

Numerical and Algebraic Computation in the web: exploring benefits and limitations

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June 22, 2001

1 Introduction

In this article we describe a research in development that treats with the problem to provide teaching and learning based on the web, to give support to undergraduate students at the discipline of Numerical and Algebraic Computation in the Computer Science Course. The Internet, through the Web has been contributed to emerge new teaching and learning environments that provide opportunities of sharing learning resources as tasks of creating new resources for learning [1]. The main idea of this project is to offer several opportunities of adaptive learning, using the facilities of the Internet. Adaptive learning with computer is known as intelligent tutoring and with the growing use of Internet, new researches have been developed. As example we can cite the works of [2], [3], and [4].

2 What are the contents and the internet resources associated

In the discipline cited, we introduce the traditional numerical methods, and also present the principles of computer algebra, as well teach how to use and programming in a Computer algebra System, in particular, the system Maple. The contents to be presented are being organized in such way that the resources of the web can be help on understanding the theoretical concepts. The outline of the lessons are the following: i) Number representation and computer arithmetic, ii) Algebraic Computation, iii) Systems of Linear Algebraic Equations, iv) Evaluation of Functions, v) Interpolation, vi) Data Fitting, vii) Root Finding and Nonlinear System of Equations, viii) Integration and Derivative; ix) Ordinary Differential equations.

For each class of problem the following resources will be available: i) Webpages with the theoretical concepts, ii) examples of computer programmes that implement the methods in a Computer Algebra System, iii) Description of related Maple Library Functions, iv) Software for downloading, v) Online execution program, vi) Guideline for practical classes and vii) Bibliography and Interesting Links.

3 State of development

In this section we describe how the resources cited in the last section (i to vii) are being developed.

At the moment we are producing the *html* files with the concepts linked to examples performed using the Maple. We are concerned with the integration among theory, example, and how the problem is solved using an algorithm step by step. So, all the time that an example of problem is presented, the student can see the intermediate results, and in what point of the algorithm the computation is. Among the tools used to generated the HTML files, it is the Latex2HTML.

Study of Techniques related to Internet that are in progress include language to develop dynamic webpages (Javascript, Java and PHP, standard for the web as XML and MathML, that is the standardization of mathematical communication over the web. There are also other important standards that have a significant impact on use of the Web for teaching and learning, that include RDF (Resource Description Framework) and IMS (Instructional Management System Project). See [5]. Additionally we are looking for techniques that support interface between computer algebra system and web standards.

A set of computer programs that implement the algorithms studied are being developed using the Computer Algebra System Maple. Such programs can be presented by means a viewer in the webpages or can be downloaded.

Also, we are organizing a library with public software and the best solutions proposed by students that will be available for downloading.

The online execution program of the algorithms that are studied in that discipline are being developed, in such way, that the student can test his own problems and see the result given by the system. Further, it is being constructed a database of problem examples organized by category. The idea is that the student can choose one example from this database. The problem examples are being collected from the related literature and also constructed to consider special situations to verify stability features of the methods studied, as well see examples of ill-conditioned problems. To develop such programs, It is being studied the best way to delivery the program in the web, but at the moment is being used Javascript and applets Java. We are strongly thinking in develop computer algebra examples to be run at the web, but at the moment we do not conditions to do so. Now, it is in development the topic of matricial arithmetic and methods to solve linear systems, and we are doing experiments with the students, that are also participating in the development of the project.

A guideline for practical classes contains a collect of exercises and hints to solve them. The files with the solutions will be available after the student have been delivered their practical exercises.

With respect to the bibliography, we have been included as suggest the netlib service, by means the material available on the URL <http://www.netlib.org/index.html> and the site of anonymous ftp (file transfer protocol) at <ftp://ftp.netlib.org>.

In the next phase of the project, problems may be proposed to the students, and the solution given by them must be analysed by the system and compared with the correct answer. This will be implemented, based on the following idea: for each class of problem, we have a file with a collection of instances of them, from what will be selected one to be proposed to the student solve it. The student must introduce the values of the intermediate steps of resolution of the problem, that are being compared with the correct solution. Here we have based on the idea of [4], [6] that established he concept of Intelligent Tutoring Tool which provide a teaching tool on the Internet that helps the student to practice numerical examples at similar way as in the class with a tutor.

4 Concluding Remarks

With such project, we believe to give an opportunity to the students to explore different approaches to solve a problem: numerical, algebraic or mixed them. Several techniques related to Internet accessibility of Mathematics is helpful to improve the opportunities of learning. Also we have been observed that the involvement of students in the project is a way to estimulate them to learn about the topics approached.

5 Acknowledgments

Many thanks to Marcelo Luiz Venci, Jos Francisco L. de Almeida and Thalita B. Veronese, students of the Computer Science course, for their contributions in the task of programming for the web.

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