



Sheet 4 Solutions CSP

1 CSP

1. Consider the following logic puzzle:

In five houses, each with a different color, live 5 persons of different nationalities, each of whom prefer a different brand of cigarette, a different drink, and a different pet. Given the following facts, the question to answer is Where does the zebra live, and in which house do they drink water?

- (a) The Englishman lives in the red house.
- (b) The Spaniard owns the dog.
- (c) The Norwegian lives in the first house on the left.
- (d) Kools are smoked in the yellow house.
- (e) The man who smokes Chester elds lives in the house next to the man with the fox.
- (f) The Norwegian lives next to the blue house.
- (g) The Winston smoker owns snails.
- (h) The Lucky Strike smoker drinks orange juice.
- (i) The Ukrainian drinks tea.
- (j) The Japanese smokes Parliaments.
- (k) Kools are smoked in the house next to the house where the horse is kept.
- (l) Coffee is drunk in the green house.
- (m) The Green house is immediately to the right (your right) of the ivory house.
- (n) Milk is drunk in the middle house.

Discuss different representations of this problem as a CSP. Why would one prefer one representation over another?

Then answer the required question applying the constraints

Answer:

First Approach:

Represent the CSP as 5 Variables and the domain of each one is a combination of house place, color, nationality, drink, pet, cigarette brand.

Second Approach:

Represent the CSP as 30 variables each one takes only one value and each 5 have a specific domain so 5 variables are colors, 5 are drinks and so on...

This approach can be applied using 25 variables only assuming that houses are ordered



from left to right so c1 represents color of most left house, d1 its drink, c2 color of next house and so on.

The second approach will add new constraints which are linking each 6 variables together so we can say C1 (color variable), D1 (drink variable) are of the same house and so on to link the 30 variables. This is the advantage of first approach over the second. But the first approach is difficult to apply the backtracking algorithm on because the assign of a variable needs assigning 6 values at the same time and also the reassigning in the backtracking so, we prefer the second approach over the first one because it is easier to solve though introduces new constraints.

Third Approach:

Represent the CSP using 25 variables each one representing specific value of feature for example we have 5 color variables (red, yellow, blue, green, ivory) and so on... and the domain of each variable is for which house this feature will be assigned so it will be an integer from 1 to 5

This approach is the better one because the constraints representation as binary constraints will be very easy for example the first constraint will be represented as $\{english = red\}$ which is not that easy in the second approach. But, if one feature values set is large for example we choose from all the world nationalities we will not apply this approach as it will introduce many variables and we will choose the second approach.

Solution using second or third approach:

Constraints Satisfying Arrangement: n - c - f - d - k { m - l - a - b - i - j - g - h - e }

Before applying d we conclude from m, a that first house is yellow as it can't be red (a) and can't be green or ivory (m)

When applying m we have 2 options houses 3,4 or 4,5. If you try 3,4 you will need to backtrack and choose 4,5.

When applying b we have 2 options houses 4 or 5. We choose 4 as an assumption and the problem is solved, choosing 5 may lead to backtracking.

Norwegian (c)	{ Ukrainian } (i)	{ English } (a)	{ Spaniard } (b)	{ Japanese } (i)
Yellow (m - a)	Blue (f)	{ Red } (a)	{ Ivory } (m)	{ Green } (m)
{ Fox } (e)	Horse (k)	{ Snails } (g)	{ Dog } (b)	[Zebra]
[Water]	{ Tea } (i)	Milk (n)	{ Orange } (h)	{ Coffee } (I)
Kools (d)	{ Chester } (h)	{ Winston } (g)	{ Lucky Strike } (h)	{ Parliaments } (j)

Good Luck