XJTLU | Computing

CPT108: Data Structures and Algorithms

Semester 2, 2023-24

Tutorial 3

Hashtables

Problem 1. Insert the keys `E A S Y Q U T I O N` in that order into an initially empty hashtable of $M = 5$ and hash function $h(k) = (11k + 3)\%5$ using separate chaining. (Assume `A` $= 1$, `B` $= 2$, `C` $= 3, \ldots$)

Problem 2. Conisder inserting the keys $10, 22, 31, 4, 15, 28, 17, 88, 59$ into a hashtable of length $m = 11$ using open addressing. Illustrate the results of these keys using linear probing with $h(k, i) = (k + i) \mod m$ and using double hashing with $h_1(k) = k$ and $h_2(k) = 1 + (k \mod (m - 1))$. [Cormen 11.4-1]

Problem 3. Which of the following hash functions will distribute keys most uniformly over 10 buckets number 0 to 9 for k ranging from 0 to 2020?

(*Hint:* You may want to create a spreadsheet, calculate and have a look at how the distribution of the computed hash values look like)

A. $h(k) = (12 \times k) \mod 10$

B. $h(k) = (11 \times k^2) \mod 10$

C. $h(k) = k^3 \mod 10$

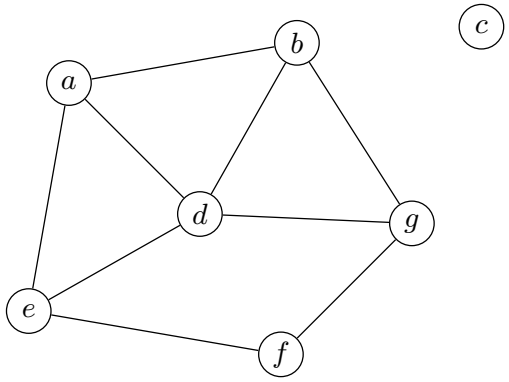
D. $h(k) = k^2 \mod 10$

Briefly explain your answers.

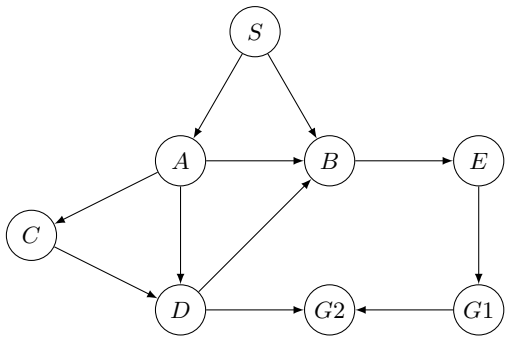
Graphs

Problem 4. What is the maximum number of edges in a graph with V vertices? What is the minimum number of edges in a graph with V vertices, none of which are isolated? [Sedgewick 4.1.1]

Problem 5. Draw the adjacency matrix and adjacency list of the graph below.



Problem 6. Suppose you have the following *directed* graph.



Start from node S, write down the path generated if breadth first search (BFS) is used. Break all ties by picking the nodes in alphabetic order.

Problem 7. Suppose you use a stack instead of a queue when running breadth first search (BFS). Does it still compute shortest paths?

References

Cormen, Thomas H. et al. (2022). *Introduction to Algorithms*. 4th. MIT Press. ISBN: 9780262046305. URL: https://mitpress.mit.edu/9780262046305.

Sedgewick, Robert and Kevin Wayne (2011). *Algorithms*. 4th. Addison Wesley.