Partial Written test

1 Exercise 1 (Punti 20)

Consider a set of fire fighting units that must be assigned to a set of fires so to ensure that each fire has at least two units allocated. Assume that: i) Each fire fighting unit can be assigned to just one fire; ii) A fire fighting unit can only be assigned to fires which are within a given distance from its initial position, i.e. for each fire F_i there is a set FFS_i that represents all the fire fighters that can be assigned to fire F_i (e.g., in Figure 1 $FFS_1 = FF_1, FF_2, FF_4$).

Formalize this task assignment problem as a CSP specifying (i) what the variables represent, (ii) the domain of the variables, and (iii) the constraints. State whether the constraint network associated to the situation in Figure 1 is

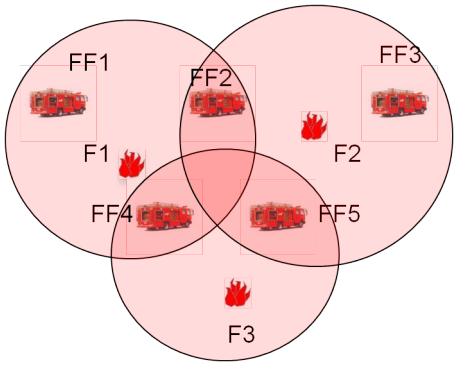

Figure 1: Fire fighting situation

consistent, and if so provide a solution.

2 Exercise 2 (Punti 25)

Consider the following **binary** cost network: Variables, $X = \{X_1, X_2, X_3, x_4\}$, Domains, $D_1 = D_2 = D_4 = \{R, B\}$, $D_3 = \{G, B\}$, Constraints $C_h = \{R_{12}, R_{13}, R_{23}, R_{24}\}$ and $C_s = \{F_1(x_1), F_2(x_2), F_3(x_3), F_4(x_4)\}$. Where each R_{ij} is an inequality constraint (i.e., $R_{ij} = \{< R, B >< B, R >\}$) and $F_i(x_i)$ is of the following form:

$$F_i(x_i) = \begin{cases} 1 & \text{if } x_i = B \\ 0 & \text{otherwise} \end{cases}$$

Provide a solution for this cost network using Bucket Elimination. Use the ordering $o = \{x_4, x_2, x_1, x_3\}$.

3 Exercise 3 (Punti 25)

Consider the following Graph coloring problem: Variables $X = \{x_1, x_2, x_3, x_4, x_5\}$, Domains $D_1 = \{R, G\}$, $D_2 = D_3 = D_4 = D_5 = \{R, B\}$, Constraints $R = \{R_{12}, R_{13}, R_{23}, R_{24}, R_{35}, R_{45}\}$. Solve it with backtracking plus forward checking and with backtracking forcing arc consistency at each step. Use the following fixed ordering for variable expansion $o = \{x_1, x_4, x_5, x_2, x_3\}$ and always expand R first. Comment on whether AC is helping w.r.t. forward checking in this case (i.e., highlight the search space avoided by AC).

4 Exercise 4 (Punti 30)

Consider the labyrinth in Figure 2 where S and G are the start and goal positions respectively. Consider the path planning problem associated to this labyrinth as a search problem and answer to the following questions.

S	4	8	12
1	5	9	13
2	6	10	14
3	7	11	G

Figure 2: Labyrinth

1. How many iterations would a IDS do ?
2. Given the following heuristics i) manhattan distance h_1, ii) manhattan distance with diagonal moves h_2, which one is preferable for doing an A* search (motivate your answer) ?
3. Show execution of A* using the heuristic of your choice