

Bachelor's Thesis Review

Prague, May 31, 2018

Title: Application of Simplex Algorithm for Submodular Discrete Energy Minimization with Binary Variables

Author: Ekaterina Tiuzhina

Supervisor: RNDr. Daniel Průša, Ph.D.

Date received: 25/05/2018

The thesis presents an algorithm on solving binary submodular max-plus energy minimization problems by linear programming (LP) relaxation and by implementing the simplex algorithm on a graph.

The proposed algorithm follows a construction of a general (not necessarily sub-modular) binary max-plus solver by [1]. In case of sub-modular pairwise potentials, the LP relaxation yields precise solution. So for the sub-modular case, the algorithm has a potential to be more efficient than the baseline algorithm [1]. However the design of the algorithm and its implementation is certainly non-trivial.

The thesis suffers from several weaknesses:

1. The major problem of the thesis is that either the implementation or the algorithm design is wrong in fact. In Sec. 5.3, it is acknowledged that the algorithm did not always deliver the same optimum as the baseline algorithm [1]. The error should have been identified and fixed, otherwise the contribution of the thesis remains questionable.
2. The experimental validation is very limited. According to the assignment, the algorithm should have been tested on both random and real computer vision instances. The testing was done on random synthetic data and tests on real data did not finish due to a long running time, see Sec. 5.2. It is understandable that the “surface fitting” instance was too large, but there are many smaller instances of sub-modular computer vision problems available, e.g. a binary segmentation with Pott’s model.
3. Moreover, to further demonstrate the efficiency of the proposed algorithm a comparison with several baseline should have been made. A quantitative comparison (in Fig. 33–37) with the general graph-based simplex solver [1] is clearly missing. Further comparisons with an LP solver (e.g. CPLEX) or a Max-Flow algorithm would be insightful.
4. The presentation is often not clear. The difficulty starts as early as in the simplex algorithm in Sec. 2.2. The explication is only presenting an example without giving the algorithm formally including all necessary terms. The graph-based algorithm is presented in two sections 3 and 4. The presentation is very technical, but often missing both formal definitions of used terms and justification of the algorithmic steps. Simply, the connection between the presented algorithm steps and the steps of the simplex algorithm is not made explicit. I believe, the text would be much clearer and more intuitive if an example of a mapping between the simplex-table and graph-based steps on a small instance is shown.

5. Implementation details of the algorithm are missing. The only detail, that is revealed is the format of the input text file. However, further details as e.g. the data-structures are not given.

The problem is clearly highly non-trivial. The thesis indicates that a certain progress was made, especially in the design of the algorithm. Regrettably, due to the weaknesses (named above), the potential was not exploited and the contribution of the thesis remains rather small. Therefore, I suggest evaluating the thesis as

D – satisfactory.

Ing. Jan Čech, Ph.D.

References

- [1] D. Průša, “Graph-based simplex method for pairwise energy minimization with binary variables,” in *Proc. CVPR*, 2015.