# 50.021 – AI

Kwan Hui

Week 02: Search

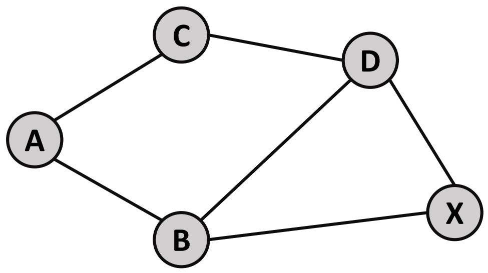
Due: 4rd June, 11:59pm
Submission: via eDimension

## 1 Problem Formulation

Missionaries and cannibals is a classical formal problem, and is generally stated as follows. Three missionaries and three cannibals are on one side of the river. They all need to cross in a boat that only holds two people at once. There must never be a situation where there is a group of missionaries in one place who are outnumbered by cannibals.

**TASK:** Formalise the missionaries and cannibals problem in terms of its state space, initial state, goal test, actions and path cost.

## 2 Tree Search VS Graph Search



**Example:** For the above graph, A is the initial state and X is the goal state. Assuming that we insert nodes in terms of lowest alphabatical order first. To perform Breadth-First Search (BFS) using graph search on the above graph, we have the following steps (and their frontier and explored set):

1. Frontier: A (Explored: )
2. Frontier: AB, AC (Explored: A)
   - *Note: AB is inserted first, followed by AC*
3. Frontier: AC, ABD, ABX (Explored: A, B)
   - *Note: ABX is the solution and is returned before inserting into the frontier, but we just list it here to show that we expanded it from AB. Alternative, you can just state that you expand this from AB.*

In this case, the solution is the path ABX.

Similarly for Depth-First Search (DFS) using graph search on the same problem, we have:

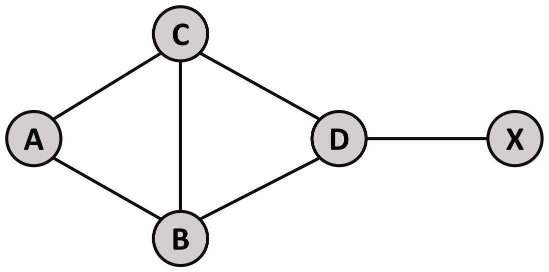
1. Frontier: A (Explored: )
2. Frontier: AB, AC (Explored: A)
3. Frontier: AB, ACD (Explored: A, C)
4. Frontier: AB, ACDX (Explored: A, C, D)
   - *Note: There is also ACDB, which we do not insert as we are using graph search*

In this case, the solution is the path ACDX.

**TASK:** Answer the following questions:
a.) Name the main difference between tree search and graph search.

b.) What is the difference between nodes and states in terms of a search problem?
c.) Does the explored set keep track of nodes or states? Why is it so?

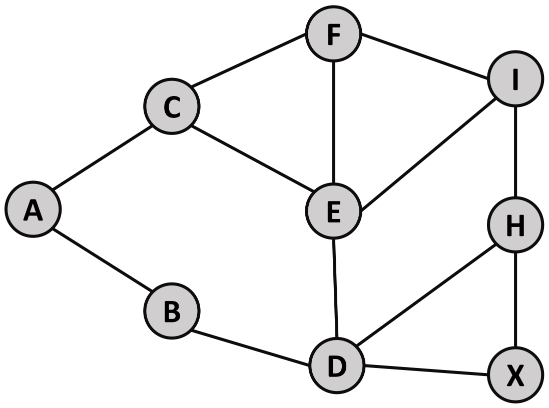
## 3 Breadth-First Search (BFS) and Depth-First Search (DFS)



For the above graph, A is the initial state and X is the goal state. Assuming that we insert nodes in terms of lowest alphabatical order first (as in 2).

**TASK:** Answer the following questions:
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).
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).
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.
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.

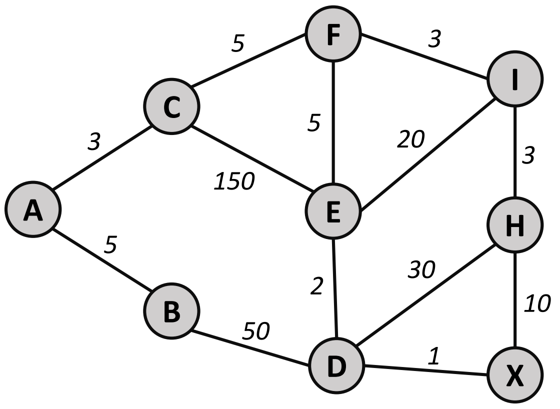
## 4 More BFS/DFS



For the above graph, A is the initial state and X is the goal state. Assuming that we insert nodes in terms of lowest alphabatical order first (as in 2).

**TASK:** Answer the following questions:
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).
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).

## 5 Uniform Cost Search (UCS)



For the above graph, A is the initial state and X is the goal state. The path cost is written on the edges of the graph.

**TASK:** 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).