Introduction to AI Assignment 1

2025/03/18

So far, we have learned lots about tree search. A common application is to find a satisfied inputs for a circuit, known as circuit satisfiability problem. A special form of circuit satisfiability problem is the 3-SAT problem, which can be defined as follows. Given a set of variables $\{x_i\}_{i=1,\dots D}$ and a Boolean formula written in the conjunctive normal form:

$$f(X) = \Lambda_{j=1}^{m}(s_{j,1}x_{\pi[j,1]} \vee s_{j,2}x_{\pi[j,2]} \vee s_{j,3}x_{\pi[j,3]}),$$

where $s_{j,k}$ and $\pi[j,k]$ represent the sign and index of the *k*th literal in the *j*th clause, respectively. The 3-SAT problem is to find a satisfiable input $\boldsymbol{x}^*$ such that $f(\boldsymbol{x}^*) = true$.

Write a program to solve the 3-SAT problem using tree search algorithms.

Implementation

The problem can be described by an $m \times 3$ integer matrix, the sign and value of the element in *i*th row and *j*th column denote the sign and index of the *j*th literal in *i*th clause, respectively. The information for each problem is stored in a .csv file named as 3SAT_Dim=D, where D is the number of variables *D* for the 3-SAT problem.

The following tree search algorithms must be included:

1. depth first search,
2. best first search, and
3. A* search.

Separate your implementation into different files. Output the solution to result.txt file, which should include the solution of a binary vector separated by space.

Analysis

Compare the performance of above methods in terms of

1. cost,
2. #expanded nodes, and
3. running time.

The maximum number of nodes used in tree search is D^3.

Describe your design and discuss your findings in this assignment.

Requirement

1. Write your program in C or C++. You will get no score if you use other programming languages. Team members can share codes but should take responsibility to check it.

2. Students should write report on your own without sharing to others including team members.
3. You have to turn in your source code and a report for the assignment. Do **not** turn in executable files. You will get zero score if the code cannot be compiled or cannot provide correct results.
4. Upload your files in a zip file in the format: SP_StudentID.zip, where StudentID is your student ID.
5. The due date is 2025/04/01. Every delay takes a penalty of 20 scores per day.
6. Plagiarism is prohibited with no exception. Being identified as plagiarism will get zero score for the assignment. This includes using any nature language processing techniques such as ChatGPT or GPT-4.