Assignment #4: Constraint Satisfaction Problems

I designed the program to be a **general solution** to both the problems. The entities in the question are divided into Variables and Values only. Rest of the entities are included as the constraints in the respective consistency functions.

Variables are defined as objects with each variable having

1. Variable type
2. Name
3. Value

Variables are further divided into different **Variable types**

1. Nationality
2. Pet
3. Food
4. Drink
5. Color
6. Job

Values for the variables are integer values.

The class CSP is the base class for all the constraint satisfaction problem defining the basic functions needed for CSP problems.

MRV Heuristic:
Same heuristic is used in both the problems. A loop iterates over each unassigned variables in the puzzle and the one which satisfies the least number of available values (using consistency function) is chosen.

‘Jobs’ Puzzle:

Representation:
The Variables for this problem are:

1. Jobs: CHEF, GUARD, NURSE, CLERK, POLLICE_OFFICER, TEACHER, ACTOR, BOXER

The DOMAIN or VALUES possible for above variables are 0 to 3 where

- 0: Roberta
- 1: Thelma

- 2: Steve
- 3: Pete

Consistency Function:
Function checks for the variables and values on various constraints given in the question.
ex:

```
if ( ( var1.name == NURSE || var1.name == TEACHER || var1.name  == POLICE_OFFICER) && isEducated == false) {
        System.out..println("Failed: Nurse Teacher and Police can not be uneducated");
        return false;
}
```

Here, the condition checks that whether the value or 'Person' assigned for these jobs are educated or not. If not then return false.

Similarly, around **8 constraints** are checked including that a person is not assigned more than 2 jobs, gender checks, education checks etc.

Note: Please see the code for all the consistency checks used.

Solution:

Job	Person
GUARD	ROBERTA
ACTOR	PETE
NURSE	STEVE
TEACHER	ROBERTA
CHEF	THELMA
BOXER	THELMA
POLICE_OFFICER	STEVE
CLERK	PETE

States Searched Without MRV: 43
States Searched With MRV: 9
Difference in states: 34

Percentage of reduction in states: 79.07%

‘Zebra’ Puzzle:

Representation:

The VARIABLES for this problem are

1. Nationality : ENGLISH, SPANISH, NORWEGIAN, JAPANESE, UKRAINE
2. Pet: DOG, ZEBRA, HORSE, SNAIL, FOX
3. Food: SNICKERS, SMARTIES, MILKY WAY, KITKAT, HERSHEY
4. Drink: JUICE, MILK, COFFEE, TEA, WATER
5. Color: GREEN, BLUE, YELLOW, IVORY, RED

The DOMAIN or VALUES possible for above variables are House number starting from 0 to 4.

Consistency Function:

The consistency function captures all the **14 conditions** mentioned in the puzzle with additional condition that no two variables of same type are assigned to the same house.
ex:

```
if (var1.type == VariableType.NATIONALITY && var1.name == ENGLISH &&
getVariableValue(VariableType.COLOR, RED) != -1 && var1.assignedValue !=
getVariableValue(VariableType.COLOR, RED)) {
        System.out.println("Failed 1");
        return false;
}
```

which checks that whether the Person with English nationality lives in the house of color red. If not then return false else continue

Note: Please see code for the actual implementation of the consistency function

Solution:

House No	**0**	**1**	**2**	**3**	**4**
Nationality	NORWEGIAN	UKRAINE	ENGLISH	SPANISH	JAPANESE
Pet	FOX	HORSE	SNAIL	DOG	**ZEBRA**
Food	KITKAT	HERSHEY	SMARTIES	SNICKERS	MILKYWAY
Drink	WATER	TEA	MILK	JUICE	COFFEE

Color	YELLOW	BLUE	RED	IVORY	GREEN

States Searched without MRV: 529464
States Searched with MRV: 51
Difference in states: 529413
Percentage of reduction in states: 99.99%

Note: Value may sometimes show a different result as the MRV function is based on little randomness. But, the values will be one of 29,51 and 336, with 51 as the prominent result.