CS 225

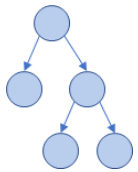
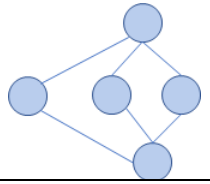
#36: Graph Traversals

April 15, 2019 · *Fagen-Ulmschneider, Zilles*

Graph Traversal

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

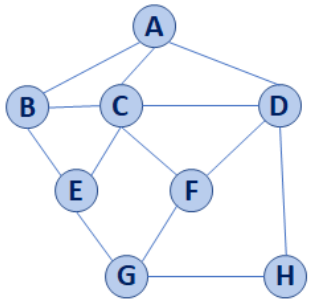
We've seen traversal before – this is different:

BST	Graph
	

BFS Graph Traversal:

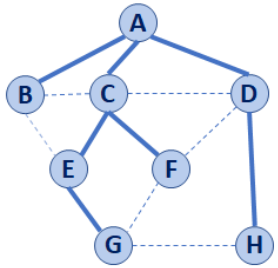
Pseudocode for BFS

```
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			

BFS 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?
   a. How can we modify our code to store update a private member variable `cycleDetected_`?
3. What is the running time of our algorithm?
4. What is the shortest path between **A** and **H**?

5. What is the shortest path between **E** and **H**?

    a. What does that tell us about BFS?

6. What does a cross edge tell us about its endpoints?

7. What structure is made from discovery edges in **G**?

Big Ideas: Utility of a BFS Traversal

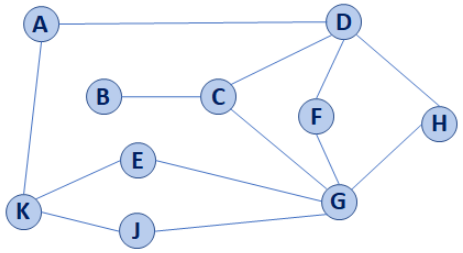
Obs. 1: Traversals can be used to count components.
Obs. 2: Traversals can be used to detect cycles.
Obs. 3: In BFS, **d** provides the shortest distance to every vertex.
Obs. 4: In BFS, the endpoints of a cross edge never differ in distance, d, by more than 1: **|d(u) - d(v)| = 1**

DFS Graph Traversal

Two types of edges:

1.

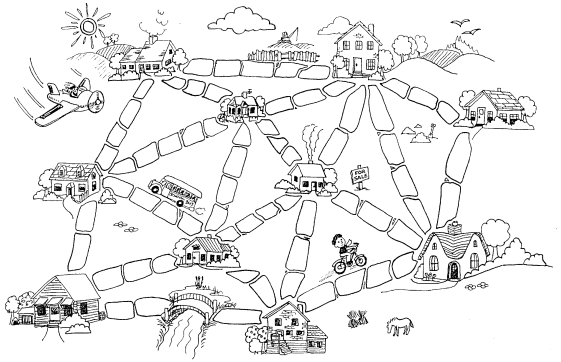
2.



Modifying BFS to create DFS

```
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)
```

Minimum Spanning Tree



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CS 225 – Things To Be Doing:

1. Programming Exam C: Thursday, April 18 – Sunday, April 21
2. lab_ml this week!
3. MP6 due tonight; MP7 released tomorrow
4. Daily POTDs resume today!