Mohand-Said Hacid
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Foundations of Intelligent Systems

15th International Symposium, ISMIS 2005
Saratoga Springs, NY, USA, May 2005
Proceedings

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Preface

This volume contains the papers selected for presentation at the 15th International Symposium on Methodologies for Intelligent Systems, ISMIS 2005, held in Saratoga Springs, New York, 25–28 May, 2005. The symposium was organized by SUNY at Albany. It was sponsored by the Army Research Office and by several units of the University at Albany including its Division for Research, College of Arts and Sciences, Department of Computer Science, and Institute for Informatics, Logics, and Security Studies (formerly the Institute for Programming and Logics). ISMIS is a conference series that was started in 1986 in Knoxville, Tennessee. Since then it has been held in Charlotte (North Carolina), Knoxville (Tennessee), Turin (Italy), Trondheim (Norway), Warsaw (Poland), Zakopane (Poland), Lyon (France), and Maebashi City (Japan).

The Program Committee selected the following major areas for ISMIS 2005: intelligent information systems, knowledge discovery and data mining, knowledge information and integration, knowledge representation, logic for artificial intelligence, soft computing, Web intelligence, Web services, and papers dealing with applications of intelligent systems in complex/novel domains.

The contributed papers were selected from almost 200 full draft papers by the Program Committee members: Troels Andreasen, Peter Baumgartner, Boualemn Benatallah, Salima Benbernou, Veronique Benzaken, Petr Berka, Elisa Bertino, Alan Biermann, Jacques Calmet, Sandra Carberry, Juan Carlos Cubero, Luigia Carlucci Aiello, Shu-Ching Chen, Christine Collet, Agnieszka Dardzinska, Ian Davidson, Robert Demolombe, Jitender Deogun, Jon Doyle, Tapio Elomaa, Attilio Giordana, Jerzy Grzymala-Busse, Mirsad Hadzikadic, Reiner Haehnle, Janusz Kacprzyk, Vipul Kashyap, Jan Komorowski, Jacek Koronacki, Tsau Young Lin, Donato Malerba, David Maluf, Davide Martinenghi, Stan Matwin, Natasha Noy, Werner Nutt, James Peters, Jean-Marc Petit, Vijay Raghavan, Jan Rauch, Gilbert Ritschard, Erik Rosenthal, Marie-Christine Rousset, Nahid Shahmehri, Andrzej Skowron, Dominik Slezak, Nicolas Spyratos, V.S. Subrahmanian, Einoshin Suzuki, Domenico Talia, Yuzuru Tanaka, Farouk Toumani, Athena Vakali, Takashi Washio, Alicja Wieczorkowska, Xindong Wu, Xintao Wu, Ronald Yager, Yiyu Yao, and Saygin Yucel.

The list of additional reviewers: Johan Aberg, Marie Agier, Lefteris Angelis, Annalisa Appice, Khalid Belhajjame, Margherita Berardi, Patrick Bosc, Henrik Bulskov, Franck Capello, Costantina Caruso, Michelangelo Ceci, Min Chen, Ioan Chisalita, Laurence Cholvy, Dario Colazzo, Carmela Comito, Antonio Congiusta, Frédéric Cuppens, Anusch Daemi, Fabien De Marchi, Elizabeth Diaz, Devdatt Dubhashi, Peter Gammie, Arnaud Giacometti, Martin Giese, Paul Goutam, Gianluigi Greco, Samira Hammiche, Thomas Herault, Seung Hyun Im, Kimihito Ito, Mikhail Jiline, Kristofer Johannisson, Fabrice Jouanot, Matti Kääriäinen, Svetlana Kiritchenko, Rasmus Knappe, Lotfi Lakhal, Patrick Lambrix, Tine Lassen, Anne Laurent, Dominique Laurent, Alexandre Lefebvre, João Fernando Lima Alcantara, Gabriela Lindemann, Yann Loyer, James Lu, Perry Mar, Carlo Mastroianni, Mirjam Minor, Dagmar Monett, Dheerendranath Mundluru, Oliver Obst, Raffale Perego, Aarne Ranta, Brigitte Safar, Lorenza Saitta, Eric San Juan, Kay Schröter, Michele Sebag, Biren Shah, Laurent Simon, Giandomenico Spezzano, Diemo Urbig, Thomas Vestskov Terney, Li-Shiang Tsay, Phan-Luong Viet, Richard Waldinger, Christoph Wernhard, Ying Xie, Jianhua Yan, Ke Yin, José Luis Zechinelli Martini, Na Zhao, and Xiaosi Zhou.

We wish to express our thanks to all ISMIS 2005 reviewers and to Alan Biermann, Jaime Carbonell, and Salvatore Stolfo who presented invited talks at the symposium. We express our appreciation to the sponsors of the symposium and to all who submitted papers for presentation and publication in the proceedings. Our sincere thanks go Floriana Esposito, David Hislop, Robert Meersman, Hiroshi Motoda, Raghu Ramakrishnan, Zbigniew Ras (Chair), Lorenza Saitta, Maria Zemankova, Djamel Zighed, and Ning Zhong who served as members of the ISMIS 2005 Steering Committee, and to both Adrian Tanasescu who was responsible for the website and submission site management and Lynne Casper who worked on all aspects of local arrangements. Also, our thanks are due to Alfred Hofmann of Springer for his continuous support.

February, 2005 M.-S. Hacid, N.V. Murray, Z.W. Raś, S. Tsumoto

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Methodologies for Automated Telephone Answering

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Abstract. We survey some of the approaches to dialogue representation and processing for modern telephone answering systems. We include discussions of their strong and weak points and some of the performance levels obtained by them.

1 Technologies for the Third Millennium

The advent of ubiquitous computing will bring computers and the Internet into our lives on an almost continuous basis. We will have machines and communication access in our offices, in our vehicles, in our brief cases, on our walls, and elsewhere. We will be able to interact with the world, access the huge Internet resources, do local computations, and much more. But how will we utilize these machines easily enough to really profit from their capabilities? One suggestion is that we should speak to them as we do to humans and receive responses back using natural language ([1],[2],[3]). However, there have been major obstacles to the development of spoken language dialogue machines over the decades and some of these remain a problem today. This paper will address some of the major ideas in the development of dialogue systems and the levels of success that are possible. The focus of much research activity in recent years has been in automatic telephone answering ([4],[5],[6],[7],[3]) but we will also mention projects that study other types of human-machine interaction ([8],[2]).

Our primary concerns in this paper are the overall conception of what a dialogue is and how a computer may represent it and manage it. We present some of the most common and most successful paradigms for dialogue processing. Given these formats, we then discuss related issues including the control of initiative, user modeling, error correction, and dialogue optimization.

2 Paradigms for Dialogue Management

The earliest and probably the most used model for dialogues has been the finite-state machine ([9]). The model enables the designer to systematically specify the sequential steps of a dialogue anticipating what the user may say and designing the responses that are needed. This is a conservative technology that enables

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precise control of every machine action and prevents surprising behaviors that could result from unanticipated situations.

For the purposes of this paper, we will do examples from the domain of credit card company telephone answering where we have some experience ([10]). We will assume a greatly simplified version of the problem to keep the presentation short but will include enough complexity to make the points. Our model will require the system to obtain the name of the caller and an identifying account code. It also will require the system to obtain the purpose of the call. In our simplified example, we will assume there are only three possible goals: to determine the current balance on the credit card account, to report that the card has been lost and that another needs to be issued, or to request that a new address be registered for this caller.

Figure 1 shows a finite-state solution for this simplified credit card problem. The interaction begins with the machine greeting the user. We omit details of what this might be but a company would have a policy as to what to say. Perhaps it would say something like this: "Hello, this is the XYZ corporation automated credit card information system. What can I do for you today?" The figure shows the kinds of caller comments expected and the machine recognition system and parser have the tasks of recognizing and processing the incoming speech. The figure shows the next steps for the machine's response. Its output system needs an ability to convert a target message into properly enunciated speech. The continuation of the diagram shows the dialogue capabilities of the system. We omit a number of transitions in the diagram that might be included for variations in the interactions, for unusual requests, and for error correction.

An example dialogue that traverses this diagram is as follows:

System: Hello. XYZ credit card management. How can I help you?
Caller: Hello. I need to report a lost credit card.
System: Please give me your name.
Caller: William Smith.
System: Thank you. And your account code?
Caller: X13794.
System: Okay, I will cancel your existing card and issue a new one within 24 hours.

A common problem with the finite state model is that designers become exhausted with the detailed specification of every possible interaction that could occur. The number of states can explode as one accounts for misrecognitions and repeated requests, variations in the strategy of the interactions, different levels of initiative, extra politeness in special cases, and more. This leads to another model for dialogue systems, the form-filling model that assumes there is a set of slots to be filled in the interaction and that processing should evolve around the concept of filling the slots. Here the software can be designed around the slots and the computations needed to fill them. The ordering of the dialogue interactions is not implicitly set ahead of time and the designer need not think about order as much. If any interaction happens to include information to fill a slot, the information is immediately parsed and entered. If an important slot