IFORS tutORial PROJECT

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ABSTRACT

Everyone knows that the Internet in general, and the World Wide Web in particular, provides new exciting tools for the development and usage of teaching/learning resources. Unfortunately, it is also a fact of life that the development of educationally rich web-based resources is not easy and can be expensive. One way to alleviate this difficulty is through cooperation and professional societies can play a major role in initiating and coordinating such joint projects.

In this paper we describe a project called tutORial that was initiated by the International Federation of Operational Research Societies (IFORS) in 1999. The goal of this project is to provide a framework for an international collaboration in the development of educationally rich tutorial models for standard Operations Research (OR) and Management Science (MS) subjects.

The project will be officially launched at the IFORS 2002 conference (July 8-12, 2002, Edinburgh, UK) but its web site is already open for preview (www.ifors.org/tutorial/). The site currently features more than twenty highly interactive modules covering topics from areas such as linear algebra, discrete mathematics, linear programming, integer programming and dynamic programming. OR/MS students are currently using it worldwide.

The goal is to expand this collection over time with contributions from OR/MS professionals and organizations worldwide. Details concerning preparation of contributions to the project can be found at the project's web site. All you need in order to use these modules is access to the Internet and a web browser. These modules are accessible free of charge.

In this discussion we give a very broad overview of the project and explain how its modules can be incorporated in undergraduate applied mathematics courses. The presentation at the conference will also feature a live demonstration of some of these modules.

Key words: math education, on line tutorials, operations research, management science, IFORS, tutORial.

1. Introduction

In this paper we take a guided tour of the IFORS tutORial project and discuss matters related to the educational resources it provides and how they can be used in actual and virtual classroom. This project will be launched officially in July 2002 during the IFORS 2002 conference, but its web site (www.ifors.org/tutorial/) has already been open for review for more that a year. Readers interested in more details about the project are invited to visit the site.

As we all know, the World Wide Web has already established itself as an extremely important technology for the development and delivery of educational resources. Unfortunately, it is also a fact of life that the development of educationally rich web-based resources is not easy and can be expensive. Thus, there is plenty of scope for co-operation in this area and professional societies can play a major role in initiating and co-ordinating such co-operative projects.

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The paper is structured as follows: In Section 2 we explain the basic philosophy underlying the project. The reason why the focus is on tutorials is explained in Section 3. Then in Section 4 we examine some of the educational aspects of the project, including the "Solve Button" dilemma. Section 5 briefly looks at the technology we have used so far in the development of the modules and Section 6 explain the basic organisational structure of the project including copyright and intellectual property issues. Section 7 lists the modules currently available at the project's web site and Section 8 briefly describes how they can be used. Section 9 reflects on the Operational Research aspects of the project. Some preliminary conclusions are drawn in Section 10.

2. Basic Philosophy

The basic principle guiding the development of this project is: "Keep it simple, mate!" It reflects two important facts about the project. Firstly, this is a very low budget project so there are no financial resources for the development of complex and elaborate tools. Secondly, the aim of the project is to serve the global OR/MS community and therefore the user interface must be friendly.

So the basic assumption is that anyone connected to the Internet via a standard WWW browsers should be able to use the modules. Another consequence of this principle is that each module is essentially a self-contained, stand-alone object. The implication is that each such module can be easily incorporated within an external courseware, and if necessary be slightly modified to suit specific needs of students and/or lecturers.

The rules for participating in the projects are also very simple: the modules are available for use free of charge.

3. Why tutorials?

The modules developed in this project are not designed to replace traditional books and lectures. They are viewed as supplements to conventional educational resources rather than as replacements. It is envisaged therefore that persons using these modules do not start from scratch. Rather, they are already familiar with the subject and wish to use the module to practice what they have learned elsewhere.

More importantly, the modules are designed to provide the students with an *interactive* facility for experimenting with methods and algorithms, including *immediate feedback* on their performance.

We adopted this approach because this kind of support is ideal for web-based implementations and serves well the international OR/MS community.

In short, the idea is to use the WWW not merely as a delivery system of static material such as lecture notes and assignment/solution sheets, but as a framework for providing students *interactive learning facilities*. In this regard the modules are tutorials rather than lectures oriented.

4. Educational matters

Our main concern is to provide what we call 'educationally rich facilities'. By this we mean that the modules are not designed merely to provide answers to questions. Rather, they are designed to enable students to practice what they learn in class or read in books and to obtain immediate feedback on their performance. For example, suppose that the math topic under consideration is 'systems of linear equations'. Then we are not interested in providing the students a facility capable of merely solving systems of linear equations. Rather, we want a facility that will enable the students to experiment (step by step) with the methods taught in class for solving such problems. For example, such facilities should enable students to experiment with row operations and use these operations to solve systems of linear equations with immediate feedback on the student's performance.

We have found that this kind of facilities is very useful in dealing with two common types of help sought by our students:

- "I obviously did something wrong here, but I do not know what/where!?"
- "I got the correct final answer but I am not sure whether the process is OK?!"

We have also noticed that students who experiment with such modules tend to be better prepared for the formal tutorial sessions so that there is much less need to spend time on rudimentary matters during these sessions.

The incorporation of such modules in OR/MS courseware pose the following dilemma: educational speaking, is it a good idea to 'automate' to the traditional (manual) drill-drill-drill approach? Should we let students attempt to solve problems on their own? Isn’t this what learning is all about? Aren't we depriving students from experiencing a fundamental and essential ingredient by providing them sophisticated electronic problem solving tools?

These are of course legitimate questions that must be carefully addressed by lecturers using problem-solving tools. They are in essence the same as those raised many years ago with regard to the use of pocket calculators.

It should be noted, however, that the incorporation of such tools in math courseware does not have to be at the expense of traditional teaching methods and processes. The fact that students have access to an educationally rich interactive module on a topic such as say systems of linear

equations does not necessarily means that students are denied the joy of solving such problem hand. Nor are they necessarily disadvantaged by an exposure to such tools.

5. Technology

The technology we have used so far is 'standard" so that users do not have to purchase any special software/hardware. A computer equipped with a recent version of one of the commercial web browsers is all that is needed to use the modules via the WWW. Needless to say, producing mathematical text for the WWW is still not as straightforward as it should be. The new math language for the WWW (MathML) may ultimately resolve this issue (Tittle [1998]).

A more annoying aspect of the technology is that it is not truly platform independent. Therefore special attention must be given to differences between operating systems (eg. Mac, Unix, Windows) and browsers (eg. Netscape Communicator, Microsoft Internet Explorer). The international nature of the project makes this issue especially important, as there is basically no control on the software/hardware used by the visitors to the site.

6. Organisation

The project is organised in a simple manner. All the modules are open to the general public free of charge. Copyright and intellectual property issues are handled in a straightforward manner: contributors retain complete control on their contributions and are free to withdraw their contributions anytime.

The project as a whole, as well as individual modules, are being incorporated in the IFORS On Line Encyclopaedia (www.ifors.org/ioe/). The modules will provide exciting facilities for live experimentation with methods and techniques discussed in the encyclopaedia.

7. Content

The web site of the project currently contains more then twenty modules dealing with various OR/MS topics. The choice of topics was not the result of a deliberate analysis, but rather a reflection of the basic nature of the project: modules are contributed by OR/MS groups worldwide. In any case, the current list is as follows:

- Linear Algebra:
  - Row operations
  - Matrix Inverse
  - Linear Equations
- Linear Programming::
  - A number of Simplex Modules
  - Dual Problems
- Dynamic Programming:
  - Shortest Path Problem
  - Travelling Salesman Problem
  - A number of Knapsack Problems
  - A number of Counterfeit Coin Problem
  - Critical Path Problem
  - Dijkstra's Algorithms
  - Towers of Hanoi

    - Prince's Pub Problem
    - Chained Matrix Product
- Integer Programming:
    - N-Queen Problem
    - 8 Easy Pieces
    - Knapsack Problem
    - Gomory's Cutting Plan
- Simulation:
    - A Random Number Testers
    - A number of Queueing System Generators

The University of Malta contributed the Simulation modules. The University of Melbourne contributed all other modules.

Additional modules are currently being developed and will appear on the web site soon. In particular, in view of the special and important role that games play in mathematical education, a directory dedicated to OR/MS oriented games is now being created.

8. User's guide

As indicated above, the modules are organised in a 'stand alone' fashion so there is no global environment to deal with on the part of users. The modules are listed according to topics and you simple surf to the module of interest.

The most important thing to remember when using the modules is that they are not designed to replace lectures and/or books. In particular, it is assumed that students have basic knowledge of the topic before they use the relevant module.

Guidelines for Lecturers: Math convention, notation and terminology are not uniformly 'standard' in all areas of operations research and management science. Thus, if you use a tutORial module in your class make sure that the students are comfortable with the notation and terminology used in the module.

Guidelines for students: The modules were not designed to facilitate easy production of solution to homework assignments. While it is perfectly OK to use the modules to check results derived manually by you, it is important that you do not become heavily dependent on them. In particular, it is very unlikely that you'll have access to these modules during exams! In short, use the modules mainly to check that you know how do solve problems on your own and to identify things that you do not do properly.

For obvious reasons, we cannot offer on-line help on the math content of the modules. We do offer, though, help with regard to the user interface of the modules.

9. Conclusions

The Internet in general and the WWW in particular are already used extensively in the delivery and development of educational resources. The ability to create educationally rich on line interactive modules for math topics poses the math community plenty of opportunities as well as major challenges.

However, the development of such modules is beyond the means of most individuals and departments. Therefore, professional societies can play an important role in co-ordinating projects whose aim is to coordinate and share the development of such resources for specialised math topics.

IFORS tutORial project serves as an example of such an initiative. We shall be delighted to share our experience with other professional societies.

REFERENCES

- Hillier, F S. and Lieberman, G.J., 1990, *Introduction to Operations Research*, Oakland CA: Holden Day.
- Tittle, E., Mikula N. and Chandak R., 1998, *XML for Dummies*, Foster City CA: IDG Books Worldwide.
- Winston, Wayne L. 1991, Operations Research: *Applications and Algorithms*, Boston: PWS-KENT.