Can state-of-the-art MaxSAT-based preprocessing and solving be effectively used for cluster editing?

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Problem Overview

Cluster Editing

Given a Graph, what is the minimum number of edge modifications to turn it into a disjoint union of cliques?

Unweighted Partial MaxSAT

Given two sets, hard clauses and soft clauses, what is an assignment of literals that satisfies all the hard clauses and minimizes the number of falsified soft clauses?
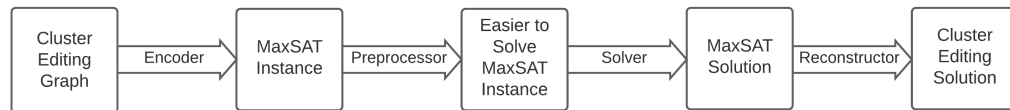
Cluster Editing Graph → Encoder → MaxSAT Instance → Preprocessor → Easier to Solve MaxSAT Instance → Solver → MaxSAT Solution → Reconstructor → Cluster Editing Solution

Figure 1: General Pipeline

Pipeline Specifics

Modelling [1]

• Transitive encoding (prevent conflict triples)
• Binary Encoding (assign vertices to cluster)
• Domain-specific Knowledge

Preprocessor

• MaxPre [4]
• SAT Techniques
• (Weighted) MaxSAT Techniques

Solvers

• MaxHS (Implicit Hitting Set) [2]
• EvalMaxSAT (Core-Guided) [3]
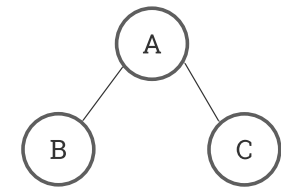• Both performed well in MaxSAT Evaluation 2020

Figure 2: Conflict Triple

Benchmarks

• Between 10 - 90 Vertices
• Between 11 - 1456 Edges
• Between 3-703 Solution Size
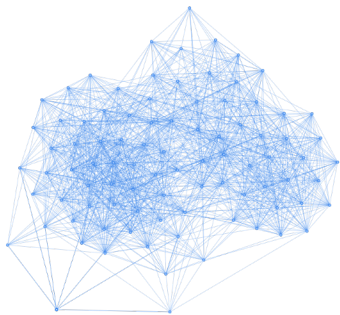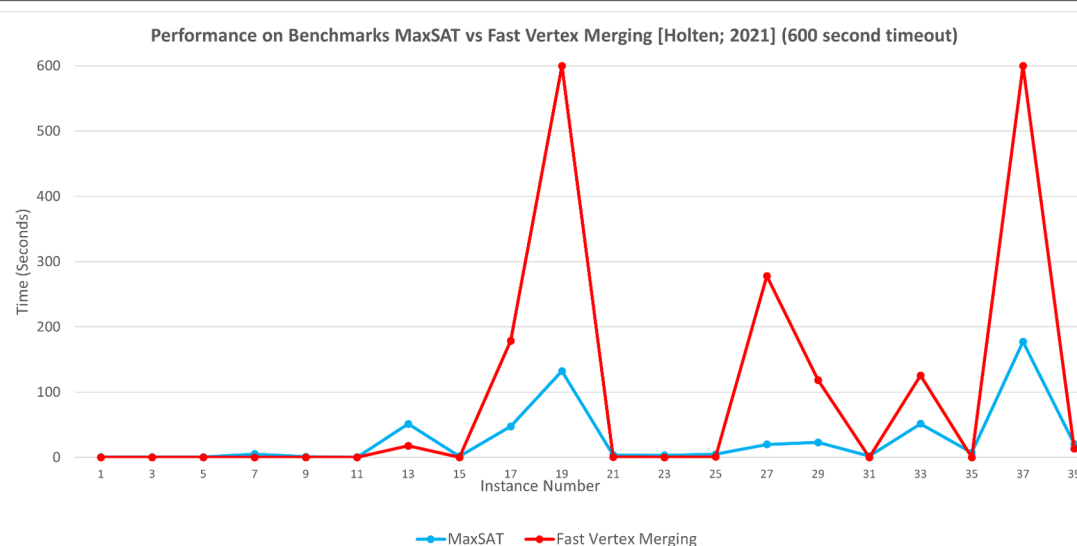• Varying Structures
• Varying densities

Figure 3: Instance exact037

Results

Performance on Benchmarks MaxSAT vs Fast Vertex Merging [Holten; 2021] (600 second timeout)

— MaxSAT   — Fast Vertex Merging

Conclusions

• Non-Obvious Interactions between modelling, preprocessing and solving
• Applicability depends on input instance
• Modelling is not very scalable (up to 500.000 clauses for 100 vertices)
• MaxHS + Preprocessed Transitive Encoding appears to be the most stable
• MaxSAT approaches are possible but might not be guided in the same way as theoretical approaches

[1] J. Berg and M. Järvisalo, Cost-optimal constrained correlation clustering via weighted partial maximum satisfiability. [2] F. Bacchus, MaxHS in the 2020 MaxSat Evaluation.
[3] F. Avellaneda, A short description of the solver EvalMaxSAT. [4] T. Korhonen, J. Berg, P. Saikko and M. Järvisalo, MaxPre: An Extended MaxSAT Preprocessor