Programming Assignment #2 Report

Name: **Arjun Agarwal**

ID: **2017B3A70285G**

I have implemented the DPLL algorithm with the following three heuristics:

1) Early Termination Heuristic
2) Pure Symbol Heuristic
3) Unit Clause Heuristic

Note: I have used the set() and frozenset() data structures in my code which are unordered data structures. Therefore, each time the Wumpus World problem is simulated, we may get a different path taken by the Agent each time (and therefore a different number of DPLL calls)

There are four cases of the simulation in which the comparisons are made:

1) Including Early Termination (ET), Pure Symbol (PS) and Unit Clause (UC) heuristics
2) Including only Early Termination (ET) and Pure Symbol (PS) heuristics
3) Including only Early Termination (ET) and Unit Clause (UC) heuristics
4) Including only Pure Symbol (PS) and Unit Clause (UC) heuristics

There are two types of comparisons I have made:

1) Taken an average of 10 simulations using the **Wumpus world given in the question** for each of the four cases.

Case	Average number of DPLL calls made	Average time taken
1) ET, PS, UC	627	1.72s
2) ET, PS	>1,000,000 #	>2,400s
3) ET, UC	454 $	0.95s
4) PS, UC	39,098	22.1s

2) I have simulated using all possible Wumpus worlds which satisfy the given requirements (there are 142 such worlds possible). I have taken the average across all the worlds for each of the four cases.

Case	Average number of DPLL calls made	Average time taken
1) ET, PS, UC	447	2.34s
2) ET, PS	>1,000,000 #	>2,400s
3) ET, UC	488	1.07s
4) PS, UC	41,232	37.12s

the Unit Clause heuristic plays a heavy role in pruning the search tree (since most of the clauses in the knowledge base contain very few number of literals). Thus, without its implementation, most of the search tree is explored. Since there are 64 propositional symbols in the knowledge base, there are 2^{64} possible assignments, many of which are getting explored.

$ it is surprising that the number of DPLL calls made without the use of the Pure Symbol heuristic is lesser than with its use. The most likely explanation for this is, since the check for entailment actually requires the condition to be unsatisfiable, the assignments which are made by the Unit Clause heuristic lead to satisfying this condition faster than using the Pure Symbol heuristic, for that particular world (given in the question). However, for all possible scenarios (table #2), we can see that the figures are consistent.

From these comparisons, we can see that the Unit Clause heuristic plays an enormous role in pruning the search tree. Without the Unit Clause heuristic, the program fails to find the path within 40 minutes of execution (and is manually terminated).

The next heuristic on which the program relies heavily on is the Early Termination heuristic. It prunes a major part of the search tree reducing the number of calls made to the DPLL function significantly (as can be seen from the table).

The Pure Symbol heuristic is not utilized as often as the other two heuristics and so does not have a distinct advantage in this particular type of problem statements (i.e. the simplified Wumpus world that we are dealing with).