Homework 1

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Question 1

State space

All possible combinations of missionaries and cannibals on either side, and on the boat, where missionaries are not outnumbered by cannibals. Additionally, there can only be a maximum of 2 humans on the boat, and also there must be at least one human on the boat to row the boat between the sides.

Example:

The M represents missionaries, and the C represents cannibals. The number of Ms and Cs at the respective columns represent the number of missionaries and cannibals at the respective locations. The last column keeps track of the location of the boat.

	Left Side	Boat	Right side	Boat location
1	$MMMCCC$			L
2	$MMCC$	MC		R
3	$MMCC$	M	C	R
4	MMC	MC	C	L
5	MMC	C	MC	L
6	MC	MC	MC	L
7	MC	C	MMC	R
8			$MMMCCC$	R
9	etc	etc	etc	etc

Initial state&

The initial state is when the missionaries and cannibals all start off at one side of the river, which is represented by the first row in the table above.

Goal test

The goal test is when all missionaries and cannibals are at the other side of the river, as represented by the 8th row in the table above

Actions

The actions are:

- to place a missionary or a cannibal on or off the boat, either to or from the side of the river where the boat is at (assuming that the configuration is in the state space, ie no cannibals outnumbering the missionaries, and maximum number of people on the boat is 2)
- to row the boat from one side to another if there is at least one human on boat

Path cost

The path cost can be determined as the number of times the boat is rowed from one side to another until all missionaries and cannibals are transported from one side of the river to the other (ie when the goal is reached)

Question 2

a) Name the main difference between tree search and graph search.

The main difference is that the graph search maintains a explored set so that it does not revisit nodes during the search, while the tree search does not do this. The advantage is that the graph search would not repeatedly revisit the node or end up in an infinite loop, while the disadvantage is that it takes up more memory.

b) What is the difference between nodes and states in terms of a search problem?

The state is a representation of a physical configuration while the node is a data structure, which is part of a tree, compromising of states, parent-node, child-node(s), action, path-cost, depth etc

c) Does the explored set keep track of nodes or states? Why is it so?

The explored set keeps track of previously visited states. This is so that it does not generate new child-nodes with the same states. It does not keep track of nodes because different nodes can have the same state. Example, if you were to go from Arad to Sibiu and to Arad again. The first Arad and the second Arad are of the same state, but of different nodes as the second time you visit Arad you would have incurred a path cost of going from Sibiu to Arad. However, to prevent revisiting Arad, it is the state that we are concerned with not revisiting.

Question 3

a.) Run BFS as a graph search, and list down the following: (i) the frontier/queue at every step; (ii) the explored set at every step; and (iii) the solution (if any).

Step	Chosen Node	Frontier	Explored Set
1		A	
2	A	AB, AC	A
3	AB	ABD, AC	A, B
4	AC	ABD, ACD	A, B, C
5	ABD	$ABDX, ACD$	A, B, C, D

Technically the function stops halfway during step 5 as we do the goal test on the child of ABD which is ABDX to indeed find that it is the goal, the last line of adding ABDX into the frontier would not be computed as we return from the function.

The solution is ABDX.

b) Run DFS as a graph search, and list down the following: (i) the frontier/queue at every step; (ii) the explored set at every step; and (iii) the solution (if any).

Step	Chosen Node	Frontier	Explored Set
1		A	
2	A	AB, AC	A
3	AC	AB, ACD	A, C
4	ACD	$AB, ACDX$	A, C, D

Similar to before, ACDX might not have been added in the frontier since we return immediately after doing the goal test.

The solution is ACDX

c) If BFS is run as a tree search (instead of a graph search), what additional nodes will be inserted? List down 3 such nodes.

ABA,ABC,ACB as there is no explored set and we can revisit nodes.

d.) If DFS is run as a tree search (instead of a graph search), what additional nodes will be inserted? List down 3 such nodes.

ACB, ACBD, ACBA

Question 4

a) Run BFS as a graph search, and list down the following: i) the frontier/queue at every step; (ii) the explored set at very step; and (iii) the solution (if any).

Step	Chosen Node	Frontier	Explored Set
1		A	
2	A	AB, AC	A
3	AB	ABD, AC	A, B
4	AC	ABD, ACE, ACF	A, B, C
5	ABD	$ABDH, ABDX, ACE, ACF$	A, B, C, D

The solution is ABDX.

a) Run DFS as a graph search, and list down the following: i) the frontier/queue at every step; (ii) the explored set at very step; and (iii) the solution (if any).

Step	Chosen Node	Frontier	Explored Set
1		A	
2	A	AB, AC	A
3	AC	AB, ACE, ACF	A, C
4	ACF	$AB, ACE, ACFI$	A, C, F
5	$ACFI$	$AB, ACE, ACFIH$	A, C, F, I
6	$ACFIH$	$AB, ACE, ACFIHD, ACFIHX$	A, C, F, I, H

The solution is ACFIHX.

Question 5

Run UCS as a graph search, and list down the following: (i) the frontier/queue at every step (including the path cost of each node); (ii) the explored set at every step; and (iii) the solution (if any).

Step	Chosen Node	Frontier	Explored Set
1		$\{A\}$	
2	A	$\{AC:3, AB:5\}$	A
3	AC	$\{AB:5, ACF:8, ACE:153\}$	A, C
4	AB	$\{ACF:8, ABD:55, ACE:153\}$	A, B, C
5	ACF	$\{ACFI:11, ACFE:13, ABD:55\}$	A, B, C, F
6	$ACFI$	$\{ACFE:13, ACFIH:14, ABD:55\}$	A, B, C, F, I
7	$ACFE$	$\{ACFIH:14, ACFED:15\}$	A, B, C, E, F, I
8	$ACFIH$	$\{ACFED:15, ACFIHX:24\}$	A, B, C, E, F, H, I
9	$ACFED$	$\{ACFEDX:16, ACFIHX:24\}$	A, B, C, D, E, F, H, I
10	$ACFEDX$	$\{ACFIHX:24\}$	A, B, C, D, E, F, H, I

The solution (which is optimal) is ACFEDX at path cost of 16.