17.2
Breadth First Search
Breadth First Search (BFS)

Overview

1. **BFS** is obtained from **BasicSearch** by processing edges using a **queue** data structure.
2. It processes the vertices in the graph in the order of their shortest distance from the vertex \( s \) (the start vertex).

As such...

1. **DFS** good for exploring graph structure
2. **BFS** good for exploring **distances**
xkcd take on DFS

PREPARING FOR A DATE:
WHAT SITUATIONS MIGHT I PREPARE FOR?
1) MEDICAL EMERGENCY
2) DANCING
3) FOOD TOO EXPENSIVE

OKAY, WHAT KINDS OF EMERGENCIES CAN HAPPEN?
A) SNAKEBITE
B) LIGHTNING STRIKE
C) FALL FROM CHAIR

HMM, WHICH SNAKES ARE DANGEROUS? LET'S SEE...
A) CORN SNAKE
B) CARTER SNAKE
C) COPPERHEAD

THE RESEARCH COMPARING SNAKE VENOMS IS SCATTERED AND INCONSISTENT. I'LL MAKE A SPREADSHEET TO ORGANIZE IT.

IM HERE TO PICK YOU UP. YOU'RE NOT DRESSED?
BY LCD, THE INLAND TAIPAN HAS THE DEADLIEST VENOM OF ANY SNAKE.
Queue Data Structure

Queues

A queue is a list of elements which supports the operations:

1. enqueue: Adds an element to the end of the list
2. dequeue: Removes an element from the front of the list

Elements are extracted in **first-in first-out (FIFO)** order, i.e., elements are picked in the order in which they were inserted.
**BFS Algorithm**

Given (undirected or directed) graph $G = (V, E)$ and node $s \in V$

**BFS($s$)**

Mark all vertices as unvisited
Initialize search tree $T$ to be empty
Mark vertex $s$ as visited
set $Q$ to be the empty queue

**enqueue**(Q, s)

while $Q$ is nonempty do

$u =$ dequeue($Q$)

for each vertex $v \in \text{Adj}(u)$

if $v$ is not visited then

add edge $(u, v)$ to $T$

Mark $v$ as visited and enqueue($v$)

**Proposition**

**BFS($s$) runs in $O(n + m)$ time.**
BFS: An Example in Undirected Graphs

BFS tree is the set of purple edges.
**BFS: An Example in Undirected Graphs**

The BFS tree is the set of purple edges.

T1. [1]  
T2. [2,3]  
T3. [3,4,5]  
T4. [4,5,7,8]  
T5. [5,7,8]  
T6. [7,8,6]  
T7. [8,6]  
T8. [6]  
T9. []
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T1, T2, T3, T4, T5, T6, T7, T8, T9 are the different levels in the BFS traversal.
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BFS: An Example in Undirected Graphs


BFS tree is the set of purple edges.
BFS: An Example in Directed Graphs
THE END

... (for now)