

## Publications 2005

### *1. Peer-reviewed Journal Papers*

1. Tom Wanyama, Behrouz H. Far, "A Multi-Agent Framework for Conflict Analysis and Negotiation: Case of COTS selection," *Transactions of Institute of Electronics, Information and Communication IEICE, Special Issue of Software Agent and its Applications*, vol. E88-D, no. 9, pp. 2047-2058, 2005. 9.

**Abstract.** The process of evaluating and selecting Commercial Off-The-Shelf (COTS) products is complicated because of conflicting priorities of the stakeholders, complex interdependences among the evaluation criteria, multiple evaluation objectives, changing system requirements, and a large number of similar COTS products with extreme capability differences. Numerous COTS evaluation and selection methods have been proposed to address the complexity of the process. Some of these methods have been successfully applied in industry. However, negotiation to resolve stakeholder conflicts is still an ad hoc process. In this paper, we present a systematic model that assists the COTS selection stakeholders in identifying conflicts, as well as in determining and evaluating conflict resolution options. Our model is facilitated by an agent-based decision support system; which has user agents that assist the stakeholders in the COTS evaluation and negotiation process. The agents utilize a hybrid of analytic and artificial intelligence techniques to identify conflicts and the corresponding agreement options. Moreover, each user agent analyzes the agreement options in detail before advising its client about which goals to optimize, and which goals to compromise in order to reach agreement with the other stakeholders. Finally, the community of agents facilitates information sharing among stakeholders in a bid to improve the quality of their COTS selection decisions.

2. Behrouz H. Far, A. Halim Elamy, "Functional Reasoning Theories, Problems and Perspectives," *Artificial Intelligence for Engineering Design, Analysis and Manufacturing (AIEDAM)*, vol. 19, no. 2, pp. 75-88, 2005. 5.

**Abstract.** Functional Reasoning (FR) enables people to derive and explain function of artifacts in a goal-oriented manner. FR has been studied and employed in various disciplines, including philosophy, biology, sociology, and engineering design and enhanced by the techniques borrowed from computer science and artificial intelligence. The outcome of FR research has been applied to engineering design, planning, explanation and learning. A typical FR system in engineering design usually incorporates (1) representational mechanisms of function concept together with (2) description mechanisms of state, structure or behaviour and (3) explanation and reasoning mechanisms to derive and explain functions. As for representation, philosophers have long argued whether function of an artifact is a genuine property of it. As for explanation and reasoning, they have produced theories for functional ascription by an external viewer as part of an explanation. To build a FR-based system, the theory based on which the system is built and the underlying

assumptions must be explicitly identified. This point is not always clear in the engineering of FR-based systems. Understanding the underlying assumptions, logical formulation and limitations of functional reasoning theories will help developers assessing their systems correctly. The intended purpose of this paper is to review various functional reasoning theories, their underlying assumptions and limitations. This will later serve as a benchmark for comparing various FR techniques.

## 2. Chapter of the Books

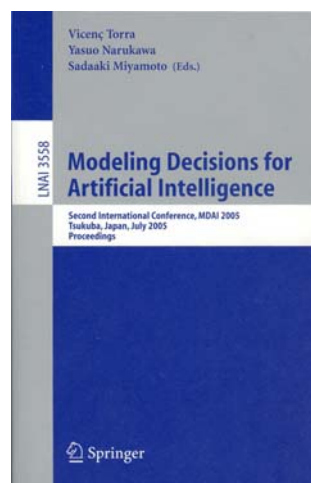
1. *Nora Houari and Behrouz H. Far, "A Novel Approach for Developing Autonomous and Collaborative Agents," Knowledge-Based Intelligent Information and Engineering Systems: 9<sup>th</sup> International Conference, KES 2005, Melbourne, Australia, September 14-16, Lecture Notes in Computer Science, Lecture Notes in Artificial Intelligence, Vol. 3683, Rajiv Khosla, Robert J. Howlett, Lakhmi C. Jain (Eds), pp. 8-15, ISBN: 3-540-28896-1, 2005. 9.*

**Abstract.** In this paper we present a novel approach that customizes the BDI model to define a so-called RBDIA: "Rapport – Belief – Desire – Intention – Adaptation" as a generic method to support progress from individual autonomous agent concept towards a collaborative multiple agents. Rapport here refers to the component that connects an agent to its environment, whereas Adaptation module incorporates mechanisms of learning. The contribution of this paper is twofold: first, we develop a novel modeling approach that enable us to combine the internal and social structures of collaborative multigent, and second the proposed methodology is applied to a real-world application for assistance in product development process. We believe that the five proposed tiers for multiagent systems (MAS) development serves for mastering the complexity and the difficulty of setting up effective autonomous collaborative MAS.



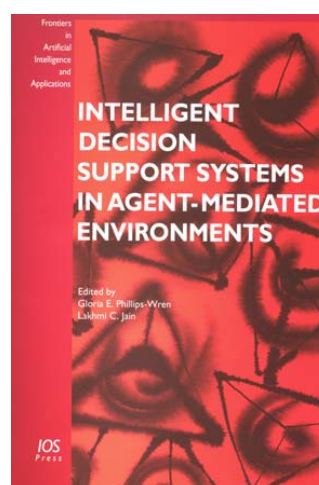
2. *Tom Wanyama and Behrouz H. Far, "Qualitative Reasoning Model for Trade-off Analysis," Modeling Decisions for Artificial Intelligence, 2<sup>nd</sup> International Conference, MDAI 2005, Tsukuba, Japan, July 25-27, 2005, Lecture Notes in Computer Science, Lecture Notes in Artificial Intelligence, Vol. 3558, Torra, Vicenç; Narukawa, Yasuo; Miyamoto, Sadaaki (Eds.), pp. 99-109, ISBN: 3-540-27871-0, 2005. 7.*

**Abstract.** In Multi-Criteria Decision Making problems such as choosing a development policy, selecting software products, or searching for commodities to purchase, it is often necessary to evaluate solution options in respect of multiple objectives. The solution alternative that performs best in all the objectives is the dominant solution, and it should be selected to solve the problem. However, usually the selection objectives are incomparable and conflicting, making it impossible to have a dominant solution among the alternatives. In such cases, tradeoff analysis is required to identify the objectives that can be optimized, and those that can be comprised in order to choose a winning solution. In this paper we present a tradeoff analysis model based on the principles of qualitative reasoning that provides visualization support for understanding interaction and trade-off dependences among solutions evaluation criteria which affect the trade-off among selection objectives. Moreover, the decision support system based on our trade-off analysis model facilitates discovery of hidden solution features so as to improve the completeness and certainty of the user preference model.



3. Behrouz H. Far, Guenther Ruhe, "Prescriptive Decision Support based on Software Agent Interaction," *Decision Support in Agent Mediated Environments, Chapter 7, pp. 161-186*, Gloria Phillips-Wren and Lakhmi Jain (Edts.), *Knowledge-Based Intelligent Engineering Systems Series, IOS Press B.V., 2005. ISBN 1-58603-476-6*.

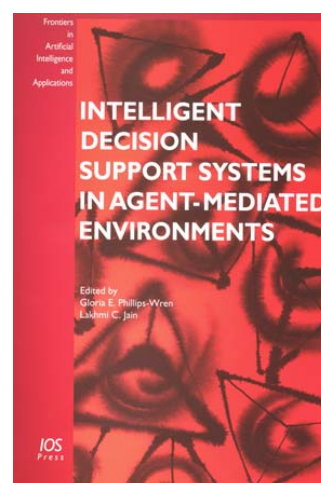
**Abstract.** The capabilities and offerings of decision support systems of today are extending the ones of the earlier days in terms of providing more flexible support. They help acquisition and handling large amounts of information and knowledge; better dissemination and resolving different perspectives; and better explanation to understand the provided support. For this purpose we strongly rely on multi-agent systems. Software agents are knowledgeable, autonomous, situated and interactive software entities. In the context of providing decision support, they have been designed and implemented for retrieving, screening, filtering of data, information and knowledge. This is called descriptive decision support. However, there is more and more emphasis to effectively and efficiently exploit all the information



available. We will call this prescriptive decision support and investigate the use of intelligent agents for that purpose. In a heterogeneous agent environment, the types of agent interactions supports the decision making process. We suggest an agent model by which we can clearly distinguish different agent's interaction scenarios. The model has five attributes: goal, control, interface, identity and knowledge base. Based on this, the agents are providing appropriate analytical support for different types of problem characteristics. Different modules (implemented as agents) are offered to address the respective problem type. Using the model, we analyze and describe possible scenarios; devise the appropriate reasoning and decision making techniques for each scenario; and build a library of reasoning and decision making modules that can be used to provide prescriptive decision support. We describe the implementation of this approach providing the process and the modules of an agent-based decision support system. The approach is illustrated by an online auction agency example.

4. *Mohsen Afsharchi, Behrouz H. Far, "Knowledge Orchestration Agency: Knowledge Management Using Intelligent Software Agents," Decision Support in Agent Mediated Environments, Chapter 3, pp. 71-89, Gloria Phillips-Wren and Lakhmi Jain (Edts.), Knowledge-Based Intelligent Engineering Systems Series, IOS Press B.V. , 2005. ISBN 1-58603-476-6.*

**Abstract.** Modern knowledge management solutions for enterprises must address three basic concerns: representation, distribution and management of knowledge resources. Three research challenges to address these concerns are XML based knowledge representation, peer-to-peer architecture and intelligent software agents, respectively. On the representation side, representing and encoding knowledge using XML has received much attention and has gained popularity. On the distribution and management side, a knowledge management paradigm that supports elicitation of individualized knowledge, allows multiplicity and heterogeneity of perspectives within organizations, and consequently maps organizational structure to technological architecture is needed. Peer-to-peer architecture and software agents acting as counterparts of their peers together are well suited to handle these tasks as well as complex interactions in social process of knowledge management. In this



article we explore structural requirements of distributed knowledge management and how to empower that with XML based knowledge representation, peer-to-peer architectures and software agents in order to build an orchestrated knowledge management system.

### **3. Peer-reviewed Conference Papers**

1. *Nora Houari and Behrouz H. Far, "Integrated Approach for Developing Autonomous and Interactive Software Agents," The 10<sup>th</sup> IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2005) September 19-22, 2005, Catania, Italy, 2005. 9.*

**Abstract.** An approach to extend the BDI model to define a so-called "DIBRA: Desire-Intention-Belief-Rapport-Adaptation" is proposed. Two additions, the Rapport is the component that connects an agent to its environment; the Adaptation module implements learning. In this paper we first propose a development approach that enables us to combine the internal and the interactive structures of multiagent system and then we use the method to address a real-world application targeting assistance in product development process.

2. *Pankaj Bhawnani, Behrouz H. Far and Guenther Ruhe, "Explorative Study to Provide Decision Support for Software Release Decisions," IEEE ICSM International Conference on Software Maintenance, Budapest, Hungary, Sept 25-30, 2005. 9.*

**Abstract.** The paper presents a reliability driven decision support approach to study the effects of defect repository patterns on software release decisions. The proposed approach called 6C evaluates the suitability of existing reliability models in guiding release decisions and provides different solution alternatives with respect to some project specific parameters for making such decisions. The case study presented reveals the impact of project and domain specific uncertainty factors such as risk, testing effort and target reliability on time to market decisions for the software release when the underlying assumptions made by existing reliability models are violated.

3. *Behrouz H. Far, and Mohsen Afsharchi "Extraction, Representation and Reuse of Software Design Knowledge," The 2<sup>nd</sup> CDEN International Conference on Design Education, Innovation, and Practice, 2005. 7.*

**Abstract.** In this research we focus on understanding the nature of the knowledge used during the various phases of the software development process. We have found that there are two types of knowledge involved in software development: (1) descriptive knowledge represented by conversion and coding rules, e.g., a rule for splitting a class into two; and (2) prescriptive knowledge required for deployment of global or local strategies at a micro design level; e.g., knowledge required to

answer the question “why should a class should be split into two?” Most of the already existing knowledge management solutions address descriptive knowledge. Elicitation and management of the prescriptive knowledge is difficult in the sense that it is probabilistic, personalized, distributed and context specific. Also we have found that prescriptive knowledge tends to be used in decision making processes involving multiple stakeholders with different perspectives (e.g., designer, tester, software architect and project manager). We also report on a prototype system called ISS-OKM to extract and reuse both the descriptive and prescriptive knowledge.

4. *Nora Houari and Behrouz H. Far, “DIBRA: A New Methodology for Autonomous and Interactive Software Agents Development,” The 4<sup>th</sup> IASTED International Conference on Computational Intelligence, CI 2005, July 4-6, 2005, Calgary, Alberta, Canada, pp. 176-181, 2005. 7.*

**Abstract.** In this paper we present an approach that customize the BDI model to define a so-called “DIBRA: Desire-Intention-Belief-Rapport-Adaptation” as a generic method to support progress from individual autonomous agent concept towards interactive multiple agents. Rapport here refers to the component that connects an agent to its environment, whereas Adaptation module incorporates mechanisms of learning. The contribution of this paper is twofold; first, we propose a development approach that enables us to combine the internal and the interactive structures of multiagent system; second, the proposed methodology is applied to a real-world application targeting assistance in product development process. We believe that the five proposed tiers for multiagent systems (MAS) development serves for mastering the complexity and the difficulty of setting up effective autonomous interactive MAS.

5. *Nora Houari and Behrouz H. Far, “Supporting Mutual Meaning Sharing in Multiagent Systems: A Semiotic-Based Approach,” International Conference on Cybernetics and Information Technologies, Systems and Applications (CITSA 2005) and the 11<sup>th</sup> International Conference on Information Systems Analysis and Synthesis (ISAS 2005), Orlando, USA, 2005. 7.*

**Abstract.** In this research we argue that a semiotics-based approach is an essential step to unlock the full potential of software agent system. Most of the already proposed frameworks suppose that agents are understood primarily when interacting. Such assumption may be unrealistic practically, for autonomous and heterogeneous agents. This supposition has never held for people, and for the same reason it will never hold for agents. In this work, we take into account that agent may often want to maintain their own individualized and private ontology, but still be able to identify the same concrete object when they are referring to the same meaning. In this paper we suggested a novel approach called EasyCoop well founded on the three elements of semiotics (syntax, Semantics, pragmatics), and based on probabilistic distributions for meaning understanding as a mapping from form to meaning conditioned by context. Such notions make our approach applicable to a broad range types of ontologies. We introduce a generic algorithm

(MCCL-Mutual Collaborate Concept learning) that extends classical concept learning from single to multiple agents setting, and takes into account different levels of collaboration task in multiagent system which determine the type of the adaptability (Modify, Merge, or Unchanged). We describe a set of experiments on several real world domains to evaluate the effectiveness of our approach, and finally, we review the related work and discuss the future work.

6. *Rajeev Babbar, Abraham O. Fapojuwo, and Behrouz H. Far, "Intelligent Resource Management in 3G (UMTS) Wireless Networks," The 17<sup>th</sup> International Conference on Wireless Communications, 11-13 July 2005, Calgary, Canada, 2005. 7.*

**Abstract.** In this paper, we investigate the use of agent technology for radio resource management in 3G wireless networks. The proposed scheme is based on collaborating agents and Open Agent Architecture (OAA) and addresses the problem of radio resource management (specifically bandwidth) in third generation (3G) such as Universal Mobile Telecommunication System (UMTS). Specifically addressed were the issues of call admission control and load balancing for the wireless network service provider. The effectiveness of the proposed scheme was demonstrated by analytical and simulation techniques. It is found that the proposed Agent-Based Resource Management (ABRM) scheme distributes the traffic load much more evenly compared to the non agent based approach. It also provided performance improvement on the order of approximately 400% reduction in call blocking and call dropping rates.

7. *Li Jiang, Armin Eberlein and Behrouz H. Far, "Combining Requirements Engineering Techniques - Theory and Case Study," 12<sup>th</sup> IEEE International Conference and Workshop on the Engineering of Computer-Based Systems, ECBS 2005, 2005.4.*

**Abstract.** Selection of requirements engineering (RE) techniques during software project development is a challenge for most developers. One of the reasons is that there is a great lack of requirements engineering education in most academic programs, so software developers have to learn requirements engineering practices on the job. This can easily result in the selection of techniques that are ill-suited for a particular project, as the selection is based on personal preference rather than on the characteristics of the project. Very little research has been done in the area of technique selection based on project attributes. This paper describes research into the selection and combination of RE techniques as well as a case study that applied the selection process to an industrial software project.

#### **4. Conference Presentations**

1. *Halim Elamy, Reda Alhaji, Behrouz H. Far, "Building Data Warehouses with Deferred Incremental Maintenance for Decision Support," 18<sup>th</sup> IEEE Canadian Conference on Electrical and Computer Engineering CCECE 2005, 2005. 5.*

**Abstract.** Data warehousing is an emerging technology that facilitates gathering

and integrating heterogeneous data from distributed sources and extracting information that can be utilized as a knowledge base for decision support. Once a data warehouse is built, we need to maintain it consistent with the underlying data sources, which always subject to dynamic updates. Much work has been done on manipulating and mining data warehouses. However, most of the published works pay no attention to the issue of building a complete data warehouse from scratch, and employing it as a crucial technique to support the decision making process. In this paper, we exhibit a comprehensive case study, based on utilizing a ready-made commercial database for designing and implementing a data warehouse (DW) with incremental maintenance capabilities. Furthermore, we will demonstrate the process of employing the constructed data warehouse as a decision support tool to provide the management with accurate, precise, and quick information, upon which decisions can be made.

2. Halim Elamy, Behrouz H. Far, “Utilizing Incomplete Block Design in Evaluating Agent-Oriented Software Engineering Methodologies,” *18<sup>th</sup> IEEE Canadian Conference on Electrical and Computer Engineering CCECE 2005*, 2005. 5.

**Abstract.** In the past couple of decades, agent-oriented technology has been arisen in order to assist in developing intelligent software that is able to solve challenging problems. More than twenty Agent-Oriented Software Engineering methodologies (AOSE) are presented in literature. Nevertheless, the immaturity of this emerging technology made developers run into extreme difficulties when deciding which methodology can best fit a prospective application. A little work has been conferred to compare and evaluate small numbers of agent-oriented methodologies. However, such related work lacks the reliable framework that can be effectively implemented; most of the proposed approaches are not capable to provide sufficient knowledge to support the decision of selection. In this paper, we present a more reliable framework that adopts statistical techniques to evaluate AOSE methodologies and come up with a set of metrics that help in selecting the most appropriate methodology, or assembling more than one, to accommodate the anticipated characteristics of the desired application.

3. Tom Wanyama, Behrouz H. Far, “Towards Providing Decision Support for COTS Selection,” *18<sup>th</sup> IEEE Canadian Conference on Electrical and Computer Engineering CCECE 2005*, 2005. 5.

**Abstract.** The evolution of software engineering has led to Component-Based Software Development, which in turn has engendered tremendous interest in the development of plug-and-play reusable software, leading to the concept of Commercial Off-The-Shelf (COTS) software components. The use of COTS is increasingly becoming commonplace. This is mainly due to shrinking budgets, accelerating rates of COTS enhancement, development time and effort constraints, and expanding system requirements. However, the process of selecting COTS products is characterized by a multiplicity of challenges, which should be addressed in order to harness the benefits of COTS-Based Software Development. In this paper we preset a model that splits the COTS selection process into layers;



basing on the (intra-layer) activities which affect the choice of a decision support to address a particular challenge. Moreover, we evaluate the COTS selection methods in the reviewed literature according to how they address the challenges. Finally we present the functionalities of an ideal Decision Support System (DSS) for COTS selection, as well as the techniques for achieving the functionalities.

4. Tom Wanyama, Behrouz H. Far, "Using Prediction to Provide Decision Support for the Elicitation of User Preferences," 18<sup>th</sup> IEEE Canadian Conference on Electrical and Computer Engineering CCECE 2005, 2005. 5.

**Abstract.** In Multi-Criteria Decision Making problems such as selecting development policies, selecting software products, or searching for commodities to purchase, it is necessary to have a precise model of the user preferences. Studies have revealed that often people are unable to state their preferences up front, and that they start to evaluate solution alternatives with a small set of high-value preferences; but change the value of those preferences as they discover other solution features which they can incorporate into their preference models. While, a variety of preference elicitation models have been proposed, limited or no effort has been made to utilize historical data to provide decision support for the elicitation of user preferences. In this paper, we discuss using neural net to take advantage of historical data, and provide decision support for developing user preference models, as well as preference value functions; from a set of high-value preferences. Moreover, we report results of using our technique to elicit the user preferences for evaluating and selecting a Commercial-Off-The-Shelf software component.

5. Adnan Ahmed, Behrouz H. Far, "Topology Discovery for Network Fault Management Using Mobile Agents in ad-hoc Networks," 18<sup>th</sup> IEEE Canadian Conference on Electrical and Computer Engineering CCECE 2005, 2005. 5.

**Abstract.** Managing today's complex and increasingly heterogeneous networks requires in-depth knowledge and extensive training as well as collection of very large amount of data. Fault management is one of the functional areas of network management that entails detection, identification and correction of anomalies that disrupt services of a network. The task of fault management is even harder in ad-hoc networks where the topology of the network changes frequently. It is very inefficient if not impossible to discover the ad-hoc network topology using traditional practices of network discovery. We propose a mobile multi agent system for topology discovery that will allow fault management functions in ad-hoc network. Comparison to current mobile agent based topology discovery systems is also presented.

6. Junling Huang, Behrouz H. Far, "Intelligent Software Measurement System (ISMS)," 18<sup>th</sup> IEEE Canadian Conference on Electrical and Computer Engineering CCECE 2005, 2005. 5.

**Abstract.** Intelligent Software Measurement System (ISMS) is a multiagent

knowledge-based system that automates the ten-step Goal-Driven process to produce a software measurement plan based on user's particular business goal(s). The initial task of converting a high-level business goal to several low-level measurement goals has already been accomplished. In the second phase of the ISMS project we concentrate on the core task of automating the conversion of a set of measurement goals to a software measurement plan which involves measures and corresponding actions. The ISMS architecture and software agents (PAs and EAs) are further designed to facilitate the process of the second phase of ISMS with respect to system learning and knowledge updating. Considering the variety and complexity of software measures and actions, an ontology for software measurement is defined and used to build the ISMS software measurement knowledge base.

7. *Nora Houari, Behrouz H. Far, "Building Collaborative Intelligent Agents: Revealing Main Pillars," 18<sup>th</sup> IEEE Canadian Conference on Electrical and Computer Engineering CCECE 2005, 2005. 5.*

**Abstract.** Software agents are persistent, knowledgeable, autonomous, collaborative, and learnable entities. One important feature of software agents is the ability to interact and communicate as a team to achieve more than they could individually. Although the Belief-Desire-Intention (BDI) agent model is possibly the best known and used model of practical reasoning agent; nevertheless, this model does not address the key concept of how individual agent learn from the environment and manipulate itself to collaborate with others. In this paper we present a novel approach that customize the BDI model to define a so-called "RBDIA: Rapport-Belief-Desire-Intention-Adaptation" as a generic method to support progress from individual autonomous agent concept towards a collaborative multiple agents. Rapport here refers to the component that connects an agent to its environment, whereas Adaptation module incorporates mechanisms of learning. We believe that the five proposed tiers for multiagent systems modeling serves for mastering the complexity and the difficulty of setting up effective autonomous collaborative MAS.