Lab02: PL Resolution

Problem description

Given a knowledge base (**KB**) and a query **α**, both are sets of propositional clauses in CNF. Refer to Textbook, Chapter 7, Figure 7.12, to **implement the PL-RESOLUTION function** to check whether **KB entails α** (KB ⊨ α).

Provide 5 non-trivial test cases, along with the submission, to validate your program

In the report, discuss the PL resolution algorithm's efficiency and suggest some solution(s) to address the limitations

Input specifications

The input file stores the KB and α, whose format is as follows:

- The first line contains a positive integer M, which is the number of clauses in query α
- M next lines represent the clauses in query α, one clause per line
- The M+2 line contains a positive integer N, which is the number of clauses in the KB
- N next lines represent the clauses in KB, one clause per line.

A (positive) literal is represented by one uppercase letter, i.e. A-Z. A negated literal is a literal associated with a minus symbol ('-') right ahead. Literals are connected by the OR keyword. There may be multiple white spaces between literals and keywords.

Output specifications

The output file stores the set of clauses generated during the resolution and the conclusion. The output format is as follows

- The first line contains a non-negative integer M_1, which indicates the number of clauses generated in the first loop.
- M_1 next lines represent the newly generated clauses in the first loop (including the empty clause). An empty clause is represented by the string "{}".
- Subsequent loops (of M_2, M_3,…, M_n clauses) are represented as stated above.
- The last line shows the conclusion, i.e. whether "KB entails α". Print YES if KB entails α. Otherwise, print NO.
- Duplicates, i.e., clauses that are identical to some clauses appeared previously (e.g., in the current/previous loop or in the original KB) are ignored.

Code specifications

The main function must perform the following basic actions

- Read the input data and store it in appropriate data structures
- Call the function PL-Resolution, which implements the PL-Resolution algorithm
- Write the output data to the output file in valid format

Important notes

- Pay attention to the meanings of true and false of the PL-RESOLUTION function in the textbook. Do not forget to include the negation of the query α.
- Literals within a clause (both in input data and output data) are sorted following the alphabetical order.
- The entailment is checked at the end of each loop, instead of after generating a clause.
- The clause A ∨ B ∨ -B is considered equivalent to A ∨ True and hence equivalent to True. Deducing that True is true is not very helpful. Therefore, any clause in which two complementary literals appear can be discarded.
- The input data is assumed to be in valid format.

An example of the given KB and query α in the input.txt file.

Input.txt	Output.txt	Note
1	3	
-A	-A	(-A OR B) resolves with (-B)
4	B	(-A OR B) resolves with (negative of -A)
-A OR B	-C	(B OR -C) resolves with (-B)
B OR -C	4	
A OR -B OR C	-B OR C	(A OR -B OR C) resolves with (-A)
-B	A OR C	(A OR -B OR C) resolves with (B)
	A OR -B	(A OR -B OR C) resolves with (-C)
	{}	(-B) resolves with (B)
	YES	KB entails α since an empty clause exists in KB.

- Another example of the same KB yet another query α.

1	2	
A	-C	
4	-B OR C	(A OR -B OR C) resolves with (-A)
-A OR B	2	
B OR -C	-A OR C	(-A OR B) resolves with (-B OR C)
A OR -B OR C	A OR -B	(A OR -B OR C) resolves with (-C)
-B	1	
	A OR -C	(B OR -C) resolves with (A OR -B)
	0	No new sentence found
	NO	KB does not entail α since no new clause is created and no empty clause is found.

Rubric

Criteria	Points
Read the input data and successfully store it in some data structures	1.0pt
The output file strictly follows the lab specifications	1.0pt
Implement the propositional resolution algorithm	2.0pts
Provide a complete set of clauses and exact conclusion	3.0pts
Five test cases: both input and output files	1.0pt
Discussion on the algorithm's efffiency and suggestions	2.0pts

Submission preparation

This is an INDIVIDUAL assignment.
Prepare a folder that includes the following subfolders

- SOURCE: all Python files should be put in here
- INPUT: five non-trivial test cases of different KB-α pairs
- OUTPUT: corresponding output files to the input files in the INPUT folder
- DOCUMENT: a PDF-formatted file that presents a check list of what you have/have not done, a brief description of main functions (so that the Lab Instructors do not miss any of your efforts) and responses to the requirements in the Problem description

Name the main folder following your Student ID and compress it in common format.