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Term-End Staff Graded Assignment
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Assignment Title: **Problem Solving Using Artificial Intelligence Techniques**

Question 1 Consider 3-liter and 5-liter water jugs. None of the jugs has any markings. You also have a running tap. You must use the jugs and the tap so that you exactly have 4 liters of water. How can this be done with the help of basic concepts of artificial intelligence (AI)? List all the production rules to reach the solution.

We fill the 5-litre jug from the tap and empty the 5-litre jug into the 3-litre jug leaving 2 litres in the 5-litre jug. We then empty the contents of the 3-litre jug. We then fill the 2 litres from the 5-litre jug into the 3-litre jug, which means that the 3-litre jug currently has 2 litres of water. Then we fill the 5-litre jug from the tap and fill the 3-litre jug until it is full. It will take just one litre from the 5-litre jug. This leaves us with 4 litres of water in the 5-litre jug.

Question 2 Show the operation of resolution using the following predicates (with appropriate reasoning):

A: P ∨ Q V R
B: ¬P V R
C: ¬Q

D: ¬R

Using resolution, we can show that P is false and R is true.

From A and B, we know that P ∨ R is true.

We know that Q is false and R is true from C and D.

Therefore, P is false, and R is true.

From A, we know that P ∨ Q ∨ R is true.

From B, we know that ¬P ∨ R is true.

From C, we know that ¬Q is true.

From D, we know that ¬R is true.

Therefore, P is false, and R is true.

Explanation:

A: P Q V R

B: P V R

C: Q

D: ¬R

Using resolution, we can demonstrate that P is not true, but R is.

Because of A and B, we can deduce that P does not equal R.

Because of C and D, we can deduce that R is correct, whereas Q is not.

As a result, hypothesis P is incorrect, while hypothesis R is true.

We may deduce from point A that the order P > Q > R is correct.

Because of B, we can deduce that P R is correct.

Because of C, we can deduce that Q is correct.

Because of D, we can deduce that R is correct.

As a result, hypothesis P is incorrect, while hypothesis R is true.

Question 3

Solve the following crypt-arithmetic problem using the concept of constraint satisfaction problem:

TWO

+ TWO = FOUR. Give appropriate reasoning for each step.

We can make this into a Constraint Satisfaction Problem model as follows:

- Variables: Each of the letters
- Possible values: {0,1,..,9}
- Constraints: all letters have different values, addition works as intended, and leading digits aren't zero.
- Variables: F,T,U, W , R, O, X1, X2, X3 Domains: {0, 1, 2, 3, 4, 5, 6, 7, 8, 9} (same domain for all)
- Sample constraints: alldiff (F,T,U, W , R, O) or a binary constraint for all, e.g., F 6= T, F 6= U.
- A unary constraint: F 6= 0
- An n-ary constraint: O + O = R + 10 × X1 Can add constraints to restrict the Xi ’s to 0 or 1.

"Addition works as intended" can be made concrete with these equations, where C_1 and C_10 are the carry values.

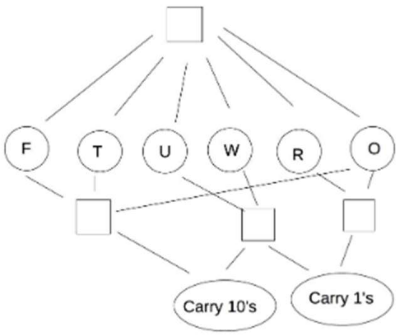
O + O = R + 10 * C_1

W + W + C_1 = U + 10*C_1

T + T + C_10 = O + 10*F

"All different" and the equational constraints involve multiple variables. Usually best to keep them in that form, rather than converting to binary. We can visualize this using a slightly different type of graph with some extra nodes:

- nodes for the basic variables
- nodes for auxiliary variables (carry values)
- square boxes for constraints, attached to variables they involve



Considering the operation TWO+ TWO = FOUR, we look at the place values to see if we can't generalise:

- Can we eliminate possible answer choices based on regrouping or properties?

We will use an organised list for each letter.
We will plug in an option to see if it works. If it does not, we will cross it off our list.
The answer we come up with after a process of elimination commencing from 1 is 765 + 765 = 1530 = Two + Two = Four.

The solution is assigning all the variables from their domain to satisfy all the constraints. There may be a single, multiple, or no solution for any constraint satisfaction problem.