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BRIEF CONTENTS

INVITED SPEAKERS IV

SPECIAL SESSION CHAIRS V

ORGANIZING AND STEERING COMMITTEES VI

SENIOR PROGRAM COMMITTEE VII

PROGRAM COMMITTEE VIII

AUXILIARY REVIEWERS XII

SELECTED PAPERS BOOK XIV

SPONSOR XIV

FOREWORD XV

CONTENTS XVII

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SELECTED PAPERS BOOK

A number of selected papers presented at ICEIS 2007 will be published by Springer, in a book entitled Enterprise Information Systems IX. This selection will be done by the conference Chair and program co-chairs, among the papers actually presented at the conference, based on a rigorous review by the ICEIS 2007 program committee members.

SPONSOR

FOREWORD

This volume contains the proceedings of the Ninth International Conference on Enterprise Information Systems (ICEIS 2007) organized by the Institute for Systems and Technologies of Information Control and Communication (INSTICC) and the University of Madeira, in collaboration with ACM/SIGMIS and AAAI. Furthermore, the conference was sponsored by the Portuguese Foundation for Science and Technology (FCT).

ICEIS has become a major point of contact between research scientists, engineers and practitioners in the area of business applications of information systems. This year, five simultaneous tracks were held, covering different aspects related to enterprise computing, including: "Databases and Information Systems Integration", "Artificial Intelligence and Decision Support Systems", "Information Systems Analysis and Specification", "Software Agents and Internet Computing" and "Human-Computer Interaction". All tracks describe research work that is often oriented towards real world applications and highlight the benefits of Information Systems and Technology for industry and services, thus making a bridge between the Academia and the Enterprise worlds.

Following the success of 2006, ICEIS 2007 also had a number of satellite workshops, related to the field of the conference. This year we collaborated in the organization of the following ten international workshops: 7th International Workshop on Pattern Recognition in Information Systems; 1st International Joint Workshop on Wireless Ubiquitous Computing; 5th International Workshop on Modelling, Simulation, Verification and Validation of Enterprise Information Systems; 5th International Workshop on Security In Information Systems; 4th International Workshop on Natural Language Processing and Cognitive Science; 4th International Workshop on Computer Supported Activity Coordination; 3rd International Workshop on Model-Driven Enterprise Information Systems; 1st International Joint Workshop on Technologies for Collaborative Business Processes and Management of Enterprise Information Systems; 1st International Workshop on RFID Technology - Concepts, Applications, Challenges and 1st International Workshop on Human Resource Information Systems.

This year, ICEIS 2007 received 644 paper submissions from more than 40 countries in all continents. 72 papers were published and presented as full papers, i.e. completed work (8 pages/30' oral presentation), 198 papers reflecting work-in-progress or position papers were accepted for short presentation, and another 131 contributions were scheduled for poster presentation.

These numbers, leading to a "full-paper" acceptance ratio below 12%, and a total acceptance ratio below 65%, show the intention of preserving a high quality forum for the next editions of this conference. Additionally, as usual in the ICEIS conference series, a number of invited talks, presented by internationally recognized specialists in different areas, have positively contributed to reinforce the overall quality of the Conference and to provide a deeper understanding of the Enterprise Information Systems field.

A book of Selected Papers will be published, following the conference, by Springer in the newly created series "Lecture Notes in Business Information Processing" (LNBIP). This series brings the

successful LNCS approach to areas such as business information systems, e-business, B2B integration, Enterprise applications and industrial software development.

The program for this conference required the dedicated effort of many people. Firstly, we must thank the authors, whose research and development efforts are recorded here. Secondly, we thank the members of the program committee and the additional reviewers for their diligence and expert reviewing. Thirdly, we thank the invited speakers for their invaluable contribution and for taking the time to synthesise and prepare their talks. Fourthly, we thank the workshop chairs and the special session chairs whose collaboration with ICEIS was much appreciated. Finally, special thanks to all the members of the local organising committee, especially Jorge Cardoso, whose collaboration was fundamental for the success of this conference.

This year, the organization will distribute two awards to papers presented at the conference: the best paper award and the best student paper award, mainly based on the classifications provided by the Program Committee members.

We wish you all an exciting conference and an unforgettable stay in the lovely island of Madeira. We hope to meet you again next year for the 10th ICEIS, to be held in Barcelona - Spain, details of which are available at http://www.iceis.org.

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CONTENTS

INVITED SPEAKERS

KEYNOTE LECTURES

THE 4 X 4 SEMANTIC MODEL - Exploiting Data, Functional, Non-functional and Execution Semantics Across Business Process, Workflow, Partner Services and Middleware Services Tiers IS-5
Amit P. Sheth and Karthik Gomadam

TRENDS IN BUSINESS PROCESS ANALYSIS - From Verification to Process Mining IS-13
Wil M. P. van der Aalst

INFORMATION LOGISTICS IN NETWORKED ORGANISATIONS - Issues, Concepts and Applications IS-23
Kurt Sandkuhl

SERVICE-ORIENTED ARCHITECTURE - One Size Fits Nobody IS-31
Christoph Bussler

INTRODUCING AN IT CAPABILITY MATURITY FRAMEWORK IS-35
Martin Curley

DRIVING AHEAD: JOINT ENTERPRISE-EMBEDDED COMPUTING IN SMART CLOUDS, SMART DUST AND INTELLIGENT AUTOMOBILES IS-49
K. Venkatesh Prasad

ENTERPRISE INFORMATION SYSTEMS FOR USE: FROM BUSINESS PROCESSES TO HUMAN ACTIVITY IS-51
Larry Constantine

ARTIFICIAL INTELLIGENCE AND DECISION SUPPORT SYSTEMS

FULL PAPERS

IMPROVING CONTENT-ORIENTED XML RETRIEVAL BY APPLYING STRUCTURAL PATTERNS 5
Philipp Dopichaj

DELINEATING TOPIC AND DISCUSSANT TRANSITIONS IN ONLINE COLLABORATIVE ENVIRONMENTS 14
Noriko Imafuji Yasui, Xavier Llorà, David E. Goldberg, Yuichi Washida and Hiroshi Tamura

A DISTRIBUTED MULTI-AGENT SYSTEM TO SOLVE AIRLINE OPERATIONS PROBLEMS 22
Antonio Castro and Eugenio Oliveira

IMPRECISE EMPIRICAL ONTOLOGY REFINEMENT - Application to Taxonomy Acquisition 31
Vít Nováček

NAMED ENTITY RECOGNITION IN BIOMEDICAL LITERATURE USING TWO-LAYER SUPPORT VECTOR MACHINES 39
Feng Liu, Yifei Chen and Bernard Manderick

SHORT PAPERS

SPECIALIST KNOWLEDGE DIFFUSION
Mounir Kehal 49

MOBILE DECISION MAKING AND KNOWLEDGE MANAGEMENT: Supporting Geoarchaeologists In The Field
Martin Blunn, Julie Cowie, David Cairns, Clare Wilson and Donald Davidson 57

INTERCONNECTING DOCUMENTATION - Harnessing the Different Powers of Current Documentation Tools in Software Development
Christian Prause, Julia Kuck, Stefan Apelt, Reinhard Oppermann and Armin B. Cremers 63

USING DECISION TREE LEARNING TO PREDICT WORKFLOW ACTIVITY TIME CONSUMPTION
Liu Yingbo, Wang Jianmin and Sun Jiaguang 69

PERSONAL KNOWLEDGE MANAGEMENT AS AN ICEBREAKER: Motivating Contributions to Knowledge Management Systems
Harald Kjellin and Terese Stenfors-Hayes 76

GROUP DECISION SYSTEMS FOR RANKING AND SELECTION - An Application to the Accreditation of Doping Control Laboratories
Xari Rovira, Núria Agell, Mónica Sánchez, Francesc Prats and Montserrat Ventura 82

PROVISION OF CONTEXT-SENSITIVE ENTERPRISE KNOWLEDGE FOR DECISION SUPPORT: An Approach based on Enterprise Models and Information Demand Contexts
Tatiana Levashova, Michael Pashkin and Magnus Lundqvist 88

IMPLEMENTING PRIORITIZED REASONING IN LOGIC PROGRAMMING
Luciano Caroprese, Irina Trubitsyna and Ester Zumpano 94

APPLYING INTEGRATED EXPERT SYSTEM IN NETWORK MANAGEMENT
Antonio Martín, Carlos León, Juan I. Guerrero and Francisco J. Molina 101

INTELLIGENT E-LEARNING SYSTEMS - An Intelligent Approach to Flexible Learning Methodologies
Sukanya Ramabadran and Vivekanand Gopalkrishnan 107

REACTIVE COMMONSENSE REASONING - Towards Semantic Coordination with High-Level Specifications
Michael Cebulla 113

EXPLANATION GENERATION IN BUSINESS PERFORMANCE MODELS - With a Case Study in Competition Benchmarking
Hennie Daniels and Emiel Caron 119

CREATING A BILINGUAL PSYCHOLOGY LEXICON FOR CROSS LINGUAL QUESTION ANSWERING - A Pilot Study
Andrea Andrenucci 129

SIMILARITY ASSESSMENT IN A CBR APPLICATION FOR CLICKSTREAM DATA MINING PLANS SELECTION
Cristina Wanzeller and Orlando Belo 137

LEARNING TO RANK FOR COLLABORATIVE FILTERING
Jean-Francois Pessiot, Tuong-Vinh Truong, Nicolas Usunier, Massih-Reza Amini and Patrick Gallinari 145

MRE-KDD+: A MULTI-RESOLUTION, ENSEMBLE-BASED MODEL FOR ADVANCED KNOLWEDGE DISCOVERY
Alfredo Cuzzocrea 152

MULTI-AGENT BUILDING CONTROL IN SHARED ENVIRONMENT
Bing Qiao, Kecheng Liu and Chris Guy 159

AN ATTITUDE BASED MODELING OF AGENTS IN COALITION
Madhu Goyal 165

RULE BASED STABILITY CRITERIA FOR COALITION FORMATION UNDER UNCERTAINTY
Chi-Kong Chan and Ho-Fung Leung 171

AN AGENT-BASED APPROACH TO SUPPORT PERFORMANCE MANAGEMENT FOR DYNAMIC AND COLLABORATIVE WORK
Nora Houari and Behrouz H. Far 178

A CONNECTIONIST APPROACH IN BAYESIAN CLASSIFICATION
Luminita State, Catalina Cocianu, Panayiotis Vlamos and Viorica Stefanescu 185

RECURRENT NEURAL NETWORKS APPROACH TO THE DETECTION OF SQL ATTACKS
Jaroslaw Skaruz, Franciszek Seredynski and Pascal Bouvry 191

NEURALTB WEB SYSTEM: Support to the Smear Negative Pulmonary Tuberculosis Diagnosis
Carmen Maidantchik, José Manoel de Seixas, Afrânio Kritski, Fernanda C. de Q Mello, Rony T. V. Braga, Pedro H. S. Antunes and João Baptista de Oliveira e Souza Filho 198

PROBLEMS AND FEATURES OF EVOLUTIONARY ALGORITHMS TO BUILD HYBRID TRAINING METHODS FOR RECURRENT NEURAL NETWORKS
M. P. Cuéllar, M. Delgado and M. C. Pegalajar 204

SELF-LEARNING PREDICTION SYSTEM FOR OPTIMISATION OF WORKLOAD MANAGEMENT IN A MAINFRAME OPERATING SYSTEM
Michael Bensch, Dominik Brugger, Wolfgang Rosenstiel, Martin Bogdan, Wilhelm Spruth and Peter Baeuerle 212

A MULTI-AGENT ARCHITECTURE FOR ENVIRONMENTAL IMPACT ASSESSMENT: Information Fusion, Data Mining and Decision Making
Marina V. Sokolova and Antonio Fernández-Caballero 219

INVESTIGATIONS ON OBJECT-CENTERED ROUTING IN DYNAMIC ENVIRONMENTS: ALGORITHMIC FRAMEWORK AND INITIAL NUMERICAL RESULTS - Support for Distributed Decision Making in Transport Systems
Bernd-Ludwig Wenning, Carmelita Görg, Andreas Timm-Giel, Jörn Schönberger and Herbert Kopfer 225

AN APPROACH FOR ASSESSING DESIGN SYSTEMS: Design System Simulation and Analysis for Performance Assessment
Richard Sohnius, Eyck Jentzsch, Wolf-Ekkehard Matzke and Vadim Ermolayev 231

THE IMPORTANCE OF AGGREGATION OPERATOR CHARACTERISTICS IN MARKETING RESEARCH
Kris Brijs, Benoît Depaire, Koen Vanhoof, Tom Brijs and Geert Wets 237

ATTRIBUTE CONSTRUCTION FOR E-MAIL FOLDERING BY USING WRAPPERED FORWARD GREEDY SEARCH
Pablo Bermejo, José A. Gámez and José M. Puerta 247

TREND ANALYSIS BASED ON EXPLORATIVE DATA AND TEXT MINING: A Decision Support System for the European Home Textile Industry
Andreas Becks and Jessica Huster 253

USING GRAMMARS FOR TEXT CLASSIFICATION
P. Kroha and T. Reichel 259

HEAVYWEIGHT ONTOLOGY MATCHING - A Method and a Tool based on the Conceptual Graphs Model
Frédéric Furst and Francky Trichet 265

A PLATFORM DEDICATED TO KNOWLEDGE ENGINEERING FOR THE DEVELOPMENT OF IMAGE PROCESSING APPLICATIONS
Arnaud Renouf, Régis Clouard and Marinette Revenu 271

MODELLING HUMAN REASONING IN INTELLIGENT DECISION SUPPORT SYSTEMS
V. N. Vagin and A. P. Yeremeyev 277

GENERALIZED MULTICRITERIA OPTIMIZATION SOFTWARE SYSTEM MKO-2
Mariana Vassileva, Vassil Vassilev, Boris Staykov and Danail Dochev 283

A DECISION SUPPORT SYSTEM FOR PREDICTING THE RELIABILITY OF A ROBOTIC DISPENSING SYSTEM
J. Sturek, S. Ramakrishnan, P. Nagula and K. Srihari 289

PAIRWISE COMPARISONS, INCOMPARABILITY AND PARTIAL ORDERS
Ryszard Janicki 297

ENERGY MANAGEMENT INFORMATION SYSTEMS: AN EXPLORATORY STUDY OF IMPLEMENTATIONS USING ADAPTIVE STRUCTURATION THEORY
Orla Kirwan, Willie Golden and Padraig Molloy 303

OBTAINING AND EVALUATING GENERALIZED ASSOCIATION RULES
Veronica Oliveira de Carvalho, Solange Oliveira Rezende and Mário de Castro 310

AN INTELLIGENT INFORMATION SYSTEM FOR ENABLING PRODUCT MASS CUSTOMIZATION
Haifeng Liu, Wee-Keong Ng, Bin Song, Xiang Li and Wen-Feng Lu 316

A NEW FUZZY LOGIC CONTROLLER FOR TRADING ON THE STOCK MARKET
Francesco Maria Raimondi, Salvatore Pennacchio, Pietro Via and Marianna Mulè 322

AN EMPIRICAL STUDY OF SIGNIFICANT VARIABLES FOR TRADING STRATEGIES
M. Delgado Calvo-Flores, J. F. Núñez Negrillo, E. Gibaja Galindo and C. Molina Férnandez 330

A QUALITATIVE EXPERT KNOWLEDGE APPROACH TO RENDERING OPTIMIZATION
D. Vallejo-Fernandez, C. Gonzalez-Morcillo and L. Jimenez-Linares 336

A NICHE BASED GENETIC ALGORITHM FOR IMAGE REGISTRATION
Giuseppe Pascale and Luigi Troiano 342

FUZZY INTERVAL NUMBER (FIN) TECHNIQUES FOR MULTILINGUAL AND CROSS LANGUAGE INFORMATION RETRIEVAL
Theodoros Alevizos, Vassilis G. Kaburlasos, Stelios Papadakis, Christos Skourlas and Petros Belsis 348

A EVOLUTIONARY APPROACH TO SOLVE SET COVERING
Broderick Crawford, Carolina Lagos, Carlos Castro and Fernando Paredes 356

POSTERS

ARCHITECTURAL DESIGN VIA DECLARATIVE PROGRAMMING
Luís Moniz Pereira and Ruben Duarte Viegas 363

SOLVING THE MULTI-OBJECTIVE MIXED MODEL ASSEMBLY LINE PROBLEM USING A FUZZY MULTI-OBJECTIVE LINEAR PROGRAM
Iraj Mahdavi, Babak. Javadi and S. S. Sabet 370

INTEGRATION OF A FUZZY SYSTEM AND AN INFORMATION SYSTEM FOR THE TERRITORIAL UNITS RANKING
Miroslav Hudec and Mirko Vujošević 374

DYNAMIC WEB DOCUMENT CLASSIFICATION IN E-CRM USING NEURO-FUZZY APPROACH
Iraj Mahdavi, Babak Shirazi, Namjae Cho, Navid Sahebjamnia and Meysam Aminzadeh 378

AGENT-BASED APPROACH FOR ELECTRICITY DISTRIBUTION SYSTEMS
Kimmo Salmenjoki, Yaroslav Tsaruk, Vagan Terziyan and Marko Viitala 382

DEVELOPMENT OF A DECISION SUPPORT SYSTEM FOR COMPUTER AIDED PROCESS PLANNING SYSTEM
Manish Kumar 390

HOLONIC ARCHITECTURE FOR A MULTIAGENT-BASED SIMULATION TOOL
Nancy Ruiz, Adriana Giret and Vicente Botti 395

GU METRIC - A New Feature Selection Algorithm for Text Categorization
Gulden Uchyigit and Keith Clark 399

CONTEXT-BASED INTELLIGENT EDUCATIONAL SYSTEM FOR CAR DRIVERS
Juliette Brezillon, Patrick Brezillon, Thierry Artieres and Charles Tijus 403

DATA MINING CLUSTERING TECHNIQUES IN ACADEMIA
Vasile Paul Bresfelean, Mihaela Bresfelean, Nicolae Ghişoiu and Călin-Adrian Comes 407

NEURAL NETWORKS FOR DATA QUALITY MONITORING OF TIME SERIES
Augusto Cesar Heluy Dantas and José Manoel de Seixas 411

FORECASTING OF CHANGES OF COMPANIES FINANCIAL STANDINGS ON THE BASIS OF SELF-ORGANIZING MAPS
Egidijus Merkevičius, Gintautas Garšva, Stasys Girdzijauskas and Vitolis Sekliuckis 416

FEEDFORWARD NEURAL NETWORKS WITHOUT ORTHONORMALIZATION
Lei Chen, Hung Keng Pung and Fei Long 420

LEARNING GREEK PHONETIC RULES USING DECISION-TREE BASED MODELS
Dimitrios P. Lyras, Kyriakos N. Sgarbas and Nikolaos D. Fakotakis 424

THE JUMP PROJECT: PRACTICAL USE OF SEMANTIC WEB TECHNOLOGIES IN EPSS SYSTEMS
Giovanni Semeraro, Ignazio Palmisano, Nicola Abbattista and Silverio Petruzzellis 428

DAY OF THE WEEK EFFECT IN SMALL SECURITIES MARKETS
Virgilijus Sakalauskas and Dalia Kriksciuniene 432

EMPLOYING SOFTWARE MULTI-AGENTS FOR SIMULATING RADIOLOGICAL ACCIDENTS
Tadeu Augusto de Almeida Silva and Oscar Luiz Monteiro de Farias 436

INTEGRATING AGENTS INTO COOPERATIVE INTELLIGENT DECISION SUPPORT SYSTEMS
Abdelkader Adla 440

SELF-ORGANIZING MAPS FOR CLASSIFICATION OF THE RIO DE JANEIRO STATE CITIES BASED ON ELECTRICAL ENERGY CONSUMPTION
Luiz Biondi Neto, Pedro Henrique Gouvêa Coelho, João Carlos Soares de Mello and Lidia Angulo Meza 447

INTELLIGENT SYSTEM FOR IMAGE COMPRESSION
Adnan Khashman and Kamil Dimililer 451

MISUSE DETECTION - An Iterative Process vs. A Genetic Algorithm Approach
Pedro A. Diaz-Gomez and Dean F. Hougen 455

MISUSE DETECTION - A Neural Network vs. A Genetic Algorithm Approach
Pedro A. Diaz-Gomez and Dean F. Hougen 459

AUTOMATIC EVALUATION OF THE QUANTITATIVE SEISMOCARDIOGRAM
Z. Trefny, J. Svacinka, S. Trojan, J. Slavicek, P. Smrcka and M. Trefny 463

THE RETRIEVAL PROCESS IN THE SAFRS SYSTEM WITH THE CASE-BASED REASONING APPROACH
Souad Demigha 468

APPLICATION OF A GENETIC ALGORITHM TO A REAL WORLD NURSE ROSTERING PROBLEM INSTANCE
Özgür Kelemci and A. Sima Uyar 474

LSGENSYS - AN INTEGRATED SYSTEM FOR PATTERN RECOGNITION AND SUMMARISATION OF MULTI-BAND SATELLITE IMAGES
Hema Nair 478

SPECIAL SESSION ON BUSINESS INTELLIGENCE, KNOWLEDGE MANAGEMENT AND KNOWLEDGE MANAGEMENT SYSTEMS

HUMAN-CENTERED META-SYNTHETIC ENGINEERING FOR KNOWLEDGE CREATIVE SYSTEM
Cui Xia, Dai Ruwei, Li Yaodong and Zhao Mingchang 485

KNOWLEDGE FLOW ANALYSIS TO IDENTIFY KNOWLEDGE NEEDS FOR THE DESIGN OF KNOWLEDGE MANAGEMENT SYSTEMS AND STRATEGIES - A Methodological Approach
Oscar M. Rodríguez Elias, Ana I. Martínez García, Jesús Favela Vara, Aurora Vizcaíno and Juan Pablo Soto 492

KNOWLEDGE MANAGEMENT SYSTEMS WITH REPUTATION AND INTUITION - What for?
Juan Pablo Soto, Aurora Vizcaíno, Javier Portillo and Mario Piattini 498

KNOWLEDGE SHARING AND ORGANIZATIONAL PERFORMANCE - An Agent-mediated Approach
Virginia Dignum 504

ENRICHING EXECUTIVES' SITUATION AWARENESS AND MENTAL MODELS - A Conceptual ESS Framework
Li Niu, Jie Lu and Guangquan Zhang 510

AUTHOR INDEX 517

SPECIAL SESSION ON BUSINESS INTELLIGENCE, KNOWLEDGE MANAGEMENT AND KNOWLEDGE MANAGEMENT SYSTEMS

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KNOWLEDGE MANAGEMENT SYSTEMS WITH REPUTATION AND INTUITION
What for?

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Keywords: Knowledge management, multi-agent systems, communities of practice, reputation.

Abstract: Nowadays knowledge management is considering to be one of the more important processes by those companies worried about their competitiveness. These companies focus their efforts on developing systems that can be used to capture, store and reuse the knowledge generated by theirs employees. Nevertheless, all this effort may be in vain if the system is not greatly used by the employees because the knowledge that these systems have is often not valuable or on other occasions the knowledge sources do not provide the necessary confidence to reuse the information. In an attempt to avoid this situation, we propose a multi-agent architecture based on communities of practice and on the reputation concept with the purpose of controlling the utility of information stored in a knowledge base.

1 INTRODUCTION

In recent years knowledge management is a topic of special interest to organizations who are worried about their employees' learning and competitiveness since a suitable management of this process can help organizations to increment the collaboration of their members and encourage the sharing of information between them. The exchange of information among employees in an organization represents an important success factor in improving the knowledge flow necessary for a suitable knowledge management. An essential ingredient of knowledge sharing information in organizations is that of "community of practice", by which we mean groups of people with a common interest where each member contributes knowledge about a common domain (Wenger, 1998). This concept has become more and more popular within the field of the knowledge management where it is mainly used as a knowledge management tool to support the externalization of knowledge, both for reuse as well as for purposes of innovation (Huysman & Wit, 2000). The importance of the concept of communities of practice at an organizational level is parallel to the growth in the interest of management approaches such as organizational learning and knowledge management. Communities of practice enable their members to benefit from each other's knowledge. Most of the learning that takes place in organizations occurs informally in communities of practice (Lesser, 2000). An interesting fact is that individuals are frequently more likely to use knowledge built by their community team members than those created by members outside their group (Desouza, 2006). For these reasons, we consider the modelling of communities of practices into knowledge management systems an adequate method by which to provide these systems with a certain degree of control to measure the confidence and quality of the information provided for each member of the community.

In order to carry this out, we have designed a multi-agent architecture in which agents try to emulate humans' rating knowledge sources with the goal of fostering the use of knowledge bases where intelligent agents provide "trustworthy knowledge" to the employees and foster knowledge flow among them.

The remainder of this work is organized as follows. The next section presents two important concepts that take place in the process of obtaining

information (trust and reputation). In section three the multi-agent architecture proposed to manage trustworthy knowledge bases is described. In section four the reputation management used in the agents' community is presented. In section five we illustrate how the architecture and reputation management have been used to implement a prototype which detects and suggests trustworthy documents for members in a community of practice. Finally in section six conclusions are presented.

2 TRUST AND REPUTATION

The main goal of our work is to rate the credibility of information sources and of knowledge. To do this, we first need to define two important concepts: trust and reputation. The former can be defined as confidence in the ability and intention of an information source to deliver correct information (Barber & Kim, 2004) and the latter as the amount of trust an agent has in an information source, created through interactions with information sources. There are other definitions for these concepts (Gambetta, 1988; Marsh, 1994). However, we have presented the most appropriate for our research since the level of confidence in a source is based on previous experience of this.

Figure 1: Reputation factors.

The reputation of an information source not only serves as a means of belief revision in a situation of uncertainty, but also serves as a social law that obliges us to remain trustworthy to other people. Therefore, people, in real life in general and in companies in particular, prefer to exchange knowledge with "trustworthy people" by which we mean people they trust. People with a consistently low reputation will eventually be isolated from the community since others will rarely accept their justifications or arguments and will limit their interaction with them. It is for this reason that the remainder of this paper deals solely with reputation. However, if we attempt to imitate the behaviour of the employees in a company when they are exchanging and obtaining information we observe that apart from the concept of reputation other factors also influence. For this reason, in this paper we argue that reputation is not a single notion but one of multiple parts (see Figure 1). These are:

- Position: employees often consider information that comes from a boss as being more reliable than that which comes from another employee in the same (or a lower) position as him/her (Wasserman & Glaskiewics, 1994). However, this is not a universal truth and depends on the situation. For instance in a collaborative learning setting collaboration is more likely to occur between people of a similar status than between a boss and his/her employee or between a teacher and pupils (Dillenbourg, 1999). Because of this, as will be explained later, in our research this factor will be calculated by taking into account a weight that can strengthen this factor to a greater or to a lesser degree.
- Expertise: this term can be briefly defined as the skill or knowledge of a person who knows a great deal about a specific thing. This is an important factor since people often trust in experts more than in novice employees. Moreover, tools such as expertise location (Crowder et al, 2002) are being developed with the goal of promoting the sharing of expertise knowledge (Rodríguez-Elías et al, 2004).
- Previous experience: People have greater trust in those sources from which they have previously obtained more "valuable information". Therefore, a factor that influences the increasing or decreasing reputation of a source is "previous experience" and this factor can help us to detect trustworthy sources or knowledge.
- Intuition: When people do not have a previous experience they often use their "intuition" to decide whether or not they are going to trust something. Other authors have called this issue "indirect reputation or prior-derived reputation" (Mui et al, 2002). In human societies, each of us probably has different prior beliefs about the trustworthiness of strangers we meet. Sexual or racial discrimination might be a consequence of such prior belief (Mui et al, 2002). We have tried to model intuition according to the similarity between the user profiles, the greater the similarity between one agent and another, the greater the intuition level.

Taking all these factors into account we have defined an own "concept of reputation". In section four we shall describe how we use this definition to rate knowledge and information sources.

3 A MULTIAGENT ARCHITECTURE TO DEVELOP TRUSTWORTHY KNOWLEDGE BASES

When implementing a knowledge management system we must consider the importance a knowledge base has within that system. In this work we have focused our attention on the difficulties of controlling the quality of the contributions and the "reputation" of contributors of a knowledge management system. A knowledge management system must store only useful knowledge for employees. However, sometimes the knowledge which is put into a knowledge base is not very valuable. This decreases the trust that employees have in their knowledge bases and reduces the probability of people using it. In order to avoid this situation we have developed a multi-agent architecture in charge of monitoring and evaluating the knowledge that is stored in a knowledge base.

To design this architecture we have taken into account how people obtain information in their daily lives and concretely how this exchange of information takes place in communities of practice. Bearing in mind the advantages of working with groups of similar interests we have organized the agents into communities of people who are interested in similar topics. Thus, Figure 2 shows different communities where there are two types of agents: the *User Agent* and the *Manager Agent*. The former is used to represent each person that may consult or introduce knowledge in a knowledge base.

The *User Agent* can assume three types of behaviour or roles similar to the tasks that a person may carry out in a knowledge base. Therefore, the User Agent plays one role or another depending upon whether the person that it represents carries out one of the following actions:

- The person contributes new knowledge to the communities in which s/he is registered. In this case the User Agent plays the role of **Provider**.
- The person uses knowledge previously stored in the community. Then, the User Agent will be considered as a **Consumer**.
- The person helps other users to achieve their goals, for instance by giving an evaluation of certain knowledge. In this case the role is of a **Partner**. So, Figure 2 shows that in community 1 there are two User Agents playing the role of Partner, one User Agent playing the role of Consumer and another being a Provider.

The fact that this agent can act both as consumers and also as providers of knowledge may lead to better results because they aim to motivate the active participation of the individual in the learning process, which often results in the development of creativity and critical thinking (Kan, 1999).

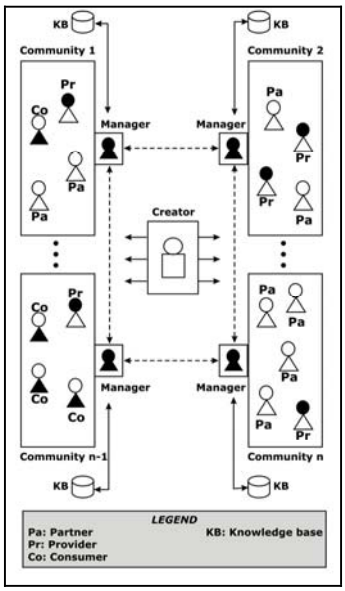

Figure 2: Multi-agent architecture.

The second type of agent within a community is called the *Manager Agent* (represented in black in Figure 2) which is in charge of managing and controlling its community. In order to accomplish this, the Manager Agent can perform the following tasks:

- Registering an agent in its community. It thus controls how many agents there are and how long the stay of each agent in that community is.
- Registering the frequency of contribution of each agent. This value is updated every time an agent makes a contribution to the community.
- Registering the number of times that an agent gives feedback about other agents' knowledge. For instance, when an agent "A" uses information from another agent "B", the agent A should rate this information. Monitoring how often an agent gives feedback about other agents' information helps to detect whether agents contribute to the creation of knowledge flows in the community since it is as important that an agent contributes with new information as it is that another agent contributes by evaluating the relevance or importance of this information.
- Registering the interactions between agents. Every time an agent evaluates the contributions of another agent the Manager Agent will

register this interaction. But this interaction is only in one direction, which means, if agent A consults information from agent B and evaluates it, the Manager records that A knows B but that does not means that B knows A because B does not obtain any information about A.

Besides these agents there is another in charge of initiating new agents and creating new communities. This agent has two main roles: the "creator" role is assumed when there is a petition (made by a User Agent) to create a new Community and the "initiator" role is assumed when the system is initially launched. This agent, which is not included in any of the communities, is located in the centre of Figure 2, and is called the *Creator Agent*.

The following section describes how the agent works in order to obtain reputation values.

4 REPUTATION MANAGEMENT IN AGENTS' COMMUNITIES

The idea of using reputation values has two objectives. The first of them is that agents help employees to discover the information that is most relevant for them, thus, decreasing the overload of information that employees often have and strengthening the usage of knowledge bases in companies. Another objective is to avoid the situation of employees storing valueless information in a knowledge base. In order to accomplish this successfully, we need to manage reputation in such a way that the agents can obtain reputation values that can be used to maintain the quality of the information in knowledge bases.

Bearing in mind that the reputation notion described in section 2 is composed of position, expertise, previous experiences and intuition, we will describe the formulas used to measure the level of reputation in agents' communities.

For instance, the reputation of $agent_j$ in the eyes of $agent_s$ is a collective measure defined by the previously describe reputation factors in section two and is computed as follows:

$$R_{sj} = w_e * E_j + w_p * P_j + w_i * I_j + \left(\sum_{j=1}^{n} QC_j\right)/n$$

where R_{sj} denotes the reputation value that $agent_s$ has in $agent_j$ (each agent in the community has an opinion about each of the other agent members of the community).

E_j is the value of expertise which is calculated according to the degree of experience that a person has in a domain.

P_j is the value assigned to the position of a person. This position is defined by the organizational diagram of the enterprise. Therefore, a value that determines the hierarchic level within the organization can be assigned to each level of the diagram.

I_j is the value assigned to the intuition which is calculated by comparing the users' profiles of each one.

In addition, previous experience should also be calculated. We suppose that when an agent A consults information from another agent B, the agent A should evaluate how useful this information was. This value is called QC_j (Quality of *j*'s Contribution). To attain the average value of an agent's contribution, we calculate the sum of all the values assigned to their contributions and we divide it between their total. In the expression n represents the total number of evaluated contributions.

Finally, w_e, w_p and w_i are weights with which the Reputation value can be adjusted to the needs of the organizations. For instance, if an enterprise considers that all their employees have the same category, then w_p=0. The same could occur when the organization does not take its account employees' intuitions or expertise into account.

In this way, an agent can obtain a value related to the reputation of another agent and decide to what degree it is going to consider the information obtained from this agent.

Moreover, when a user wants to join to a community in which no member knows anything about him/her, the reputation value assigned to the user in the new community is calculated on the basis of the reputation assigned from others communities where the user is or was a member. For instance, an User Agent called j, will ask each community manager where he/she was previously a member to consult each agent which knows him/her with the goal of calculating the average value of his/her reputation (R_{Aj}). This is calculated as:

$$R_{Aj} = \left(\sum_{i=1}^{n} R_{ij}\right)/n$$

where n is the number agents who know j and R_{ij} is the value of j's reputation in the eyes of i. In the case of being known in several communities the average of the values R_{Aj} will be calculated. Then, the User Agent j presents this reputation value (similar to when a person presents his/her curriculum vitae when s/he wishes to join a company) to the Manager Agent of the community to which it is "applying". This mechanism is similar to the "word-of-mouth" propagation of information for a human (Abdul-Rahman & Hailes, 2000).

In the case of the user being new in the community then this user is assigned a "new" label in order for the situation to be identified.

Once the Community Manager has obtained a Reputation value for j it is added to the community member list.

In the following section, we will describe a prototype developed to validate each of our proposals.

5 PROTOTYPE

In order to evaluate the architecture and formulas to manage reputation we have developed a prototype system into which people can introduce documents and where these documents can also be consulted by other people. The goal of this prototype is for agents software to help employees to discover the information that may be useful to them thus decreasing the overload of information that employees often have and strengthening the use of knowledge bases in companies. In addition, we try to avoid the situation of employees storing valueless information in the knowledge base.

The main feature of this system is that when a person searches for knowledge in a community, and after having used the knowledge obtained, that person then has to evaluate the knowledge.

When a user wants to join to a new community the person will use a "*Register Menu"* and choose a community from all the available communities. In this case the Manager Agent will ask whether there are any agents that know new user in order to set a reputation value on this person.

In addition, the prototype provides the options of proposing new documents, using community documents and updating reputation values, proposing new topics in the community, etc. We shall now describe only two situations, due to limitations of space:

1) Proposing new documents. It is assumed that any person is able to propose documents in those communities where he/she is a member. To propose a document a person must use the "Propose Menu" and will have to configure the followings options:

- Community: The person must select the community to which s/he proposes to add a document.
- Topic: In each community there may be different topics or areas and the user will choose the one in which s/he intends to propose the document.
- Document: The proposed document.
- Author: Indicates who the author of the document is since a person may propose other authors' documents. In this case, the proposal is considered as a contribution but not as the proposer's own contribution.
- Knowledge Source: Where the knowledge came from. It could have come from a partner, from the person him/herself, from a web page, etc.

Once the user has chosen the options, the User Agent takes the values and sends them to the Manager Agent that is in charge of adding the new document to the community document list and modifying the frequency of contribution of this agent in this community.

2) Using community documents and updating reputation values. People can search for documents in every community in which they are registered. When a person searches for a document relating to a topic his/her User Agent consults the Manager Agent about which documents are related to their search. Then, the Manager agent answers with a list of documents. The User Agent sorts this list according to the reputation value of the authors, which is to say that the contributions with the best reputations for this Agent are listed first. On the other hand, when the user doesn't know the contributor then the User Agent consults the Manager Agent about which members of the community know the contributors. Thus, the User Agent can consult the opinions that other agents have about these contributors, thus taking advantage of other agents' experience. To do this the Manager consults its interaction table and responds with a list of the members who know the User Agent Then, this User Agent contacts each of them. If nobody knows the contributors then the information is listed, taking their expertise and positions into account. In this way the User Agent can detect how worthy a document is, thus saving employees' time, since they do not need to review all the documents related to a topic but only those considered most relevant by the members of the community or by the person him/herself according to previous experience with the document or its authors.

Once the person has chosen a document, his/her User Agent adds this document to its own document list (list of consulted documents), and if the author of the document is not known by the person because it is the first time that s/he has worked with him/her, then the Community Manager adds this relation to the interaction table. This step is very important since when the person evaluates the document consulted, his/her User Agent will be able to assign a QC for this document.

6 CONCLUSIONS

The main contribution of this paper is to add a reputation concept to knowledge bases with the idea of emulating people's behaviour within communities since according to literature the exchange of knowledge is likely to take place in these communities thanks to the trust that members have in each other. Moreover, we have proposed a new definition of "reputation" which considers aspects that affect the degree of trust that a person has in something (a knowledge source, a person, a piece of knowledge). In this definition intuition, a concept that according to (Mui et al, 2002) has not yet been modelled by agent systems has been included.

Another important advantage of our approach is that we use easy and generic formulas to measure the reputation in knowledge management systems. This is very important because our focus may be useful in several situations.

In addition, this work has illustrated how the architecture can be used to implement a prototype. The main functionalities of this architecture are:

- Detecting information which is not particularly useful in a knowledge base.
- Displaying useful information to employees according to the user's profiles.
- Detecting the most important knowledge sources of a company. Since our approach rates information as well as the contributor this could also help companies to detect those employees with more knowledge about a topic (expert detection).

This architecture may also be useful in the implementation of a recommender system as the better evaluated information can be sent to interested parties. For instance, our research group will use our architecture to evaluate research papers and the best valuated papers will be sent to the members of the group who work on related topics. In addition the architecture can be used to support virtual communities, or to detect the most trustworthy employees or with the best reputation.

All these situations provide organizations with a better control of their knowledge bases which will have more trustworthy knowledge and it is consequently expected that employees will feel more willing to use it.

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AUTHOR INDEX

Abbattista, N. 428
Adla, A. 440
Agell, N. 82
Alevizos, T. 348
Amini, M. 145
Aminzadeh, M. 378
Andrenucci, A. 129
Antunes, P. 198
Apelt, S. 63
Artieres, T. 403
Baeuerle, P. 212
Becks, A. 253
Belo, O. 137
Belsis, P. 348
Bensch, M. 212
Bermejo, P. 247
Blunn, M. 57
Bogdan, M. 212
Botti, V. 395
Bouvry, P. 191
Braga, R. 198
Breşfelean, M. 407
Breşfelean, V. 407
Brezillon, J. 403
Brezillon, P. 403
Brijs, K. 237
Brijs, T. 237
Brugger, D. 212
Cairns, D. 57
Calvo-Flores, M. 330
Caron, E. 119
Caroprese, L. 94
Carvalho, V. 310
Castro, A. 22
Castro, C. 356
Castro, M. 310
Cebulla, M. 113
Chan, C. 171
Chen, L. 420
Chen, Y. 39
Cho, N. 378
Clark, K. 399
Clouard, R. 271
Cocianu, C. 185
Coelho, P. 447
Comes, C. 407
Cowie, J. 57
Crawford, B. 356
Cremers, A. 63
Cuéllar, M. 204
Cuzzocrea, A. 152
Daniels, H. 119
Dantas, A. 411
Davidson, D. 57
Delgado, M. 204
Demigha, S. 468
Depaire, B. 237
Diaz-Gomez, P. 455, 459
Dignum, V. 504
Dimililer, K. 451
Dochev, D. 283
Dopichaj, P. 5
Elias, O. 492
Ermolayev, V. 231
Fakotakis, N. 424
Far, B. 178
Farias, O. 436
Férnandez, C. 330
Fernández-Caballero, A. 219
Furst, F. 265
Galindo, E. 330
Gallinari, P. 145
Gámez, J. 247
García, A. 492
Garšva, G. 416
Ghişoiu, N. 407
Girdzijauskas, S. 416
Giret, A. 395
Goldberg, D. 14
Golden, W. 303
Gonzalez-Morcillo, C. 336
Gopalkrishnan, V. 107
Görg, C. 225
Goyal, M. 165
Guerrero, J. 101
Guy, C. 159
Houari, N. 178
Hougen, D. 455, 459
Hudec, M. 374
Huster, J. 253

AUTHOR INDEX (CONT.)

Janicki, R. 297
Javadi, B. 370
Jentzsch, E. 231
Jiaguang, S. 69
Jianmin, W. 69
Jimenez-Linares, L. 336
Kaburlasos, V. 348
Kehal, M. 49
Kelemci, Ö. 474
Khashman, A. 451
Kirwan, O. 303
Kjellin, H. 76
Kopfer, H. 225
Kriksciuniene, D. 432
Kritski, A. 198
Kroha, P. 259
Kuck, J. 63
Kumar, M. 390
Lagos, C. 356
León, C. 101
Leung, H. 171
Levashova, T. 88
Li, X. 316
Liu, F. 39
Liu, H. 316
Liu, K. 159
Llorà, X. 14
Long, F. 420
Lu, J. 510
Lu, W. 316
Lundqvist, M. 88
Lyras, D. 424
Mahdavi, I. 370, 378
Maidantchik, C. 198
Manderick, B. 39
Martín, A. 101
Matzke, W. 231
Mello, F. 198
Mello, J. 447
Merkevičius, E. 416
Meza, L. 447
Mingchang, Z. 485
Molina, F. 101
Molloy, P. 303
Mulè, M. 322
Nagula, P. 289
Nair, H. 478
Negrillo, J. 330
Neto, L. 447
Ng, W. 316
Niu, L. 510
Novácek, V. 31
Oliveira, E. 22
Oppermann, R. 63
Palmisano, I. 428
Papadakis, S. 348
Paredes, F. 356
Pascale, G. 342
Pashkin, M. 88
Pegalajar, M. 204
Pennacchio, S. 322
Pereira, L. 363
Pessiot, J. 145
Petruzzellis, S. 428
Piattini, M. 498
Portillo, J. 498
Prats, F. 82
Prause, C. 63
Puerta, J. 247
Pung, H. 420
Qiao, B. 159
Raimondi, F. 322
Ramabadran, S. 107
Ramakrishnan, S. 289
Reichel, T. 259
Renouf, A. 271
Revenu, M. 271
Rezende, S. 310
Rosenstiel, W. 212
Rovira, X. 82
Ruiz, N. 395
Ruwei, D. 485
Sabet, S. 370
Sahebjamnia, N. 378
Sakalauskas, V. 432
Salmenjoki, K. 382
Sánchez, M. 82
Schönberger, J. 225
Seixas, J. 198, 411
Sekliuckis, V. 416

AUTHOR INDEX (CONT.)

Semeraro, G. 428
Seredynski, F. 191
Sgarbas, K. 424
Shirazi, B. 378
Silva, T. 436
Skaruz, J. 191
Skourlas, C. 348
Slavicek, J. 463
Smrcka, P. 463
Sohnius, R. 231
Sokolova, M. 219
Song, B. 316
Soto, J. 492, 498
Souza Filho, J. 198
Spruth, W. 212
Srihari, K. 289
State, L. 185
Staykov, B. 283
Stefanescu, V. 185
Stenfors-Hayes, T. 76
Sturek, J. 289
Svacinka, J. 463
Tamura, H. 14
Terziyan, V. 382
Tijus, C. 403
Timm-Giel, A. 225
Trefny, M. 463
Trefny, Z. 463
Trichet, F. 265
Troiano, L. 342
Trojan, S. 463
Trubitsyna, I. 94
Truong, T. 145
Tsaruk, Y. 382
Uchyigit, G. 399
Usunier, N. 145
Uyar, A. 474
Vagin, V. 277
Vallejo-Fernandez, D. 336
Vanhoof, K. 237
Vara, J. 492
Vassilev, V. 283
Vassileva, M. 283
Ventura, M. 82
Via, P. 322
Viegas, R. 363
Viitala, M. 382
Vizcaíno, A. 492, 498
Vlamos, P. 185
Vujošević, M. 374
Wanzeller, C. 137
Washida, Y. 14
Wenning, B. 225
Wets, G. 237
Wilson, C. 57
Xia, C. 485
Yaodong, L. 485
Yasui, N. 14
Yeremeyev, A. 277
Yingbo, L. 69
Zhang, G. 510
Zumpano, E. 94

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