Algorithms and Data Structures for Data Science

Graph Traversals

CS 277

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UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Department of Computer Science

Exam 3 Signups Available

April 24 — April 27

Very limited window for makeup exams (since end of semester is near)

Covers content from week 10 — 14

Learning Objectives

Re-introduce breadth first search traversal in a graph

Explore use cases for BFS traversal

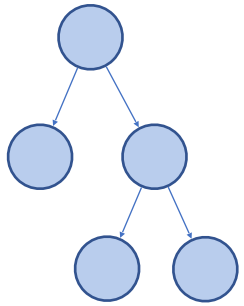
Introduce depth first search traversal in a graph

Graph Traversals

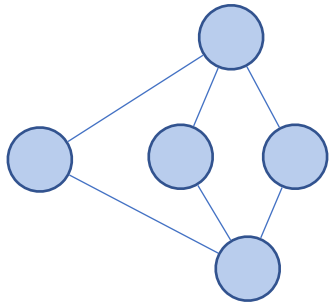
There is no clear order in a graph (even less than a tree!)

How can we systematically go through a complex graph in the fewest steps?

Tree traversals won't work — lets compare:

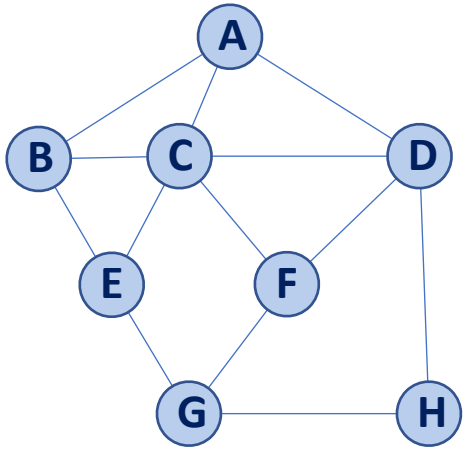


- Rooted
- Acyclic
- Clear base cases ('doneness')



- Arbitrary starting point
- Can have cycles
- Must track visited nodes directly

Simple BFS Traversal



1) Create a queue and a visit list

2) Initialize both to contain our start

3) While queue not empty:

   Remove front vertex of queue

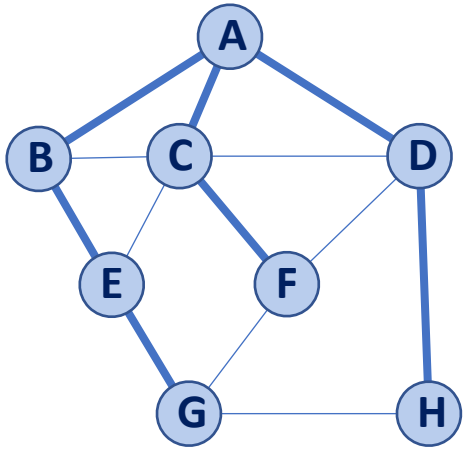
   Check if each edge has been seen before

   Add unvisited edges to queue (and list)

Queue

Visited

Simple BFS Traversal



1) Create a queue and a visit list

2) Initialize both to contain our start

3) While queue not empty:

   Remove front vertex of queue

   Check if each edge has been seen before

   Add unvisited edges to queue (and list)

What is my runtime?

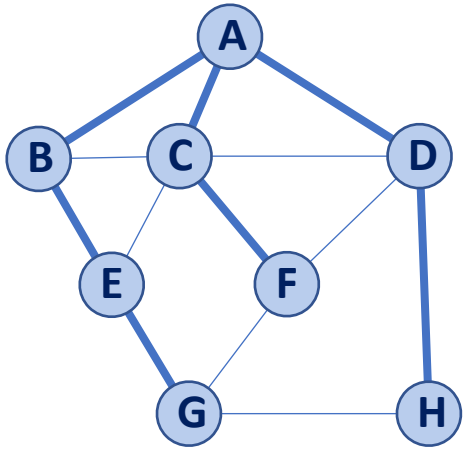
Queue

G H F E D C B A

Visited

A B C D E F H G

Simple BFS Traversal



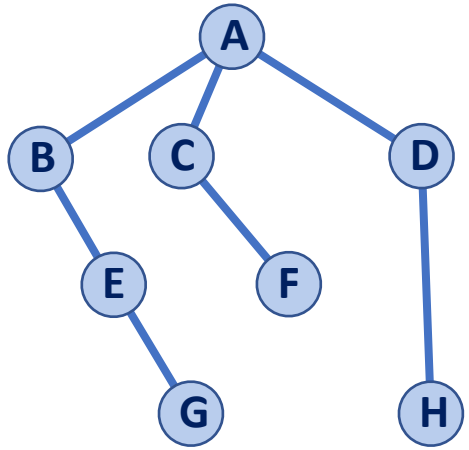
What is the shortest distance from **A** to **H**?

What is the shortest path from **A** to **H**?

What is the shortest path from **A** to **F**?

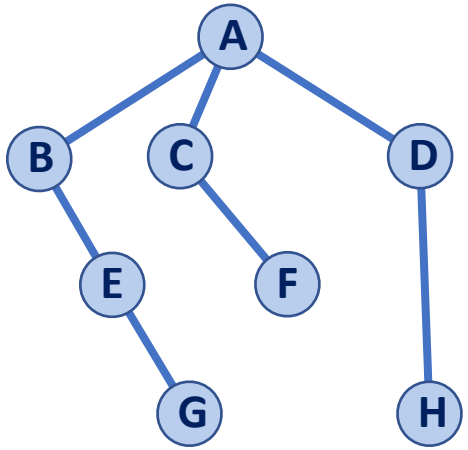
What is the shortest distance from **A** to **F**?

Simple BFS Traversal



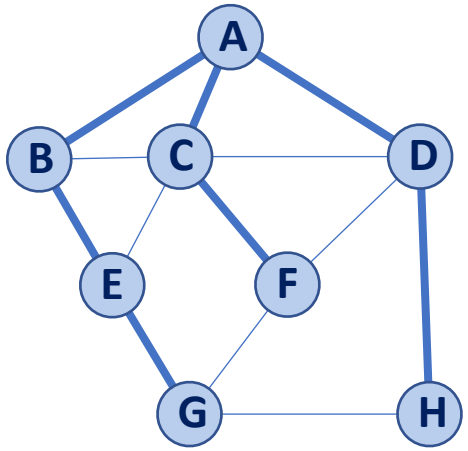
What data structure is this?

Simple BFS Traversal



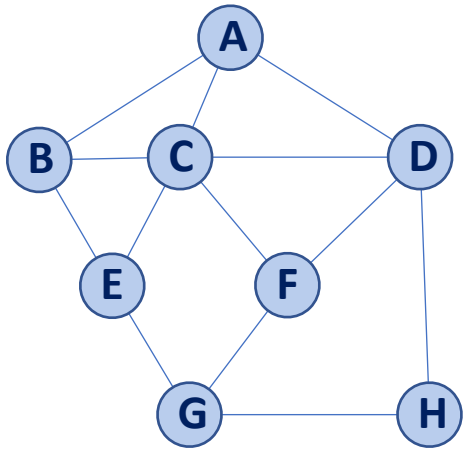
A **minimum spanning tree** is a tree formed by a subset of graph edges such that all vertices are connected with the smallest total possible edge weight

On an unweighted, undirected graph this MST can be built by tracking **discovery** edges during a BFS traversal

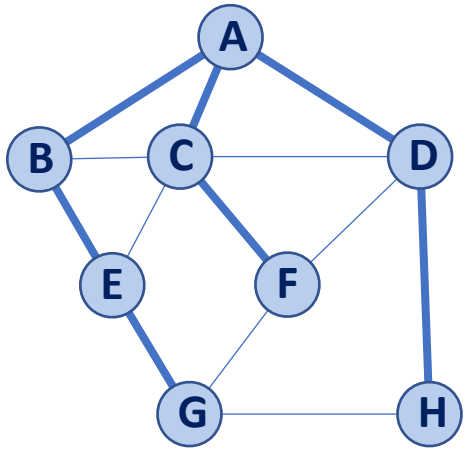


We call the remaining edges **cross** edges. What can I say about a graph with at least one **cross** edge?

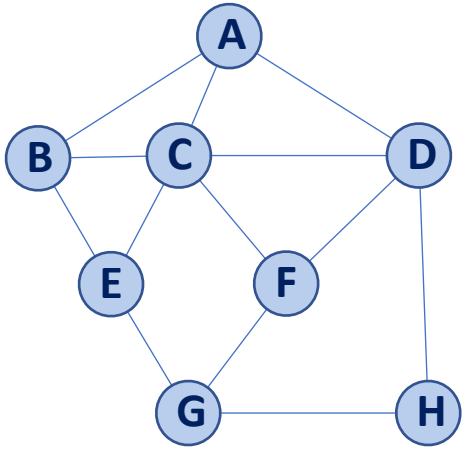
Traversal: BFS



If we modify our BFS traversal algorithm, we can track both **distances** and **discovery edges!**



Traversal: BFS



Replace 'visited' list with a **distance** and a **previous**

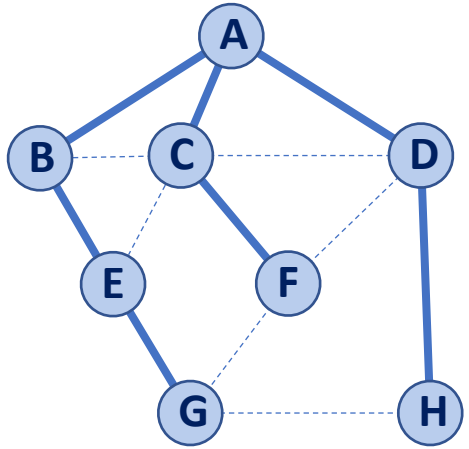
When we add to queue, record **previous**.

When we process vertex from queue, record **distance**.

Vertex	Distance	Previous
A		
B		
C		
D		
E		
F		
G		
H		

Queue

Traversal: BFS



Replace 'visited' list with a **distance** and a **previous**

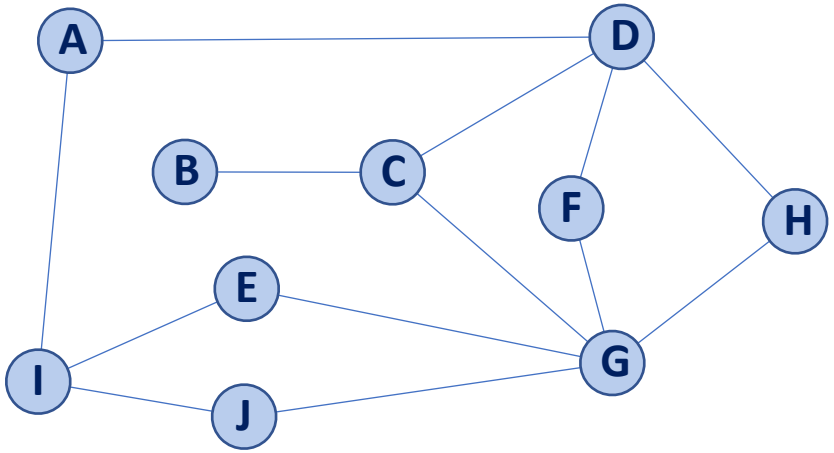
When we add to queue, record **previous**.

When we process vertex from queue, record **distance**.

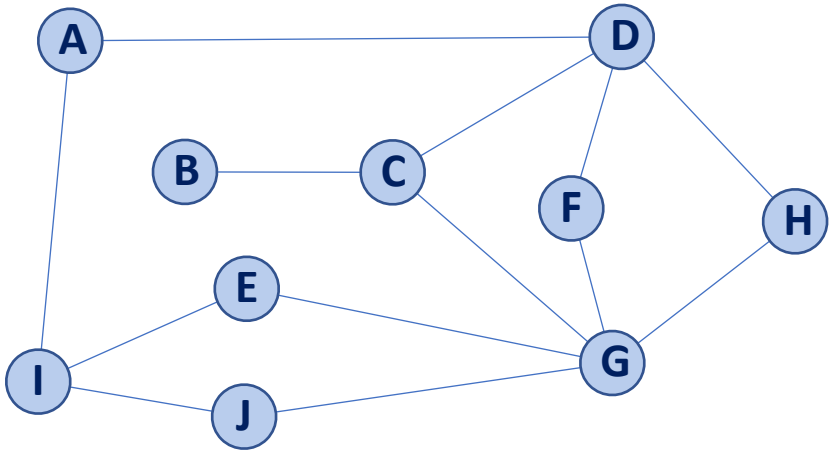
Vertex	Distance	Previo
A	0	-
B	1	A
C	1	A
D	1	A
E	2	B
F	2	C
G	3	E
H	2	D

Queue

Traversal: DFS



Traversal: DFS



1) Create a stack and a visit list

2) Initialize both to contain our start

3) While stack not empty:

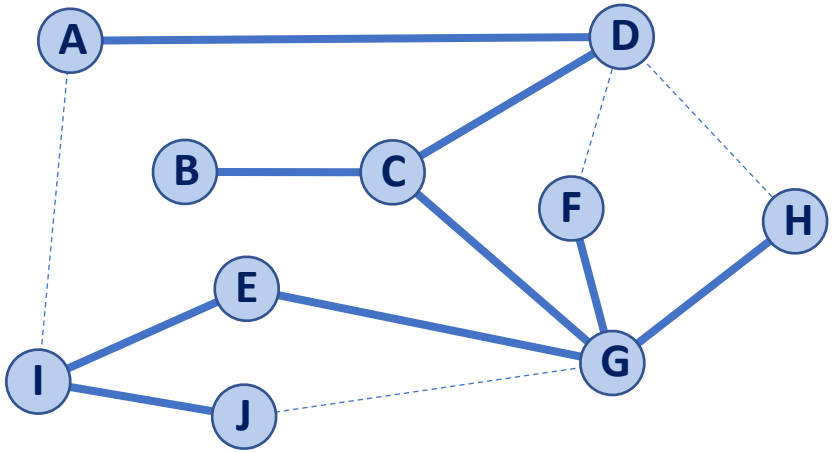
Remove top item from stack (temporarily)

If first time seeing top vertex, process it

If one or more adjacent edges unvisited,
add the item back to stack before…

Add ***one*** unseen adjacent vertex to stack

Traversal: DFS



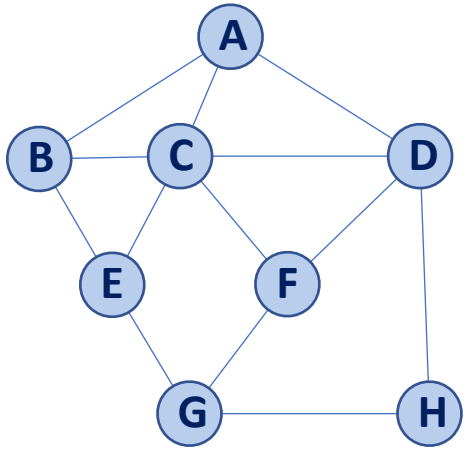
Does distance have meaning here?

Do our edge labels have meaning here?

Discovery Edge

Back Edge

Traversal: DFS



DFS vs BFS

DFS:

Pros:

Cons:

BFS:

Pros:

Cons: