

# Constraint-Satisfaction Problems: Cryptarithm

**Due** Oct 30, 2020 by 11:59pm      **Points** 20      **Submitting** a file upload

It turns out that writing code for Constraint Satisfaction Problems is about twice as hard as any of the coding that we've done so far.

Because of that, I'm going to move away from coding for this homework.

Consider the cryptarithm puzzle from figure 6.2 in the book:

```

  T W O
+ T W O
-----
F O U R

```

Recall the rules for a cryptarithm:

- Each letter stands for a single, unique digit
- There are no leading 0s
- When the replacement is complete, the addition is correct

Thus, this puzzle can be cast as a CSP with the formulation:

Variables are  $\{T, W, O, F, U, R, C_{10}, C_{100}, C_{1000}\}$ . (The C variables represent possible carries in the long addition)

Domains are  $[0, 1]$  for the C variables,  $[1, 2, 3, 4, 5, 6, 7, 8, 9]$  for T and F, and  $[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]$  for other variables.

Suppose that we did write a CSP solver that used backtracking search interleaved with inference using forward-checking, and **minimum-remaining-values** for selecting variables, and **least-constraining-value** for selecting values. Write out the steps that our solver would take to solve this cryptarithm.

You should make it clear for each step what is happening (i.e. a variable selection or value assignment), and after an assignment, what the resulting inferences are.

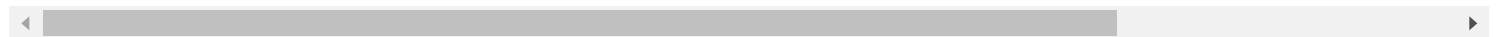
Submit your answer as a pdf.

A suggestion for how to clearly write this out is to build a table (maybe in google sheets or some other spreadsheet program) that shows the domains for each variable, and then remove values from those domains after an inference step. (Restoring them if backtracking happens)

Here is an example of a reasonable way to present the information:

Step	C10	C100	C1000	F	T	W	O	U
Initial setup	0, 1	0, 1	0, 1	1,2,3,4,5,6,7,8,9	1,2,3,4,5,6,7,8,9	0,1,2,3,4,5,6,7,8,9	0,1,2,3,4,5,6,7,8,9	0,1,2
Choose variable C10, Choose value 0								
	0	0, 1	0, 1	1,2,3,4,5,6,7,8,9	1,2,3,4,5,6,7,8,9	0,1,2,3,4,5,6,7,8,9	1,2,3,4	0,1,2

Note: I do not promise that this first step is correct, this is just an example of how to present and track for yourself what's happening.



Some Rubric							
Criteria	Ratings						Pts
Description of criterion	<b>20 pts Full Marks</b>	<b>18 pts minor mistakes</b>	<b>15 pts some mistakes but overall correct idea</b>	<b>13 pts incorrect method but well explained</b>	<b>10 pts incorrect answer/ major mistakes</b>	<b>5 pts incorrect answer and incomplete</b>	20 pts
Total Points: 20							