4511W, Fall-2018
ASSIGNMENT 4 :
Assigned: 11/2/18 Due: 11/7/18 at 11:00 PM (submit via moodle, you may scan or take a picture of your paper answers in a zip under 20 MB if you have multiple files)

Problem 1. (20 points)
You are going shopping for groceries for Thanksgiving meal with the family. Your options are:

- Turkey - $10 – 8000 calories – Meat – Main meal
- Potatoes - $7 – 1000 calories – Veggie – Side
- Gravy - $3 – 900 calories – Meat – Side
- Bread - $4 – 1200 calories – Veggie – Main meal
- Cranberry sauce - $1 – 600 calories – Veggie – Side
- Salad - $5 – 400 calories – Veggie – Side
- Lasagna - $25 – 9500 calories – Meat – Main meal
- Pumpkin pie - $7 – 2500 calories – Veggie – Main meal

You need to buy at least one Turkey, in addition to enough food for the gathering. You must purchase over 30,000 calories total, while not spending more than $100. You also need to ensure there is both a main meal meat option, yet both a side and main meal veggie options for vegetarians. Assume the vegetarians will need at least 2,000 calories of sides and 4,000 calories in their main meal. Your "main meal" must also be at least twice as many calories as your "sides". Finally, you need to have some different food options, so you must pick at least 6 of the 8 listed options above.

Formulate this problem as a constraint satisfaction problem.

Problem 2. (20 points)
Suppose your younger sibling is doing a minor is CSci and wants to take: 1133, 1933, 2011, 4011, 4041. Your sibling bugs you to make a schedule that follows these rules:
(1) Can complete all courses in three semesters
(2) No more than 2 CSci classes per semesters
(3) 1133 must be taken before 1933
(4) 2011 and 1933 must be taken before 4041
(5) 2011 must be taken before 4011

Write down the domains/possible values for each CSci course that are 1-consistent.

Next write down the domains for each CSci course that are 2-consistent. Show your work.

Is it possible for your sibling to fail a course and need to retake it while still following all these rules? If so, which one. If not, explain why not.

Problem 3. (20 points)
This question pertains to representing different aspects of a modified game "Connect four" into propositional logic. If you are unfamiliar with the rules of connect four, look here:

https://en.wikipedia.org/wiki/Connect_Four

However, instead of playing of needing to “connect four in a row” to win, you only need to “connect three in a row”.

(1) List the propositions symbols/variables you would use to represent a the modified connect four game. For each proposition, clearly identify what Truth or Falsehood it is representing. (Note: If there is a pattern to them, you can use “...” if you think you have been clear enough for the graders to understand you.)

(2) Write a proposition using your symbols/variables from part (1) to represent what valid configurations there are cell in the bottom row and far left column.

(3) Write a proposition using your symbols/variables from part (1) to represent what valid configurations there are cell in the row one up from the bottom and far left column.

(4) Assume player 1’s piece has just been played in the middle column and bottom row. Write a proposition that checks whether or not this player has just won (assuming they had not won before).

Problem 4. (15 points)
Convert the following sentence into CNF (Conjunctive Normal Form). Show work for full credit.

$$\big((A \wedge B) \Rightarrow (\neg C \wedge \neg D)\big) \Rightarrow \big(E \vee (\neg F \wedge G)\big)$$

Problem 5. (25 points)
Assume you have a KB defined in CNF as below (for each part show work!):

$$(\neg A \vee B \vee C \vee \neg D), (B \vee \neg C \vee D), (A \vee B \vee \neg D),$$
$$(A \vee \neg B \vee C), (A \vee \neg C \vee \neg E), (\neg A \vee C), (\neg B \vee D)$$

(1) Use resolution to determine if the following sentence is entailed from the KB:
$A \vee B \vee D$

(2) Use resolution to determine if the following sentence is entailed from the KB:
$\neg A \vee \neg B \vee D$

(3) Use resolution to determine if the following sentence is entailed from the KB:
$A \vee C$

(4) Use resolution to determine if the following sentence is entailed from the KB:
$\neg A \vee D$

Programming (python/lisp):

This time we will look at the constraint satisfaction code in:
/root/csp.py
/root/tests/test_csp.py

Problem 6. (15 points)
The "Zebra" problem is a classic constraint satisfaction problem defined as a set of 5: houses, people (of nationality), pets, cigars, drinks and colors. House 1 is on the far left with house 5 on the far right (house 3 is in the middle). Each house (numbered) has a single person (nationality), pet, cigar, drink and color associated with the house. No two houses share the same of any property (for example, each house has its own unique pet). The rules are:

- There are five houses.
- The Englishman lives in the red house.
- The Spaniard owns the dog.
- Coffee is drunk in the green house.
- The Ukrainian drinks tea.
- The green house is immediately to the right of the ivory house.
- The Old Gold smoker owns snails.
- Kools are smoked in the yellow house.
- Milk is drunk in the middle house.
- The Norwegian lives in the first house.
- The man who smokes Chesterfields lives in the house next to the man with the fox.
- Kools are smoked in the house next to the house where the horse is kept.
- The Lucky Strike smoker drinks orange juice.
- The Japanese smokes Parliaments.
- The Norwegian lives next to the blue house.

The question is then: Who owns the Zebra? And who drinks water?

(5/15 points) This classic problem is what is already put in as the Zebra problem. Run the backtracking_search() on this problem and report the answer to the two questions above. (It is fine to use the default parameters for backtracking_search().)

(10/15 points) Modify the problem to match the Zebra problem below (with names, family structure, cars owned/driven and hair color) and report: Who has blond hair? Who has an Uber car?

- There are five houses.
- The owner of the 4th house is single (marital status).
- Aziz owns a Toyota.
- Erastus lives next to Chea.
- The house with the white hair owner is to the right of the house with three children.
- The person who owns a Toyota has one daughter and no sons.

- The 2nd house owners drives a minivan.
- The person with blond hair lives between the person with white hair and the person with black hair.
- Bérénice lives to the right of the person who does not won a car.
- The owner of the house with red hair owns a Toyota.
- Chea does not own a car.
- Bérénice has two sons and no daughters as children.
- The person who owns a Jeep has eight children.
- Dragana has brown hair.