Project 4

Due Date: Nov 5, 2015

I. Entailment in Propositional Logic

Minesniffer is a variant of the popular Minesweeper game. The Minesniffer game consists of an N x M board of cells (N rows and M columns). Each cell may potentially hold one mine. The task at hand is to locate all the cells with mines. Hints to locate them are available in cells that do not have mines. Specifically the cells without mines will be labeled with a numeric value between 0 and 8. The numeric value in a cell in the (i,j)th position of the board denotes the number of mines in cells adjacent to (i,j). Cells adjacent to the cell at (i,j) are those bordering it on its left, right, above, below and the corners. Cells where a mine may be located are labeled "X". Here's an example:

1	2	2	1	0
1	X	X	1	0
1	2	2	1	0

(i,j) means the ith row and jth column cell at row i and column j. Assume that the row numbers increase from bottom to top and column numbers increase from left to right. The cell at (1,1) has 3 adjacent cells: (1,2) is labeled with the value 2; (2,1) is labeled with the value 1; (2,2) is labeled X. The 1 in (1, 1) means that a mine is located in one of its 3 adjacent cells.

You will take a board configuration such as the one shown in the example above and determine if there are mines located in cells marked X. For the example above both the X's will be true meaning there is a mine in both these cells.

You will use SAT solvers to do this task. You will reduce the board configuration into CNF and then call MiniSAT solver (http://minisat.se/MiniSat.html). A satisfying assignment will assign true or false to the X's.

See http://www.dwheeler.com/essays/minisat-user-guide.html for the syntax of CNF sentences accepted by the solver.

(1) Generate CNF file

You will complete this part in Python.

Input: A plaintext file describing the layout -

The first line of the file are the number of rows and columns respectively. Each following line corresponds to the cells of a row starting with the topmost row. Cells in a row are separated by commas. The example above is described thus:

```
3 5
1,2,2,1,0
1,X,X,1,0
1,2,2,1,0
```

Output: A file of CNF constraints to feed to the solver.

(2) Use the MiniSAT solver

Download the solver from http://minisat.se/MiniSat.html. Linux users can use the executable directly. For Windows/Mac users, follow the instructions to compile. Please take a look at other resources listed on the page if you have issues with compiling.

Windows Users: a. You'll need Cygwin; b. If gcc says something about memUsedPeak not declared, edit line 40 of core/Main.cc:

```
double mem_used = 0;  //memUsedPeak();
```

Run the command:

```
minisat_static cnf.txt output.txt
```

II. Prolog Tasks

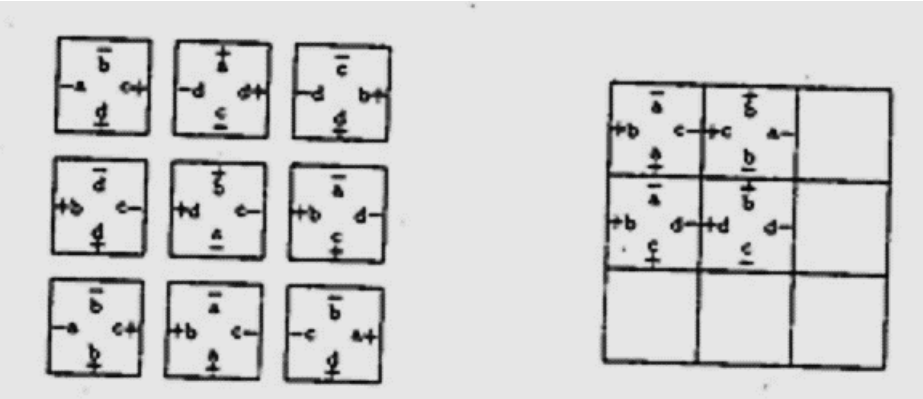
Encode the following problems in Prolog and solve them.

II.1 – The Missionaries and Cannibals Problem:

Three missionaries and three cannibals seek to cross a river. A boat is available which holds two people, and which can be navigated by any combination of missionaries and cannibals involving one or two people. If the missionaries on either bank of the river, or "en route" in the river are outnumbered at any time by the cannibals, the cannibals will succumb to their anthropologic tendencies and do away with the missionaries. Find the simplest schedule of crossing that will permit all the missionaries and cannibals to cross the river safely.

II.2 – The Assembly Problem:

Nine parts of an electronic board have square shape, the same size and each edge of every part is marked with a letter and a plus or minus sign. The parts are to be assembled into a complete board as shown in the figure below such that the common edges have the same letter and opposite signs. Write a planner in Prolog such that the program takes *?assemble* as the query and outputs how to assemble the parts, i.e. determine the locations and positions of the parts w.r.t. the current positions so that they fit together to make the complete board.



II.3 – The Puzzling case of the water and zebra:

A situation involves five houses in a row amongst which are distributed five colors, five drinks, five nationalities, five cigarettes, and five pets subject to the following constraints:

The Englishman lives in the red house.
The Spaniard owns a dog.
The Norwegian lives in the first house
Kools are smoked in the yellow house.
Chesterfields are smoked next to where the fox is kept.
The Norwegian lives next to the blue house.
The Old Gold Smoker owns snails
The Lucky Strike smoker drinks orange juice
The Ukrainian drinks tea
The Japanese smokes Parliaments
The Kools smoker lives next to where the house is kept
Coffee is drunk in the green house
The green house is to the immediate right of the ivory house
Milk is drunk in the middle house

Mr. Watson asks Mr. Holmes: Who drinks water? Who keeps the zebra?
Elementary Mr. Watson says Mr. Holmes: -- drinks water; -- keeps zebra. What is -- ?

Submission:
1. On or before midnight of the due date you should pack your files in a ZIP file and submit through BLACKBOARD.
2. Put down the names and IDs of your group members in a readme file.