Data Structures

Other Stuff

CS284

Shortest path in unweighted graph

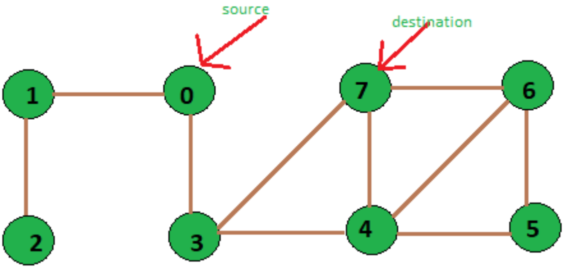


Figure: Caption

BFS

```
// from https://www.geeksforgeeks.org/shortest-path-unweighted-gra
public boolean BFS(ArrayList<ArrayList<Integer>> adj, int src, int
{
    LinkedList<Integer> queue = new LinkedList<Integer>();
    boolean[] visited = new boolean[v];

    for (int i = 0; i < v; i++) {
        visited[i] = false;
        dist[i] = Integer.MAX_VALUE;
        pred[i] = -1;
    }
    visited[src] = true;
    dist[src] = 0;
    queue.add(src);
```

Shortest path in unweighted graph

```
        while (!queue.isEmpty()) {
            int u = queue.peek();
            queue.poll();
            for (int i = 0; i < adj.get(u).size(); i++) {
                int ith_item = adj.get(u).get(i);
                if (visited[ith_item] == false) {
                    visited[ith_item] = true;
                    dist[ith_item] = dist[u] + 1;
                    pred[ith_item] = u;
                    queue.add(ith_item);

                    if (ith_item == dest)
                    return true;
                }
            }
        }
        return false;
    }
```

Hashing

Theorem (copied from http://staff.ustc.edu.cn/ csli/graduate/algorithms/book6/chap12.htm). Given an open-address hash table with load factor $\alpha = n/m < 1$, the expected number of probes in an unsuccessful search is at most $1/(1 - \alpha)$, assuming uniform hashing.

Proof. In an unsuccessful search, every probe but the last accesses an occupied slot that does not contain the desired key, and the last slot probed is empty. Let us define

$p_i = \Pr[\# \text{ probs} = \text{i}]$ Thus, the expected number of probes is

$$1 + \sum_{i=0}^{\infty} i p_i$$

Hashing

To evaluate the above equation, define $p_i = \Pr[\# \text{ probs} \geq \text{i}]$ Thus

$$\sum_{i=0}^{\infty} i p_i = \sum_{i=0}^{\infty} q_i$$

Now let's estimate q_i. The probability that the first probe accesses an occupied slot is $q_1 = n/m$, whereas $q_2 = \frac{n}{m} \times \frac{n-1}{m-1}$, thus $1 + \sum_{i=0}^{\infty} q_i = 1 + \alpha + 2 + \cdots = 1/(1-\alpha)$

$\square$

Hashing

Theorem. In a hash table in which collisions are resolved by chaining, a successful search takes time $(1 + \alpha/2)$

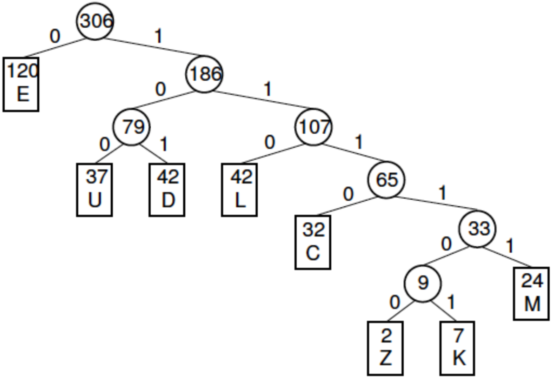
Theorem. We assume that the key being searched for is equally likely to be any of the n keys stored in the table. To find the expected number of elements examined, we therefore take the average, over the n items in the table, of 1 plus the expected length of the list to which the ith element is added. The expected length of that list is (i- 1)/m, and so the expected number of elements examined in a successful search is

$$\frac{1}{n}\sum_{i=1}^{n}(1+\frac{i-1}{m}) = 1 + \frac{\alpha}{2} - 1/2m$$

$\square$

Huffman tree

There are 8 characters, there frequencies are E: 120, U: 37, D: 42, L: 42, C: 32, Z: 2, K: 7, M: 24. Count the number of bits you need to encode the document.



Huffman tree

There are 8 characters, there frequencies are E: 120, U: 37, D: 42, L: 42, C: 32, Z: 2, K: 7, M: 24. Count the number of bits you need to encode the document.

Answer. $6 * 2 + 6 * 7 + 5 * 24 + 4 * 32 + 3 * 42 + 3 * 42 + 3 * 37 + 1 * 120 = 785$