Approximation Ratio of a Deterministic Polynomial Black Box Over a MaxSAT Oracle*

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Abstract. We consider in this study an experimental algorithm, of polynomial nature that created from 10 years of experimentation in the laboratory, acts as a deterministic black-box optimizer on several NP problems, including MaxSAT, and the massive number of experiments performed, HESS algorithm always breaks the limits of inapproximability for Max3SAT. To make our experimental study, we have selected a broad set of instances from past SAT competitions. The HESS black-box algorithm, along with all experiment, show on all SATISFIABLE instances, a breaking of the inapproximability ratio for Max3SAT.

Keywords: SAT · MaxSAT · Black Box · Polynomial · Experimental · Approximation · NP-Complete · NP-Hard

1 Introduction

HESS back-box algorithm built over trial and error along ten years of experimentation, destined initially to solve the Travelling Salesman Problem, with several simplifications along the years there is the final most simple form of the algorithm for binary problems. The central Hypothesis corroborated with the current state of the art instances that the approximability ratio over a MaxSAT oracle always breaks the limit for a Polynomial MaxSAT Approximation Algorithm. The vast majority of the academics agreed on that $P \neq NP$ the main argument is the void on practical evidence of contrary possibility, the intention bellow HESS algorithm is given an experimental approach to the possibility of that $P = NP$, putting the inapproximability theorem for Max3SAT into an experimental proof.

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2 Backgound

Håstad [1] demonstrates the following theorem, say that unless P=NP `Max3SAT` is inapproximable beyond the random assignment threshold.

Theorem 1. *For every $\epsilon > 0$, computing $(7/8 + \epsilon)$-approximation to* `Max3SAT` *is NP-Hard.*

3 HESS black-box

The complexity of the HESS black-box algorithm is O(nO(Oracle)). The spatial complexity is linear over the input instance, and the oracle defines the entire behavior of the black-box, this return the current number of satisfied clauses from the current assignment.

HESS black-box

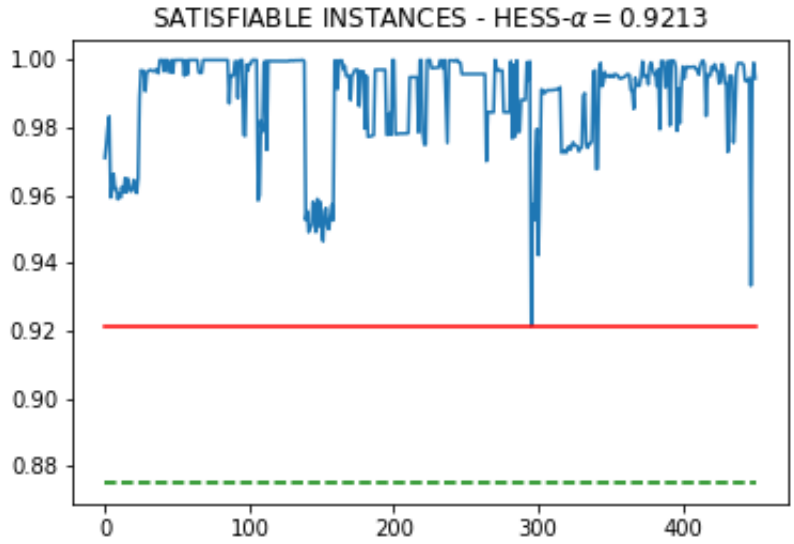
```
 1: procedure HESS(n, Q)                          ▷ The MaxSAT Oracle
 2:     g ← 0
 3:     k ← 0
 4:     for k ← 0, n do
 5:         x[k] ← ¬x[k]
 6:         l ← Q(x)
 7:         if l > g then
 8:             g ← l                             ▷ Save current assigment
 9:             o ← x
10:             go to 5
11:         else if l < g then
12:             go to 5
13:         end if
14:     end for                                   ▷ Return the best assigment
15:     return o
16: end procedure
```

4 Procedure

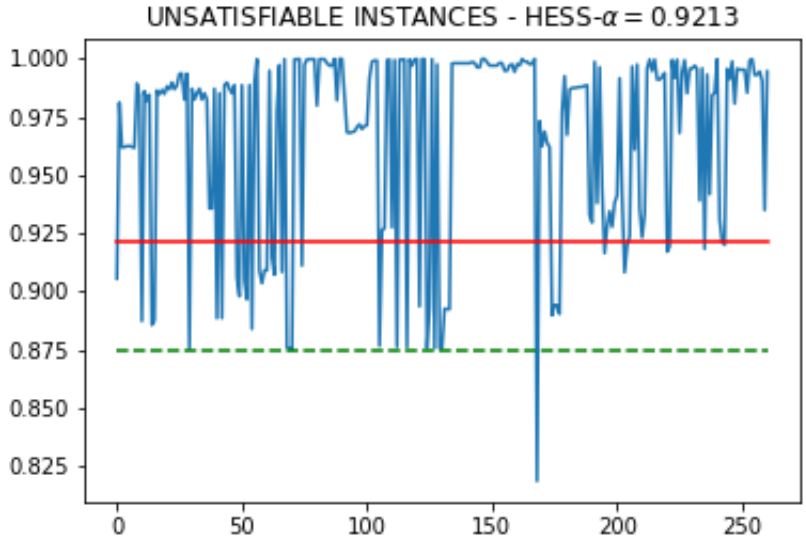
The HESS black-box algorithm implemented on C89 and compiled with GCC version 9.2.1 20191008 (Ubuntu 9.2.1-9ubuntu2) on Ubuntu 19.10. It is considering all instances from SAT Race [2] 2015, 2018, 2019, separated by year and ordered by size on disk, are created execution script, calling the HESS black-box algorithm and save this output into a CSV file, next analyze and plot data with Python3 and the libraries Pandas, Matplotlib and JupyterLab. The output of HESS black-box implementation includes the name of the instance, the number of variables, number of clauses, max clause size, the ratio between the number of clauses and number of variables, HESS-α ratio, number of queries to MaxSAT oracle, time of resolution, and model for the current HESS-α ratio.

5 Results

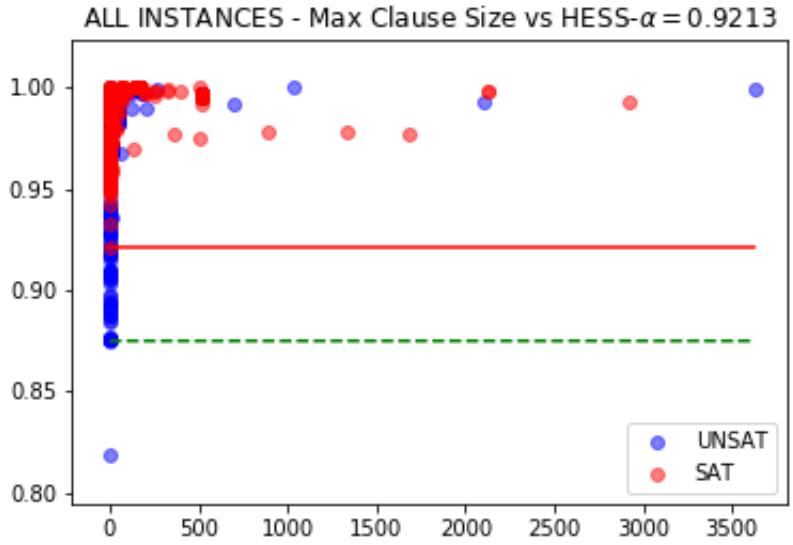
Observe a pattern across all SAT instances, with α=0.92 independent of the max clause size.



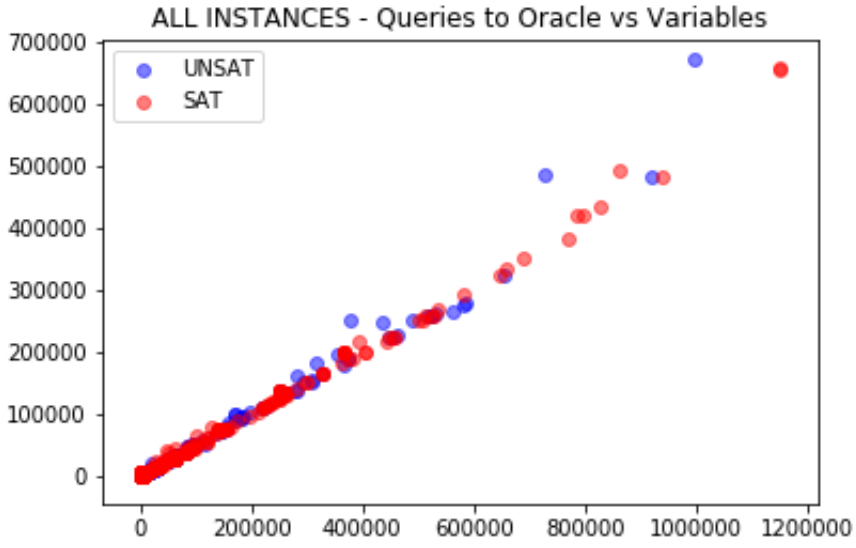
UNSAT instances, not respect the ratio, perhaps observe some instances are below the α ratio.



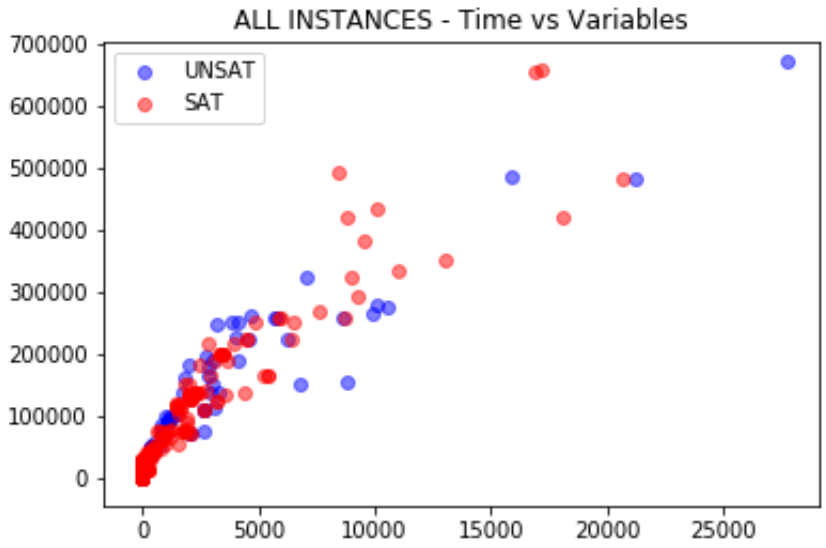
The max clause size across all instances SAT and UNSAT, vs. HESS-$alpha$.



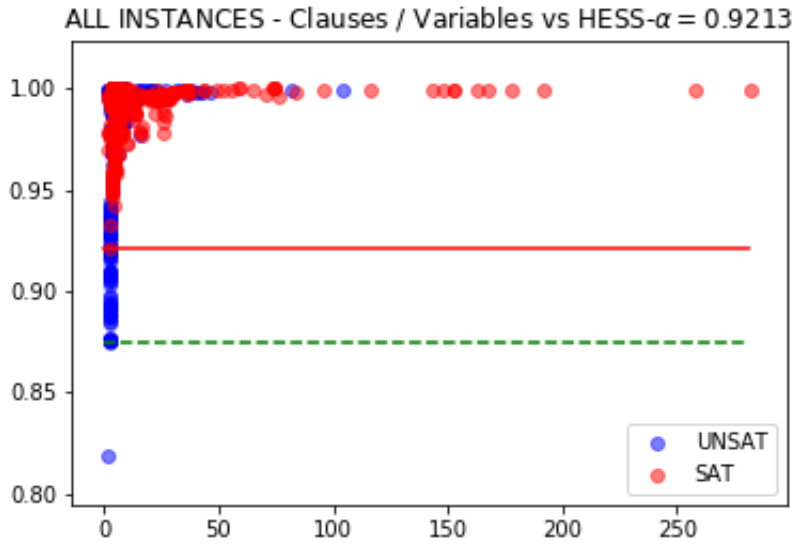
The number of queries to $MaxSAT$ oracle vs. the number of variables.



The time across all SAT and UNSAT instances the number of variables.



The ratio between the number of clauses and the number of variables vs. HESS-*alpha*.



6 Discussion

The experiment for SAT instances is inside of the scope of the Hypothesis; the ratio of approximability for SAT instances of the HESS black-box algorithm is 0.92.

The UNSAT instances do not respect this ratio, and in some cases, USAT instances have the same behavior of SAT instances, this makes the separability of SAT and UNSAT instances impossible from the radius, but in the case that an instance bellowed the radio is always UNSAT for the sample DATA.

For the study, do not separate the instances by max clause size because the HESS-α ratio is not presenting particularities about this issue.

A small number of large instances near the 1GB on disk from SAT races not processed by difficulties with the RAM of the laboratory machine.

7 Conclusion

The HESS black-box algorithm satisfies at the experimental level the requirements for being a candidate for the possibility of P=NP.

References

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2. The International SAT Competition Web Page, http://www.satcompetition.org.