

## CS 3600 Introduction to AI

### Constraint Satisfaction Problem

Solve the cryptarithmic problem in Figure 6.2 of the Russell & Norvig textbook by hand, using the strategy of back-tracking with forward checking and the MRV and least-constraining value heuristics.

The exact steps depend on certain choices you are free to make; here are the ones I made:

- a. Choose the **X<sub>3</sub>** variable. Its domain is **{0, 1}**.
- b. Choose the value 1 for **X<sub>3</sub>**. (We can't choose 0; it wouldn't survive forward checking, because it would force **F** to be 0, and the leading digit of the sum must be non-zero.)
- c. Choose **F**, because it has only one remaining value.
- d. Choose the value 1 for **F**.
- e. Now **X<sub>2</sub>** and **X<sub>1</sub>** are tied for minimum remaining values at 2; let's choose **X<sub>2</sub>**.
- f. Either value survives forward checking, let's choose 0 for **X<sub>2</sub>**.
- g. Now **X<sub>1</sub>** has the minimum remaining values.
- h. Again, arbitrarily choose 0 for the value of **X<sub>1</sub>**.
- i. The variable **O** must be an even number (because it is the sum of **T + T** less than 5 (because **O + O = R + 10 A ~ 0**). That makes it most constrained.
- j. Arbitrarily choose 4 as the value of **O**.
- k. **R** now has only 1 remaining value.
- l. Choose the value 8 for **R**.
- m. **T** now has only 1 remaining value.
- n. Choose the value 7 for **T**.
- o. **U** must be an even number less than 9; choose **U**.
- p. The only value for **U** that survives forward checking is 6.
- q. The only variable left is **W**.
- r. The only value left for **W** is 3.
- s. This is a solution.

This is a rather easy (under-constrained) puzzle, so it is not surprising that we arrive at a solution with no backtracking (given that we are allowed to use forward checking).