



## SF2812 Applied Linear Optimization, 2015/2016

### Project assignment 2C

Due Tuesday March 8 2016 15.15

Discussion between the groups is encouraged, but each group must individually solve the assignments. It is *not* allowed to use solutions made by others in any form. Please see the course web page for more detailed information on the rules for the assignments.

Instructions on how to present the project assignments can be found at the course web page.

The exercises are divided into basic exercises and advanced exercises. Sufficient treatment of the basic exercises gives a passing grade. Inclusion of the advanced exercises is necessary for the higher grades (typically A-C). A member of a group who has not worked on the advanced exercises says so in the self assessment form.

Instructions for the report:

- The report should have a leading title page where the project name and the group members' names, personal number and e-mail addresses are clearly stated.
- The report should be written using a suitable word processor.
- The contents should be such that another student in the course, who is not familiar with the project, should be able to read the report and easily understand:
  1. What is the problem? What is the problem background? This does *not* mean a copy of the project description, but rather a suitable summary of necessary information needed in order to understand the problem statement.
  2. How has the group chosen to formulate the problem mathematically? What assumptions have been made? If these assumptions affect the solution, this should be noted.
  3. What is the meaning of constraints, variables and objective function in the mathematical formulation?
  4. What is the solution of the formulated optimization problem? If suitable, refer the mathematical solution to the terminology of the (non-mathematical) problem formulation. (There could be more than one optimization problem.)
- Most project descriptions contain a number of questions to be answered in the report. The report *must* contain the answers to these questions. They should, however, in a natural way be part of the content of the report and not be given in a "list of answers". The purpose of the questions is to suggest suitable issues to consider in the part of the report where the results are interpreted and analyzed. Additional interpretations are encouraged as well as generalizations and other ways of modeling the problem.
- A suggested outline of the report is as follows:
  1. Possibly a short abstract.
  2. Problem description and background information.
  3. Mathematical formulation.
  4. Results and analysis (interpretation of results).
  5. A concluding section with summary and conclusions.

Deviations from the outline can of course be done.

- Each member of the group should fill out a self assessment form and append at the end of the report.
- GAMS code should not be part of the report, and should not be referred to in the report.
- Each group should upload the following documents via the Bilda page of the course no later than by the deadline of the assignment:
  - The report as a pdf file including self assessment forms. (If you are unable to include the self assessment forms in the pdf file you may upload them as separate files, or as a last resort leave them in paper form at the beginning of the presentation lecture.)
  - GAMS files.

Please upload your documents as individual pdf and gms files, and not as zip files.

---

At a particular university, the annual distribution of scholarships to high-performing students has been done entirely by hand. To improve this procedure, one now wants to solve this task as an optimization problem.

For a given number of scholarships and applicants (students), the task is to distribute the money fairly, where a higher grade average of the applicant implies more money. It is part of the assignment to give a distribution which you find fair. All applicants that we consider have already been screened and guaranteed to receive money. Two applicants with the same grade average should receive the same amount of money. Further, it is desirable to have a problem formulation where the received amount of money of the students reflect their respective grade average.

For practical reasons, one does not want any student to receive money from too many different scholarships (at most four).

There are lower and upper limits of the amount that an applicant can receive. It is desirable that these values do not fluctuate too much between the different annual handouts. According to previous years, it is suggested to use 4000 kr as a lower limit and 18000 kr as an upper limit.

The given data of scholarships and approved applicants from this year is given in the GAMS file `stipend.gms`, which can be found at the course's Bilda page. This file contains the average grade of each student (`AverageGrade`) and the total amount of money that is available at each scholarship (`MoneyScholar`). For some scholarships, there are limits on the number of students that can receive scholarships. The lower upper limits are given in the file (`MinStudFromSchol` and `MaxStudFromSchol`). Further, depending on what program a student belongs to, he or she only qualifies for a subset of the scholarships. This is included in the GAMS file such that the largest amount of money that each applicant can receive from a scholarship is given in the table `MoneyMax`.

### Basic exercise

1. Assist the administrator by making a plan that can be optimized by a solver instead of solving this task by hand. Do this by formulating a mixed-integer linear programming model in GAMS and solve this model.

### Advanced exercises

2. In addition, one wants to ensure that an applicant with the grade average 5.00 receives at least 1000 kr more than any applicant with lower grade average. Another desirable feature is that each applicant receives money in units of 500 kr. Modify your model to incorporate these additional features.
3. Discuss potential improvements of the model.

*Remark:* The problems that you formulate are probably larger than what the student version of GAMS can handle. If so, please use NEOS.

*Good luck!*