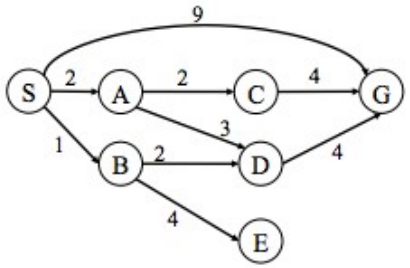
Searching Questions

- **Consider the following search problem, represented as a graph. The start state is S and the only goal state is G. Note that the following problems variously reference both tree search and graph search. For questions which require a heuristic, use the one given below.**

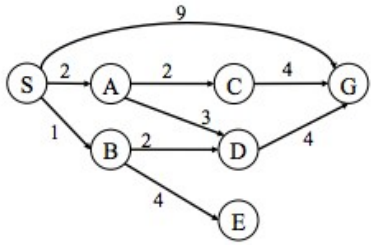


Heuristic

S	A	B	C	D	E	G
6	0	6	4	1	10	0

Q. What path will BFS tree search return?
Q. What path will UCS tree search return?
Q. What path will Greedy tree search return?
Q. What path will A* tree search return?

Searching Questions



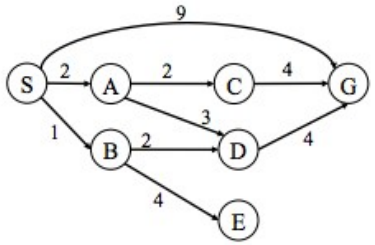
Heuristic

S	A	B	C	D	E	G
6	0	6	4	1	10	0

Q. What path will BFS search return?

- **S-G (BFS finds the path to the goal with the fewest edges.)**

Searching Questions



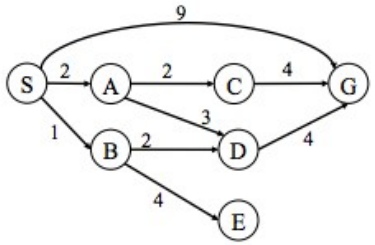
Heuristic

S	A	B	C	D	E	G
6	0	6	4	1	10	0

Q. What path will UCS search return?

- **S-B-D-G (UCS tree search always nds the optimal path.)**

Searching Questions



Heuristic

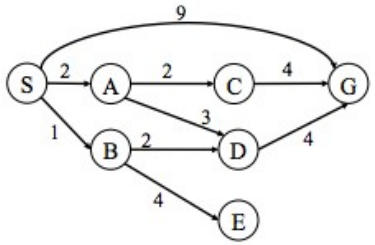
S	A	B	C	D	E	G
6	0	6	4	1	10	0

Q. What path will Greedy search return?

- **S-G**

Path expanded	Fringe (ordered by heuristic alone)
S	S-A(0) S-G(0) S-B(6)
S-A	S-G(0) S-A-D(1) S-A-C(4) S-B(6)
S-G	S-A-D(1) S-A-C(4) S-B(6)

Searching Questions



Heuristic

S	A	B	C	D	E	G
6	0	6	4	1	10	0

Q. What path will A* search return?

- **S-B-D-G**

Path expanded	Fringe (ordered by path + heuristic cost)
S	S-A(2+0) S-B(1+6) S-G(9+0)
S-A	S-A-D(5+1) S-B(1+6) S-A-C(4+4) S-G(9+0)
S-A-D	S-B(1+6) S-A-C(4+4) S-G(9+0) S-A-D-G(9+0)
S-B	S-B-D(3+1) S-A-C(4+4) S-G(9+0) S-A-D-G(9+0) S-B-E(5+10)
S-B-D	S-B-D-G(7+0) S-A-C(4+4) S-G(9+0) S-A-D-G(9+0) S-B-E(5+10)
S-B-D-G	S-A-C(4+4) S-G(9+0) S-A-D-G(9+0) S-B-E(5+10)

Heuristic Questions

Consider the 8-puzzle in which there is a 3 x 3 board with eight tiles numbered 1 through 8. The goal is to move the tiles from a start configuration to a goal configuration, where a move consists of a horizontal or vertical move of a tile into an adjacent position where there is no tile. Each move has cost 1.

Q. Is the heuristic function defined by $h = \sum_{i=1}^{8} \alpha_i d_i$ **admissible, where d_i is the number of vertical plus the number of horizontal moves of tile *i* from its current position to its goal position assuming there are no other tiles on the board, and 0 ≤ ai ≤ 1 is a constant weight associated with tile *i*?**

Yes, it is admissible because each di is a lower bound on the number of moves to get each tile to its goal position and the weights decrease those values.

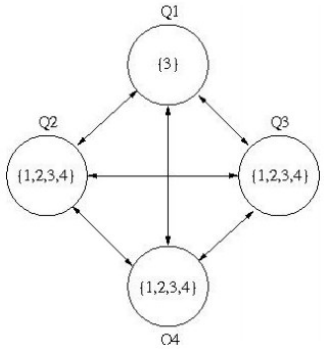
Q. Is the heuristic defined by h(n) = 8 – cost(n) admissible, where cost(n) is the cost from start to node n?

No, it is not admissible because, for example, if a start node configuration is only one move away from the goal configuration, then h(start) = 8 – 0 = 8 but h*(start) = 1. Also, there are situations where h(n) could be negative for some nodes, which is not allowed.

CSP (Constraint Satisfaction Problem) Questions

4 Queens Problem.

Formulation of this problem. Q_i is put somewhere in *i*-th column. Then the possible values in the domain for each variable are the row numbers in which it could be placed. For example, Q_1 = {3} means that Q_1 only can be put (1, 3). Initial constraint graph is given as below

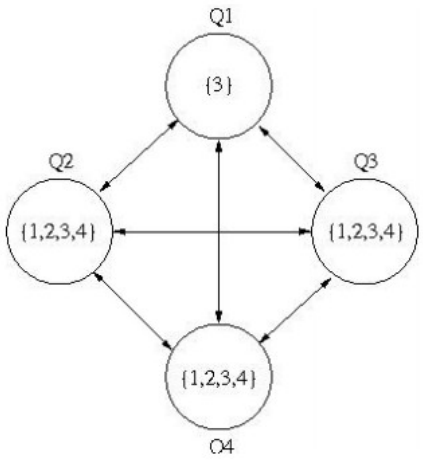


Q. Apply forward checking and give the remaining candidate values for the variables Q_2, Q_3 and Q_4.

Q_2: {1}
Q_3: {2, 4}
Q_4: {1, 2, 4}

CSP (Constraint Satisfaction Problem) Questions

Q. Fill in the table below with the candidate values of each queen after each of the following steps of applying the arc consistency algorithm to the figure. An arc "x -> y" is consistent if for each value of x there is some value of y that is consistent with it.



	Q1	Q2	Q3	Q4
Initial domain	3	1,2,3,4	1,2,3,4	1,2,3,4
After Q2 → Q1	3	1	1,2,3,4	1,2,3,4
After Q3 → Q1	3	1	2,4	1,2,3,4
After Q2 → Q3	3	1	2,4	1,2,3,4
After Q3 → Q2	3	1	4	1,2,3,4

Propositional Logic Problems

Q. Is the Propositional Logic (PL) sentence (A $\Leftrightarrow$ B) $\wedge$ ($\neg$A $\vee$ B) valid, unsatisfiable, or satisfiable?

A	B	A $\Leftrightarrow$ B	$\neg$A $\vee$ B	(A $\Leftrightarrow$ B) $\wedge$ ($\neg$A $\vee$ B)
T	T	T	T	T
T	F	F	F	F
F	T	F	T	F
F	F	T	T	T

A. Not Valid and Satisfiable
Since the last column contains both T and F, the sentence is satisfiable.

Propositional Logic Problems

Q. Prove (A $\wedge$ B) |= (A $\Leftrightarrow$ B) using a truth table.

A	B	A $\wedge$ B	A $\Leftrightarrow$ B
T	T	T	T
T	F	F	F
F	T	F	F
F	F	F	T

A. Since for each row where the next to last column is T, the last column is also T (this only occurs here for the first row), entailment is proved.