A Virtual Laboratory on Natural Computing: A Learning Experiment

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ABSTRACT

Natural computing is a terminology used to describe computational algorithms developed by taking inspiration from information processing mechanisms in nature, methods to synthesize natural phenomena in computers, and novel computational approaches based on natural materials. The virtual laboratory on natural computing (LVCoN) is a Web environment to support the teaching and learning of natural computing, and whose goal is to provide didactic contents about the main themes in natural computing, in addition to interactive simulations, videos, exercises, links for related sites, forum, and other materials. This article describes an experiment with LVCoN during a School of Computing in Brazil. The results are presented in four parts: Self-Evaluation, Evaluation of LVCoN, Evaluation of the Simulations (Applets), and Interviews. The results allowed us to positively evaluate the structure and contents of LVCoN, in the sense that most students were satisfied with the environment. Besides, most students liked the experience of working with a virtual laboratory, and considered a hybrid teaching approach; that is, one mixing lectures with virtual learning, very appropriate and productive.

Keywords: bio-inspired computing; learning experiment; LVCoN; natural computing

INTRODUCTION

Natural computing (de Castro, 2007) is a terminology that has been used to describe three main areas of research: (1) methods that take inspiration from nature to develop problem-solving algorithms; (2) computational approaches to synthesize natural phenomena; and (3) the use of natural materials (e.g., molecules) to compute.
The Virtual Laboratory on Natural Computing (LVCoN) presents many important features of virtual laboratories for supporting teaching and learning activities, such as the use of high-quality didactic contents associated with the many subjects of natural computing, interactive algorithms implemented in applets, availability of links to related works and subjects, and a Learning Matrix so that students and instructors can develop their own study agendas.

This article presents the results of a learning action with the Portuguese version of LVCoN conducted during a School of Computing held in Brazil in April, 2007. This action was performed in limited time, for although the learning matrix of LVCoN suggests 100 hours to complete the course, only 10 hours were available for the action during School of Computing. Therefore, some specific topics had to be selected for the experiments, and the time and shape of each activity had to be substantially reduced or altered. In such a scenario, it is possible to investigate the impact of a work under pressure in the group of students, to assess the degree of satisfaction of the students with the environment, to evaluate the potential of LVCoN as a self-learning and self-evaluation tool, and to evaluate the usefulness of LVCoN as a tool for supporting the teaching and learning of natural computing.

This article is organized as follows. Section 2 makes a brief introduction to natural computing, and Section 3 describes LVCoN. Section 4 describes the experimental protocol used, and the results are presented in Section 5. The article is concluded in Section 6. Appendices 1 to 6 present the learning matrices, the self-evaluation form, the form to assess LVCoN, and the interviews protocol.

**NATURAL COMPUTING**

*Natural computing* is the computational version of the process of extracting ideas from nature to develop computational systems, or using natural materials (e.g., molecules) to perform computation. It can be divided into three main branches (de Castro, 2006, 2007; de Castro & Von Zuben, 2004):

1. **Computing inspired by nature**: It makes use of nature as inspiration for the development of problem solving techniques. The main idea of this branch is to develop computational tools (algorithms) by taking inspiration from nature for the solution of complex problems.

2. **The simulation and emulation of nature by means of computing**: It is basically a synthetic process aimed at creating patterns, forms, behaviors, and organisms that (do not necessarily) resemble “life-as-we-know-it.” Its products can be used to mimic various natural phenomena, thus increasing our understanding of nature and insights about computer models.

3. **Computing with natural materials**: It corresponds to the use of novel natural materials to perform computation, thus constituting a true novel computing paradigm that comes to substitute or supplement the current silicon-based computers.

Therefore, natural computing can be defined as the field of research that, based on or inspired by nature, allows the development of new computational tools (in software, hardware, or “wetware”) for problem solving, leads to the synthesis of natural patterns, behaviors, and organ-
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