Robin Cohen, Bob Kass,
Cécile Paris, Wolfgang Wahlster (editors):

Third International Workshop on User Modeling (UM'92)

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UM92

Third International Workshop on User Modeling

organized by:

Robin Cohen (Waterloo, Canada)
Bob Kass (Ann Arbor, USA)
Cécile Paris (Marina del Rey, USA)
Wolfgang Wahlster (Saarbrücken, Germany)

Sunday, August 9 – Thursday, August 13, 1992

Preface

The International Workshop on User Modeling series is the main international gathering for researchers in the field of User Modeling, and the principal forum for the presentation of research by this community. This report comprises the abstracts of the papers selected for presentation at the *Third International Workshop on User Modeling (UM92)* that was held from August 9 to August 13, 1992 at the International Conference and Research Center for Computer Science (IBFI) at Schloß Dagstuhl, Germany.

Following on from the two previous International Workshops on User Modeling that took place in Maria Laach, Germany (1986) and in Honolulu, Hawaii (1990), UM92 brought together forty active researchers in the area of User Modeling, drawing researchers from several disciplines, such as Artificial Intelligence, Linguistics, Psychology, Education and Intelligent Tutoring Systems, Computer-Human Interaction and Interface Design. The workshop focused on new and recent developments, with emphasis on the following topics:

- Formal Representations of User Models (Belief Modeling)
- Psychological Foundations and Cognitive Modeling
- Empirical Studies
- User Interfaces and Natural Language Generation
- Plan Recognition
- Student Modeling

The workshop was organized to allow for:

- Paper presentations, organized into sessions chaired by a commentator who directed general discussion at the end of each session;
- Panel discussions; and
- Parallel discussion groups on specific sub-topics, with all participants from the parallel groups later joined together for sharing of new insights.

60 researchers were invited to submit papers for the workshop. From these researchers 31 papers were received and reviewed by an international program committee of leading researchers in the field that was chaired by Robin Cohen, Bob Kass and Cécile Paris. We would like to thank the additional reviewers:

Douglas Appelt, Susan Brennan, Beatrice Cahour, Gerhard Fischer, Brad Goodman, Jim Greer, Jürgen Krause, Diane Litman, Michael McTear, Alex Quilici, John Self, Bruce Spencer, Peter van Beek, Ursula Wolz, Ingrid Zukerman

for their help.

Local Arrangements were handled by Elisabeth André, Winfried Graf and Wolfgang Wahlster of the German Research Center for Artificial Intelligence (DFKI).

The workshop organizers decided that the best papers of the workshop would be sent for publication in the *User Modeling and User Adapted Interaction* journal after the workshop.

We would like to thank the International Conference and Research Center for Computer Science (IBFI) for the financial support and the IBFI stuff for their assistance with arranging the workshop as well as DFKI, SIGART and ACL for additional sponsoring.

September 1992

Robin Cohen
Bob Kass
Cécile Paris
Wolfgang Wahlster

Program

Sunday, August 9

Arrival and Registration from 3:00 pm

Monday, August 10

Morning

9:00-9:15 **Welcome**
Wolfgang Wahlster

9:15-10:30 **Papers: Formal Representation I**
Commentator: Wolfgang Wahlster

Frens Dols and K. van der Sloot
'Modelling Mutual Expectations in Belief-Based Interactive Systems'
Jürgen Allgayer, Hans Jürgen Ohlbach and Carola Reddig
'Modelling Agents with Logic'

10:30-11:00 **Break**

11:00-12:15 **Papers: Formal Representation II**
Commentator: Wolfgang Wahlster

Alfred Kobsa
'Towards Inferences in BGP-MS: Combining Modal Logic and Partition Hierarchies for User Modelling'
Giorgio Brajnik and Carlo Tasso
'A Flexible Tool for Developing User Modeling Applications with Nonmonotonic Reasoning Capabilities'

12:15-1:30 **Lunch**

Afternoon

1:30-3:15 **Papers: Psychological Modeling**
Commentator: Jürgen Krause

Anthony Jameson
'Generalizing the Double-Stereotype Approach: a Psychological Perspective'

Beatrice Cahour
'How Do Experts Categorize the Interlocutor during Advisory Dialogs?'

3:15-3:45 **Break**

3:45-5:30 **Empirical Studies**
Commentator: Ursula Wolz

Jack Edwards and Keith Hendy
'Development and Validation of User Models in an Air Traffic Control Simulation'
David Benyon, Judy Kay and Richard Thomas
'Building User Models of Editor Usage'

6:00 **Dinner**

Evening **Panel: Empirical Evaluation of User Models**
Chair: Alfred Kobsa

Tuesday, August 11

Morning
9:00-10:45 **Papers: User Interfaces and Natural Language Generation**
Commentator: Judy Kay

Robert Kass and Irene Stadnyk
'Using User Models to Improve Organizational Communication'
Gerhard Fischer
'Shared Knowledge in Cooperative Problem Solving Systems'
Ingrid Zukerman
'Content Planing Based on a Model of a User's Beliefs and Inferences'

10:45-11:15 **Break**

11:15-12:30 **Papers: Plan Recognition**
Commentator: Ingrid Zukerman

Robert Weida and Diane Litman
'Terminological Plan Reasoning and Recognition'
Sandra Carberry, Zunaid Kazi, and Lynn Lambert
'Modeling Discourse, Problem-Solving, and Domain-Goals Incrementally in Task-Oriented Dialogue'

12:30-2:00 **Lunch**

Afternoon
2:00-5:45 **Discussion Groups**

3:30-4:00 **Break**

Group 1:
Does Student Modeling have Different Issues from User Modeling?
Chair: Gordon McCalla

Group 2:
Does User Modeling Require Psychological Modeling?
Chair: Anthony Jameson

Group 3:
Does Interface Design Differ from User Modeling?
Chair: Brad Goodman

Group 4:
The Practicality of User Models - Ready for Real Systems or Still far Away?
Chair: Michael McTear

6:00 **Dinner**

Evening Editorial Board Meeting for UMUAI Journal, Informal Demos, Discussions, Socializing

Wednesday, August 12

Morning
9:00-12:00 **Reports from the Discussion Groups**

12:15-2:00 **Lunch**

Afternoon
2:00-6:00 **Free Time**
Sightseeing, Hiking, Informal Demos, etc.

6:00 **Special Dinner (Buffet)**

After Dinner
German-French Chanson Evening

Thursday, August 13

Morning
9:00-10:45 **Student Modeling**
Commentator: Julita Vassileva

Sandra Katz and Alan Lesgold
'Approaches to Student Modeling in the SHERLOCK Tutors'
John Self
'Are Theories of Diagnosis Applicable to Cognitive Diagnosis?'
Gordon McCalla, Jim Greer and Randy Coulman
'Enhancing the Robustness of Model-Based Recognition'

10:45-11:15 **Break**

11:15-12:15 **"Business Meeting"**
Discussion of Future User Modeling Workshops or Conferences, Feedback on UM'92, etc.

12:15-1:45 **Lunch**

Afternoon
1:45-3:15 **Panel: Acquisition of User Models**
Chair: David Chin

3:15 **"Official" End of UM92**

6:00 **Dinner**

Formal Representation

Modelling Mutual Effects in Belief-based Interactive Systems

Frens J.H. Dols and Ko van der Sloot (Tilburg)

Successful communication is based on conventions between interlocutors concerning the nature of communicative acts. Knowledge-based systems engaged in a communicative process with humans must be able to apply the conventions that govern the interaction, so that a dialogue manager may construct and maintain a common context of understanding.

A formal description of communicative conventions is presented which takes into account not only the preconditions for correct use, but also the *intended impact* of a communicative act. In addition, mutual uncertainty with respect to the recognition of an act and the contingency of its subsequent effectiveness are formally distinguished. The resulting formalization turns out to be elegant and concise for both analysis and generation of communicative acts by a belief-based system.

Modelling Agents with Logic

Jürgen Allgayer, Hans Jürgen Ohlbach, and Carola Reddig (Saarbrücken)

Our aim is to show the potential power of the combination of methods and systems from the areas Natural Language Processing (NLP) and Automated Deduction Systems (ADS). The testbed is an Agent Model, which on the one hand serves as a central knowledge source of the NLP system, and on the other hand is a collection of a number of logical methods for representation and reasoning. Hence, the Agent Model is the meeting point of NLP and ADS, which from the NLP side can be used as a component to be queried about what holds and what follows – as User Models have always been. In this paper we concentrate on the representation and *mechanization* of deduction for the intuitive notions like belief, intention, causal relations etc. which are needed for modelling intelligent agents and which are widely discussed in the philosophical logic literature.

Towards Inferences in BGP-MS: Combining Modal Logic and Partition Hierarchies for User Modeling

Alfred Kobsa (Konstanz)

The paper describes ongoing work on the enhancement of the user modeling shell system BGP-MS by general inferential capabilities. Although the current representational basis of BGP-MS falls under the "partition paradigm" (which is today predominant in the field of user modeling) modal logic was selected as the principal representation for inference rules in order to take advantage of its greater expressive power. A combination of the partition and the modal logic paradigms for belief modeling is being developed which exploits the advantages of both approaches.

A Flexible Tool for Developing User Modeling with Nonmonotonic Reasoning Capabilities

Giorgio Brajnik and Carlo Tasso (Udine)

The paper presents first a general structured framework for user modeling, which includes a set of *basic user modeling purposes* exploited by a user modeling system when providing a set of services to other components of an application based on user modeling. At a higher level of abstraction, such an application may perform a *generic user modeling task*, which results from an appropriate combination of some basic user modeling purposes.

The central aim of the paper is to present, within the framework proposed, a flexible general-purpose shell, called *UMT (User Modeling Tool)*, which supports the development of user modeling applications. UMT features a non-monotonic approach for performing the modeling activity: more specifically, it utilizes a modeling approach called *assumption-based user model* which exploits an ATMS-like mechanism for maintaining the consistency of the user modeling. The modeling task is divided into two separate activities, one devoted to user classification and user model management, and the other devoted to consistency maintenance of the model. The modeling knowledge exploited by UMT is represented by means of stereotypes and production rules. UMT is capable of identifying, at any given moment during an interaction, all the possible alternative models which adequately describe the user and are internally consistent. The choice of the most plausible one among them is then performed using an explicit preference criterion. UMT is also characterized by a very well defined and simple interface with the hosting application, and by a specialized development interface which supports the developer during the construction of specific applications. The paper includes an example application in the field of information providing systems. UMT has been developed in Common LISP.

Psychological Modeling

Generalizing the Double-Stereotype Approach: A Psychological Perspective

Anthony Jameson (Nijmegen)

It is often useful for a user modeling component to reason about the knowledge of the user in terms of (a) the user's level of *knowledgeability* about a given domain and (b) the level of *difficulty* of the knowledge items encountered in that domain. The initial realization of this approach in KNOME (Chin, 1989) can be generalized considerably using two types of input from psychological research: (a) relevant concepts from the theory of psychological testing; and (b) experimental research on how people apply similar concepts in their everyday reasoning about knowledge. The resulting conceptualization can deal in a natural way with the the high degree of uncertainty that permeates this type of reasoning in a user modeling context, as well as with the various ways in which (lack of) knowledge can manifest itself in behavior. It also makes possible a principled treatment of the complications that arise when several different knowledge dimensions are relevant to reasoning about knowledge within a single domain. This conceptualization is illustrated with examples generated by the *Ipsometer*, a program used as a standard with which to compare the results of psychological experiments.

How Do Experts Categorize the Interlocutor during Advisory Dialogs?

Beatrice Cahour (Paris)

It is useful for the research in user modeling via stereotypes to have a cognitive model of the categorization process. The objective of this paper is to describe how and when experts categorize their interlocutor during technical consultation dialogs. First we describe the types of criteria allowing the experts to evaluate the level or the type of the interlocutor. Then we develop, in a dynamic perspective, when and how the experts categorize the interlocutor during the dialog.

The results show that a stereotype is considered as a possible category by the experts by two ways of selection: through a pre-categorization, or directly from a typical feature. The analysis of the protocols allows us to describe three different processes used by the experts for the categorization:

- Rapid fixation on a stereotype;
- Step by step elimination of stereotypes;

- Progressive precision of the profile of the interlocutor.

Two points are finally stressed:

- The categorization made by the experts does not always correspond to the subject's actual type; several causes of this mismatching are described.
- The experts do not always categorize the interlocutors; for half of the dialogs, the experts only identify patterns of knowledge or items of knowledge but do not try to categorize the interlocutor with a stereotype.

Empirical Studies

Development and Validation of User Models in an Air Traffic Control Simulation

Jack L. Edwards (Toronto) and Keith Hendy (North York)

As a response to problems associated with an increasing amount of world-wide air traffic and a projected shortfall in the number of future air traffic controllers, those agencies and organizations responsible for Air Traffic Control (ATC) are turning increasingly to automation as an important solution. Current ATC systems provide only passive, reactive support to controllers but, in the future, they will have to be more "intelligent", having some ability and scope for independent decision and action. In order for such systems to make the right decisions and take the right actions, they will need to understand what the controller is doing, what they are doing and the relationships between the two. They will also need to understand how best to dialogue with the controller about what is taking place. To support this kind of functionality, explicit models of the task, controller (user), system and dialogue will be needed. Such representations will include knowledge of the problem domain, of the actions of controllers at the interface and of any high-level goals that a system is able to infer from those actions and the current state of the problem domain. Storing that knowledge, separately and explicitly, will also provide a sound basis for carrying on intelligent dialogue with the controller. The present research uses results from subjects' performance in an ATC simulation to help develop a system capable of inferring high-level goals fromlow-level, subjectPactions at the interface. The research seeks to demonstrate that accurate and reliable on-line tracking of humans' high-level goals is possible and, through its results, to foster more informed consideration of the kinds of intelligent support that such systems might provide to controllers. The methodology used a Hypercard-based, visual task analysis of the ATC simulation sessions to generate representations for the plans of twenty Ss. The task analysis was performed in a natural way, during the debriefing sessions, by the Ss' themselves and ambiguities in Ss' plans were resolved at a later time by an analyst. Hypercard stacks were created for each trial, which contained information about the current state of the problem domain as the trial proceeded, Ss' low-level interface actions and Ss' routings for all aircraft. That is, the final stack for each trial contained all the information necessary for a system to infer Ss' high-level plans. In the system development phase of the study, data from Ss' task analyses were used to build a library of plans for handling aircraft in the problem domain. The goal was to be able to use only problem-domain information and Ss' low-level interface actions to infer Ss' plans. The development environment included Smalltalk-80, the NexpertObject expert system shell and bridges between those two environments and Hypercard. The system was developed using data from the twenty Ss mentioned above and validated with data from an additional twenty Subjects.

Building User Models of Editor Usage

David Benyon (Milton Keynes), Judy Kay (Sydney), and Richard Thomas (Leeds)

The Basser Data project is a long term study of over 1000 individual users of the sam text editor. The rationale for the project is to explore both short and long-term usage of computer systems. We selected a text editor as the focus for the study because editors are important software tools widely used by a range of people for many differing purposes. Many editors, and sam in particular, have very powerful facilities such as searching for characters and strings, replace commands and links to other software.

User Interfaces and Natural Language Generation

Using User Models to Improve Organizational Communication

Robert Kass and Irene Stadnyk (Ann Arbor)

Members of large organizations suffer from a communication problem that appears in two forms. First, senders of information must determine who should see the information they are sending—a "Who do I tell?" problem. Second, information seekers must determine where to find the information they are looking for, which often becomes a "Who do I ask?" problem. This paper describes InVision, a prototype knowledge-based system designed to address this communication problem in the context of the engineering release process of large organizations. A crucial component of InVision is a user modelling component that maintains models of the knowledge and information needs of each member of the organization. Building such user models is a significant challenge. In addressing this user model acquisition problem, InVision adopts a dual approach that exploits a "computer as tool" metaphor to allow users to directly edit their user models using a specification by reformulation interface, and that exploits a "computer as agent" metaphor in which the system observes users' interactions with a database system and automatically updates their user models. Thus, this paper makes two points: (1) that a knowledge-based system can be used to facilitate communication in large organizations by maintaining models of its members' knowledge and information needs, and (2) the task of building those models is best addressed by synergistically exploiting both the *tool* and *agent* user interface metaphors.

Shared Knowledge in Cooperative Problem Solving Systems

Gerhard Fischer (Boulder)

Integrated, domain-oriented, knowledge-based design environments are examples of cooperative problem-solving systems relying on shared knowledge. Research goals pursued in the context of design environments are to support human problem-domain communication, to make information relevant to the task at hand, and to tailor information to a specific user or class of users.

The shared knowledge between a user and a system will not be static, but it will increase and change over time. There are two major ways that this can be achieved: by making systems adaptable (e.g., by supporting end-user modifiability), and adaptive (e.g., systems act differently based on a model of a specific task situation or a specific user).

We have developed prototypes of design environments that (1) demonstrate the need for shared knowledge, (2) support the incremental growth of shared knowledge, and (3) use the shared knowledge to make the interaction more user-specific and more task-oriented. Adaptable and adaptive mechanisms are used to achieve these goals.

Content Planning Based on a Model of a User's Beliefs and Inferences

Ingrid Zukerman (Clayton)

Most Natural Language Generation systems developed to date assume that a user will learn only what is explicitly stated in the discourse. This assumption leads to the generation of discourse that states explicitly all the information to be conveyed, and that does not address further inferences from the discourse. This paper describes a content planning mechanism which addresses these problems by consulting a model of the user's beliefs and inferences. These inferences are applied in backward reasoning mode to generate discourse that conveys the intended information, and in forward reasoning mode to draw further conclusions from the presented information. In addition, our mechanism minimizes the generated discourse by presenting only information the user does not know or about which s/he has misconceptions. The domain of our implementation is the explanation of concepts in high school algebra.

Plan Recognition

Terminological Plan Reasoning and Recognition

Robert Weida and Diane Litman (New York)

Terminological knowledge representation systems (e.g., KL-ONE and its descendants) are widely used in AI to represent and reason with concept descriptions. They compute subsumption relations between concepts and automatically classify concepts into a taxonomy. One limitation of current systems is their inability to handle complex compositions of concepts, such as constraint networks where each node is described by an associated concept. For example, plans are often represented (in part) as collections of actions related by a rich variety of temporal constraints. The T-REX system integrates terminological reasoning with constraint network reasoning to classify such plans, producing a "terminological" plan library. T-REX also introduces a new view of plan recognition which uses the plan library's definitional nature to dynamically partition the plan library by modalities, e.g., necessary, possible and impossible, as actions are observed.

Modeling Discourse, Problem-Solving, and Domain-Goals Incrementally In Task-Oriented Dialogue

Sandra Carberry, Zunaid Kazi, and Lynn Lambert (Newark)

A crucial component of a user model is the system's beliefs about the user's intentions. This paper presents an overview of our tripartite, plan-based model which incrementally infers the plans and goals of the participants during an ongoing expert-consultation dialogue and identifies how intentions contribute to one another. This tripartite model has three levels: the domain level (with domain goals such as traveling by train); the problem-solving level (with plan-construction goals such as instantiating a parameter in a plan); and the discourse level (with communicative goals such as expressing surprise). Our tri-partite model has a number of advantages over previous approaches, including 1) providing a better representation of user intentions than previous models, 2) allowing the nuances of different kinds of goals and processing to be captured at each level, and 3) enabling the incremental recognition of communicative goals that cannot be recognized from a single utterance alone. In addition, our model distinguishes between exploration of alternative plans and commitment to a single plan, and it accomplishes this within a general framework for incremental plan inference that both can handle bottom-up as well as top-down dialogues and can capture contingent as well as total commitment.

Student Modeling

Approaches to Student Modeling in the Sherlock Tutors

Sandra Katz and Alan Lesgold (Pittsburgh)

Student modeling the task of building dynamic models of student ability is fraught with uncertainty, caused by such factors as multiple sources of student errors, careless errors and lucky guesses, learning and forgetting. Within the context of the Sherlock intelligent tutoring systems project, we have been experimenting with various ways of making the task of modeling student knowledge more tractable. The philosophical basis underlying each approach is that student models do not need to be precise and accurate to be useful. We describe these approaches, focusing on the one we have developed furthest thus far. The approach, which is based on fuzzy set theory, aims at building imprecise, or "fuzzy" diagnostic student models (e.g., Hawkes et al., 1990). We have built upon this approach by developing techniques for representing and updating discrete student knowledge variables in our avionics troubleshooting tutor, Sherlock II. We describe these techniques and, more broadly, the student modeling component in this tutor. We frame our discussion of the "fuzzy" student modeling approach we are developing with a description of its more crude predecessor, and of our plans for future work on imprecise student modeling using Bayesian inferencing techniques.

Are Theories of Diagnosis Applicable to Cognitive Diagnosis?

John Self (Lancaster)

This paper considers the problem of cognitive diagnosis (a term often regarded as synonymous with student modelling) as an instance of general diagnosis, as studied in AI. Many issues in cognitive diagnosis, previously discussed informally, are mapped onto formal techniques, with consequent increased clarity and rigour. But it is concluded that the 'general' theories for diagnosis must be broadened to fully encompass the problems of cognitive diagnosis.

Enhancing the Robustness of Model-Based Recognition

Gordon McCalla, Jim Greer, and Randy Coulman (Saskatoon)

In this paper we describe an approach to recognition which enhances both the effectiveness and robustness of model-based recognition. Instead of being in a flat data structure, models in our approach are arrayed into granularity hierarchies. This gives a recognition system the ability to back off to coarser grain sizes when finer-grained recognition fails. Robustness is further enhanced through use of cases. Essentially, once granularity-based recognition has been carried out to recognize some user behaviour, the resulting instantiation pattern is used as the basis for a case. In future, recognition proceeds first by "running" granularity-based recognition on some new behaviour, and then comparing the resulting instantiation pattern to stored patterns in a case library of such patterns. In this paper, we discuss the recognition system, experiments with various algorithms for retrieving cases, and our use of this approach to recognition in the development of an advisor for novice LISP programmers as they learn recursion.

Dagstuhl-Seminar 9233:

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