Course: Discrete Mathematics with Graph Theory

Learning Outcomes

Learning outcome	E-assessment method (f2f assessment omitted)
LO1: Define and classify binary relations	Data base with tasks implemented in LMS with shuffle
LO2: Apply algorithms based on prime numbers on practical problems	Homework tasks implemented in LMS (Sage, Python) + **2nd example** described below
LO3: Understand the structure and types of proofs in mathematics	Data base with tasks implemented in LMS, e-discussion groups
LO4: Define and relate basic notions in graph theory	Data base with tasks implemented in LMS
LO5: Apply algorithms and theorems from graph theory on solving problems	Homework tasks implemented in LMS (Sage, Python applets)
LO6: Use mathematics literature from variety of sources and at least one text processor and LMS suitable for mathematics	Practical problem implemented in LMS + social software (for example: delicious)
LO7: Structure and solve real work problems by tools from discrete mathematics and graph theory working in teams	Defining/solving practical problem implemented in wiki – **1st example** described below

Content

The syllabus consists of two parts: in the first part different topics in discrete mathematics are covered and the second half is dedicated to the graph theory and its applications. The topics have sound mathematical theoretical foundations but there are also a lot of applications of mathematical theory in informatics and business, e.g. problem solving exercises that are performed individually or in teams.

Teaching

Blended teaching and learning. Lecturing and exercises f2f; Problem solving in teams - LMS; Collaborative learning – wiki…

Evaluation

There are several of them (data-base with exercises for individual work with shuffle system,

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modeling with open-source software, cryptography problems, problem owning/solving etc.) and I pointed out two in more details.

1st Example: Let us describe the way which we used in this course in order to assure the fulfillment of the **learning outcome LO7: Structure and solve real work problems by tools from discrete mathematics and graph theory working in teams** that is connect to the following outcomes at the level of study program: *The ability to understand and apply mathematical methods, models and techniques appropriate for solving problems in the field of information and business systems) concerning mathematical modelling and problem solving*. Besides classical problem solving, when the description of a problem is given to students by teachers, we try to develop additional student's competence connected with recognizing real life problems that can be formulated and afterwards solved by the usage of non-trivial mathematical theories and techniques which students have learned in the course. In such a case students become problem owners (replacing the industrial representatives) and they are interested to formulate it carefully and also to monitor the solution finding process, as well as to evaluate the final solution. This teaching method engages students actively in a deep conceptual mathematical activity, to develop their ability in mathematical reasoning and collaborative learning. It is very important at the beginning of collaborative work to explain the educational goals of the activity and to provide students with the joint problem space.

wiki has been introduced in order to support student team work, problem setting and problem solving exercises and to enable monitoring of students' work and progress. In this particular situation students are divided into teams of three and in the first part of their team work each group has to identify and describe one real world problem that can be, in their opinion, solved by methods of discrete mathematics or graph theory. The proposed problem has to be described correctly and references have to be given by the use of delicious social bookmarking.

After this first phase teams exchanged their problem assignments and the second stage of the problem solving phase starts. In this phase each team has to investigate and work on finding the solution to the assignment, prepared by some other team. The whole collaboration has to be recorded in the wiki system implemented in the LMS Moodle.

The evaluation of the project has been done by using of rubrics implemented in Moodle by professor and two assistants. Peers can also influence overall evaluation (in rubrics there is a recognized criterion for that.)

2nd example. When investigating integer numbers, their properties and corresponding theorems have been introduced, different applications like RSA cryptosystem, the usage of congruencies in ISBN (International Standard Book Number) and UPC (Universal Product Code) is discussed and investigated. An interesting exercise that we use, as **formative** assessment of **LO2**: *Apply algorithms based on prime numbers on practical problems*, is to provide communication between students and teachers by using the RSA cryptosystem and public and private keys for encryption and decryption. A teacher sends encrypted exercise to a student and the student has to decrypt it, solve it, and then again send encrypted solution back to the teacher. The whole process was implemented in Moodle

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by use of open source mathematics software Sage (before we used Mathematica software). Further, especially fruitful opportunities for students' investigations can be found in the graph theory when particular emphasis is put on applications and problem solving in the area of ICT.

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