Prof. Dr. Rüdiger Ehlers Francisco Palau, M.Sc.

Applied Computational Engines 2018 – Assignment Sheet 4

Due: **14th May 2018**, 7:30 am

Please indicate your **name** and **email address**. You can work in **groups** of up to **three** students. Only one submission per group is necessary. However, in the tutorials every group member must be able to present the solutions to each problem solved by your group.

Please submit your solutions either

- by e-mail to `fpalau@uni-bremen.de` **and** `rehlers@uni-bremen.de`, or
- on paper in **letter box 52** (Francisco Palau-Romero) on floor 6 of the MZH building.

Note that you will need 50% of the points on all exercise sheets in order to take the "Fachgespräch" OR the oral exam. We may ask you to present your solutions in the tutorial, especially if you work in a group. We aim for asking everyone taking part in the course to present at least twice during the course of the semester.

Optimal Propagation (30 pts.)

Check if the following encoding of a constraint set over six variables is optimally propagating. Show that you covered all cases in case of optimal propagation, and give a counter-example in case the encoding is not optimally propagating. All constraints are given in the DIMACS format.

- `3 -5 0`
- `1 -5 0`
- `-1 -3 5 0`
- `2 -4 -5 0`
- `-2 -3 4 0`
- `-1 -4 5 0`
- `1 -2 -3 0`

Note that there are $3^5 = 729$ partial variable valuations, which may seem like a lot. The problem can either be solved by writing a program that iterates over all possible partial valuations and checks if unit propagation can infer all literals implied by the CNF formula and the partial valuation, or by considering all partial valuations by hand and doing the same. In the latter case, you want to perform the search in a smart way. For instance, when considering the partial valuation $\{v_1 \mapsto \mathbf{true}, v_2 \mapsto \mathbf{false}, v_3 \mapsto \mathbf{false}\}$, unit propagation yields $\{v_4 \mapsto \mathbf{false}, v_5 \mapsto \mathbf{false}\}$, which is a complete assignment, so this case covers all 9 partial valuations that include $\{v_1 \mapsto \mathbf{true}, v_2 \mapsto \mathbf{false}, v_3 \mapsto \mathbf{false}\}$.

Tseitin Encoding (20 pts.)

Let the following Boolean formula be given:

$$\psi \wedge ((x \wedge z) \vee y) \wedge (((y \oplus a) \vee z) \oplus \neg y)$$

Assuming that ψ is a already in CNF, we want to perform a Tseitin encoding of the other constraints. Also remove all clauses that can be removed due to polarity, where common sub-formulas are only encoded once.