Use of computer technique in teaching of optimization

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Abstract: - The paper deals with the use of computer technique in teaching of informatics subjects at our University, to be specific in teaching of the subject Optimization. This subject is teaching at the Department of Informatics as a compulsory subject in the eighth term of master study. We aim at the application and the presentations that are considerable to be a valuable the process of teaching of optimizing methods.
This paper shows some of evaluations that we have obtained from students that had a possibility to use and test this software and presentations created.

Key-Words: - optimization, software, optimizing algorithms, presentation

1 Introduction

In order to learn some knowledge and to remember it for longer time; the best way is to perceive them by as many senses as possible. The principle of demonstration is used in education for many years. In terms of maintaining as well as other principles in teaching, to make the lessons more effective; we have concluded to create the means that could help to understand much easier to optimization algorithms at the lectures.

The subject Optimization is taught in the eighth term of master study as compulsory subject. This subject belongs to the class of theoretic informatics. The content of the subject includes basic optimizing methods. The subject Optimization is compulsory for all students of Informatics. Students, that do not have the combination with Mathematics, might not know some of the mathematical procedures, and hence they have a problem to understand the optimality algorithms. Therefore, we have decided to create supporting materials for teaching this subject.

2 Content of subject Optimization

Students for master degree, that study Informatics at our department, have two lessons of lectures and two lessons of practices. Content of subject includes following themes:

1. One-parametrical optimality methods – Fibonacci method, method of the golden section, Newton's method
2. More-parametrical optimality methods – least squared method (discrete and continuous case), gradient method, method of ultimate descent, simplex method and Newton's method
3. More-parametrical optimization with constraint – Lagrange method, penalty method, linear programming

It is obvious that this is a subject with strong mathematical background. For derivation of every optimizing method mathematical procedures and accomplishments of mathematical analysis are used, e.g. definitions and theorems about functions, about extremes of functions of one and more variables, or calculation of the first and second derivations and partial derivations of these functions.

3 Study materials

The materials for the study of Optimization consist of more components forming a complete unit in the end. For each method there is a teaching text created as well as a presentation.

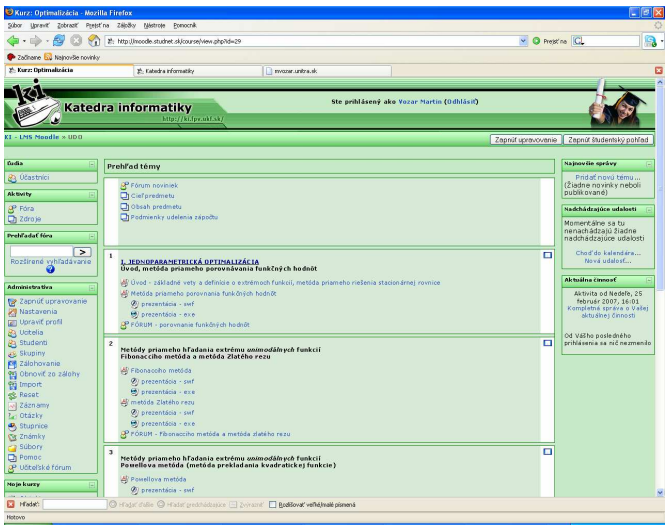

Fig.1 Course in LMS Moodle

There is an algorithm created for each method subjected to the curriculum. Each one has been programmed within one application.

To make the materials available for students any time, we created a course in LMS Moodle. Individual lectures are thematically grouped and chronologically sorted according to the exact date they are to be lectured.

We will focus at describing the individual parts of the course later on.

3.1 Teaching text

The teaching text aims at covering the material taught at the lectures in a written form. For each method there is a *pdf* file created consisting of an accurate (step-by-step) process of derivation of the optimizing method as well as the algorithm for each individual method written in Delphi. At the end of each teaching text there is a model situation described incorporating the method being taught. There is an extract from a teaching material in the figure below.

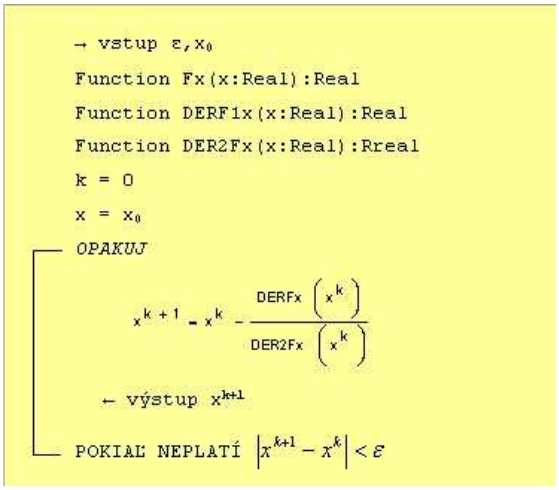

Fig. 2 An extract from the teaching text

3.2 Presentations

For creating of presentations we used a graphic editor based on vector graphics, e.g. Macromedia Flash MX. There are presentations created for each individual method and a teacher is free to use them while giving a lecture or at the seminars. Using presentations, we stimulate students' imagination, as well as, by using visual material, we facilitate their learning and understanding of the algorithm.

The whole presentation emulates the form of the e-learning course. Each page of the presentation is divided into two parts. On the right, there is an algorithm written. The algorithm is supplemented by a multimedia part on the left where there is a derivational process described following a concrete example. The last page of a presentation contains an algorithm of the method chosen written in a quasi Delphi language. Students are obliged to program the algorithm at the seminars as well as to use the algorithm for solving of the optimality problems.

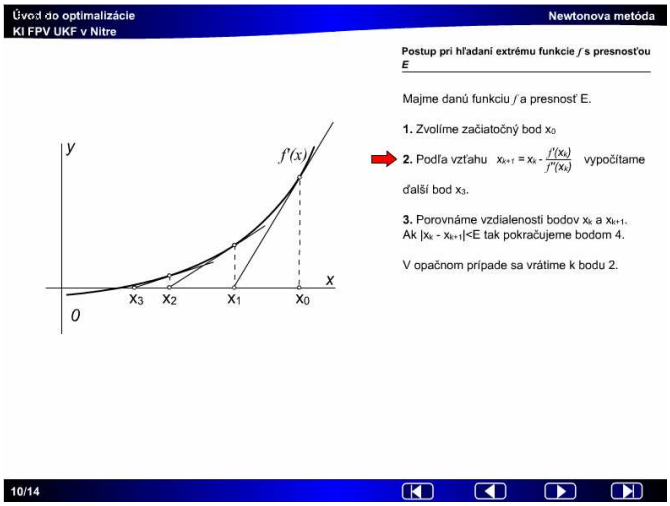

Fig. 3 A presentation of Newton's method

In the figure above, there is a presentation of Newton's method with one variable displayed.

3.3 Application

The main window of an application includes two panels, e.g. Calculus and Graph of the function. On the left, there are the results of iterations of all the methods chosen displayed. The precision of the iteration as well as the total number of iterations is shown on the left. On the right, there is a graph of objective function, as well as a graphic progress of the iteration for function of one variable displayed and an extreme point founded.

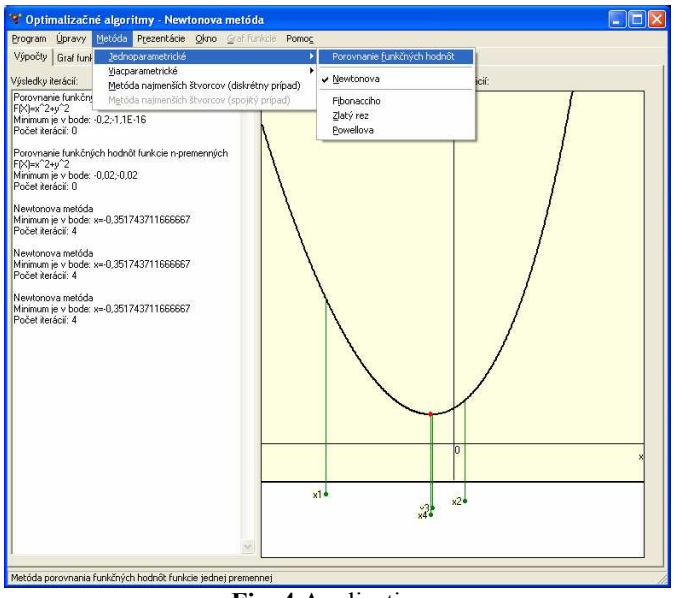

Fig. 4 Application

The graph of a function of two variables as well as the progress of iterations and an extreme point are presented in the second panel, e.g. Graph of function of two variables. The graph and a graphic progress of the algorithm are shown for the latest method being run within the application.

Use of the application is easy and intuitive. A user can choose any of one-parametrical and more-parametrical methods from the list in the main menu. The option Method is shown in the fig. 4 below. All the methods within the application correspond with the content of the subject Optimization.

The application allows running of more optimality algorithms at the same time – each one in an individual window. Each method has a specific window where the user inputs initial conditions of the algorithm. For example, in the Newton's method (fig.5), the user has to input the start point of the iteration, precision of the calculus and the maximum number of iterations (prevention against the overflow), interval for drawing of the graph of a function (vertical axis and horizontal axis) and finally the objective function. It is possible to choose from all kinds of functions of maximum nine variables.

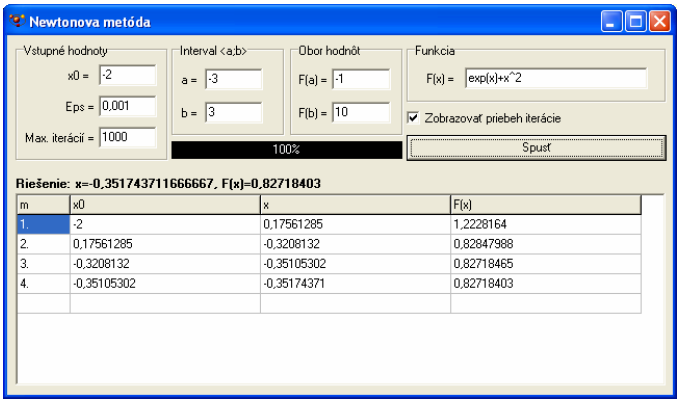

Fig. 5 The window for the Newton's method

The last item of the main menu incorporates two options namely Information about program and Help.

Graph of the function of more variables is shown in the second panel. This is displayed in the figure 6. Above the graph there are control elements situated. These can be modified by the user in order to control displaying of the graph.

There arouses a question. What to use the application for? Students program the algorithms at the seminars. They use them to solve the optimality tasks. The application should motivate them to create their own programs similar to this application. It means that their programs should include debugging of inputs, summary of outputs and eventually a graphic output. Moreover, students can compare results of their algorithms with the results of the application described, and thus to check precision of their own programs.

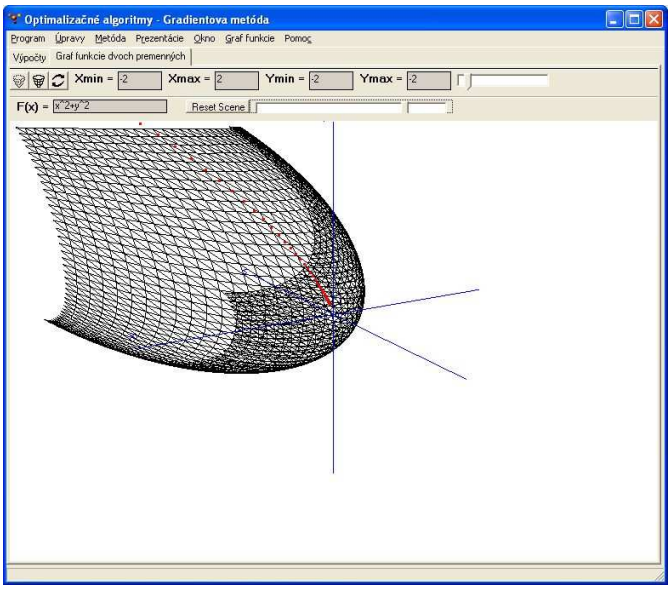

Fig. 6 Second panel - Graph of Gradient Function

3.4 Optimization – an e-learning course in LMS Moodle

The Optimization course has the same content and the structure follows the curriculum for the Optimization subject. Each thematic unit contains:

1. teaching text (*pdf* file)
2. presentation of optimizing method (*swf* and *exe* files)
3. discussion forum where students discus the problems they have encountered while programming and solve them together or with their teacher

4 Evaluation of aids

We asked students to fill up the questionnaire that was aimed at evaluation of the presentations and the application. We gained 31 evaluations that was the exact number of students undergoing the eighth term. In the paper, we mention only some of the twelve questions.

The 1st question:

At the lectures, there are presentations of optimizing methods used as visual aids. Do you think it is a useful aid foe students or not?"

Respondents could choose one of three answers: yes – no – don't know. 30 respondents answered positively. It represented 97 % from all the respondents. Negative answer was not chosen by any respondent. The results are shown in the graph below.

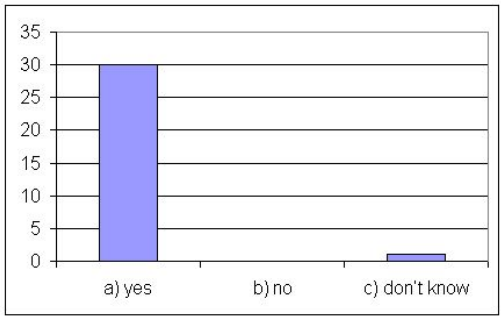

Fig. 7 Graph 1

According to the questionnaire we can presume that students accepted incorporation of the presentations into lectures.

Then, the students were asked to evaluate properties of the application and presentations. There were seven properties mentioned. Respondents were asked to mark the properties from one to five. The best one was marked by 1 and the worst one was marked by 5. Respondents were asked to evaluate whether:

1. the control of application was easy
2. organization of items in the menu was clear
3. organization of the objects within the application (the part for displaying the results and the part with a graph) was optimal
4. listings in the Calculus window are useless
5. the display of a graphic progression of iterations is satisfactory
6. the text in presentations was clear and intelligible
7. quantity of text in a presentation was satisfactory

We tested H0 hypothesis: There is no statistically important difference between individual properties of application. For there was only one group of students questioned we will use Friedman test. According to results of the test we can refuse H0 hypothesis with 99% of reliability. In regard to median and quartile span the properties of application are positive. There was only one statistical difference between the 4th and other properties. This difference occurred due to the negative formulation of the 4th property. There would not have been any difference if the 4th property had been formulated positively.

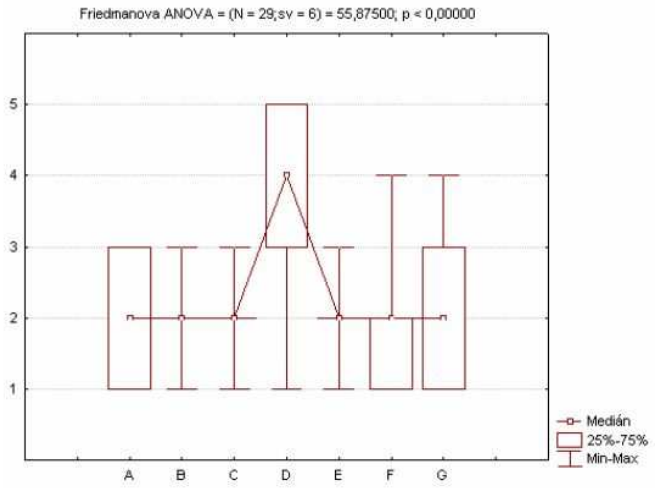

Fig. 8 Graph 2

Graph 2 is called a box graph. It shows descriptive performances as median, quartile span (middle 50 %) and variational span (minimal and maximal values).

4 Conclusion

On the basic of the research as well as practical experience, we can agree upon the conclusion that the described presentations and the application will be sufficient aid facilitating the teaching and learning of Optimization subject. A teacher can use this material at the lectures, seminars, moreover; students can use them at home while preparing for school.

References:

[1] http://moodle.studnet.sk/course/view.php?id=29