constraint for defining these domains as this will make it possible to relax a constraint if no feasible schedule can be generated. When constraints change during scheduling and/or execution of all or part of the matchmaking process, the respective matchmaking process will be rescheduled. In this case, scheduling is treated as a sequence of constraint satisfaction problems, and commitments are transferred from one problem to the next.

Looking Forward

The present matchmaker system exploits ontology, planning and scheduling within a constraint-based framework. Important issues currently being addressed include real-time updating of constraints and its integration into the HCI plan and ontology for the matchmaker system.

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