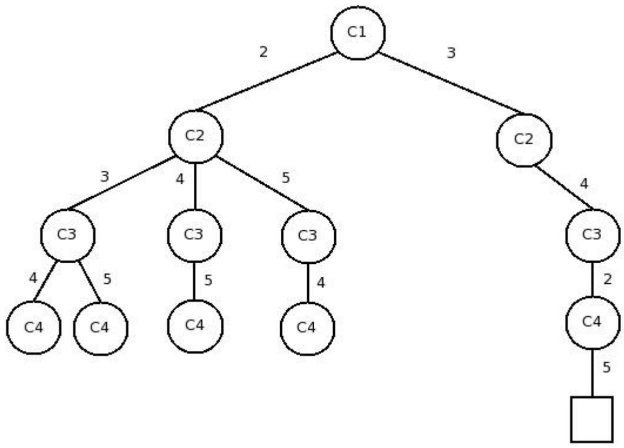
Solutions to Exercises Week 9
Intelligent Systems Programming (ISP)

Exercise 1

a) Backtracking:

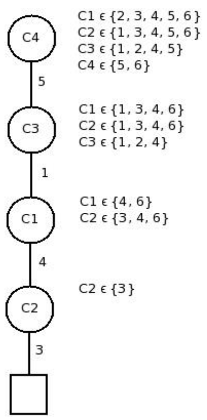


Each **leaf** on the tree with a circular shape represents a failed node. The variable inside the circle is the variable that doesn't have a possible value in its domain to fulfill the constraints. The square represents a solution.

The solution found is: $C_1 = 3$, $C_2 = 4$, $C_3 = 2$, $C_4 = 5$.

All failed leaves are failed for the same reason, it is not possible to assign a value to C_4 that satisfies the constraint $C_4 – C_3 > 2$.

b) Now the FC + MRV tree:



Here the combination of forward checking and the MRV heuristic finds a solution without any failed leaves. However, another solution, $C_1 = 4$, $C_2 = 3$, $C_3 = 1$, $C_4 = 5$ was found by the MRV.

Exercise 2

CSP Model:

Variables: {*B*, *C*, *D*, *F*, *G*, *M*, *P*}

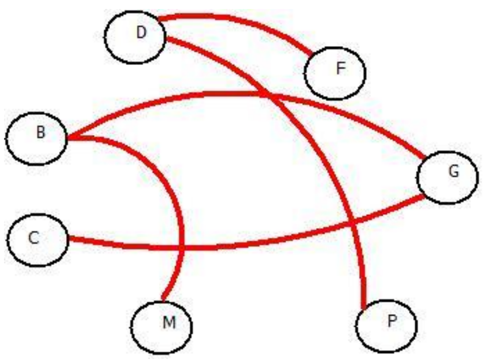
Domains: {[*1…7*], [*1…7*], [*1…7*], [*1…7*], [*1…7*], [*1…7*], [*1…7*]}

Constraints: {*B≠ C*, *B≠D*, *B≠F*, *B≠G*, *B≠M*, *B≠P*, *C ≠D*, *C ≠F*, *C ≠G*, *C≠M* ,*C ≠P*, *D ≠F*, *D ≠G*, *D≠M* ,*D ≠P*, *F ≠G*, *F≠M*, *F ≠P*, *M≠ G*, *M≠ P* ,*G≠ P*}

a) *adj*(*X*,*Y*) : *X=Y+1* || *X=Y-1*.

The main idea of the adj constraint is to represent the fact that for a pair of variables the values assigned to them have to be next to each other, no matter which of those values come first. In the case of the constraint above you can observe that for any possible value assigned to *X*, the value assigned to *Y* has to be either the next or the one before to the X value.

b)



This is the graph representation of the cps model considering just the adjacency constraints.

c) The new CSP is defined as:

Variables: {*B*, *C*, *D*, *F*, *G*, *M*, *P*}

Domains: {[*1…7*], [*1…7*], [*1…7*], [*1…7*], [*1…7*], [*1…7*], [*1…7*]}

Constraints: {*B≠ C*, *B≠D*, *B≠F*, *B≠G*, *B≠M*, *B≠P*, *C ≠D*, *C ≠F*, *C ≠G*, *C≠M* ,*C ≠P*, *D ≠F*, *D ≠G*, *D≠M* ,*D ≠P*, *F ≠G*, *F≠M*, *F ≠P*, *M≠ G*, *M≠ P* ,*G≠ P*, *B=1*, *adj*(*B*,*G*), *adj*(*B*,*M*), *adj*(*C*,*G*), *adj*(*F*,*D*), *adj*(*P*,*D*)}

The first constraint to be considered is *B=1*, since it is the only unary constraint. After *B* has been assigned to *1*, *G* gets assigned to *2* due to *adj*(*B,G*), and so does M due to *adj*(*B,M*), (neither of the two variables have in their domains the value *0*, therefore the only adjacent position to *B* is 2). The assignments *M=2* and *G=2* break the constraint *M≠ G,* making the CSP inconsistent.

Exercise 3

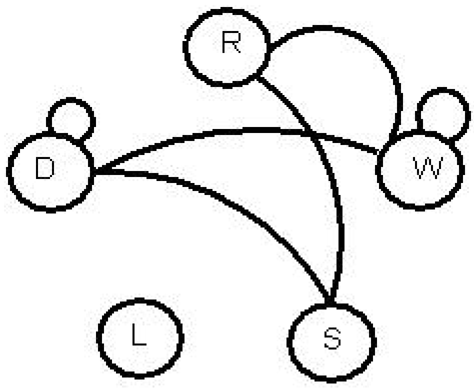
a) CSP model:

Variables: {*R*, *D*, *L*, *S*, *W*}

Domains: {*1*, *2*, *3*} for each variable

Constraints: {*S ≠ D*, *S = R*, *D ≠ 3*, *D ≠ W*, *W = 2*, *W ≠ R*}

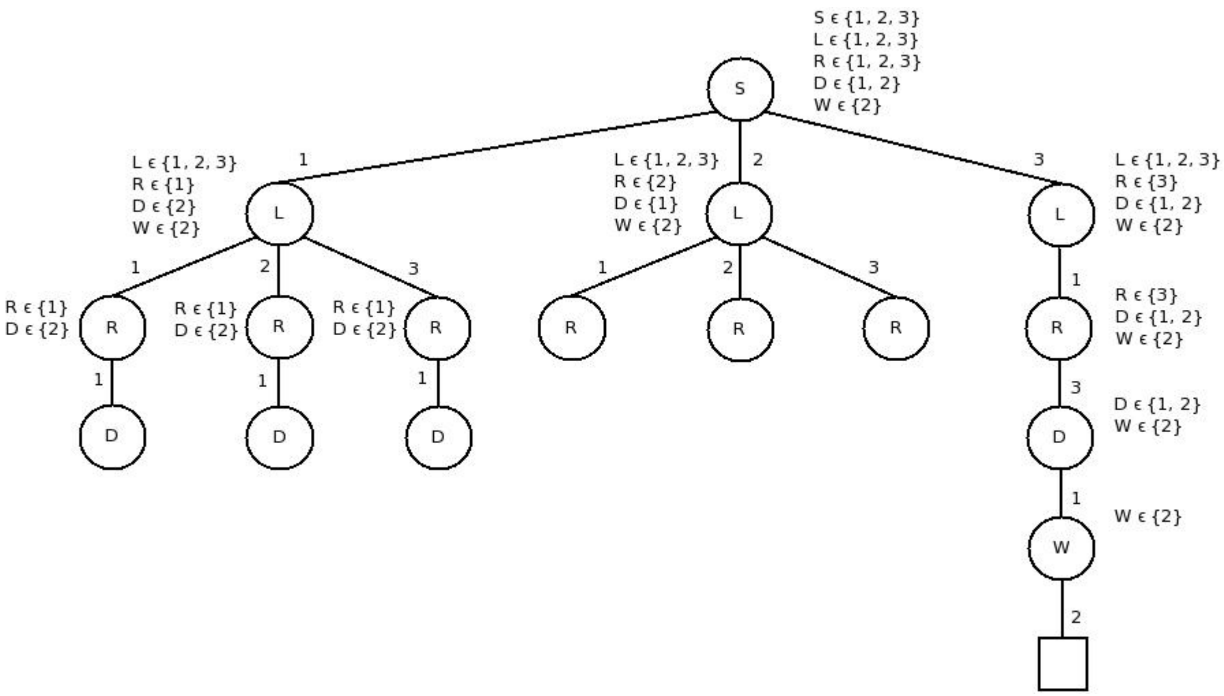
b) CSP graph:



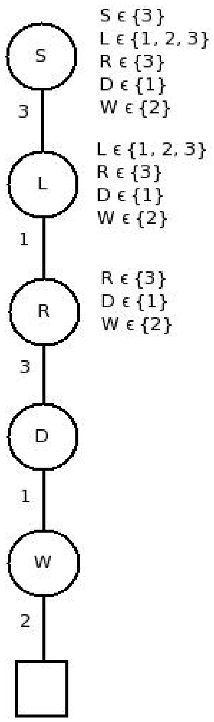
c) Each node has right next to it the domain of the variables after executing FC with the previous variable-value assignment. In the case of the first node the domains shown are the result of executing node consistency on the CSP. The values on the edges of the search tree represent the variable-value assignment represented by the branch. Each **leaf** with a circular shape represents a failed node (not possible variable-value assignment). The **leaf** with a square shape represents a solution.

The solution found by FC was {*S = 3*, *L = 1*, *R = 3*, *D = 1*, *W = 2*}

FC search tree:



d) MAC search tree:



The solution found by the MAC algorithm was {*S = 3*, *L = 1*, *R = 3*, *D = 1*, *W = 2*}, the same found by the FC algorithm.