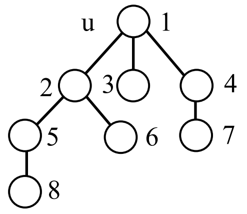
Walking a graph
David Gries

A breadth-first walk of a graph



A breadth-first search of this graph starting at u visits the nodes in breadth-first order:

First u. Then all nodes 1 edge from u. Then all nodes 2 edges from u. And so forth.

However, a person *walking* the graph as if it were a town with intersections and roads between them would not be able to jump around like that. Instead, the walker could only walk from one intersection (node) to another along a road (an edge).

We show Walker Red making such a walk to visit all nodes of the graph, visiting nodes in bfs order. It's clear that a bfs walk is inefficient. Actually, a dfs walk is much better, and we now develop it.

The specification of the depth-first walk of a graph

We develop an implementation of a dfs walk, showing one way to organize it.

public static void dfsWalk(State s)

The method has a parameter s of class State. Class State has two methods of interest to us:

- Function s.standingOn() returns the Node on which the walker is currently standing.
- Procedure s.moveTo(w) moves the walker to node w. But an exception occurs if w is not a neighbor of the node on which the walker is standing —if there's no edge from the node where the walker is standing to w.

Now lets look at the specification of dfsWalk:

- First, the walker is standing on a node given by state s, we call it u.
- Second, as usual, every node reachable along paths of unvisited nodes from u are to be visited.
- Third, and this is important. We *must* state where the walker will be standing when the method terminates. The walker will be standing where they started, on node u.
- Fourth, we have the precondition that u is unvisited.

The method body

We now develop the method body from the specification. First, let's save the node on which the walker is standing in a local variable u and then visit u, since the spec says it is unvisited.

Next, each unvisited neighbor w of u has to be processed —a recursive dfs has to be done on each unvisited neighbor. How to do that?

According to the spec of dfsWalk, the walker must be standing on the node, so the first step is to move to node w. Now, dfsWalk can be called, using s as the argument. When that call terminates, according to the method spec, the walker will be standing on that same node w. But the walker needs to be on node u —either to process the next neighbor or because the method is done. Therefore, we insert the move to u. That completes the development.

```
/** The walker is standing on a Node u (say) given by State s.
    Visit every node reachable along paths of unvisited nodes from node u.
    End with walker standing on Node u.
    Precondition:  u is unvisited. */
public static void dfsWalk(State s) {
    Node u= s.standingOn();
    Visit u;
    for each neighbor w of u {
        if (w is unvisited) {
            s.moveTo(w);
            dfsWalk(s);
            s.moveTo(u);
        }
} }
```

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