

## Assignment 2

### Part I: Written Problems

#### Question 1:

Q.1:  $B > C = A > F = D > E$

- choose  $E = 1$ . Domain of  $E = A = B = C = D = F = \{1, 2, 3, 4, 5, 6\}$
- choose  $A = 1$ , choose  $B = 1$ . Failure, Backtrack.
- choose  $A = 1$ , choose  $B = 2$ ,  $C = 1$ ,  $D = 1$ , Failure. (not  $B = 1, \dots, 6$ )
- choose  $A = 1$ , choose  $B = 2$ ,  $C = 1$ ,  $D = 2$ . Failure.  
We choose  $D$  from  $1 \rightarrow 6$  and it still failure, backtrack to  $C$ .
- choose  $A = 1$ ,  $B = 2$ ,  $C = 2$ , Failure. will failure, Backtrack to  $B$ .  
We choose  $C$  from  $2 \rightarrow 6$  and it still failure, Backtrack to  $B$ .
- Choose  $A = 1$ ,  $B = 3$ ,  $C = 1$ ,  $D = 1$ . Failure.  
We consider that the program will continue failure whenever  $B$  from  $1 \rightarrow 6$ .  
Backtrack.
- choose  $A = 2$ ,  $D = 1$ . Failure.  
choose  $A = 2$ ,  $B = 2$ . Failure.  
choose  $A = 2$ ,  $B = 3$ ,  $C = 1$ . Failure.  
choose  $A = 2$ ,  $B = 3$ ,  $C = 2$ ,  $D = 1$ . Failure.  
choose  $A = 2$ ,  $B = 3$ ,  $C = 2$ ,  $D = 2$ . Failure.
- we consider that the program will continue failure whenever  $B, C, D$  from  $1 \rightarrow 6$ .  
Backtrack.
- choose  $A = 3$ ,  $B = 1$ . Failure.
- choose  $A = 3$ ,  $B = 2$ . Failure.  $(B = 4)$  continue failure when  $B = 3$
- choose  $A = 3$ ,  $B = 4$ ,  $C = 1$ . Failure.  $(C = 3)$ , continue failure  $C = 3, 3$
- choose  $A = 3$ ,  $B = 4$ ,  $C = 3$ ,  $D = 1$ . Failure.
- choose  $A = 3$ ,  $B = 4$ ,  $C = 3$ ,  $D = 2$ ,  $F = 1$ . Failure.
- choose  $A = 3$ ,  $B = 4$ ,  $C = 3$ ,  $D = 2$ ,  $F = 2$ . Succeed.

Hence:

\*)  $B = 1, A = 3, B = 4, C = 3, D = 2, F = 2$ .

b) Forward checking:  $B > C = A > F = D > E$

→ choose  $E = 1$ ; Domain:  $A = B = C = D = F = \{2, 3, 4, 5, 6\}$

1) choose  $E = 1$ ;  $A = 2$ ; Domain:  $B = \{3, 4, 5, 6\}$

$C = \{2\}$

$D = F = \{\emptyset, 4, 5, 6\}$

→ choose  $E = 1$ ,  $A = 2$  cause  $D = F = \{\emptyset\}$  failure when can not choose

→ choose  $E = 1$ , Domain:  $A = \{3, 4, 5, 6\}$  "D" and "F", Backtrack.

$B = C = D = F = \{2, 3, 4, 5, 6\}$

→ choose  $E = 1$ ,  $A = 3$ , Domain:  $B = \{4, 5, 6\}$

$C = \{3\}$

$D = F = \{2, 3\}$

→ choose  $E = 1$ ,  $A = 3$ ,  $B = 4$ , Domain:  $C = \{3\}$

$D = F = \{2, 3\}$

→ choose  $E = 1$ ,  $A = 3$ ,  $B = 4$ ,  $C = 3$ , Domain:  $D = F = \{2\}$

→ choose  $E = 1$ ,  $A = 3$ ,  $B = 4$ ,  $C = 3$ ,  $D = 2$ , Domain:  $F = \{2\}$

→ choose  $E = 1$ ,  $A = 3$ ,  $B = 4$ ,  $C = 3$ ,  $D = 2$ ,  $F = 2$  (solution)



c) Constraint propagation:  $B > C = A > F = D > E$

Domain:  $A = B = C = D = E = F = \{1, 2, 3, 4, 5, 6\}$

•) choose  $E = 1$ : Domain  $A = B = C = D = E = F = \{2, 3, 4, 5, 6\}$

•) choose  $E \neq 1, A = 2$  cause inconsistent.

Domain  $B = \{3, 4, 5, 6\}$

$D = F = \{\emptyset\}$  (inconsistent) \*

Remove  $A = 2$  from Domain of  $A$ .  $A = \{3, 4, 5, 6\}$

•) choose  $E = 1, A = 3$ , Domain  $B = \{4, 5, 6\}$

$C = \{3\}$

$D = F = \{2\}$

By using Constraint propagation  $D, C, F$  have 1 choice. We have answer:

•) choose  $E = 1, A = 3, B = 4, C = 3, D = 2, F = 2$  (Solution)

**Question 2 & 3:**

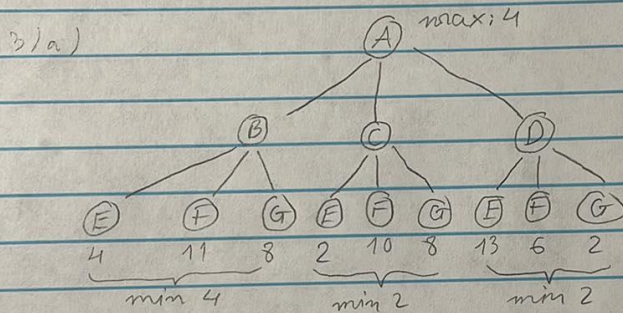
2) a) Case 1: pigeon / hole

$$x_{ij} \vee x_{i(j+1)} \vee \dots \vee x_{in}$$

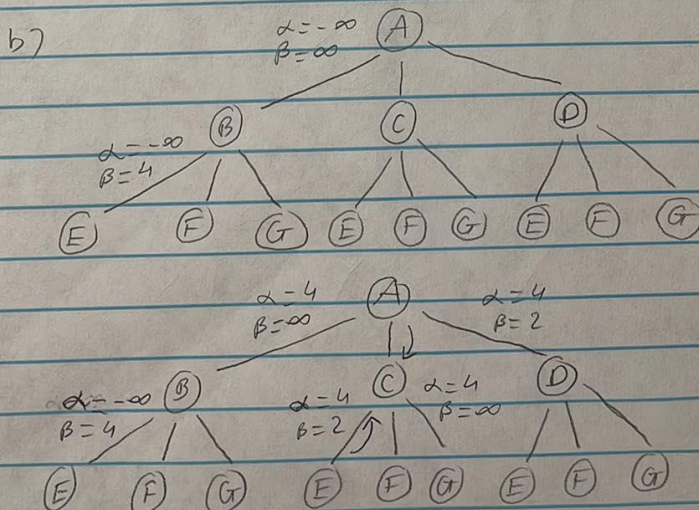
Case 2: hole / pigeon

$$\sim x_{ij} \vee \sim x_{i(n+1)}$$

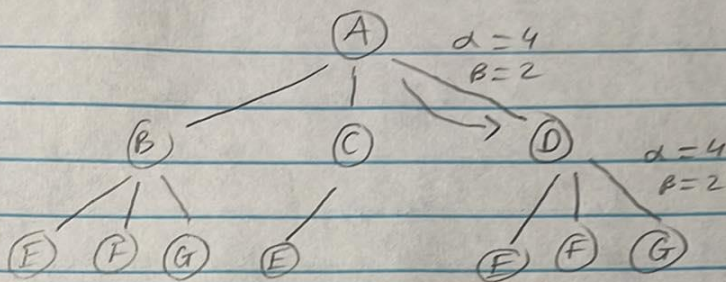
b) For case 1, a pigeon in a hole requires  $n$  clauses.  
Likewise, for case 2,  $n$  clauses would be needed. Thus,  
big O notation is  $O(n)$



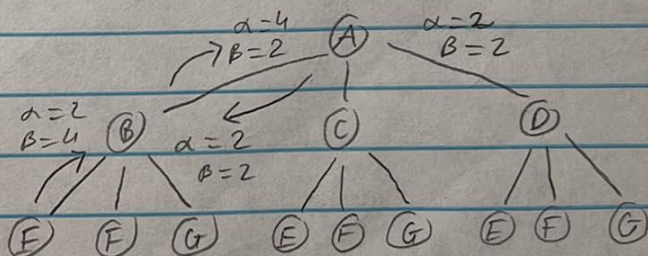
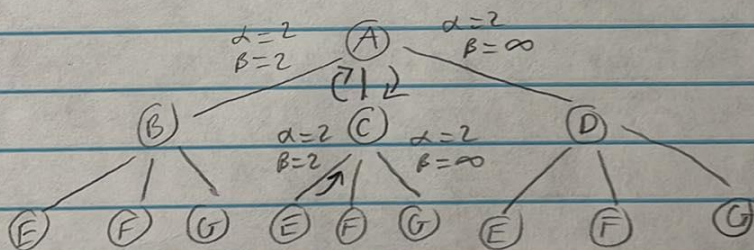
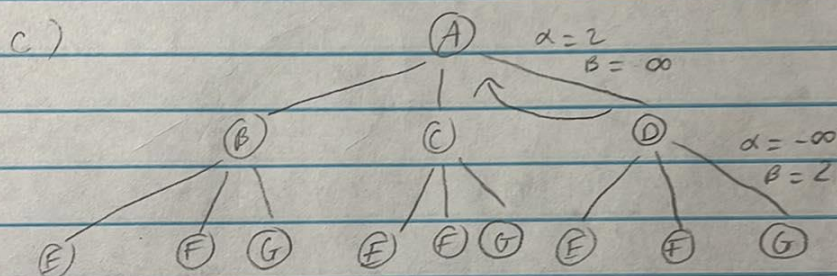
Maximizer move:  $A \rightarrow B \rightarrow E$







Final value at A is  $\alpha=4, \beta=2$   
 $\uparrow$   $\uparrow$   
 max min



Final value at A is  $\alpha=4, \beta=2$   
 $\uparrow$   $\uparrow$   
 max min