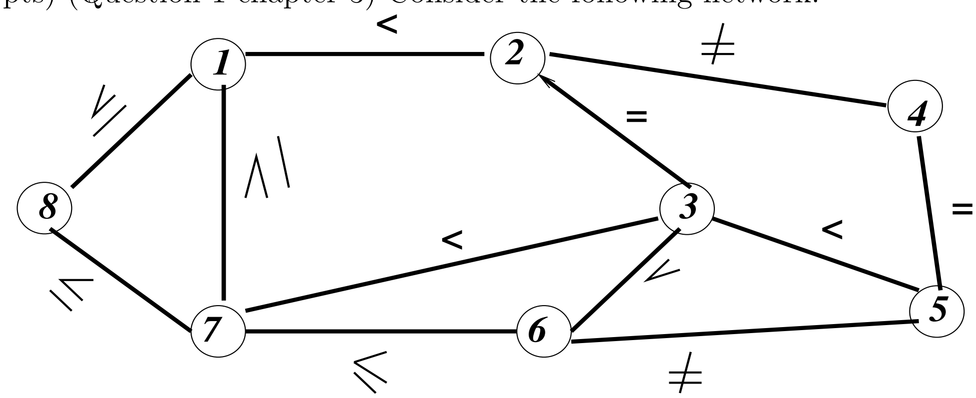
**Rina Dechter, Fall-2022**

# CS 275, Assignment 2

Read chapter 3 in the textbook and answer the following questions. Whenever you are asked to generate arc or path consistent networks you should not only show the end-result, but show also how it is derived. You can either implement one of the known algorithms and submit your code, or hand-simulate one of the known algorithms. **Stop when your simulation takes more then one page.**

1. (20 pts) (Question 1 chapter 3) Consider the following network.

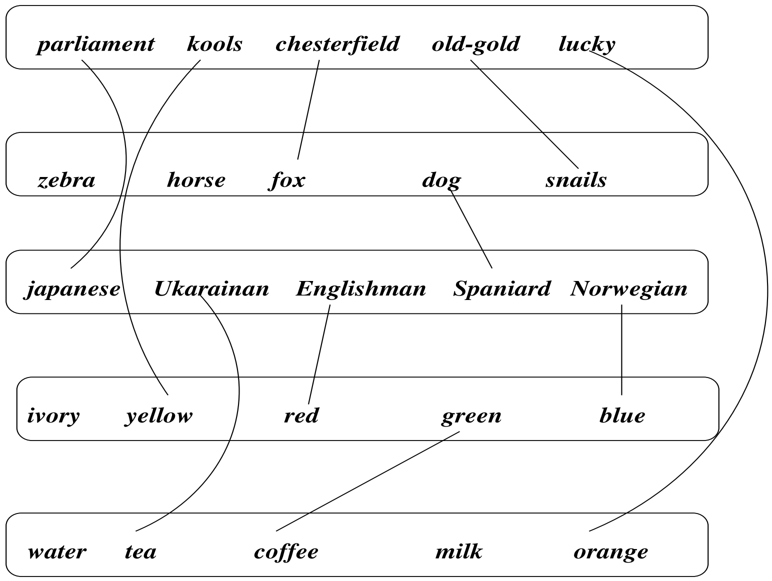



   Assume that each variable has a domain of $\{1, 2, 3, 4\}$ and the constraints are the algebraic constraints.

   (a) Find an equivalent arc-consistent network. Specify the revised domains of each variable.

   (b) Is the generated arc-consistent network also path-consistent?

2. (15 pts) (Question 2 chapter 3 ). Consider the CSP formulation of the Zebra problem where you have 25 variables divided into clusters, and where the domains are the houses numbers (see figure below).
   a) Is the problem arc-consistent? If not specify an equivalent arc-consistent problem (give the revised domains).
   b) Is the original problem path-consistent? Justify your answer.




3. (5 pts **extra credit**) Implement an arc-consistency algorithm (in Python or any other language). Submit your code and the result of running the algorithm on the formulation of the Zebra model in your previous homework. How much time did it take to generate an arc-consistent network? How is it compared with running minizinc to find a solution?

4. (10 pts) (question 6 chapter 3) Prove that the minimal network is always path-consistent: Any consistent pair of values can always be extended to any third variable.

5. (5 pts, **extra credit**, question 7 chapter 3) Prove that a bi-valued non-empty path-consistent network is consistent. Prove that it is also the minimal network.

6. (15 pts) (question 11 chapter 3) Consistency algorithms may *effect* a constraint network by changing it (i.e., tightening domains or constraints, and adding constraints of various scope sizes).

   (a) Let $\mathcal{R}$ be an arbitrary 3-graph coloring problem, where the domain of every variable has 3 values. Discuss the effects of enforcing 2-consistency on $\mathcal{R}$. What would be the effect of enforcing $i$-consistency ($i$ = 2,3,4,..k-1,k,k+1...) in general.

   (b) Given a $k$-graph coloring problem, what would be the effect of enforcing $2, 3, 4, ...k-1, k, k+1$-consistency on a $k$-coloring problem?

7. (15 pts) (question 17, chapter 3) Generate an arc and path-consistent network which is equivalent to the 3-variable network described by the following constraints:

$$D_x: \ x \in [3, 10], \quad D_y: \ y \in [5, 12], \quad R_{xy}: \ x + y = 10$$
$$D_z: z \in [-11, 12], \quad R_{yz}: y + z \leq 3$$

For arc-consistency show explicitly the domains of each variable. Show also how it is derived. For path-consistency show the domain and the 3 constraints of the path-consistent network.