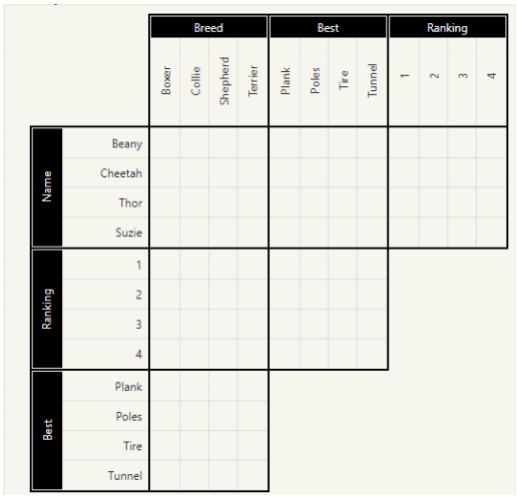
Constraints Satisfaction Problem Solving in Python

Problem:

Here we use CSP Python programming to solve Agility Competition Logic Grid Puzzle inwhich four dogs took part in an agility competition and we need to answer questions like which is the breed of the dog named Thor, etc.
https://www.brainzilla.com/logic/logic-grid/agility-competition/

The goal of this exercise is to figure out the combination of the dog's name, the breed, the task they were best in, and which place they ranked in. We are given the following clues:

1. Only the winning dog has the same initial letter in name and breed.
2. The Boxer ranked 1 position after the Shepherd. None of them likes the tunnel, nor jumping through the tire.
3. Cheetah and the dog who loves the poles were 1st and 3rd.
4. Thor doesn't like the plank and didn't come 2nd.
5. Cheetah either loves the tunnel or she came 4th.
6. The dog who loves the plank came 1 position after the dog who loves the poles.
7. Suzie is not a Shepherd and Beany doesn't like the tunnel



Proposed Solution:

For the fore mentioned Logic Grid Puzzle, we use the python-constraint library that offers solvers for Constraint Satisfaction Problems.

The problem is put forward in terms of variables (Name, Breed, Best and Ranking), domains (there are four competitors so from 1 to 4) and constraints (the 7 clues given) according to which we are to model our solution.

Hence, for the solution, we declare our set of variables:
Name (Beany, Cheetah, Thor, Suzie);
Breed (Boxer, Collie, Shepherd, Terrier);
Best (Plank, Poles, Tire, Tunnel);
Ranking (1, 2, 3, 4)

Next we add them to the problem model and specify their domain, i.e., each of these will be assigned a value from 1 to 4. These values state which set they belong to, for example (Beany, Tire, 2, Terrier) all are equal to 1; (Cheetah, Tunnel, 1, Collie) are all assigned the value 2 and so on.

Using the 'AllDifferentConstraint()' built-in constraint, we makes sure that no one of these are assigned twice.

Lastly we interpret the clues mentioned above and add them as constraints for the solver to stick by.

- ✓ (Interpreting from clue 3) Cheetah came 1st. So the values assigned to the name "Cheetah" should be same as that assigned to the ranking "1".
- ✓ (Interpreting from clue 1) The value assigned to Cheetah must be same as that assigned to Collie.
- ✓ On the other hand, Beany cannot be a Boxer so they must have different values assigned and so must Thor and Terrier, and Suzie and Shepherd.
- ✓ (Interpreting from clue 5) Since Cheetah came 1st, she must love the tunnel. So the values assigned to the name "Cheetah" should be same as that assigned to the best sport "tunnel".
- ✓ (According to the 6th clue)The dog who loves the plank came 1 position after the dog who loves the poles, which also means that the dog doing the plank cannot be 1st and that the dog that loves the poles cannot be 4th so their values are assigned accordingly. The difference between the two is 1 and plank and the ranking 1 are not assigned the same value and so is poles with the ranking 4.
- ✓ (As per the 2nd clue)The same goes with the Boxer who ranked 1 position after the Shepherd. Also neither the Shepherd nor the Boxer like Tunnel or Tire, so none of the four combinations will be allotted similar values.
- ✓ (As per the 4th clue) The same goes with Thor who doesn't like the plank and didn't come 2nd.
- ✓ Lastly, it is mentioned that Suzie is not a Shepherd which have already established earlier, and that Beany doesn't like the tunnel. Since Cheetah has already claimed the tunnel, we leave this one too.

After providing all the essential clues as constraints, we simply call the getSolutions() function of the constraint library which gives us the optimal solution.

		Breed				Best				Ranking			
		Boxer	Collie	Shepherd	Terrier	Plank	Poles	Tire	Tunnel	1	2	3	4
Name	Beany	✗	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
	Cheetah	✗	✓	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗
	Thor	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✓	✗
	Suzie	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✓
Ranking	1	✗	✓	✗	✗	✗	✗	✗	✓				
	2	✗	✗	✗	✓	✗	✗	✓	✗				
	3	✗	✗	✓	✗	✗	✓	✗	✗				
	4		✗	✗	✗	✓	✗	✗	✗				
Best	Plank	✓	✗	✗	✗								
	Poles	✗	✗	✓	✗								
	Tire	✗	✗	✗	✓								
	Tunnel	✗	✓	✗	✗								

Name	Breed	Best	Ranking
Beany	Terrier	Tire	2
Cheetah	Collie	Tunnel	1
Thor	Shepherd	Poles	3
Suzie	Boxer	Plank	4