

Assignment 3 : Lab Report

1. *Introduction*

Two functions where one generates a general wumpus world rule set as CNF structure and a function that takes in a knowledge base and a theorem and tries to prove it by contradiction. For generating the knowledge base how many rules will be created. Will there be a lot of overlap and how descriptive should these rules be? I think that having more descriptive rules will allow us to prove theorems faster which would be the ideal situation for having a knowledge base that is descriptive.

2. *Method*

CS4300_BR_gen_KB - This function is setup to generate rules about Wumpus World. A total of 434 sentences were generated to build a comprehensive way to describe the behavior of Wumpus World. These rules include cell coordinates and a set of 5 special labels : B, G, P, S, W standing for "Breeze" , "Gold" , "Pit" , "Stench" , and "Wumpus" accordingly. In generating the rules, the neighbors of each individual cell must be considered. In this case, a connectivity graph helps to enumerate neighbors of cells in order to add rules relevant to each cell. In the generation of the connectivity graph, one can observe that corners on the 4x4

grid have 2 connections, edges cells have 3 connections and interior cells have 4 connections. Since there are 4 corner cells, 8 edge cells, and 4 interior cells there are 48 connections to consider ($2*4 + 8*3 + 4*4$). The rules generated are as follow :

If there is a breeze in a cell then there must be at least one pit in its neighboring cells. 64 sentences

If there is a stench in a cell then there must be a wumpus in at least of of that cell's neighboring cells. 64 sentences

There must be one wumpus on the board. 120 sentences

There must be one gold on the board. 120 sentences

The wumpus must be on a valid space (The wumpus must not be positioned on a cell which contains a pit). 16 sentences

The gold must be on a valid space (The gold must not be positioned on a cell which contains a pit). 16 sentences

If there is a pit in a cell then there must be breezes on all neighboring cells. 16 sentences.

If there is a wumpus in a cell then there must be stench on all neighboring cells. 16 sentences.

There must be gold on the board at some cell. 1 sentences

There must be wumpus on the board at some cell. 1 sentences

CS4300_RTP - This function is a general purpose Resolution Theorem Prover that attempts to resolve a CNF theorem with an accompanying knowledge base and return whether the theorem is provable or not (represented with an empty or complete set). In order to see if a theorem is provable its clauses are first insert, negated, into the knowledge base that is passed in. This is because the Theorem Prover algorithm attempts to prove a theorem through a proof by contradiction. After the negated clauses are inserted, a 'new' list is created to track new sentences added to the knowledge base. Next, clauses are looped through in pairs in a brute force method. Each pair is processed within a function that finds tautologies and collapses them into possible new clauses; these clauses are inserted in 'new'. If new is a subset of our knowledge base then new clauses haven't been come across and the theorem can't be proved. Otherwise new clauses are added to the knowledge base and will be processed again. If in the chance that, when resolving two clauses, all of the literals within the two clauses have been collapsed then the theorem has been proved and can be returned in the form of an empty set.

3. Verification of Program

To verify that we have the correct rule set for CS4300_BR_gen_KB we add up all the rules that are covered in the method section which would be $64 + 64 + 120 + 120 + 16 + 16 + 16 + 16 + 2 = 434$ rules. There are 64 rules for the breeze logic having a neighboring pit, 64 similar rules but for stench to wumpus instead, 120 rules that there is wumpus only on one spot on the board, a similar 120 rules that there is only gold on one spot of the board, 16 rules that there is no wumpus

on a pit, another similar 16 for no gold on a pit. Then there are extra two sets of 16 rules that give more information that if a cell has a pit then all of its neighbors must have breezes and a similar rule set for wumpus' and stench.

To verify CS4300_RTP we ran it with the example provided where DP would be the knowledge base and we are trying to prove and thm is the theorem we are trying to prove. When we run this we get the expected result of empty since 4 can be proved through contradiction. The opposite theorem of -4 for thm also gives the correct output of it not being empty since you can not prove it by contradiction.

DP(1).clauses = [-1,2,3,4];

DP(2).clauses = [-2];

DP(3).clauses = [-3];

DP(4).clauses = [1];

thm(1).clauses = [4];

vars = [1,2,3,4];

4. Data and Analysis

None, since there is no data needed to answer the questions proposed in the introduction.

5. Interpretation

With our rule set being larger than 402 rules with ours being 432 instead we presume that these extra 32 rules with detailed information about whether cells

have a pit or wumpus will allow us the break down rules at a faster rate allowing us to prove the questioned theorem faster even know it won't change the outcome.

For RTP with the two outcomes there is a very different way of the resolution being resolved. When it is true we broke down the rules so such simple states that we can break them down to a state where nothing exists which shows the rule set is true. When this doesn't happen where the rules can no longer be broken down it signifies that there is no solution that it can reach and shows that the theorem presented it not true.

6. *Critique*

We think that those extra rules that we argued are important not the knowledge itself but it terms of breaking down the knowledge faster. They aren't going to give a different solution to a questioned theorem but for us we think more descriptive knowledge like for a cell to have a pit all its neighbors must a have a breeze is useful information to have for our knowledge base and these rules are not included with the breeze must have one neighboring pit logic. Even though it will infer this information when it breaks down the rule set, we think that including it in the knowledge base will be more helpful than not including it.

7. *Log*

Eric : CS4300_BR_gen_KB - 9 hours

CS4300_RTP - 6 hours

CS4300_PL_Resolve - 1 hour

Monish : CS4300_BR_gen_KB - 9 hours

CS4300_RTP - 6 hours

CS4300_PL_Resolve - 1 hour