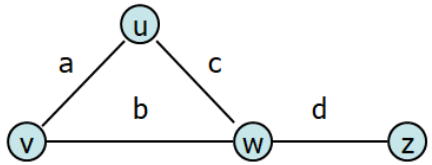
CS 225

#35: Adjacency List + BFS

November 16, 2018 · *Wade Fagen-Ulmschneider*

Graph Implementation #3: Adjacency List



Vertex List	Edges
u	a
v	b
w	c
z	d

Operations on an Adjacency Matrix implementation:

insertVertex(K key):

removeVertex(Vertex v):

incidentEdges(Vertex v):

areAdjacent(Vertex v1, Vertex v2):

insertEdge(Vertex v1, Vertex v2, K key):

Running Times of Classical Graph Implementations

	Edge List	Adj. Matrix	Adj. List
Space	**n+m**	**n^2**	**n+m**
insertVertex	**1**	**n**	**1**
removeVertex	**m**	**n**	**deg(v)**
insertEdge	**1**	**1**	**1**
removeEdge	**1**	**1**	**1**
incidentEdges	**m**	**n**	**deg(v)**
areAdjacent	**m**	**1**	**min(deg(v), deg(w))**

Big Picture Ideas: Comparing Implementations

Q: If we consider implementations of simple, connected graphs, what relationship between n and m?

- On connected graphs, is there one algorithm that underperforms the other two implementations?

...what if our graph is sparse and not connected?

Q: Is there clearly a single best implementation?

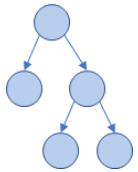
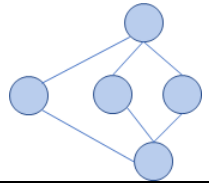
- Optimized for fast construction:

- Optimized for areAdjacent operations:

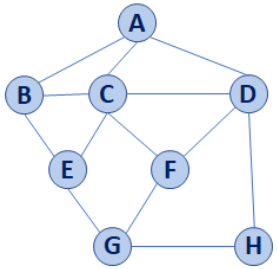
Graph Traversal

Objective: Visit every vertex and every edge in the graph.
Purpose: Search for interesting sub-structures in the graph.

We've seen traversal before – this is different:

BST	Graph
	

BFS Graph Traversal:

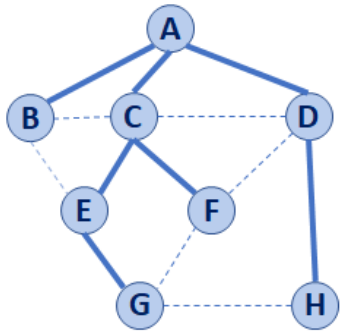


Pseudocode for BFS

```
1   BFS(G):
2     Input: Graph, G
3     Output: A labeling of the edges on
4         G as discovery and cross edges
5
6     foreach (Vertex v : G.vertices()):
7       setLabel(v, UNEXPLORED)
8     foreach (Edge e : G.edges()):
9       setLabel(e, UNEXPLORED)
10    foreach (Vertex v : G.vertices()):
11      if getLabel(v) == UNEXPLORED:
12         BFS(G, v)
13
14  BFS(G, v):
15    Queue q
16    setLabel(v, VISITED)
17    q.enqueue(v)
18
19    while !q.empty():
20      v = q.dequeue()
21      foreach (Vertex w : G.adjacent(v)):
22        if getLabel(w) == UNEXPLORED:
23           setLabel(v, w, DISCOVERY)
24           setLabel(w, VISITED)
25           q.enqueue(w)
26        elseif getLabel(v, w) == UNEXPLORED:
27           setLabel(v, w, CROSS)
```

Vertex (v)	Distance (d)	Prev. (p)	Adjacent
A			
B			
C			
D			
E			
F			
G			
H			

BST Graph Observations



1. Does our implementation handle disjoint graphs? How?
   a. How can we modify our code to count components?
2. Can our implementation detect a cycle? How?

CS 225 – Things To Be Doing:

1. **Programming Exam C is different than usual schedule:**
   Exam: Sunday, Dec 2 – Tuesday, Dec 4
2. lab_dict on-going; due on Tuesday, Nov. 27
3. MP6 EC+3 due tonight; final due date on Monday, Nov. 26
4. No POTDs over break (next one after today is Monday, Nov. 26)