



SF2812 Applied Linear Optimization, 2017/2018

Project assignment 1B

Due Wednesday February 14 2018 23.59

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.

- 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 Canvas page of the course no later than by the deadline of the assignment:
 - The report as a pdf file.
 - GAMS files.

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

- Each student should fill out a paper copy of the self assessment form and hand in at the beginning of the presentation lecture.

The company Green Destruct AB is specialized at environmental friendly processes for destructing hazardous material. In particular, they handle a waste product which is created in the process of producing wooden floors. They have four plants that are able to handle this particular wood-floor waste product, located in Arboga, Fagersta, Ludvika and Nyköping. The weekly capacities of the four plants for this wood-floor waste product, given in tons, is as follows:

Arboga	Fagersta	Ludvika	Nyköping
7	8	9	8

The destruction cost is 100 kr/kilo of this particular waste.

The company that produce the wood-floors have plants in Eskilstuna, Falun, Gävle, Norrköping, Stockholm, Uppsala, Västerås and Örebro. Each week it is expected that 31 tons of hazardous material is produced, distributed at the eight cites as:

Eskilstuna	Falun	Gävle	Norrköping	Stockholm	Uppsala	Västerås	Örebro
2	2	4	3	9	6	3	2

Green Destruct has an agreement with the wood-floor company to take care of their waste of this particular kind, where the quantities are specified above. It is collected once a week and transported to a destruction site. The wood-floor producing company pays 250 kr/kilo to Green Destruct for this service.

Green Destruct is then responsible for collecting the waste at the wood-floor plants once a week, transporting it to their destruction plants and destruct it there.

For the transportation, Green Destruct has an agreement with a transportation company. The transportation cost is 1 kr per kilo per kilometer up to 1500 kilos. Above 1500 kilo, Green Destruct has to pay an additional 40% extra.

Green Destruct estimates that their own cost for destructing the waste at their site is 100 kr/kilo.

The distances between the wood-floor producing sites and the destruction sites are given in the following table.

	Eskilstuna	Falun	Gävle	Norrköping	Stockholm	Uppsala	Västerås	Örebro
Arboga	45	165	195	110	156	129	52	40
Fagersta	95	88	126	187	176	117	66	103
Ludvika	137	63	150	220	222	163	112	112
Nyköping	82	260	257	59	106	168	128	135

Basic exercises

1. Green Destruct wants to know which is the best way of transporting the material and where to destruct it.

Create a model in GAMS and solve the problem.

2. Green Destruct are concerned that there is rather little excess destruction capacity compared to the production of the wood-floor company. Help them to analyze the situation by pointing out the destruction site with excess capacity.

Advanced exercises

3. The reason why Green Destruct are so concerned about the excess destruction capacity is that they are about sign a new contract with the wood-floor company where they instead of having a contract where they take care of a fixed amount of waste, they take care of all waste produced a certain week. The previously given numbers are the expected values of the production, and the waste production can be modeled as normally distributed with 5% standard deviation. It is likely that the waste production for the different wood-producing plants will be correlated, as the demand is likely to be similar at all sites.

As for the transportation, the cheaper class of transportation, up to 1500 kg, must be the same each week, but the additional transportation which is 40% more expensive, can be changed in between the weeks.

Green Destruct are not sure if they can handle such fluctuations with their current destruction capacities at the destruction plants. If needed, they can increase the capacities at the destruction plants, but the cost in excess of the nominal capacities will be 200 kr/kilo.

Help Green Destruct to analyze the situation. How will their strategy change?

4. Suggest model improvements. In particular, try to identify vulnerabilities and weaknesses of Green Destruct's situation.

The distance table can be found at the Canvas page of the course.

Good luck!