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Computational Intelligence in Decision and Control

Proceedings of the 8th International FLINS Conference

Da Ruan
Javier Montero
Jie Lu
Luis Martínez
Pierre D'hondt
Etienne E Kerre
editors

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Computational Intelligence in Decision and Control

FLINS, originally an acronym for Fuzzy Logic and Intelligent Technologies in Nuclear Science, is now extended to Computational Intelligence for applied research. The contributions to the eighth edition in the series of FLINS conferences cover state-of-the-art research, development, and technology for computational intelligence systems in general, and for intelligent decision and control in particular.

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Computational Intelligence in Decision and Control

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editors

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Foreword

FLINS, an acronym originally for **F**uzzy **L**ogic and **I**ntelligent Technologies in **N**uclear **S**cience (1994), has been launched in line with the Belgian Nuclear Research Centre (SCK•CEN)'s objective to give PhD and Postdoc researchers the opportunity to carry out future-orientated research. FLINS was initially built within one of the above-mentioned postdoc positions. Now fourteen years later FLINS has been extended to *Computational Intelligence in Decision and Control* (2008) to advance the theory and applications of decision making and control for complex systems related research in particular. FLINS'08 is the eighth in a series of conferences on computational intelligence systems. It follows the successful FLINS'94 in Mol, FLINS'96 in Mol, FLINS'98 in Antwerp, FLINS'00 in Bruges, FLINS'02 in Gent, FLINS'04 in Blankenberge, Belgium, and FLINS'06 in Genova, Italy. FLINS'08 in Madrid, Spain, once again aims at covering state-of-the-art research and development in all aspects related to *Computational Intelligence in Decision and Control*. The principal missions of FLINS are: (1) conducting research on computational intelligence systems for solving intricate problems pertaining to nuclear/power research and related complex systems; (2) bridging the gap between machine intelligence and complex systems via joint research with Belgian, European, and international research institutes and universities; and (3) encouraging interdisciplinary research and bringing multi-discipline researchers together via the international FLINS conferences on computational intelligence systems.

FLINS'08, organized by Complutense University, Madrid, Spain, co-sponsored by the Belgian Nuclear Research Centre (SCK•CEN), Ghent University (UGent) in Belgium, Complutense University, Technical University of Madrid and the Government of Spain, and co-supported by University of Alcalá de Henares, the Interdisciplinary Institute of Mathematics of Madrid (IMI), European Centre for Soft Computing in Spain and European Society for Fuzzy Logic and Technology (EUSFLAT), offers a unique international forum to present and discuss techniques that are new and promising for *Computational Intelligence in Decision and Control* and to launch international co-operations.

The FLINS'08 proceedings consist of a series of invited lectures by distinguished professors and individual presentations, in a total of 184 papers selected out of 292 regular submissions plus 6 invited plenary and semi-plenary papers from 35 countries. The 3 plenary lectures are: (a) *Soft computing applications in prognostics and health management* by Piero Bonissone (General Electric, USA), (b) *Knowledge sharing and collaboration in fuzzy* *processing* by Witold Pedrycz (University of Alberta, Canada), (c) *Why do fuzzy representations need a careful design* by Enric Trillas (European Centre for Soft Computing, Spain), and the 3 semi-plenary lectures are: (d) *SCK•CEN: The Belgian Nuclear Research Centre research towards a sustainable option* by Pierre D'hondt (SCK•CEN, Belgium), (e) *New information processing methods for control in magnetically confinement nuclear fusion* by Andrea Murari (Consorzio RFX/ENEA EURATOM, Spain), (f) *What is Soft Computing? Revisiting possible answers* by Luis Magdalena (European Institute for Soft Computing, Spain). Each of the 6 invited papers is embedded as the first paper in the 6 contributed parts, respectively, in the proceedings: (I) Data Analysis and Information Processing, (II) Knowledge Representation and Learning, (III) Classification, Clustering, and Aggregation Techniques, (IV) Decision Making and Risk Analysis, (V) Decision Support Systems and Web Intelligence, and (VI) Control and Industrial Applications.

We are pleased to announce the launch of a new international journal on *Computational Intelligence Systems* in line with FLINS activities by Atlantis Press in Paris. The journal will also publish selected and extended papers from FLINS'08 in the near future. At the same time, we are happy to embed the FLINS'08 proceedings into the World Scientific Proceedings Series on *Computer Engineering and Information Science*.

Thanks are due to all contributors, referees, regular and invited sessions' chairs, and program committee members of FLINS'08 for their kind co-operation and enthusiasm for FLINS'08; to Pierre D'hondt and Etienne Kerre for their roles as FLINS advisors and program chairs of FLINS'08; to Jie Lu and Luis Martínez for their co-working as program co-chairs of FLINS'08; to Javier Montero (the local organization chair of FLINS'08 in Madrid) for his great leadership and efforts to make FLINS'08 a success and to the whole team of the local organization, including L. Garmendia, V. López, J.A. Martín, S. Muñoz, T. Ortuño, M. Santos, G. Tirado, J. Yáñez, especially to D. Gómez and B. Vitoriano for both of their key roles that made the proceedings of FLINS'08 possible in a timely manner, and to Chelsea Chin (Editor, World Scientific) for her kind advice and help to publish this volume.

Da Ruan, FLINS'08 General Chair
Mol & Gent, May 2008

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Implementation of a Mobile Group Decision Making Support System with Incomplete Information

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In this contribution we present some working implementations of a mobile group decision making support system that allows to deal with experts' preferences expressed by means of fuzzy preference relations. The system supports incomplete information situations, that is, the situations where the experts do not give all the preference values that they are usually requested. Several implementations have been created in order to compare the advantages and disadvantages of different existing mobile technologies in both the client and server sides of the system.

Keywords: Group Decision Making, Decision Support System, Incomplete Information, Mobile Technologies

1. Introduction

Group Decision Making (GDM) consists of multiple individuals interacting in order to reach a decision. Usually, each decision maker (expert) may approach the decision process from a different angle, but they have a common interest in reaching an agreement on selecting the best decision.[4] To do so, experts are usually required to provide their preferences about the alternatives of the problem by means of a particular preference structure or format. Additionally, as current communication technologies improve, it is possible to carry out distributed decision processes where the experts do not need to meet together in order to reach a solution for their decision problem. Moreover, mobile technologies may allow the experts to commu-

nicate their preferences to solve the problem from almost everywhere. So, there is a need to study the different existing mobile technologies in order to be able to provide the experts with the appropriate tools to carry out distributed decision processes in an efficient and easy way.

In this contribution we present several working implementations of a mobile GDM support system based on an existing GDM model[2] which allows to solve decision problems where experts do not need to meet together to express their preferences, since they are provided with a mobile device and processed in a central server. The implementations are able to deal with information expressed using fuzzy preference relations[2,3] and with incomplete information situations,[1,3,6] that is, the situations where the experts do not provide all the preference values that they are requested. The different implementations offer the same options to the different experts, but they are created using different technologies (web, Adobe Flash Lite, .NET Web Services and Servlets + Java ME) which allow the experts to use the system with a very wide range of mobile devices. Additionally, with those implementations, we are able to compare the different advantages and disadvantages of each mobile technology for the GDM field.

The paper is set as follows: In section 2 we briefly present the GDM model in which the support system implementations are based. In section 3 we describe the system architecture. In section 4 we present the different implementations of the support system and discuss some advantages of the different technologies. Finally, some conclusions and future work are presented in section 5.

2. Preliminaries

In this section we briefly describe the GDM model in which the different implementations are based. For a more detailed description of the model, check.[2]

In this model we assume that a GDM problem consists on a set of experts $E = \{e_1, \ldots, e_m\}$ that have to choose among a set of feasible solution alternatives $X = \{x_1, \ldots, x_n\}$. We assume that experts express their preferences by means of fuzzy preference relations:[2,3]

Definition 2.1. A fuzzy preference relation P on a set of alternatives X is a fuzzy set on the product set $X \times X$, i.e., it is characterized by a membership function $\mu_P \colon X \times X \longrightarrow [0,1]$.

This definition is extended to support the situations where experts do not provide complete fuzzy preference relations, but incomplete ones, that is, relations where some of the preference values are not given.

In the model, the additive transitivity property given by Tanino[5] is used in order to estimate the missing values in the relations and to compute some consistency measures at three different levels (preference degree level, alternative level and relation level).

Once the experts provide their fuzzy preference relations and the system computes the consistency measures for each preference relation, several consensus measures are obtained at the same three levels. Particularly, some consensus degrees are used to measure the current consensus level of the process and some proximity measures give information about how close to the collective solution every expert is. At this point the system checks the current consistency and consensus state and if it is not good enough (there is not enough consistency / consensus) the system produces some recomendations to the experts based on the preferences that they provided and the consistency and consensus measures that have been computed in order to start a new consensus round in which they could change their preferences to narrow their differences and thus to obtain a solution of consensus. In the case that the consistency / consensus state is good enough, the system aggregates the preferences of the experts and applies a selection process to obtain the final solution to the problem. The whole GDM model is depicted in fig. 1(A).

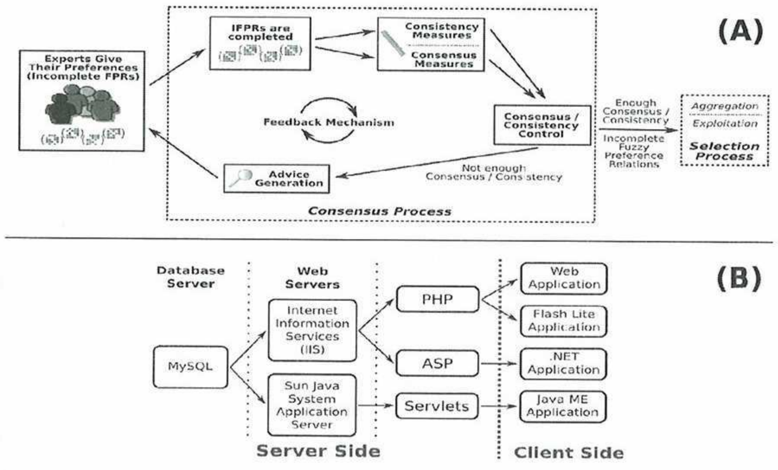

Fig. 1. (A) GDM model scheme, (B) System Architecture

3. System Architecture

In order to be able to deploy the different implementations of the group decision support system, several software packages have been installed on a central server. At the bottom of all the different technologies that have been used we find the database server (MySQL in our case). All the different technologies do use the same database and consecuently, they share all the data, which allow the different users to use any of the different implementations in every step of the process. On top of the database, 2 different web servers are installed. The first one, Internet Information Services (IIS) is configured to be able to work with both ASP (Active Server Pages) and PHP (Hypertext Preprocesor). The latter is Sun Java System Application Server, which allows to use Servlets on the server side. Above these servers we finally have the four implementations of the group decision support system. The first one is a "classical" web approach and the second one is an Adobe Flash Lite application. Both use IIS with PHP for the communication with the server. The third implementation is a .NET application that uses IIS with ASP for the communication with the server. Finally, the fourth implementation is a Java ME (Micro Edition) application that uses the Servlets to communicate with the server. This is depicted in fig. 1(B).

4. Support System Implementations

In this section we describe the four implementations of the GDM support system and we point out the advantages and disadvantages of every one of them. Those advantages and disadvantages are usually imposed by each one of the technologies used in each particular implementation.

First, we must note that every support system has to provide an appropriate interface to the experts, not only when they are providing their fuzzy preference relation, but also when showing the information about the problem to the experts and when the system gives recommendations at the advice generation step. For every implementation several problems have been faced, but one which is common for this kind of systems is the reduced screen and the limited input keyboards that are present in the majority of the mobile devices.

Web Implementation: This first implementation is the easiest one. The output of the information is given in form of web pages (HTML) and the inputs provided by the experts is gathered by means of simple HTML forms. The main advantage of this approach is that it is easily implemented without any explicit knowledge about mobile devices and technologies. Also, it can be used in a wide range of devices, from usual computers to laptops and tablet PCs. However, this implementation is not usually suitable for small and more limited devices as PDAs and mobile phones as the browser capabilities on this kind of devices is usually quite limited. Moreover, usual web pages are not easily displayed in small screens, and thus, the forms that the experts have to use to provide their preferences turn out to be confusing.

Adobe Flash Lite Implementation: Flash Lite is a proprietary solution from Adobe, specially designed to create mobile applications in a wide range of mobile devices. Thus, it is designed taking into account the difficulties present in those kind of devices, as for example the limited screen space and the navigation using a limited keyboard. Additionally, as it is usual with Flash applications, the interface can be highly customised in order to create an attractive application, including icons, scrolling elements, tooltips and even sounds which help the experts to use the system (see fig. 2). However, there also exist some drawbacks for this technology, as for example, that it is a non-free solution and that to exploit all its interface benefits it is necessary to have a deep insight in the Adobe Flash technology. The communication with the server is made by means of *http* requests, which involves parsing the information generated by the web server.

.NET Implementation: This proprietary solution from Microsoft offers some interesting characteristics to deploy this kind of mobile support systems. For example, the communication between the client application and the server is simple as there exist explicit communication mechanisms between the interface elements in the client side and the server information structures. Additionally, the input elements that this platform offers for mobile devices (input boxes, scrolling elements, combo boxes...) have a consistent look with many other .NET applications which makes it look more familiar even to the experts that have not deal with it in the past (see fig. 2). Some drawbacks are that this is a non-free technology and that only high-end mobile devices (usually PDAs) can deal with .NET applications.

Servlets + Java ME Implementation: This implementation has been constructed using Servlets on the server side and Java ME on the client side. This allows to have a clear communication scheme between both sides as it incorporates mechanisms to transparently receive and send information from and to the server. One of the main advantages of this implementation is that Java ME is a technology that is being incorporated into many mobile devices as a standard, and so, it is possible to run this application even in some low-end mobile phones. Among the different difficulties to deploy the Java ME application we have that Java ME does not incorporate floating

point support, and thus, to introduce and validate fuzzy inputs implies more work than in other platforms.

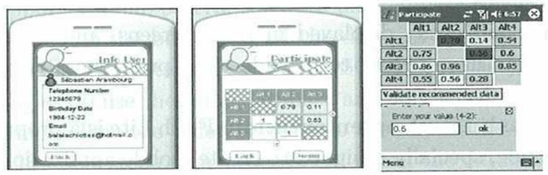

Fig. 2. Screenshots for the Flash Lite (left, center) and the .NET applications (right)

5. Conclusions and Future Work

In this contribution we have presented some working implementations of a mobile support system for GDM which allow the experts to use the system from a wide range of mobile devices. We have also pointed out some of the advantages and disadvantages of each one of the technologies in order to compare them for this particular kind of problems. In the future we will improve those implementations to allow the use of different kinds of preference structures and we will incorporate some methods to help the experts to complete the preference relations that they introduce in a consistent way, thus minimizing the effort of expressing their preferences.

Acknowledgments

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References

1. A.Ok. Efe, *Utility representation of an incomplete preference relation.* Journal of Economic Theory **104** (2002) 429–449
2. E. Herrera-Viedma, S. Alonso, F. Chiclana, F. Herrera, *A Consensus Model for Group Decision Making with Incomplete Fuzzy Preference Relations*, IEEE Transactions on Fuzzy Systems **15:5** (2007) 863–877
3. E. Herrera-Viedma, F. Chiclana, F. Herrera, S. Alonso, *A Group Decision-Making Model with Incomplete Fuzzy Preference Relations Based on Additive Consistency.* IEEE Transactions on S.M.C., Part B, **37:1** (2007) 176–189
4. G.H. Marakas, *Decision Support Systems in the 21th Century*, 2nd edition, New Jersey: Pearson Education, Inc., 2003
5. T. Tanino, *Fuzzy preference orderings in group decision making.* Fuzzy Sets and Systems **12** (1984) 117–131
6. Z.S. Xu, *Goal Programming Models for Obtaining the Priority Vector of Incomplete F.P.R.*, Int. J. of Approximate Reasoning, **36** (2004) 261–270