Global Optimisation and Mobile Learning

1 Introduction

Mobile devices, such as cellular phones and Personal Digital Assistants (PDA), have become part and parcel of our everyday life. These mobile technologies and their wide adoption in the society are influencing not only the way we live, but also the way we learn, the way we work, and the way we socialise. According to [1], there are estimated to be more than 1.5 billion mobile phones in the world today.

The rapid advancement of these portable technologies is also changing the way educational institutions work. It has opened up new possibilities for extending learning opportunities to all social-economic levels and a completely new dimension to the progress in education and training known as *mobile learning*. Through mobile learning, educational and training programs that were once delivered only through a face-to-face setting or networked computers can now be done almost anywhere, anytime.

2 Global Optimisation

Global optimisation, on the other hand, is a branch of applied mathematics and numerical analysis that focuses on finding the best possible solutions based on a set of criteria expressed as mathematical functions, commonly known as objective functions [2]. Global optimisation approaches can generally be divided into two types: *deterministic* and *stochastic*. The most successful example of the deterministic type is perhaps the Branch and Bound[1] methods, but they are not so attractive anymore in recent years due to the large and dynamic problem spaces that need to be tackled in today's real-world problems. A more appealing choice is therefore the stochastic solvers, such as Genetic Algorithms, Particle Swarm Optimisation, Ant Colony Optimisation, and so on. These methods are mostly inspired in part by nature and natural systems. For an overview of some popular nature-inspired methods and their practical applications, see [3].

So, what does global optimisation have to do with mobile learning? An undeniable fact is that all of us desire optimal outcomes. Very often we tend to find various alternatives in order to maximise our gain by minimising the cost we need to bear. Likewise, various aspects of the mobile learning environment need to be optimised so that the mobile learners can take full advantage of it. Global optimisation methods have been widely used in many e-learning activities. For example, very recently an e-learning decision support framework based on a set of soft computing techniques is introduced in [4] with the aim to improve e-learning experience. This framework can discover an e-learning system's usage patterns and contribute to alleviating instructors' workload. The identification of students' learning behaviour allows instructors to predict the performance of their students and pinpoint weaker students for personalised feedback. Besides that, we see the use of Genetic Algorithms for providing intelligent assessment services in an e-learning environment [5] and for classifying students in order to predict their final grade based on features extracted from log data in a web-based educational system [6], the use of Ant Colony Optimisation for the pedagogic

[1] A general optimisation algorithm that systematically enumerates all candidate solutions and discards fruitless candidates by using upper and lower estimated bounds of the quantity of solutions being optimised.

material of an online teaching website for high school students [7-8] and for sequencing of e-learning activities [9], as well as the use of Particle Swarm Optimisation for arranging a set of learning resources in order to present them in a personalised way to the learners [10]. Note that these examples are by no means a comprehensive list, but a snapshot of some interesting works that applied global optimisation methods to e-learning over the last couple of years.

3 Examples of Global Optimisation in Mobile Learning

While substantial works have been done on e-learning with global optimisation, its applications to mobile learning are still rare. Lately, an adaptive testing system for supporting versatile educational assessment has been presented [11]. In this work, the authors integrate computer based test with mobile learning for both formative assessment and self-assessment. Students are assessed through a process that uses item response theory, a well-founded psychometric theory. The problem with the use of item response theory is that a large item bank is indispensable to a test, yet when the system has a large item bank, the test item selection becomes a very tedious job. To solve the problem, Particle Swarm Optimisation method is used to speed up the searching and selection process. Furthermore, for controlling the test item exposure, an item exposure mechanism is combined with Particle Swarm Optimisation to prevent the same test item from appearing twice. When a test item was responded or an adaptive test was finished by a student, this system applies maximum likelihood estimation as an underlying psychometric theory to estimate the student's ability and give immediate feedback by showing the results to the student.

Apart from Particle Swarm Optimisation, an improved Genetic Algorithm with association rules has been proposed in [12] to analyse the vast amount of learners' profile data in a web-based mobile-learning system. The authors show that interesting relationships can be found with this method within minimal execution time. If fully developed, it is able to create an efficient mobile-learning system that understands its learners.

4 Concluding Remarks

Although brief, these works demonstrate the potential of global optimisation in mobile learning. Genetic Algorithms have been applied extensively in mobile robots with huge success (see [13, 14]). Similarly, swarm intelligence and other global optimisation methods have contributed greatly to the field of telecommunications and distributed systems (see [15, 16]). It is therefore just a matter of time before these methods are adopted extensively in mobile learning.

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Raymond Chiong
Swinburne University of Technology
Australia
rchiong@swin.edu.au

Thomas Weise
University of Kassel
Germany
tweise@gmx.de
weise@vs.uni-kassel.de

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@article{CW2009GOAML,
  author    = {Raymond Chiong and Thomas Weise},
  title     = {Global Optimisation and Mobile Learning},
  journal   = {Learning Technology},
  publisher = {IEEE Computer Society,
                  Learning Technology Task Force (LTTF)},
  volume    = {11},
  number    = {1--2},
  pages     = {26--28},
  month     = jan # {--} # apr,
  year      = {2009},
  issn      = {1438-0625},
  note      = {Learning Technology the a newsletter of the LTTF.},
  url = {http://www.it-weise.de/documents/files/CW2009GOAML.pdf},
  url = { http://lttf.ieee.org/learn_tech/issues/april2009/index.html},
}
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To be cited as:

R. Chiong and T. Weise, "Global optimisation and mobile learning," IEEE Learning Technology, vol. 11(1-2), pp. 26-28, April 2009. ISSN 1438-0625.