Preface

To lead an orchestra, you must turn your back on the crowd

Quality is not an act, it is a habit. - Aristotle (384-322 BC)

Human learning occurs as part of education, interpersonal development and training (lifelong learning). Blended (b)-learning, in particular, seen as an imaginative solution, although imprecise and evolving concept, has the potential to balance out and optimize the learning development in different delivery modes, embedded in the idea that learning is not just a one-time episode, but also a continuous and dynamic process. At the same time, through technology intermediation, the Fuzzy Logic (FL) (blended) concept, seen as an extension of multivalued logical system, can be explored to explain and solve problems in the same way that humans do, dealing with imprecise information, such as inexact measurements or available expert knowledge in the form of verbal descriptions. Moreover, artificial intelligence technologies play an important role in network collaboration, due to their advanced features and adaptive functionality. They contribute to proper support the users, by allowing adaptive modeling of their collaborative interactions, in order to successfully track their individual skills and beliefs. To this purpose, empirical data based models (EDM), which are mined from the large amount of data that are logged by the system during the computer-mediated interactions, may be used. The EDM rely on the fact that the intrinsic features of the observed interactions and their mutual interrelations can be learned from the data, using a great number of simultaneously co-operating simple processing units or operations. This approach allows the extraction of information (knowledge) from these low-level data into other forms that might be more abstract. Works in the area of EDM include the analysis of the quality of peers’ interactions and the modeling of the sequence of productive interactions.

When the analysis of peers’ interactions employs inference abilities to provide predictive utterances, the supporting system becomes even more enhanced. Yet, system modeling based on conventional mathematical formulation, is not well suited for dealing with uncertain systems, such as human behavior. A need for a more flexible approach is evident in the field. This is covered when considering EDM that make use of fuzzy inference system (FIS), utilizing FL to combine numerical and linguistic data to model the qualitative aspects of human knowledge and reasoning processes without employing precise quantitative analysis. For enhanced performance, FIS could be combined with adaptive networks. The latter are network structures consisting of nodes and directional links through which the nodes are connected. Part or all of the nodes are adaptive; hence, each output of these nodes depends on the parameters
pertaining to this node. The learning rule specifies how these parameters should be changed to minimize a prescribed error measure. By embedding the FIS into the framework of adaptive networks, we obtain the neurofuzzy-model structure that adaptively maximizes the performance index through Adaptive Network-based FIS (ANFIS).

As it is apparent from the aforementioned, a variety of possibilities and challenges could be identified in the world of FL; the same, however, could be stated for the educational world. In this vein, merging of the two worlds, sets the universe of discourse of this book, upon which deterministic descriptions of fuzzy approaches take place!

THE CHALLENGES

In this book, the variety of the FL-based models (e.g., Mamdani, Sugeno FIS, neuro-fuzzy, intuitionistic, fuzzy concept mapping) that try to efficiently model the collaborators’ skills and beliefs within computer-mediated collaborative and b-learning are introduced. The modeling approaches analyze collaborative and metacognitive data, captured through peers’ collaborative activity and beliefs on the quality of their collaboration, respectively. Based on these data, the presented models manage, through training procedures, to extract the collaborative strategy adopted by the peers, independently of the task-content. When adequately trained, the models could lead to generalization on each peer’s collaborative behavior, thus providing predictions on his/her collaborative activity in a forthcoming collaborative session. Based on this modeling, individual support could be provided to each peer that could contribute to improve his/her collaboration management. This process could lead to efficient metrics, like Quality of Collaboration (QoC), balance of collaborative activity (BCA), which in turn could be combined with the Quality of Interaction (QoI), derived from the transfer of fuzzy modeling approach within the b-learning context. In this way, hybrid FL-based models could be formed to merge current advances in computer-supported educational tools with peer’s collaborative skills and believes.

The overall challenges of the present book can be classified into four categories, namely:

- The challenge of presenting the concept of FL and its functional transfer to the educational context,
- The challenge of introducing efficient FL-based modeling approaches,
- The challenge of providing flexible metrics (e.g., QoC, BCA, QoI) that increase the intelligence of the supporting educational mechanisms and, thus, could initiate adaptive and productive feedback to the users, and
- The challenge of revealing behavioral aspects of peers’ within the context of collaborative and blended learning.

Essentially, the challenge of the present book is to provide new modeling insights in the field of computer-supported collaborative and b-learning from a FL-based perspective, so to boost the intelligence of the Learning Management Systems (LMSs) and collaborative supporting environments towards the enrichment of peers’ learning experience, resulting in a positive outcome, in terms of user generated knowledge and development of skills.

The main methodological approaches introduced in this book are based on FL. The latter, defines fuzzy systems, which are an alternative to traditional notions of set membership and logic that has its origins in ancient Greek philosophy, and applications at the leading edge of Artificial Intelligence. Yet,
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despite its long-standing origins, it is a relatively new field, and, as such, leaves much space for development. Expert systems have been the most obvious recipients of the benefits of FL, since their domain is often inherently fuzzy. Examples of expert systems with FL central to their control are decision-support systems, financial planners, and diagnostic systems for determining soybean pathology. Another area of application, akin to expert systems, is that of information retrieval. Fuzzy systems, including FL and fuzzy set theory, provide a rich and meaningful addition to standard logic. The mathematics generated by these theories are consistent, and FL may be a generalization of classic logic. The applications which may be generated from or adapted to FL are wide-ranging, and provide the opportunity for modeling of conditions. Many systems may be modeled, simulated, and even replicated with the help of fuzzy systems, not the least of which is human reasoning itself.

To this end, the present book facilitates the transfer of the aforementioned potentiality of FL to the field of education, with the latter being approached by the collaborative and b-learning aspects. In this way, the book will add to a knowledge construct of Information and Communication Technologies (ICTs)-based learning, shedding light upon the efficient modeling of learners’ behavior as expressed through their quality/balance of collaboration and quality of interaction.

ROOTING

Despite the reported applications of FL seen so far in many research fields, the use of FL in the field of education has only gained significant attention in the last decade. Gisolfi et al. (1992) and Fourali (1994; 1997) were from the pioneers who applied FL in the field of education for measuring student modeling and educational achievement, respectively, foreseeing the FL contribution in the social sciences (Fourali, 1997). Bassey (2001) has extended the notion of FL into the field of generalization, by proposing the idea of “fuzzy generalization” in educational research and across other social sciences. Other indicative examples of FL-based approaches in the field of education and collaborative learning refer to the work of Mullier (1999) and Kavčič (2001), for enhancing educational hypermedia; Kavčič et al. (2003), for student modeling based on fuzzy inference mechanisms; Barros and Verdejo (1999), Hadjileontiadou et al. (2003, 2004) for modeling peers’ collaborative interactions during collaborative learning; Hadjileontiadou and Hadjileontiadis (2003), for efficiently modeling skills and beliefs in computer-mediated collaboration using neuro-fuzzy models; Gravani et al. (2007) for FL-based modeling of professional learning. Moreover, Hwang et al. (2004) proposed a fuzzy system to evaluate the quality of educational Web sites by users’ and experts’ opinions. Ma and Zhou (2000) proposed a fuzzy set approach to assess the outcomes of student-centered learning. Capaldo and Zollo (2001) used FL to a rating problem in personnel assessment. Dweiri and Kablan (2006) presented an approach that employs fuzzy decision making for the evaluation of the project management internal efficiency. Within the concept of b-learning, Méndez and González (2010) proposed the inclusion of a FL-based controller for an introductory control engineering course. Moreover, Fasel and Zumstein (2009) introduced a fuzzy warehouse approach for Web analytics, whereas Lin (2010) proposed a fuzzy evaluation model for prioritizing the relative weights of course website quality factors. Tseng (2010) introduced a fuzzy network balanced scorecard for university performance evaluation, whereas Huang and Huang (2010) introduced an integrated decision model for evaluating educational web sites from the fuzzy subjective and objective perspectives. More recently, Dias and Diniz (2013) have proposed a FL-based modeling to estimate the LMS users’ quality of interaction within a b-learning environment.
SEARCHING FOR A SOLUTION

So far, works focused on QoI usually employ statistical analysis of LMS data, combined with transcripts of the discussions and exchanges of teacher and learners within the online forums, specifically investigating the dimension, depth and category of exchanges occurred (Ping, 2010). In general, adopting a systemic (macro-, meso, -micro) approach, the goal of the present book is to introduce a FL-based model that could take into account the interactions, as expressed through the LMS usage within a b-learning environment; by translating the knowledge of the experts in the field to fuzzy constructs, estimation, in a quantitative way, of a normalized index of the users’ QoI is feasible. The latter, then, can be used to identify user-dependent and user-independent (group-like) (dis)similarities in LMS interaction trends, correlations, distributions and dependencies with the time-period of the LMS use. In a similar fashion, the FL approach of the QoC and balance of collaborative activity (BCA) are also introduced. The adoption of FL-based modeling is due to the flexibility the fuzzy set exhibits over the crisp one in defining the way its elements exist within the set. In particular, for a crisp set, the elements of the set definitely do belong to the set, while in a fuzzy set its elements have a degree of membership in the set. In this way, FL forms a bridge between the two areas of qualitative and quantitative modeling. Although the input (e.g., users’ LMS metrics, collaborative interactions)-output (e.g., normalized index of users’ QoI, QoC, BCA) mapping of such a model is integrated into a system as a quantitative map, internally it can be considered as a set of qualitative linguistic rules that could be used to model the type of vague or ill-defined systems (such as the multi-parametric users’ interaction with LMS) that are difficult to handle using conventional binary valued (crisp) logic (Tsoukalas & Uhrig, 1996). The latter prove the efficiency of the approaches that are examined in the book, to shed light upon underlying aspects that relate with the construction of users’ interaction behavior under the LMS-based blended and collaborative learning approach.

THE UNIT OF THE BOOK

Considering the global organization of the present book, structured around a series of cases studies at three public Higher Education Institutions (from Greece (i.e., Open University and Aristotle University of Thessaloniki) and Portugal (i.e., University of Lisbon)) and four distinct Parts with corresponding Chapters, were articulated. A brief description of each Part follows:

- Part I (Chapters 1-5): Educational-ICT Background. Based on a critical review of the current literature, important educational issues related with the concepts of Online Learning Environments, Computer-Supported Collaborative Learning, Collaborative Learning, Blended-learning, Learning Management Systems, Cloud Learning Environments, Semantic Web 3.0 and Ontologies are introduced and discussed in this first Part, offering, to the reader the necessary educational background for sensing the “educational aroma” of the tackled issues explored in this book. The motivation behind this explorative Part I is the contribution to the understanding of the complex process of online learning, taking into account educational issues, such as collaboration and b-learning, placed within new context of enhanced technological mediators. From this perspective, an identified future research trend refers to the improvement of both personalization aspects and automatic adaptivity features of LMSs matching learners’ needs/preferences. At the same time,
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an important change should be considered towards a more personalized, social, open, dynamic, emergent and knowledge-pull model for learning, as opposed to the one-size-fits-all, centralized, static, top-down, and knowledge-push models of traditional learning solutions.

- Part II (Chapters 6-8): Fuzzy-Logic: Definitions and Inference Systems. This Part describes the fuzzy-logic (FL) essentials and inference systems were followed, presenting useful background for entering the mathematical expression of the knowledge representation in the fuzzy world. Additionally, methodological approaches such as Fuzzy Inference System (FIS), Adaptive Neuro-Fuzzy Inference System (ANFIS), Intuitionistic Fuzzy Inference System (IFIS), and Fuzzy Cognitive Map (FCM) are introduced and explored here, surfacing their potentialities in modeling applications. In this way, the FL seems a natural choice to approach a complex environment, trying to capture the underlying information that could enhance the knowledge and understanding of the online learning evolution. Here, the FL provides the means to make computers work with those same terms, rather than the artificial and arbitrary categories imposed by binary logic. Finally, in the context of education and online learning, this approach can offer the combination of the human learning with human-computer interaction, embedding uncertainty, stemming from the variety of views and beliefs of the stakeholders in the field.

- Part III (Chapters 9-14): FIS-Based Modeling Approaches in Learning. This Part consists of six chapters, that mainly connect the fuzzy with the educational world, from a systemic approach, giving a review of FL-based methodologies/applications related with the education domain. The main methodological approaches presented in Part II are considered as a means to better understand the coexistence of both worlds. Basically, analytical FL-based applications of the way each one is placed within the educational context are presented and discussed. In this Part, the main FL-based modeling approaches are presented, addressing exciting issues within educational scenarios, surfacing the importance of modeling features, such as the QoC, BCA and QoI, that could further enhance the educational practice and positively affect and expand the instructional design.

- Part IV (Chapters 15-16): Overall Perspective. In this final Part, the modeling methodologies previously presented are reconsidered, envisioning a prospective hybrid modeling scheme, in an effort to integrate the FL concept within the educational context of the 21st century from a dynamic and systemic perspective. In other words, these final Chapters propose/discuss a hybrid approach, involving FL-based modeling, as vehicles to improve the personalization and intelligence of an OLE within the concept of semantic Web and the associated Web 3.0 features, leading to the closure of the book general considerations and probing further thoughts with ample space for emancipated critical reflections related with the trends and FL modeling perspectives under collaborative and b-learning concept.

AUDIENCE

The concept of fuzzy logic (FL) has a very comprehensible character that facilitates its understanding even from the readers that do not come from the engineering field. Combined with the field of education, it is anticipated that the book primarily would reach educators, academic libraries, teachers, academic researchers, LMS administrators, LMS Moodle designers and professionals (specialists and non-specialists) with an interest about LMS-based electronic/collaborative/affective/blended-learning modality and designing collaborative learning settings, along with engineers that deal with educational
data analysis, affective computing and data modeling. The book could be used both as an aid to understand the underlying mechanisms in the behavior and interaction of the learners with the computer-based educational tools and to design more intelligent Online Learning Environments (iOLEs). Furthermore, the book could also be adopted in Postgraduate courses in the areas of Educational Technology, Social Research Methodology and others courses related to ICT sociocultural environment, as well as to be used as a means to inform education leaders (especially department heads) and policymakers, secondary school administrators, or other related professionals.

**FINAL NOTES**

**IF** the following questions sound intrinsic to you and to your own experience, **THEN** this book fits absolutely to you:

*What are the key channels to change in blended and collaborative instructional practice as they relate to the use of an online learning environment (OLE)? What role fuzzy logic-based modeling plays in facilitating change in educational practice? Can we model users’ QoC and QoI with OLEs? How hybrid modeling and affectiveness could lead to a personalized intelligent OLE?*

These questions are placed on an educational context that encapsulates the dynamic and extraordinary speed of technological advances. Apparently, this has a significant effect on the way we live, learn, think, work and communicate. From our perspective, we believe that technology should enrich rather than compete with human skills. Here, the efficiency and success are based on the creation of innovative processes/routes that empower interaction and collaboration. As we innovate, we should continue to rethink and be proactive with focused research, offering new guidelines/recommendations as needed, taking into account the users’ contexts and needs.

As a bottom line, the present book tries to offer a functional scaffold for effectively approaching a robust framework, integrating sophisticated data analysis and fuzzy logic-based modeling techniques in the field of online education. Clearly, our intention is to offer useful information that would evoke initiatives towards rethinking of the value and efficiency of c- and b-learning environment, both by the educators, the LMS/OLE designers and educational policy decision makers. It is our hope that the reader would appreciate and follow such endeavor.

*Sofia J. Hadjileontiadou*
*Hellenic Open University, Greece*

*Sofia B. Dias*
*Universidade de Lisboa, Portugal*

*José A. Diniz*
*Universidade de Lisboa, Portugal*

*Leontios J. Hadjileontiadis*
*Aristotle University of Thessaloniki, Greece*
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