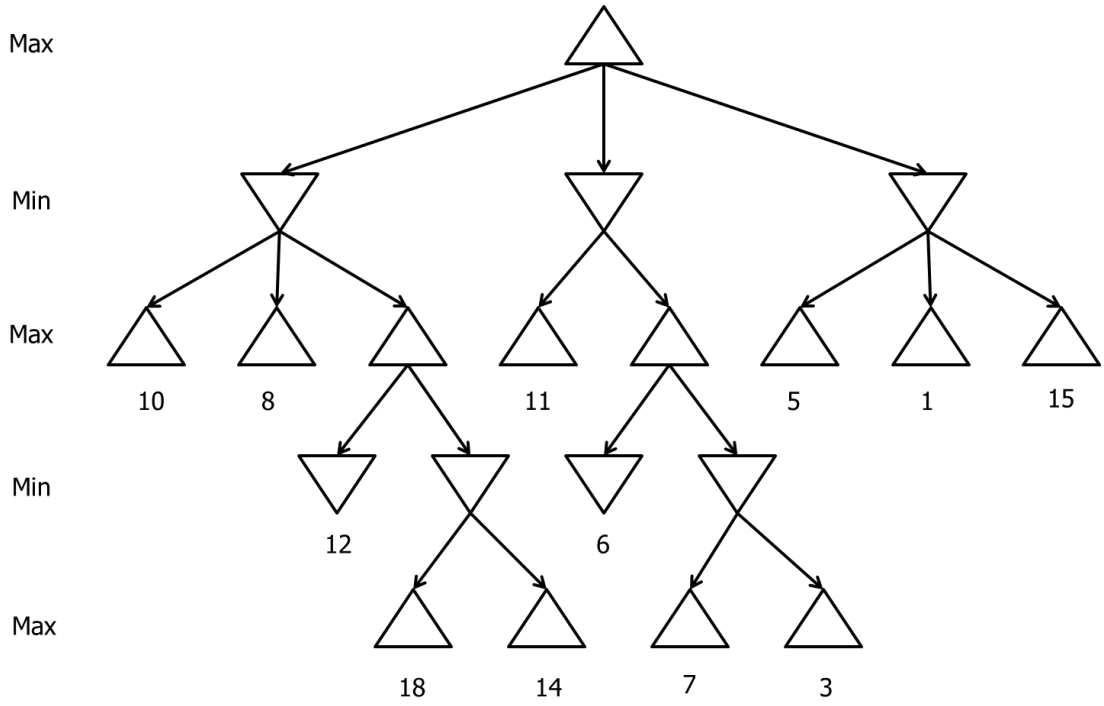
CS480 HW2

Name: SOLUTION

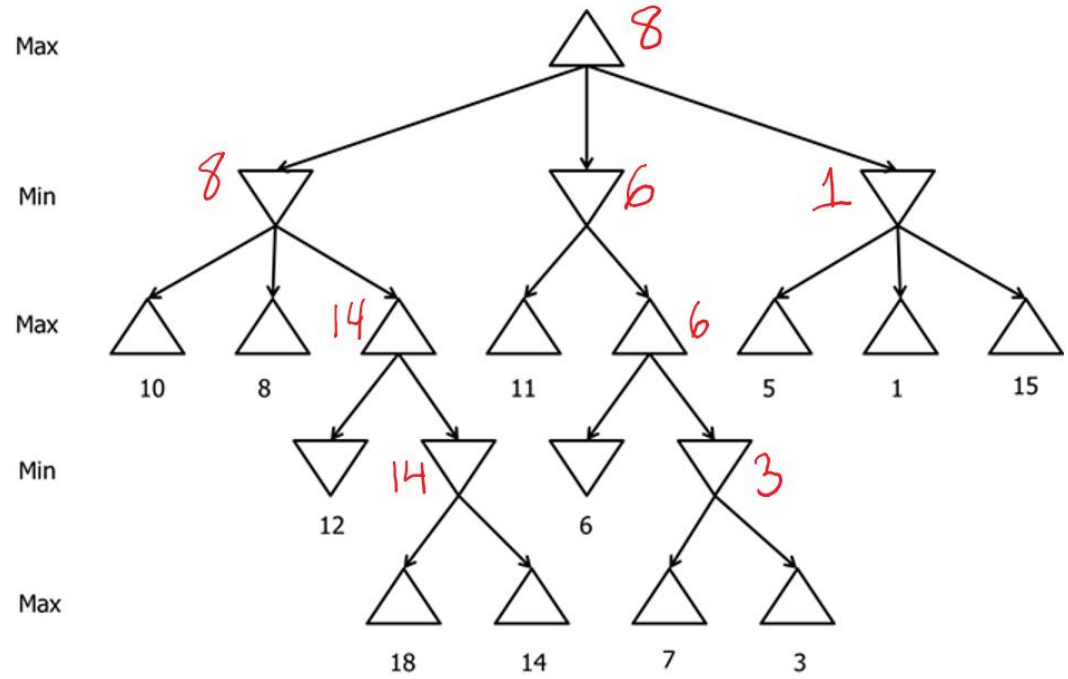
Collaborators: N/A

Use the following game tree for the first two questions.



1. Hand trace the mini-max algorithm. What is the maximum utility that MAX can achieve, assuming MIN plays optimally?

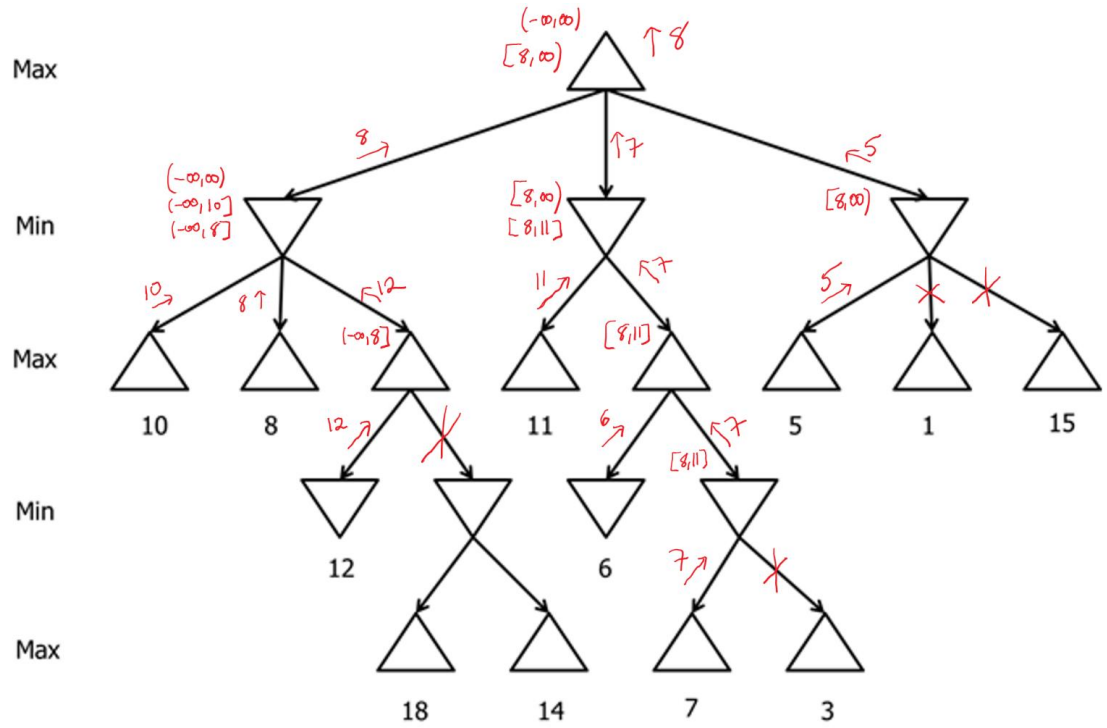
   SOLUTION:



The maximum utility MAX can achieve is 8.

2. Hand trace the alpha-beta search. Show bounds on the nodes as well as which branches are pruned, if any. What is the maximum utility that MAX can achieve, assuming MIN plays optimally?

SOLUTION:



The maximum utility MAX can achieve is 8.

3. We are given the following CSP problem.

The variables and domains are as follows.

A: {4, 5, 6, 7, 8}

B: {10, 20, 30, 40}

C: {2, 3, 4}

D: {32, 43, 56, 75, 92, 113}

The constraints are:

A + C is odd.

A + D is a square of an integer.

B + D < 60.

Solve this problem using the following heuristics and algorithms.

1)Use backtracking search.

2)For variable ordering, use MRV. If there are ties, use degree to break them. If there are still ties, break them in alphabetical order.

3)For value ordering, use LCV. Note that LCV does not cause the search to backtrack and also note that LCV does not actually modify the domains; rather, it simply counts how many values would be deleted if a particular value is assigned.

4)For inference, use forward checking.

Please show the search tree and the stack of the domains (see the lecture video for an example). When the search backtracks due to an empty domain, show it clearly on your search tree.

SOLUTION:

		C=3	~~A=8~~	~~D=56~~	~~D=92~~	~~D=113~~
A	{4,5,6,7,8}	{4,6,8}	~~8~~	~~8~~	~~8~~	~~8~~
B	{10,20,30,40}	{10,20,30,40}	~~{10,20,30,40}~~	∅	∅	∅
C	{2,3,4}	3	~~3~~	~~3~~	~~3~~	~~3~~
D	{32, 43, 56, 75, 92, 113}	{32, 43, 56, 75, 92, 113}	~~{56,92,113}~~	~~56~~	~~92~~	~~113~~

A=6	D=43	B=10
6	6	6
{10,20,30,40}	{10}	10
3	3	3
{43,75}	43	43

C={2,3,4} LCV:

C=2	C=3	C=4
A:3	A:2	A:3
3	2	3

C={3,2,4}

A={4,6,8} LCV

A=4	A=6	A=8
D:5	D:4	D:3
5	4	3

A={8,6,4}

D={56,92,113} LCV:

D=56	D=92	D=113
B:4	B:4	B:4
4	4	4

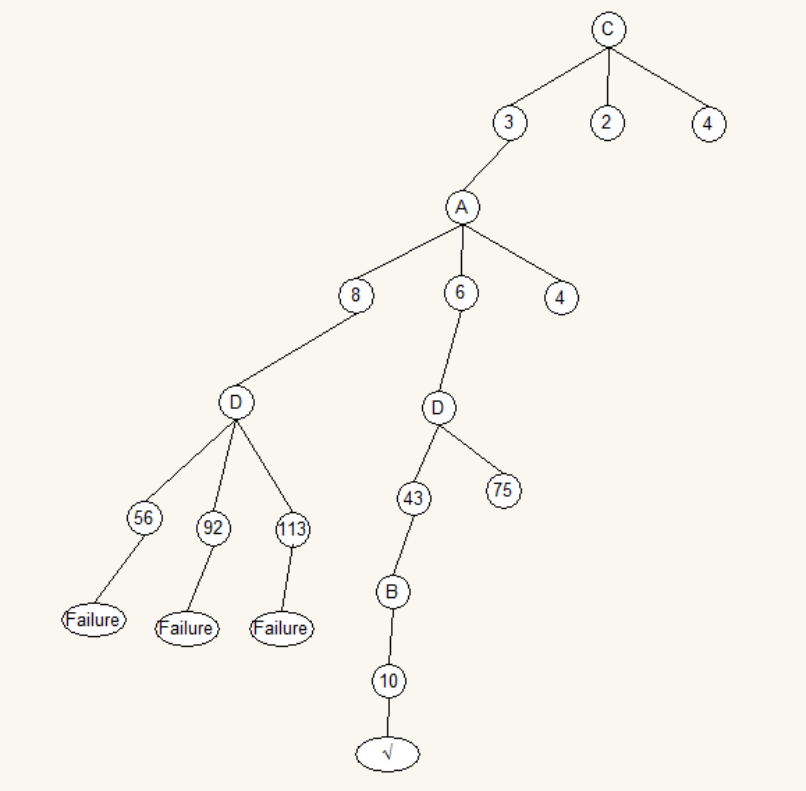
D={56,92,113}

D={43,75} LCV:

D=43	D=75
B:3	B:4
3	4

D={43,75}

Search tree



C=3,A=6,D=43,B=10

A+C=9 is odd

A+D=49 $=7^2$

B+D=53<60

4. This is the same cryptarithmetic problem we solved in class, except the domains of the variables are different.

TWO + TWO = FOUR

Assume that F is already assigned 1. In this version, we'll assume that there will be a carry over from O + O and there will be a carry over from W + W. Hence, the constraints are now:

O + O = 10 + R

W + W + 1 = 10 + U

T + T + 1 = 10 + O

And, of course, all digits are distinct. Assume the following domains:

O: {7, 8, 9}

R: {0, 2…9}

W: {5…9}

U: {0, 2…9}

T: {5…9}

Solve this problem using the following heuristics and algorithms.

1)Use backtracking search.

2)For variable ordering, use MRV. If there are ties, break them in the following order: O, R, W, U, T.

3)For value ordering: simply order the values in increasing order.

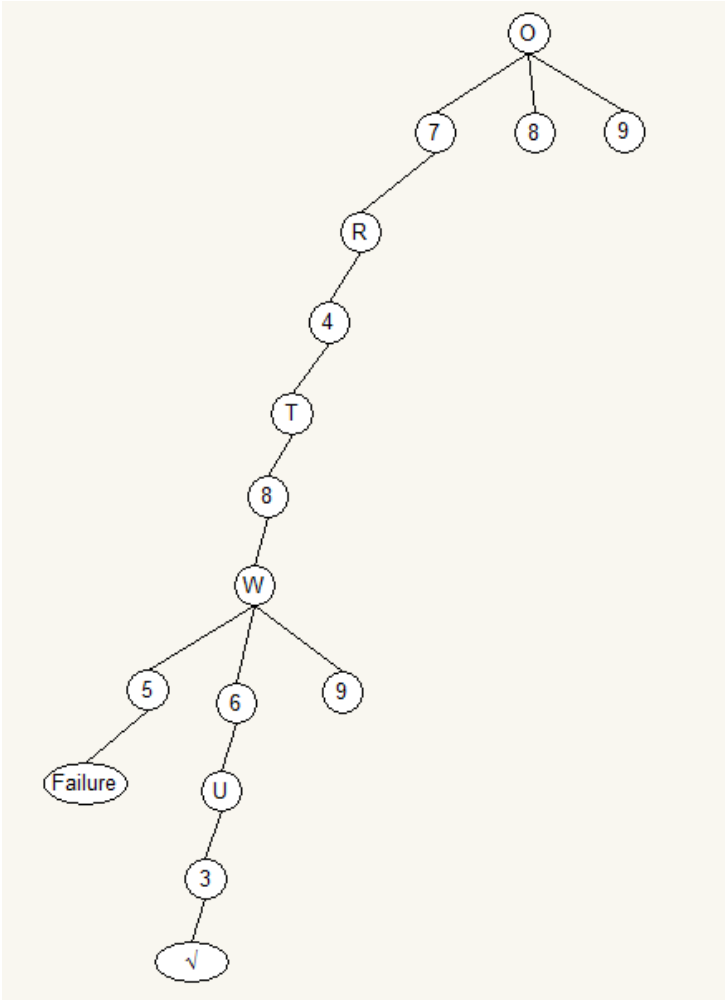
4)For inference, use forward checking.

Please show the search tree and the stack of the domains (see the lecture video for an example). When the search backtracks due to an empty domain, show it clearly on your search tree.

SOLUTION:

		O=7	R=4	T=8	~~W=5~~	W=6	U=3
O	{7, 8, 9}	7	7	7	~~7~~	7	7
R	{0, 2…9}	{4}	4	4	~~4~~	4	4
W	{5…9}	{5,6,8,9}	{5,6,8,9}	{5,6,9}	~~5~~	6	6
U	{0, 2…9}	{0,2…6,8,9}	{0,2,3,5,6,8,9}	{0,2,3,5,6,9}	~~∅~~	{3}	3
T	{5…9}	{8}	{8}	8	~~8~~	8	8

Search tree



O=7,R=4,T=8,W=6,U=3

TWO+TWO=1OUR

867+867=1734