main

October 23, 2022

1 Executive summary

The experiment descibed in this document compares 2 different algorithms for solving the 3-SAT problem. These algorithms are `prob_sat` and `gsat` and they are from the group of non-complete algorithms.

2 Introduction

The experiment is trying to answer if `prob_sat` is faster than `gsat` given 3-SAT instances that are hard (have the clauses-to-variables ration near `4.3`). These instances were downloaded from the `SATLIB` benchmarks. Parameters used to answer the experiment were as follows.

- `MAX_TRIES` - 400
- `MAX_ITER` - 30
- `gsat` $p = 0.4$
- `prob_sat` $c_m = 0, c_b = 2.3$

3 Material

`GSAT` implementation given on the lectures was used to generate solutions to instances. `Prob_sat` implementation was written in python from scratch using the same API. Both implementations ran instances from the `uf20-91R` dataset, each one for 1000 times, so that it is possible to average anomalies. Results were then saved as csv and sample from that csv could be seen bellow and full data is available as an attachment.

There were no unsolved runs, so penalization was not used before averaging the values.

```
        iter  sat_clause  all_clause       filename       alg
0         14          91          91   uf20-011.cnf  prob_sat
1        131          91          91   uf20-011.cnf      gsat
2         73          91          91   uf20-011.cnf  prob_sat
3         21          91          91   uf20-011.cnf      gsat
4         50          91          91   uf20-011.cnf  prob_sat
…       …          …          …          …       …
199795    16          91          91  uf20-0990.cnf      gsat
199796   139          91          91  uf20-0990.cnf  prob_sat
199797   299          91          91  uf20-0990.cnf      gsat
199798   263          91          91  uf20-0990.cnf  prob_sat
```

```
199799    67           91           91  uf20-0990.cnf      gsat

[199800 rows x 5 columns]
```

Data acquired from the gathering step were then averaged accross filename and algorithm columns. Resulting dataset has only 200 rows total.

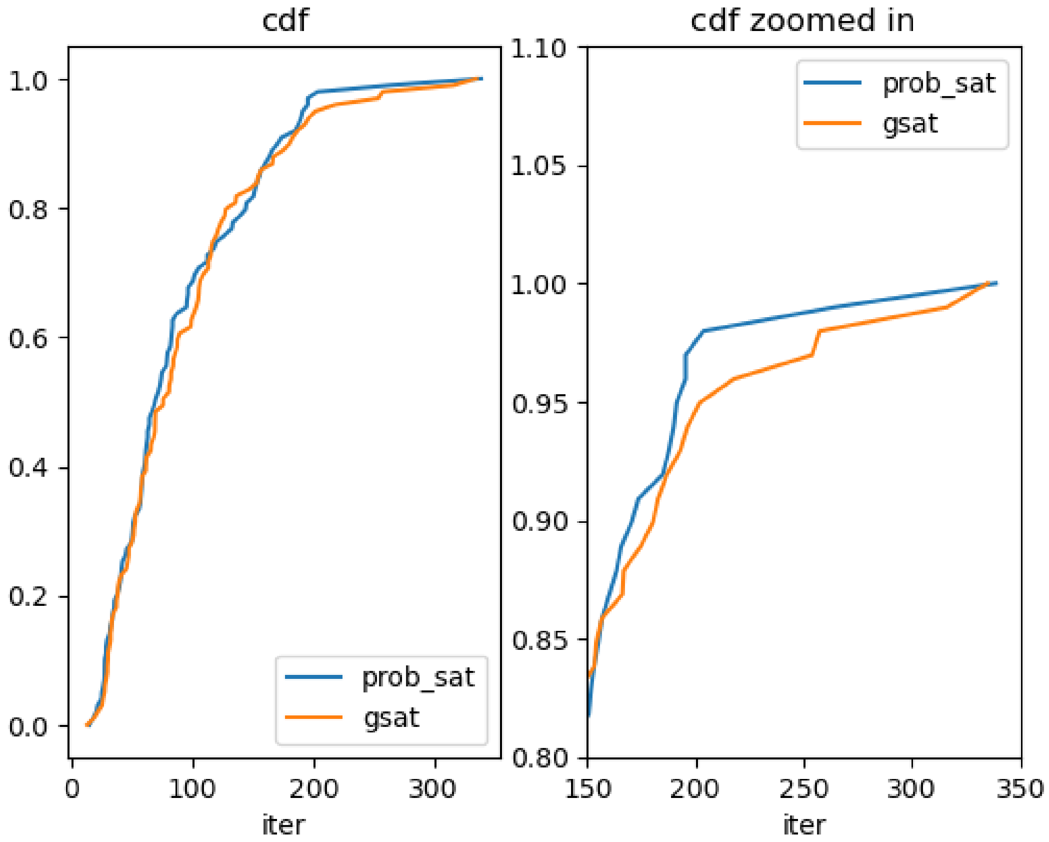
```
          filename       alg        iter  sat_clause  all_clause
0      uf20-011.cnf      gsat   32.252252        91.0        91.0
1      uf20-011.cnf  prob_sat   29.473473        91.0        91.0
2     uf20-0110.cnf      gsat   21.634635        91.0        91.0
3     uf20-0110.cnf  prob_sat   20.593594        91.0        91.0
4     uf20-0116.cnf      gsat   87.546547        91.0        91.0
..              …         …           …          …         …
195   uf20-0969.cnf  prob_sat   78.904905        91.0        91.0
196   uf20-0987.cnf      gsat   56.885886        91.0        91.0
197   uf20-0987.cnf  prob_sat   50.698699        91.0        91.0
198   uf20-0990.cnf      gsat  106.395395        91.0        91.0
199   uf20-0990.cnf  prob_sat  105.013013        91.0        91.0

[200 rows x 5 columns]
```

As the metric, the `cdf` (cummulative distributive function) over the number of iterations has been chosen. Other metrics were not conclusive, because the difference between `gsat` and `prob_sat` for these parameters is not that significant.

4 Results

Data is available in the `res.csv` file and bellow we can see the `cdf` graph with zoomed in version of the same graph on the right. It shows us the probability (`y` axis) of finding the solution given number of iteration (`x` axis).



5 Discussion

There is not a systematically better algorith, which is apparent from the intersections in the first graph. For higher iterations it seems like `prob_sat` is better, if we ignore the last point in the `cdf`, which seems to favor `gsat`.

But we cannot ignore that, because it is possible that after the 350th iteration number the `gsat` algorithm would be superior. Further measurements are needed maybe using harder instances.