# 01LIP – Linear Programming

Course project

jan.bures@cvut.cz

## Main objective

Individually formulate, solve, and validate a linear or mixed-integer linear programming model (LP/MILP). Explain the meaning of the result. Course credit requires the project and a short oral defense. Exercise attendance is optional. There is no separate course-credit test.

Related exercises are listed for each part below. The assignments and solved notebooks also support self-study.

## 1. Problem and model

Choose your own problem or use an exercise topic, such as production, transportation, blending, inventory, or project selection. Data may be real or synthetic. There is no minimum or maximum number of variables or constraints.

- Briefly describe the decision, assumptions, input data, and data sources.
- Define the variables, their meaning, units, and domains. Justify any integer or binary restrictions.
- State the objective function, optimization direction, and all constraints.

**One complete formulation is sufficient.**

You need not write out the feasible set again. Converting the entire model to other forms or deriving and solving its full dual is not required.

*Exercises:* 1 (formulation and units), 2 (indices, shared bounds, and a table of rules), 7 (balances and boundary conditions), 8 (binary variables).

## 2. Computation

Use any suitable tool, including an existing solver and the exercise templates. Implementing an optimization algorithm or using paid software is not required. State the tool, version, relevant settings, and solution status.

Provide the solution to your problem. If the original problem is infeasible or unbounded, explain why and include a meaningfully modified case that can be solved.

For a difficult MILP, you may establish the optimum of a small validation instance and provide a verified feasible solution of the main instance, a valid bound on its optimum, the time limit, and an absolute or relative optimality gap with its definition. Do not present this result as a proven optimum. An unfinished search alone is insufficient.

*Exercises:* 1 (using a solver), 3 (optimality, infeasibility, and unboundedness), 8 (integer solutions, bounds on the optimum, and the gap).

### 3. Validation and interpretation

- Recompute the objective value from the solution and check the original constraints, bounds, and any integrality restrictions. State the tolerance.
- For a large model, a summary for each constraint family is sufficient, such as the largest violation and the number of violations above the tolerance. You need not print every variable and substituted constraint. Distinguish quantities with different units.
- Explain the decision recommended by the result and the assumptions that limit its use.

*Exercises:* 1 and 3 (substitution, objective, and units), 6 (summary checks), 7 (checking balances), 8 (checking integrality).

### 4. One change to the problem

In addition to the baseline, make at least one meaningful change to the data or a constraint. State the question, changed input, solution status, and result. Compare it with the baseline and briefly explain the difference.

A small table and a comment are sufficient. An unchanged decision or an infeasible modified case is also acceptable if explained. For MILP, assess the change by solving the modified problem.

*Exercises:* 1 (a new constraint), 2 and 5 (a capacity change), 7 (infeasibility of the modified case).

### What to submit

- An annotated Jupyter notebook with saved results, or a short PDF report together with code or an editable computational file.
- Input data and brief instructions for running the calculation. For a spreadsheet solver, identify the objective cell, variable cells, constraints, and settings.
- Sources of data, text, and borrowed code. Identify external solutions, tools, and substantial assistance, including any use of AI.

The project is individual. Write in Czech or English. There is no required page count.

### Oral defense and assessment

In a short individual defense, use your text and code to explain the model, validation, and modified case. The defense can be arranged outside exercise sessions.

Assessment considers the completeness and correctness of the model, reproducibility of the calculation, validation and interpretation of the results, and your understanding. Model size, report length, and attendance are not assessment criteria.

### Deadline and submission

The instructor will publish the deadline and submission method on the course page: `https://buresj.cz/teaching/01lip`.