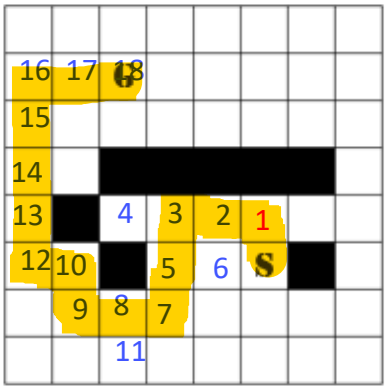
# AI-Assignment#3 (Heuristic Search)

**1)** Consider the problem of finding a path in the grid shown below from a starting square S to goal square G. Possible moves from a square are to move up, left, right, and down exactly one square. No move may be made onto a dark square or off the edge of the grid. Mark the grid squares with the number(s) indicating when that square is expanded during each search from S to G. Assume you do not generate a node if that node's associated grid position has previously been generated. In the case of ties in evaluation function values, for siblings expand them in the precedence order up, left, right, down. In the case of ties between non-siblings, use FIFO order to expand first the node that has been in the NODES list the longest. Highlight the solution path found, if any. Use the heuristic function $h(n) = |x_n - x_g| + |y_n - y_g|$; where the grid square associated with node n is at coordinates $(x_n, y_n)$ in the grid and the goal node G is at coordinates $(x_g, y_g)$.

**a. Greedy Best-First Search**

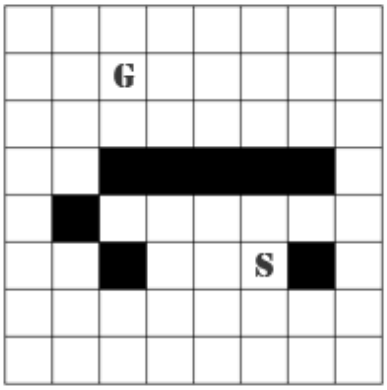
F(n) = h(n)


Search Steps & Solution Path

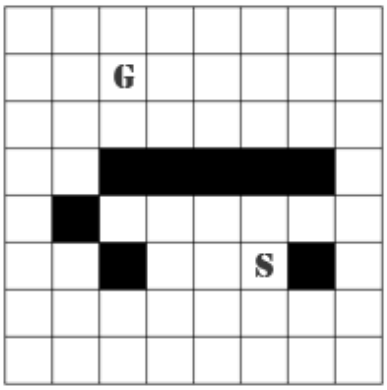



**b. A* search**

F(n)

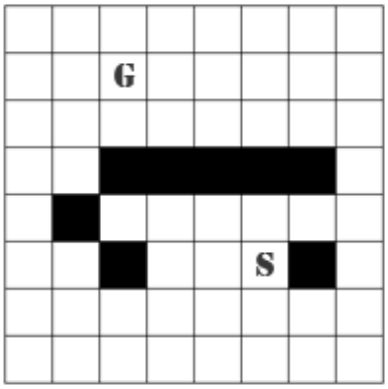



Search Steps & Solution Path

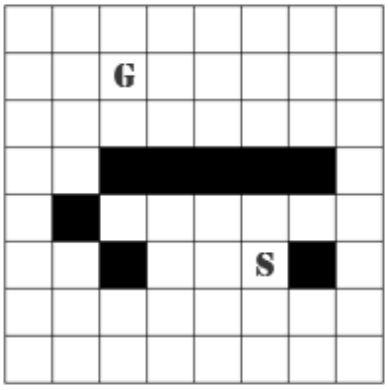



**c. Hill-Climbing Search**

F(n)




Search Steps & Solution Path



**2)** Assuming that successor states are generated in alphabetical order (in stack-based algorithms, placed on the Open List in alphabetical order either at the start or at the end), and ties (for priority-queue based algorithms) broken in alphabetical order,

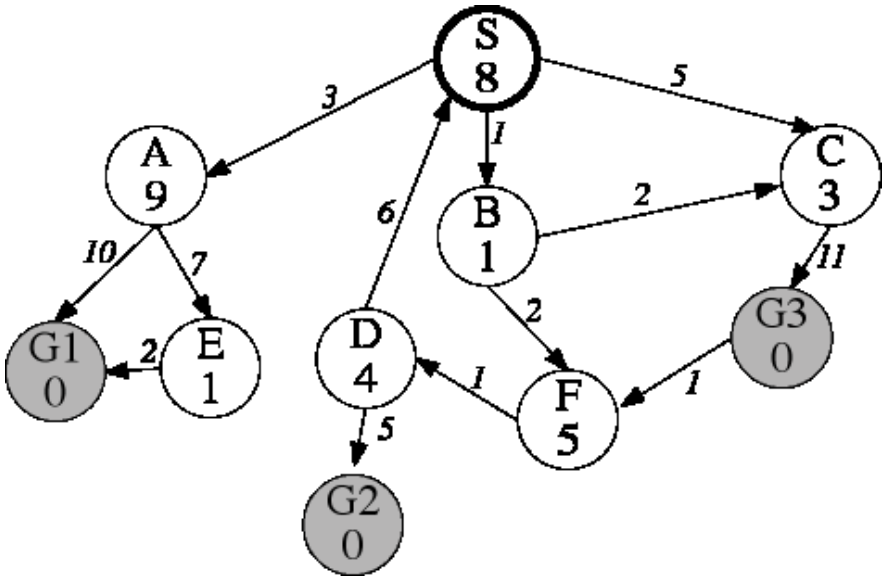
(a). ***in what order are the nodes in this graph expanded by each of the following search algorithms*** (tree search)? **Do not forget to remove repeated states**.

Also for each,

(b). ***which goal state is the founded goal state?***

(c). ***what is the cost of the path found?***

(d). ***Is the founded path optimal?***




### *a. Breadth-First Search*

Expanded Nodes: S A B C E G1
Founded Goal State: G1
Founded Cost Path: 13
Is It An Optimal Path? no

### *b. Depth First Search*

Expanded Nodes: S A E G1
Founded Goal State:
Founded Cost Path:
Is It An Optimal Path?

### *c. Uniform Cost Search*

Expanded Nodes:
Founded Goal State:
Founded Cost Path:
Is It An Optimal Path?

### *d. Iterative Deepening*

Expanded Nodes:
Founded Goal State:
Founded Cost Path:
Is It An Optimal Path?

***e. Greedy Best-First Search***

Expanded Nodes:
Founded Goal State:
Founded Cost Path:
Is It An Optimal Path?

***f. A****

Expanded Nodes:
Founded Goal State:
Founded Cost Path:
Is It An Optimal Path?

***g. IDA****

Expanded Nodes:
Founded Goal State:
Founded Cost Path:
Is It An Optimal Path?

**3)** If h1(s) and h2(s) are both admissible heuristic functions, which of the following are also admissible:

**h3(s) = h1(s) + h2(s)**

**h3(s) = | h1(s) - h2(s) |**

**h3(s) = max(h1(s), h2(s))**

**h3(s) = min(h1(s), h2(s))**

***Be sure to explain your answers. For those cases where h3(s) is not admissible, show a counter example. Which of the above four combinations do you feel is the best one? Why?***

**4) Prove each of the following statements whether it is <u>true</u> or <u>false</u>:**

a. Breadth-first search is a special case of uniform-cost search.

b. Breadth-first search, depth-first search, and uniform-cost search are special cases of best-first search.

c. Uniform-cost search is a special case of A* search.