

## Chapter 8.5

# A Survey of Optimized Learning Pathway Planning and Assessment Paper Generation with Swarm Intelligence

**Lung-Hsiang Wong**

*National Institute of Education, Singapore*

**Chee-Kit Looi**

*National Institute of Education, Singapore*

### **ABSTRACT**

One major direction in research on technology-enabled learning systems revolves round the notion of generating optimal learning pathways. Two examples of the application areas that could be presented as search and optimization problem in the context of Artificial Intelligence are:- (1) Adaptive selection and sequencing of learning objects based on the learning profiles, preferences and abilities of individual learners; (2) Automatic composition of assessment or examination papers based on instructors' specifications. In this chapter,

we present a critical discussion of the research which is concerned with the application of the paradigm of "swarm intelligence" in these two areas. The main aim of this survey is to highlight the new trends and key research achievements that have been realised in the last few years. We will also outline a range of relevant research issues and challenges that have been generated by this body of work.

### **INTRODUCTION**

Since the early years of research in Intelligent Tutoring System (ITS), researchers in the educational

DOI: 10.4018/978-1-60960-818-7.ch8.5

technology field has been deploying Artificial Intelligence (AI) to resolve the difficulties in automating decision making or data processing for various educational application systems. However, classic AI techniques like rule-based systems which have been used by earlier ITSs have been gradually losing their edge due to their limitations in dealing with the complex and uncertain nature of learning activities. The knowledge that is incorporated into such systems may be inadequate to take account of the different contexts of use, and the different goals and perspectives of end users. This is probably one of the reasons that the research activities in conventional single-machine ITS's have been "saturated" and declining since late 1990s.

We observe that in the past decade, what we have learned in ITS research has not been translated to the design of recent networked learning systems in a significant way yet. The design of such new systems may not directly adhere with the conventional ITS framework as a whole as they do not consist all four typical ITS modules – interface, domain knowledge, tutoring and student modeling. Instead they adopt and refine individual existing ITS techniques that belong only to specific components of the ITS, say, the content sequencing technique (one classic ITS technique under the tutoring module) or the overlay model (a classic ITS student modeling technique), in the context of a broader learning environment (e.g., Shang & Shi, 2000).

Meanwhile, researchers and designers of learning technologies have been exploring the use and application of techniques in soft computing, an umbrella term in AI that encompasses neural networks, fuzzy systems, genetic algorithms, and so on, into education-oriented systems. Being tolerant of imprecision, uncertainty, partial truth and approximation in solving NP-hard problems, soft computing offers the potential for feasible solutions to such potentially complex data processing and decision making processes in the new generation of learning systems.

In this paper, we survey the educational applications of yet another set of soft computing techniques – swarm intelligence (Bonabeau, Dorigo & Theraulaz, 1999). This set of algorithms is inspired by and simulates natural phenomena like the swarms of insects, birds or fishes in the form of multi-agent systems (MAS) – hence the alternative name "self-organizing agents." Typically, individual agents in such MAS possess low-level intelligence. But at the aggregate level, through some evolutionary mechanisms, high-level intelligence and adaptability could emerge from swarms of such agents. These algorithms are known to be good for solving NP-hard problems (Zhang & Lu, 2007).

In the educational technology field, swarm intelligence has been applied in various optimization tasks like curriculum planning, intelligent assessment paper generation, computer adaptive testing, student group forming, and class/exam scheduling. Except for scheduling, a common characteristic of these applications is that they emphasize the monitoring of the background, learning behaviors and performances of individuals or groups of students in order to improve their intelligence, somewhat resembling the student modeling functionality of typical ITS. Such applications are about "learning about learners" (Chen, 2008).

To date, however, no comprehensive literature survey has been conducted in this area. In this paper, we present a critical discussion of the applications of swarm intelligence in two particular areas: (1) adaptive learning object selection and sequencing according to the learner profile, preferences and ability of individual students (which are essentially state-of-the-art solutions to the classic ITS problem of curriculum sequencing); (2) automatic composition of assessment or examination papers based on the instructors' specifications (which may offer potential add-on solutions to the student modeling process of typical ITS). As functionalities in learning systems, they bear some resemblance in their computational processes as

16 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

[www.igi-global.com/chapter/survey-optimized-learning-pathway-planning/56235](http://www.igi-global.com/chapter/survey-optimized-learning-pathway-planning/56235)

## Related Content

---

### ISW: Interest-Based Small World Network of P2P

Jinlong Zeng and Guifeng Zheng (2012). *International Journal of Software Science and Computational Intelligence* (pp. 26-40).

[www.irma-international.org/article/isw/88925](http://www.irma-international.org/article/isw/88925)

### Exploring the Cognitive Foundations of Software Engineering

Yingxu Wang and Shushma Patel (2009). *International Journal of Software Science and Computational Intelligence* (pp. 1-19).

[www.irma-international.org/article/exploring-cognitive-foundations-software-engineering/2790](http://www.irma-international.org/article/exploring-cognitive-foundations-software-engineering/2790)

### Optimizing Personalized Treatment Decisions Using Deep Q-Networks in Reinforcement Learning

Arpita Nayak, Ipseeta Satpathy and Vishal Jain (2026). *Applied AI and Computational Intelligence in Diagnostics and Decision-Making* (pp. 315-336).

[www.irma-international.org/chapter/optimizing-personalized-treatment-decisions-using-deep-q-networks-in-reinforcement-learning/390121](http://www.irma-international.org/chapter/optimizing-personalized-treatment-decisions-using-deep-q-networks-in-reinforcement-learning/390121)

### Emergence Phenomenon and Fuzzy Logic in Meaningful Image Segmentation and Retrieval

Sagarmay Deband Siddhivinayak Kulkarni (2012). *Machine Learning Algorithms for Problem Solving in Computational Applications: Intelligent Techniques* (pp. 167-178).

[www.irma-international.org/chapter/emergence-phenomenon-fuzzy-logic-meaningful/67702](http://www.irma-international.org/chapter/emergence-phenomenon-fuzzy-logic-meaningful/67702)

### Perspectives on Cognitive Computing and Applications

Yingxu Wang, Witold Pedrycz, George Baciu, Ping Chen, Guoyin Wang and Yiyu Yao (2010). *International Journal of Software Science and Computational Intelligence* (pp. 32-44).

[www.irma-international.org/article/perspectives-cognitive-computing-applications/49130](http://www.irma-international.org/article/perspectives-cognitive-computing-applications/49130)