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## Primer parcial

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# 1 Introduction

This document will explain the strategies that have been used in order to make a Local Search SAT Solver. Firstly, to take an idea of how SAT should work we organised the project in different modules and classes. When we saw more or less how SAT should perform we start implementing the SAT in a single file in order to make it faster and don't waste time importing modules. Also, it was attempted to use lazy data structures in order to have an efficient experimental cost. In the next part, it will be explained the different strategies that we studied and found so as to choose the one that will compete in the SAT race.

# 2 Studied Strategies

The studied strategies were Walk-SAT and GSAT. Even though they were useful for understanding how an incomplete SAT works, our curiosity helps us to find new ones.

Our first implementation was the Walk-Sat that we've seen in the class. As it was our first implementation we weren't able to compare it with any other, so we decided to implement gsat in purpose to see which one of the two performs better.

After this we seen that our implementation of WalkSAT was the way better than the GSAT one.

Once we already implemented the two types of SATS that we seen in class, we start searching for a strategy that performs better than this both, and we found one quite interesting.

This new one was a combination of the Walksat Random restarts strategy with the functionality of the GSAT. And that makes a lot of sense for us because we thought that GSAT probably was slower due to he stucks a lot more in local minimas than WalkSAT do. This strategy is called Random Walk GSAT.

Next in the graphic below we will show how the three strategies perform in a set of satisfiable and different sized formulas:

## 3 Chosen Strategies

### 3.1 GSAT with Random Walk

As it shows the graphic REF, this strategy outperforms the other two, this is because it gets the best things of both others and put it together. Walksat skips better local minimas but it flips randomly the literal to get the next step. And GSAT gets staked more time in local minimas but it choses better the literal to flip. So basically, this strategy skips a lot of local minimas doing a step up and choses better the literal to flip (with the costs related of doing it). Here we will show de pseudocode of the strategy:

```
for i in max_tries:
    for j in max_flips
        if (probability p):
            pick a variable in some unsat clause
            and flip it in the interpretation
        else:
            follow the standard GSAT scheme
            -> Make the best possible move
```

#### 3.1.1 Implementation details

## 4 Data Structures

In order to have efficient functions, there are some data structures that helps the solver to have better efficient functions. All of them are stored in *fracaSAT* class.

1. ***formula***. This data structure was given in class. It represents a list of literals in positive and negative that encapsulates a list of clauses that the literal appear. It is a fast way of getting all the clauses that appear a literal.

2. ***clauses***. A list of clauses with their literals. This data structure is needed to get the function cost of every interpretation.
3. ***not\_found***. A list of literals that appear only in negative or positive. This data structure helps the solver to have a minimal set of clauses that evaluates true<sup>1</sup> and to get approach to local optimal. It is created when the program reads the CNF formula.

## 5 Statistics and Heuristics

In addition of developing different strategies in order to improving the solver performance, some heuristics have been created. These heuristics have been used in order to slightly modify the fracSAT object. As a result, this heuristics will modify the behaviour of our normal strategy. The main aim of them are not to be again in the same local optimals modifying the cost of these interpretations. These are some of the thoughts heuristics and those which were developed.

1. **Creating a clause of the negate interpretation** not only will not only improve the cost of the search but also this one will be incremented, as the cost of having the cost of an interpretation will be harder. That is because half of the list of our structure will append a new clause.
2. **Repeating a clause** is a more interesting idea as it will not become as hard as the previous one and the length<sup>2</sup> of the new clause will be the same of the others clauses.
3. **Making a clause of the unsatisfied clauses** will prune better than the previous one despite the fact that the cost of getting the cost of the interpretation will be harder.

Even though it is a good way to not lead to the same local minimal, it is very complicated to not overload too much the data structures with naive information.

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<sup>1</sup>Only if the negate literal appears in the cnf formula.

<sup>2</sup>Number of literals

## 6 Conclusion