Preface

Intelligent and adaptive learning systems aim at providing learners with an environment that adapts intelligently to their needs, presenting learners with suitable information, learning material, feedback and recommendations based on their individual characteristics and situation, and therefore helping to support learners making learning easier for them. The term “adaptive” refers to the functionality of the system to automatically provide different learning experiences to learners with different characteristics and needs. An adaptive system considers, for example, the learners’ prior knowledge, preferences, learning goals, misconceptions, learning styles, and cognitive abilities. The term “intelligent” means that a system uses artificial intelligence techniques in order to support learners or identify their characteristics, needs, and/or situation.

The first intelligent and adaptive learning systems were developed in the 1990s, having their roots in Adaptive Hypermedia and Intelligent Tutoring Systems. They included systems such as Interbook (Brusilovsky, Schwarz & Weber, 1996a), ELM-ART (Brusilovsky, Schwarz & Weber, 1996b), CALAT (Nakabayashi et al., 1995) and De Bra’s adaptive hypermedia course (De Bra, 1996). Recently, many research investigations have been conducted in the area of intelligent and adaptive learning, resulting in the development of numerous systems. The first intelligent and adaptive learning systems focused on considering and identifying the knowledge state and progress of students in a course or task. Since then, a broader set of characteristics, needs, and states of learners has been investigated and considered in current systems. These include, for example, students’ learning styles, cognitive abilities, affective states, learning goals, interests, misconceptions, and so on. These newer systems aim at identifying these characteristics, needs, and states dynamically by observing the students’ behaviour, progress, and interaction with the system and applying artificial intelligence techniques in order to build and update the student model.

Nowadays, technology enhanced learning takes place in many different forms and contexts, including formal and informal settings, individual and collaborative learning, learning in the classroom, at home, at work, and outdoors in real life situations using different devices such as desktop computers and mobile devices. Learning environments range from desktop-based learning systems such as learning management systems, which present learners with learning material and activities, to mobile, pervasive, and ubiquitous learning environments, which are used in real life settings and enable learners to learn from physical learning objects. In each of these forms and contexts, adaptive and intelligent support has great potential to make such learning environments more personalized, user-friendly, and effective in supporting learners in learning.

Besides focusing on supporting learners, recent intelligent and adaptive learning systems also aim at providing intelligent support and adaptive experiences for teachers and course developers. In recent
years, the need of providing sufficient support for teachers and course developers in creating and managing online courses in intelligent and adaptive learning systems has been widely identified. Therefore, recent research and development has been focusing on how to support teachers and course developers in using intelligent and adaptive learning systems, including creating, designing, and managing adaptive courses and intelligent features. Furthermore, intelligent and adaptive learning systems are aimed at facilitating regular teaching processes, enabling teachers to better monitor students’ progress and provide more informed feedback and support to their students.

This book presents innovative research on intelligent and adaptive learning systems and shows how adaptivity and intelligent support can enrich emerging areas of technology enhanced learning. This support for learners and/or teachers is facilitated through intelligent techniques, while incorporating the learners’ and/or teachers’ individual needs and characteristics. This collection is divided into six sections: the generation and provision of intelligent and adaptive courses; intelligent and adaptive feedback, testing, and assessment; the potential and use of semantic technologies in intelligent and adaptive learning systems; the enhancement of collaborative learning through adaptivity and intelligent support; the application of adaptivity and intelligent support for learning in virtual worlds; and mobile, pervasive, and ubiquitous learning enhanced through adaptivity and intelligent support.

The book deals with models, architectures, developments, and evaluations of intelligent and adaptive learning environments and systems, as well as with best practices of using adaptive and intelligent learning environments and systems. In addition, issues such as student modeling, authoring, and usability aspects in the abovementioned areas are discussed.

The first section introduces current research on intelligent and adaptive course generation and course provision in learning systems considering learners’ characteristics, behaviour, and needs, and providing intelligent support for learners and/or teachers. In the first chapter, Sampson and Karampiperis discuss one of the core issues in intelligent and adaptive learning systems, namely design approaches for the definition of adaptation behaviour in learning systems. Furthermore, the authors look into how to evaluate the performance of the design of adaptation models, which describe the rules and behaviour of adaptive learning systems. In the second chapter, Khribi, Jemni, and Nasraoui provide an overview of another important issue in intelligent and adaptive learning systems, discussing personalization issues in technology enhanced learning based on recommendation systems and Web mining technologies. Next, Peña de Carrillo, et al. introduce a context modeling approach that supports teachers and tutors, helping to reinforce their skills and abilities in carrying out reengineering processes on their pedagogical scenarios. This enables teachers and tutors to adapt their teaching actions, considering their learners’ profiles and performances in technology enhanced learning environments. In the next chapter, Tan, Ullrich, and Shen discuss how cultural issues can be considered in the course generation process of adaptive learning systems and demonstrate the changes that are required to adjust an adaptive learning system for use in another culture. The last chapter in this section, written by Butakov, et al., presents a theoretical framework that extends the capabilities of learning management systems with a multi-agent based platform using intelligent agents for performing various tasks to improve course provision.

The second section deals with intelligent and/or adaptive techniques for providing feedback to learners as well as testing and assessing learners’ performance in a course. The first two chapters focus on providing intelligent feedback. Ifenthaler discusses the theoretical background for an intelligent feedback approach and introduces two intelligent and automated model-based feedback tools. These tools provide feedback based on natural language text input as well as use graphical representations based on the learners’ prior knowledge in order to promote the learners’ self-regulated learning. In the next chapter, Kong
introduces an Internet-based intelligent learning environment for fraction learning, focusing on the Next Step Support feature that provides learners with intelligent feedback to break the impasse in fraction operations. The third chapter in this section, written by Zhou, discusses the role of self-assessment tests in intelligent tutoring systems and provides an in-depth analysis and synthesis of current research and developments in this area. Furthermore, a model for direct self-assessment is presented, emphasizing learners’ initiatives as well as an external scaffold for intelligent self-assessment. The last two chapters in this section deal with assessing learners’ competencies and performance. Bodea and Dascalu introduce a tool for adaptive e-assessment for project management competences, using the computer adaptive testing (CAT) principle. The effectiveness of the tool is demonstrated through an evaluation with 150 students. Subsequently, Bescherer et al. discuss intelligent assessment in mathematics education using semi-automatic feedback. In their chapter, the authors present a model for intelligent assessment and introduce several prototype applications of semi-automatic feedback and assessment based on this model.

The third section discusses the use of semantic technologies and ontologies for enhancing intelligent and adaptive learning systems. The first chapter in this section, written by Liu et al., discusses the automatic construction and use of directed semantic relations between learning objects in order to scaffold learners’ semantic reasoning and enable the provision of adaptive learning content based on semantic relations. An approach for directed semantic relation graph construction is introduced and a learning scenario for demonstrating the use of such a graph is presented. The next two chapters use semantic technologies and ontologies for modeling learners’ context, culture, and competencies. The chapter written by Gasparini et al. focuses on modeling context and cultural information through ontologies. They introduce a personalized approach called ADAPTSUR that aims at improving the personalization capabilities of learning systems by considering contextual and cultural aspects. Furthermore, the integration of this approach into two intelligent and adaptive learning systems is demonstrated. The chapter written by Kumar focuses on tracing metacognitive competencies related to self-regulation from learning activities of online learners through an ontology-based mechanism. This mechanism aims at providing opportunities for authentic real-time feedback that not only consider learners’ task-specific competencies but also their metacognitive competencies. The next chapter, written by Paquette and Marino, contributes to the adaptive Semantic Web and introduces a personalized assistance model that is based on ontology modeling and Semantic Web techniques, helping learners processing task-based scenarios and finding resources suited to their knowledge, competency, and context of use. The last chapter in this section, written by Charlton and Magoulas, deals with adaptation and personalization in the creation of learning designs, and introduces a context-aware adaptation framework that uses Semantic Web technologies and ontological models for supporting the creation of learning designs, providing teachers and course designers with adaptive and personalized experiences.

The fourth section deals with intelligent techniques and/or adaptation features that facilitate and improve collaborative learning. In the first chapter of this section, Wei et al. discuss the recording of live instructional activities conducted in synchronous cyber classrooms, including lectures, demonstrations and discussions. The authors explore the functional requirements for the types of instruction modes and conducted an analysis to find the best match between the instruction modes and the essential functions of recording tools, aiming at providing learners with the most effective tools to learn in a cyber classroom setting. The second chapter, written by Whatley, focuses on using agent technologies for providing intelligent support to students, supporting them in getting started on their team projects by facilitating the allocation of tasks to individuals and agreeing on ground rules for the team. A software agent system is introduced, and the evaluation of the system by students is discussed.
The fifth section discusses how virtual worlds, supported by embedded intelligence as well as adaptive and intelligent features, can be used for learning. The first chapter in this section, written by Heller and Procter, focuses on embodied and embedded intelligence in virtual worlds and introduces the agent actors Freudbot, a computer-controlled intelligent avatar who responds intelligently to his surroundings in Second Life and interacts and communicates with other avatars controlled by learners, engaging them in learning through natural language conversations. The next chapter, written by Chiang et al., introduces how virtual worlds can be used for improving language learning, benefitting from the embedded intelligence and social character of these worlds. Furthermore, this chapter demonstrates two successful case studies of language learning in Second Life.

The last section discusses how adaptivity and intelligent support can be provided in mobile, pervasive, and ubiquitous learning, with the goal of enhancing learners’ experiences, while learning from their mobile devices. The first chapter in this section, written by Molnar and Muntean, discusses the consideration of costs of the educational multimedia content delivery in mobile learning and introduces an e-learning framework that predicts a learner’s economic behaviour and takes it into account when delivering educational multimedia content. Furthermore, a mechanism for reducing the cost of the educational content delivery over multimedia networks is presented. In the next chapter, Kumar, Chang, and Leacock focus on enhancing learners’ academic writing competence through the use of personalized mobile learning and mixed-initiatives. Two studies are presented, demonstrating ways of recording traces of problem solving and writing processes that can be used for providing personalized support for improving learners’ academic writing competencies.

Sabine Graf  
Athabasca University, Canada

Fuhua Lin  
Athabasca University, Canada

Kinshuk  
Athabasca University, Canada

Rory McGreal  
Athabasca University, Canada

REFERENCES

