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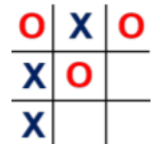
CSC 421: Assignment 2 - Part A

Q1. (3 points)

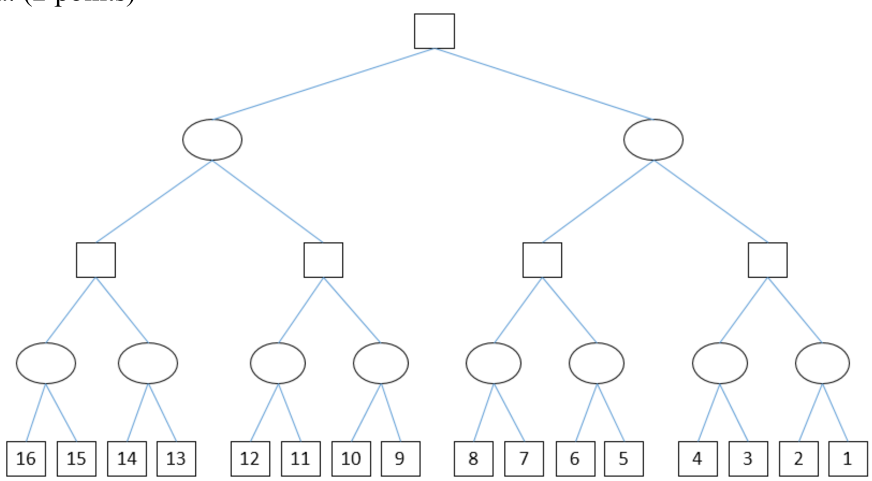
Consider the tic-tac-toe game of two players X and O and the state given in the figure. The player to make a move in this state is X.



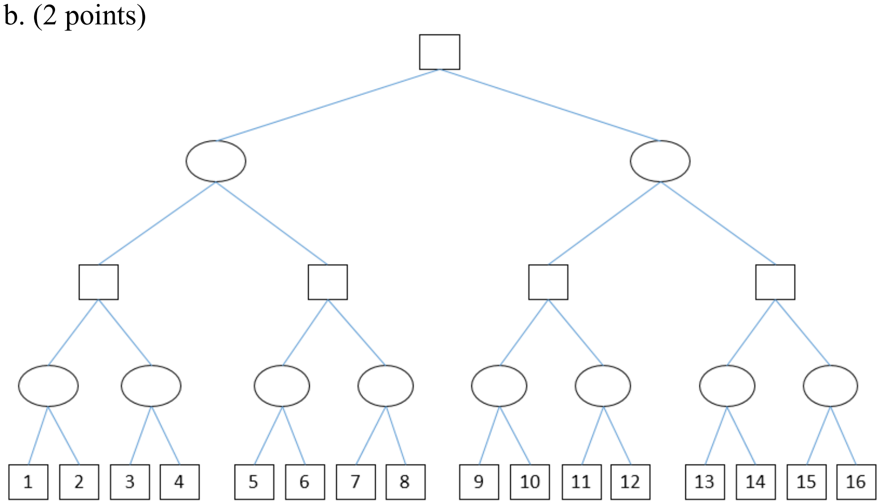
a. (1 point) Starting from this state draw the game tree. For the terminal states the utility values (for X) are +1 for win, 0 for draw, -1 for loss.
b. (2 points) Apply the alpha-beta pruning and show the branches that will be pruned (not explored).

Q2. (7 points) Perform alpha-beta pruning in the following three game trees.

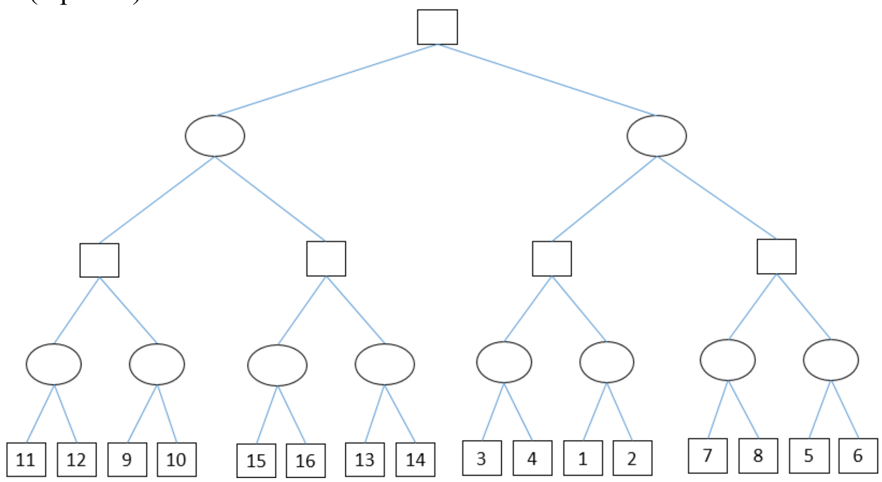
a. (2 points)



b. (2 points)



c. (2 points)



(1 point) What conclusion do you draw regarding the order of nodes and the efficacy of alpha-beta pruning?

Q3. (6 points) We want to schedule final exams for 7 courses: T (Turing Machines), L (Lambda Functions), B (Binary Numbers), C (Constraint Satisfaction), S (Software Engineering), P (P vs NP), N (Numerical Analysis). Unfortunately, there are only four one-hour time slots available (1pm, 2pm, 3pm, 4pm) and you discover there are some restrictions on how you can schedule the exams. After checking the registrations of the students who are to take the exams, you determine they fall into certain groups. You write down everything you know:

- There are students who take courses: B, C, and N.
- There are students who take: L, P, and N.
- There are students who take: S and P.
- There are students who take: L and C.
- There are students who take: T, L, and N.
- There are students who take: C and P.

Also, it turns out, the professor of T has to finish early to travel to a conference, so T can only be scheduled in the 1pm slot.

a. (2 points) Consider T, L, B, C, S, P, N as variables in a CSP, and write the domains and draw the constraint graph.
b. (4 points) Use the backtracking algorithm along with Forward Checking, as well as MRV, and D heuristics to find an assignment to the variables for this problem.

Q4. (2 points) Model the Greek-Logic puzzle as a CSP (https://www.brainzilla.com/logic/greek-logic).
Here is an instance of it that you should use for this question:
Assign the given Greek letters

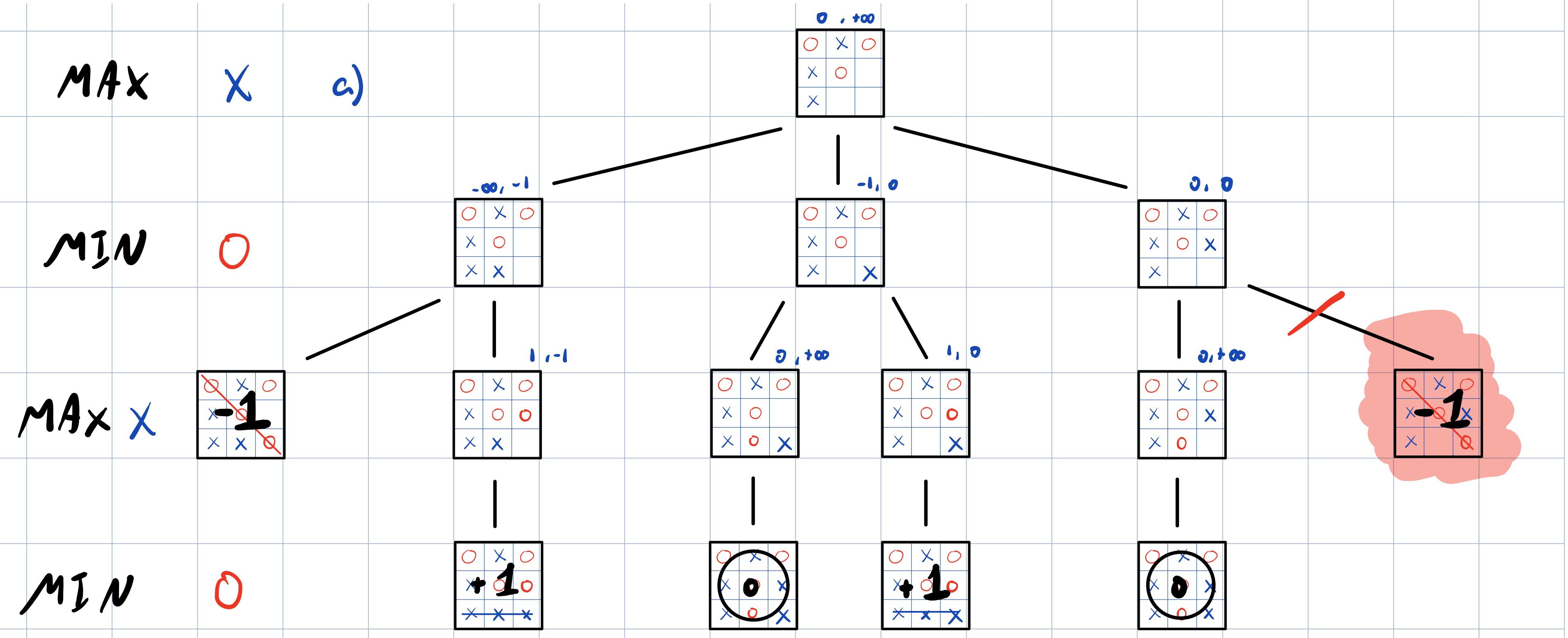
to the empty squares of grid on the right so that each letter appears exactly once in each row, column and main diagonals.

Q1. (3 points)

Consider the tic-tac-toe game of two players X and O and the state given in the figure. The player to make a move in this state is X.

O	X	O
X	O	
X		

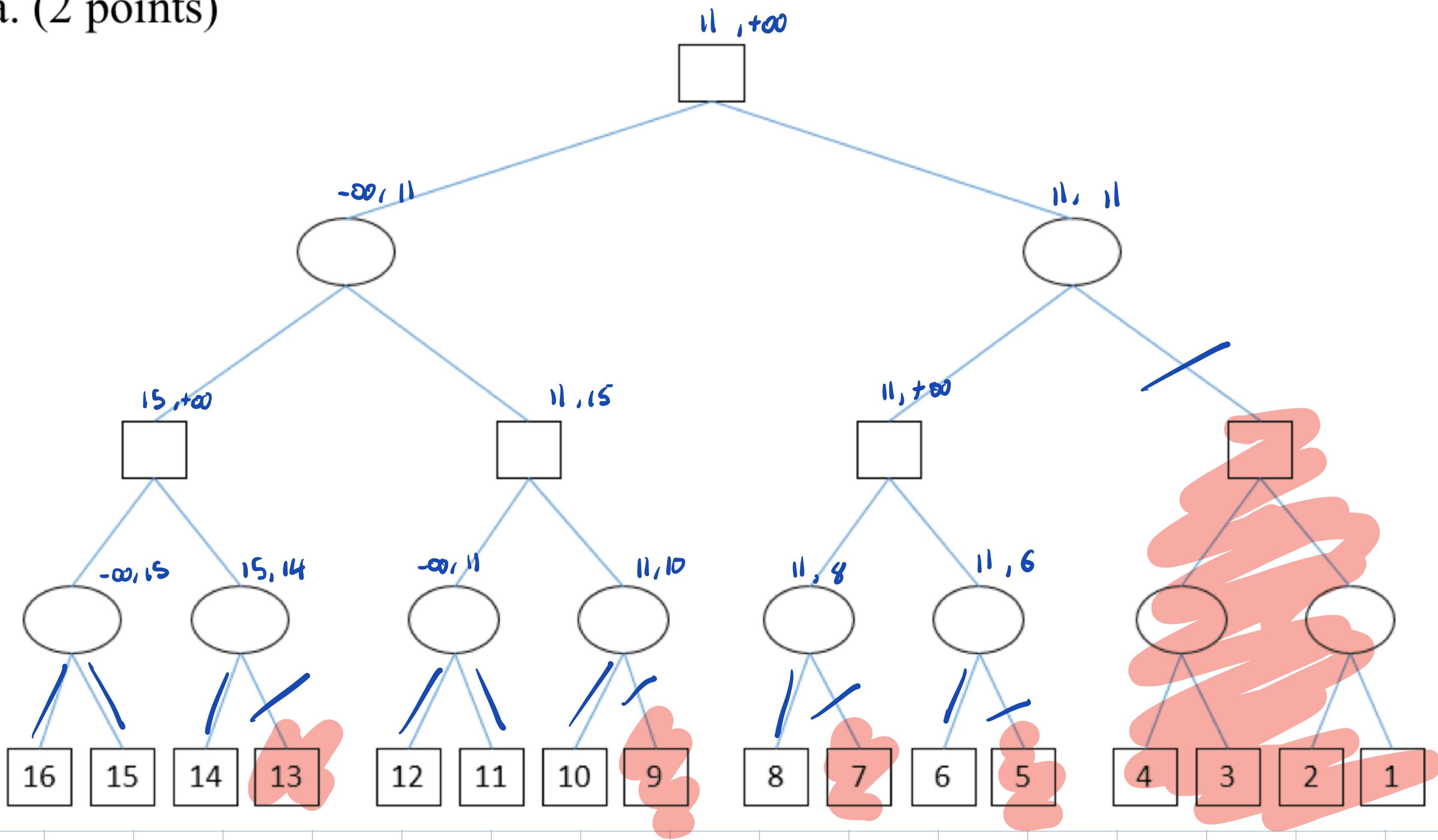
a. (1 point) Starting from this state draw the game tree. For the terminal states the utility values (for X) are +1 for win, 0 for draw, -1 for loss.
b. (2 points) Apply the alpha-beta pruning and show the branches that will be pruned (not explored).



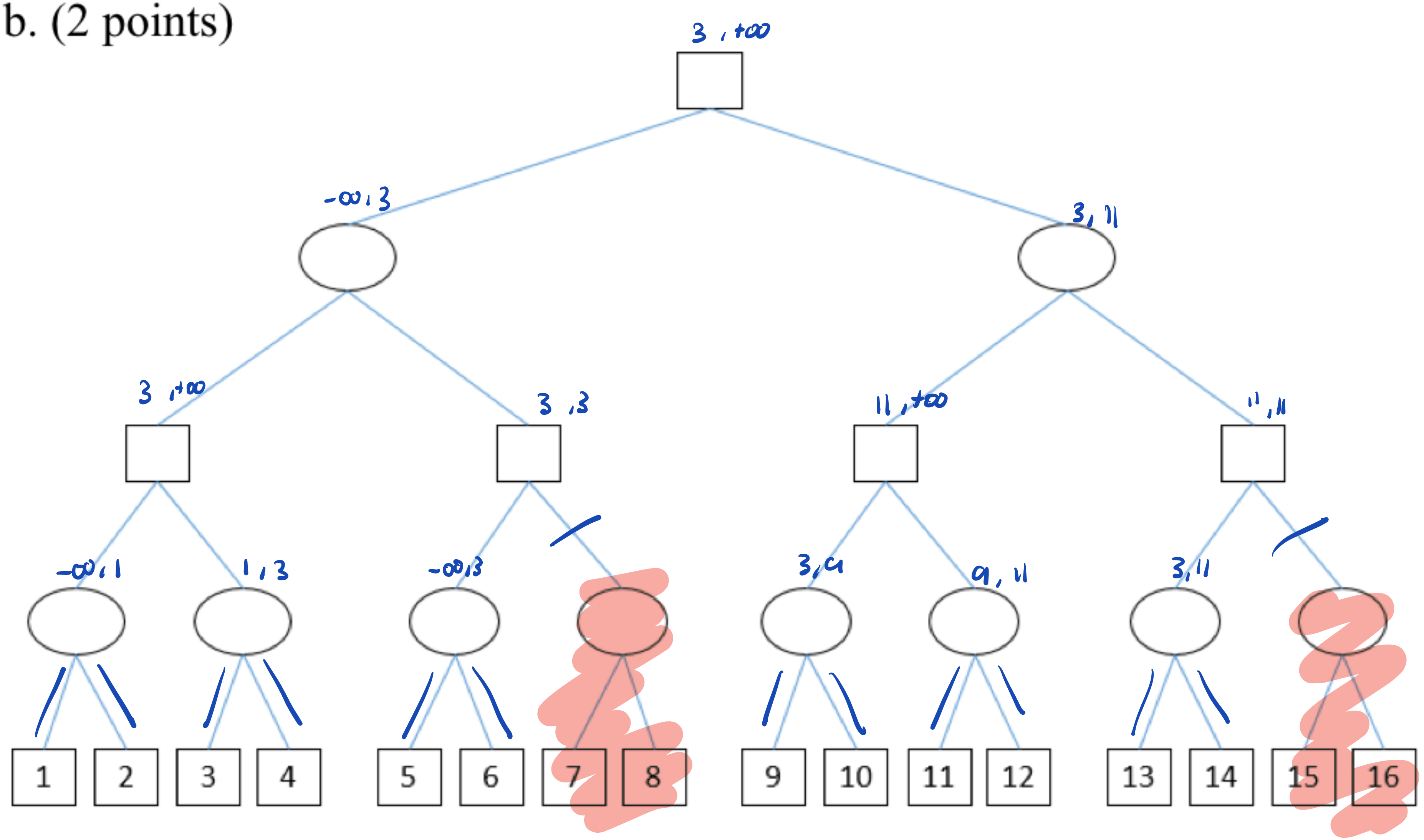
b) The node highlighted in red will be pruned.

Q2. (7 points) Perform alpha-beta pruning in the following three game trees.

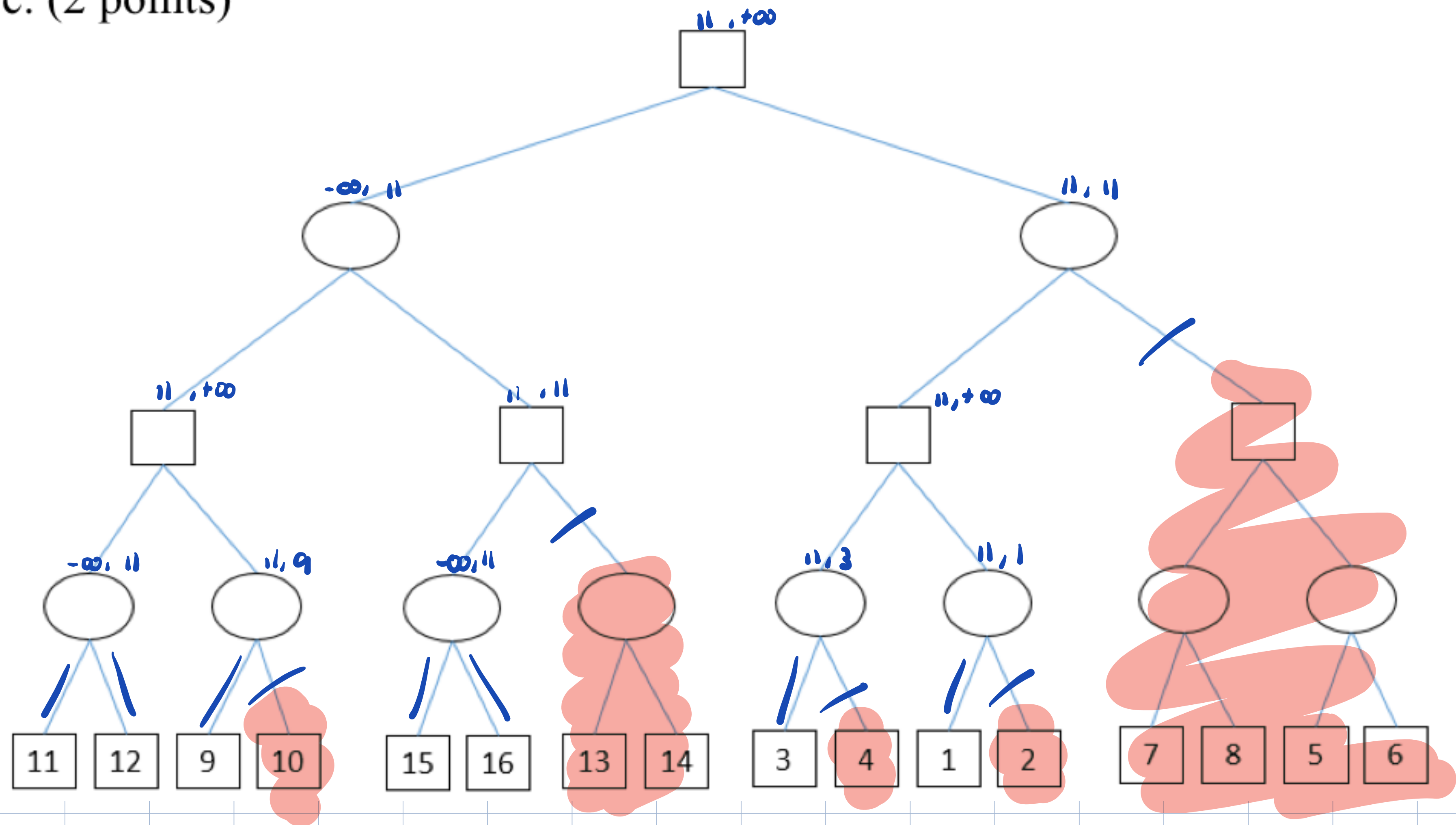
a. (2 points)



b. (2 points)



c. (2 points)



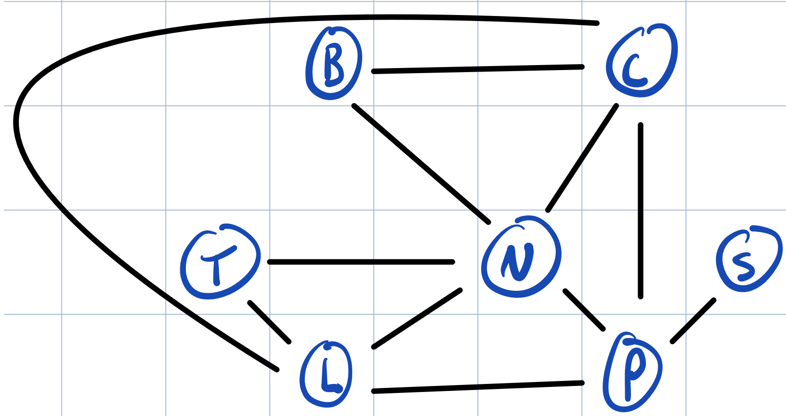
The most efficient ordering for alpha-beta pruning is when the left children of MAX nodes are greater than the right children, and the left children of MIN nodes are less than the right children. (Ideal nodes are discovered First)

Q3. (6 points) We want to schedule final exams for 7 courses: T (Turing Machines), L (Lambda Functions), B (Binary Numbers), C (Constraint Satisfaction), S (Software Engineering), P (P vs NP), N (Numerical Analysis). Unfortunately, there are only four one-hour time slots available (1pm, 2pm, 3pm, 4pm) and you discover there are some restrictions on how you can schedule the exams. After checking the registrations of the students who are to take the exams, you determine they fall into certain groups. You write down everything you know:

- There are students who take courses: B, C, and N. ✓
- There are students who take: L, P, and N. ✓
- There are students who take: S and P. ✓
- There are students who take: L and C. ✓
- There are students who take: T, L, and N. ✓
- There are students who take: C and P. ✓

Also, it turns out, the professor of T has to finish early to travel to a conference, so T can only be scheduled in the 1pm slot.

a. (2 points) Consider T, L, B, C, S, P, N as variables in a CSP, and write the domains and draw the constraint graph.



Variables: T, L, B, C, S, P, N

Domains: $D_L, D_B, D_C, D_S, D_P, D_N = \{1pm, 2pm, 3pm, 4pm\}$

$D_T = \{1pm\}$

b. (4 points) Use the backtracking algorithm along with Forward Checking, as well as MRV, and D heuristics to find an assignment to the variables for this problem.

Depth	T	L	B	C	S	P	N	
1	1	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	
2	1	2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	2 3 4	MRV(T=1), FC(L,B,C,S,P,N)
3	1	3 4	1 3 4	1 3 4	1 2 3 4	1 3 4	2	MRV, D(N=2), FC(L,B,C,S,P)
4	1	3	1 3 4	1 4	1 2 3 4	1 4	2	MRV(L=3), FC(B,C,S,P)
5	1	3	1 3 4	1	1 2 3	4	2	MRV, D(P=4)*, FC(B,C,S)
6	1	3	3 4	1	1 2 3	4	2	MRV(C=1), FC (B,S)
7	1	3	4	1	1 2 3	4	2	MRV(B=4)
8	1	3	4	1	1	4	2	MRV(S=1)

* Arbitrary vs C

Q4. (2 points) Model the Greek-Logic puzzle as a CSP (https://www.brainzilla.com/logic/greek-logic).
Here is an instance of it that you should use for this question:
Assign the given Greek letters

Λ Θ Ψ Φ Π Ω

to the empty squares of grid on the right so that each letter appears exactly once in each row, column and main diagonals.

	1	2	3	4	5	6
1	Λ	Θ	Ψ	Φ	Π	Ω
2						
3						
4						
5	Φ			Θ	Ω	Ψ
6				Λ		Θ

Variables: 36 Squares; (1,1) through (1,6) for the top row (left to right) down to (6,1) through (6,6) for the bottom row, where for (x,y) x is the row and y is the column.

Domain: All empty squares have domain: $\{\Lambda, \Theta, \Psi, \Phi, \Pi, \Omega\}$

Constraints: 14 total "All different" constraints:

6 "All diff" constraints for the rows:

AlldiFF((1,1),(1,2),(1,3),(1,4),(1,5),(1,6))

...

AlldiFF((6,1),(6,2),(6,3),(6,4),(6,5),(6,6))

6 "All diff" constraints for the columns:

AlldiFF((1,1),(2,1),(3,1),(4,1),(5,1),(6,1))

...

AlldiFF((1,6),(2,6),(3,6),(4,6),(5,6),(6,6))

2 "All diff" constraints for the main diagonals:

AlldiFF((1,1),(2,2),(3,3),(4,4),(5,5),(6,6))

AlldiFF((6,1),(5,2),(4,3),(3,4),(2,5),(1,6))