Combinatorial Optimisation and Constraint Programming (1DL442) Uppsala University – Autumn 2024 Assignment 6: The Circuit, Cumulative, Disjunctive Constraints and Black-Box Search

Prepared by Pierre Flener and Frej Knutar Lewander

— Deadline: 13:00 on Friday 17 January 2025 —

It is strongly recommended to read the *Grading Rules* below and the *Submission Instructions* at the end of this document even ***before*** attempting to tackle its tasks. It is also strongly recommended to prepare and attend the help sessions, as huge time savings may ensue.

Questions and Grading Rules

Assignment 6 is graded 0..5 and covers **Modules 6 to 9** (*not* Module 10) of the MiniCP teaching materials [1]. The tasks are as follows (solo teams or designated sub-teams may skip in Tasks B to D everything about the problems starred there), a report being only needed if you take on Task C and possibly also Task D (those tasks are mandatory for PhD students):

A. Individually: Pass *all* the **Theoretical Questions** at INGInious of *all* those modules.

B. As a team:

- Pass *all* the unit tests at INGInious for `Circuit` (Module 6), `TSP` (Module 6, with both custom search and * LNS), `VRP` (Module 6), `CumulativeDecomposition` (Module 7), `Cumulative` (Module 7), `RCPSP` (Module 7), `DisjunctiveBinary` (Module 8), `JobShop` (* Module 8, both the model and first-fail branching), `LastConflictSearch` (Module 9), `ConflictOrderingSearch` (*, Module 9), and *optionally* `Disjunctive` (Module 8, the propagator, the implementation of edge-finding being optional and * solo teams implementing at least one of the detectable-precedences and not-first-not-last filtering rules).
  If your unit tests time out (and therefore fail) at INGInious for the test method `testOptimality` on `RCPSP` or `testFindOptimality` on `JobShop` (or both), but do not time out (and therefore pass) on your own hardware, then declare so on your honour in a comment to your submission at Studium and we consider you to pass those tests also on INGInious.
- Upload *also* at Studium *all* `*.java` (except the `*Test.java`) mentioned in the questions, for a local archive at UU.

C. As a team or designated sub-team: Write a report on the problems *LNS applied to TSP* (*, Module 6), *From TSP to VRP* (Module 6), and *RCPSP* (Module 7):

- Evaluate (in the style of Section C of the MiniZinc demo report) each of the models under a suitable time-out (of at least 10 minutes per instance) in terms of:
  - the objective value;
  - the runtime in seconds, with 1 decimal place, to proven optimality;
  - the number of failures;

  for 10 instances that you create from the first 17..26 nodes of `data/tsp/tsp_26.txt` (for example, the 5th instance has the first 21 nodes) for both *VRP* with 3 vehicles and *TSP/LNS*, and for *all* the instances in `data/rcpsp` for *RCPSP*.
- Answer *all* the questions of the *LNS applied to TSP* programming problem.

D. As a team or designated sub-team, if you wrote the optional propagator of Task B for `Disjunctive` (Module 8) and it passes at INGInious.org *all* your actually targeted unit tests, then add to your report:

- a high-level description of your design choices;
- a high-level argument for the correctness of your propagator.

Advice will be offered at the help sessions.

If you pass only Tasks A and B, then your score is 3 points. If you pass only Tasks A to C, then your score is 4 points. If you pass Tasks A to D, then your score is 5 points. In all other cases, your score is 0 points and there is no grading session. There is no solution session.

References

[1] Laurent Michel, Pierre Schaus, and Pascal Van Hentenryck. MiniCP: A lightweight solver for constraint programming. *Mathematical Programming Computation*, 13(1):133–184, 2021. The source code is available at http://minicp.org and the teaching materials are available at https://www.edx.org/course/constraint-programming.

Submission Instructions

Use the following to-do list before submitting:

- If you write a report (Tasks C & D): there is no demo report, but remember best practice on comments for code and on experimental evaluation from Sections B and C of the MiniZinc demo report and use your best judgement; do ***not*** import code into the report.
- ***Thoroughly*** proofread, spellcheck, and grammar-check the report, at least once per teammate, including the comments in ***all*** code. In case you are curious about technical writing: see the English Style Guide of UU, the technical-writing Check List & Style Manual of the Optimisation group, common errors in English usage, and common errors in English usage by native Swedish speakers.
- Produce the report as a ***single*** file in ***PDF*** format; all other formats will be rejected.
- Remember that when submitting you implicitly certify (a) that your files were produced solely by your team, except where explicitly stated otherwise and clearly referenced, (b) that each teammate can individually explain any part starting from the moment of submitting your files, and (c) that your files are not freely accessible on a public repository.

- Submit (by only ***one*** of the teammates) the files (all `*.java` mentioned in the questions, except the `*Test.java`, and possibly a report) ***without*** folder structure and ***without*** compression via *Studium*, whose clock may differ from yours, by the given ***hard*** deadline.