Project 3: hashing

CPSC 335 - Algorithm Engineering

Spring 2019

Instructors: Krutik Amin ([kamin@fullerton.edu](mailto:kamin@fullerton.edu)), Doina Bein ([dbein@fullerton.edu](mailto:dbein@fullerton.edu))

# Abstract

In this project you will design, implement, and analyze one algorithm for the hashing problem. The algorithm is called Cuckoo Hashing, presented in class, and [detailed here](https://drive.google.com/open?id=177ToiScALjlMyN9J-kokIACMc0rxeJ1ykg-UAwneWM0). For this problem, you will design and implement one algorithm in C++, test it on various inputs and complete a hash table with a given input. No algorithm analysis is needed for this project.

# The Cuckoo Hashing Algorithm

There are several versions of cuckoo hashing. The version we learned in class is the simplest, where there are two hash functions, and thus only two places where any given item could be stored in the table. Let us consider the set of keys to be printable ASCII strings of length no more than 80. Let us consider the hash table size to be 17 .

If key is the string representing the key, then let be the size of the string and be the ASCII code of the (i+1)th character in the string read from left to right:

Let us consider two different hash functions, f1 and f2. Function f1 computes a large number and then brings the result into the proper range, which is , using the formulas below:

=

if then =+ tablesize

Function f2 also computes a large number and then brings the result into the proper range, which is , using the formulas below:

if then =+ tablesize

Both functions f1 and f2 compute first a large number then it brings the result into the proper range which is . But we can bring the intermediate results into this range after each calculation, we do not need to wait until we compute the final result. Also, we can ring the power term into this range before multiplying it with

You need to insert the strings below (also given in the input file in6.txt) into the hash table provided next. Please put an empty line at the end of the file.

Algorithm Engineering

California State University

Fullerton

College of Engineering

and Computer Science

Department of Computer

Science

Dynamic Programming

Monge Properties

String Matching

Matrix Searching

Optimal Tree Construction

Online algorithms

emphasis on

Server Problem

Some related problem

Self-Stabilization

One of the greatest

mysteries in science

Quantum Nature of Universe

In physics and

are known

Cuckoo hashing is fun

into the hash table (next page) using f1 for the first table and f2 for the second table. Show the result of the insertion in the table shown on next page.

Hint: consider a two-dimensional table of strings t, where t[0] is T1 and t[1] is T2. Consider a variable index that oscillates between 0 and 1as it would have oscillated between T1 and T2. In C++, the value of index could be changed using the tertiary operator: index = index? 0:1. Depending on the value of index, either apply hash function f1 (index == 0) or f2 (index == 1).

|  |  |  |
| --- | --- | --- |
|  | Table T1 | Table T2 |
| [0] | Monge Properties | One of the greatest |
| [1] |  | Online algorithms |
| [2] |  |  |
| [3] | Algorithm Engineering | College of Engineering |
| [4] | Server Problems |  |
| [5] |  | mysteries in science |
| [6] |  | emphasis on |
| [7] | Self-Stabilization | Quantum Nature of Universe |
| [8] | Optimal Tree Construction | and Computer Science |
| [9] | California State University |  |
| [10] | Department of Computer |  |
| [11] | Cuckoo hashing is fun! |  |
| [12] | Some related problem | Science |
| [13] | are known | Dynamic Programming |
| [14] | in physics |  |
| [15] | Matrix Searching | String Matching |
| [16] | Fullerton |  |

# Obtaining and Submitting Code

This document explains how to obtain and submit your work:

[GitHub Education / Tuffix Instructions](https://docs.google.com/document/d/1XspE5hRtGfc3s66cx0Fhg66PEwub2kY7SlX4lWptVeI/edit?usp=sharing)

Here is the invitation link for this project:

<https://classroom.github.com/g/qq7rmHW_>

# Implementation

You are provided with the following files.

1. cuckoo.cxx is a C++ file that contains the functions and definitions needed for this project. The function definitions are incomplete skeletons; you will need to rewrite them to actually work properly.
2. in4.txt is a text file that you can use to match the output available in problem description. You can use this file to see whether your algorithm implementation is working correctly. See sample runs.
3. in5.txt is another text file that you can use to match the output available in problem description. You can use this file to see whether your algorithm implementation is working correctly. See sample runs.
4. in6.txt is a text file for which you need to complete the table required in problem description.

# README.md contains a brief description of the project, and a place to write the names and CSUF email addresses of the group members. You need to modify this file to identify your group members.

# What to Do

Decide on who will be in your team, or decide to work alone; have one of your team members accept the GitHub assignment by following the invitation link; have any other team members join your team by following the invitation link; and add your group member names to README.md.

Then, implement each of the two algorithms in C++ using the provided skeleton code from cuckoo.cxx. Test your code using the provided text files in4.txt and in5.txt.

Once you are confident that your algorithm implementation is correct, complete the table and submit ***in PDF format***. Submit your PDF by committing it to your GitHub repository along with your code. Your report should include the following:

1. Your names, CSUF-supplied email address(es), and an indication that the submission is for project 2.
2. Completed table

# Grading Rubric

Your grade will be comprised of three parts: *Form,* *Function,* and *Analysis.*

*Function* refers to whether your code works properly by comparing it with the test files in4.txt, in5.txt and the output of in6.txt.

*Form* refers to the design, organization, and presentation of your code. A grader will read your code and evaluate these aspects of your submission.

*Analysis* refers to the correctness of your mathematical and empirical analyses, scatter plots, question answers, and the presentation of your report document.

The grading rubric is below.

1. Function = 6 points, scored by the unit test program
2. Form = 9 points, divided as follows:
   1. README.md completed clearly = 3 points
   2. Style (whitespace, variable names, comments, helper functions, etc.) = 3 points
   3. C++ Craftsmanship (appropriate handling of encapsulation, memory management, avoids gross inefficiency and taboo coding practices, etc.) = 3 points
3. Analysis = 20 points, divided as follows
   1. Report document presentation = 3 points
   2. Correct table = 17 points

*Legibility standard:* As stated on the syllabus, submissions that cannot compile in the Tuffix environment are considered unacceptable and will be assigned an “F” (50%) grade.

# Deadline

The project deadline is Friday, April 19, 11:59 pm.

You will be graded based on what you have pushed to GitHub as of the deadline. Commits made after the deadline will not be considered. Late submissions will not be accepted.

# Sample Runs for the Cuckoo Hashing Algorithm:

Example #1:

K:\202> cuckoo

CPSC 335-x – Programming Assignment #3: Cuckoo Hashing algorithm

Input the file name (no spaces)!

in4.txt

String <Algorithm Engineering> will be placed at t[3][0]

String <California> will be placed at t[2][0]

String <State University> will be placed at t[13][0]

String <Fullerton> will be placed at t[16][0]

String <College of Engineering and Computer Science> will be placed at t[11][0]

String <Department of Computer Science> will be placed at t[10][0]

String <Dynamic Programming> will be placed at t[8][0]

String <Monge Properties> will be placed at t[0][0]

String <String Matching> will be placed at t[11][0] replacing <College of Engineering and Computer Science>

String <College of Engineering and Computer Science> will be placed at t[14][1]

String <Matrix Searching> will be placed at t[15][0]

String <Optimal Tree Construction> will be placed at t[8][0] replacing <Dynamic Programming>

String <Dynamic Programming> will be placed at t[13][1]

Example #2:

K:\202> cuckoo

CPSC 335-x – Programming Assignment #3: Cuckoo Hashing algorithm

Input the file name (no spaces)!

in5.txt

String <Algorithm Engineering> will be placed at t[3][0]

String <California> will be placed at t[2][0]

String <State University> will be placed at t[13][0]

String <Fullerton> will be placed at t[16][0]

String <College of Engineering> will be placed at t[10][0]

String <and Computer Science> will be placed at t[9][0]

String <Dynamic Programming> will be placed at t[8][0]

String <Monge Properties> will be placed at t[0][0]

String <String Matching> will be placed at t[11][0]

String <Matrix Searching> will be placed at t[15][0]

String <Optimal Tree Construction> will be placed at t[8][0] replacing <Dynamic Programming>

String <Dynamic Programming> will be placed at t[13][1]

String <Online algorithms> will be placed at t[9][0] replacing <and Computer Science>

String <and Computer Science> will be placed at t[8][1]

String <emphasis on> will be placed at t[0][0] replacing <Monge Properties>

String <Monge Properties> will be placed at t[15][1]

String <Server Problem> will be placed at t[4][0]

String <Some related problem> will be placed at t[12][0]

String <Self-Stabilization> will be placed at t[7][0]

String <One of the greatest> will be placed at t[3][0] replacing <Algorithm Engineering>

String <Algorithm Engineering> will be placed at t[1][1]

CPSC 335-x - Programming Assignment #4: Cuckoo Hashing algorithm

Input the file name (no spaces)!

in6.txt

String <Algorithm Engineering> will be placed at t[3][0]

String <California State University> will be placed at t[9][0]

String <Fullerton> will be placed at t[16][0]

String <College of Engineering> will be placed at t[10][0]

String <and Computer Science> will be placed at t[9][0] replacing <California State University>

String <California State University> will be placed at t[13][1]

String <Department of Computer> will be placed at t[10][0] replacing <College of Engineering>

String <College of Engineering> will be placed at t[3][1]

String <Science> will be placed at t[12][0]

String <Dynamic Programming> will be placed at t[8][0]

String <Monge Properties> will be placed at t[0][0]

String <String Matching> will be placed at t[11][0]

String <Matrix Searching> will be placed at t[15][0]

String <Optimal Tree Construction> will be placed at t[8][0] replacing <Dynamic Programming>

String <Dynamic Programming> will be placed at t[13][1] replacing <California State University>

String <California State University> will be placed at t[9][0] replacing <and Computer Science>

String <and Computer Science> will be placed at t[8][1]

String <Online algorithms> will be placed at t[9][0] replacing <California State University>

String <California State University> will be placed at t[13][1] replacing <Dynamic Programming>

String <Dynamic Programming> will be placed at t[8][0] replacing <Optimal Tree Construction>

String <Optimal Tree Construction> will be placed at t[8][1] replacing <and Computer Science>

String <and Computer Science> will be placed at t[9][0] replacing <Online algorithms>

String <Online algorithms> will be placed at t[1][1]

String <emphasis on> will be placed at t[0][0] replacing <Monge Properties>

String <Monge Properties> will be placed at t[15][1]

String <Server Problem> will be placed at t[4][0]

String <Some related problem> will be placed at t[12][0] replacing <Science>

String <Science> will be placed at t[12][1]

String <Self-Stabilization> will be placed at t[7][0]

String <One of the greatest> will be placed at t[3][0] replacing <Algorithm Engineering>

String <Algorithm Engineering> will be placed at t[1][1] replacing <Online algorithms>

String <Online algorithms> will be placed at t[9][0] replacing <and Computer Science>

String <and Computer Science> will be placed at t[8][1] replacing <Optimal Tree Construction>

String <Optimal Tree Construction> will be placed at t[8][0] replacing <Dynamic Programming>

String <Dynamic Programming> will be placed at t[13][1] replacing <California State University>

String <California State University> will be placed at t[9][0] replacing <Online algorithms>

String <Online algorithms> will be placed at t[1][1] replacing <Algorithm Engineering>

String <Algorithm Engineering> will be placed at t[3][0] replacing <One of the greatest>

String <One of the greatest> will be placed at t[0][1]

String <mysteries in science> will be placed at t[9][0] replacing <California State University>

String <California State University> will be placed at t[13][1] replacing <Dynamic Programming>

String <Dynamic Programming> will be placed at t[8][0] replacing <Optimal Tree Construction>

String <Optimal Tree Construction> will be placed at t[8][1] replacing <and Computer Science>

String <and Computer Science> will be placed at t[9][0] replacing <mysteries in science>

String <mysteries in science> will be placed at t[5][1]

String <Quantum Nature of Universe> will be placed at t[4][0] replacing <Server Problem>

String <Server Problem> will be placed at t[1][1] replacing <Online algorithms>

String <Online algorithms> will be placed at t[9][0] replacing <and Computer Science>

String <and Computer Science> will be placed at t[8][1] replacing <Optimal Tree Construction>

String <Optimal Tree Construction> will be placed at t[8][0] replacing <Dynamic Programming>

String <Dynamic Programming> will be placed at t[13][1] replacing <California State University>

String <California State University> will be placed at t[9][0] replacing <Online algorithms>

String <Online algorithms> will be placed at t[1][1] replacing <Server Problem>

String <Server Problem> will be placed at t[4][0] replacing <Quantum Nature of Universe>

String <Quantum Nature of Universe> will be placed at t[7][1]

String <in physics> will be placed at t[14][0]

String <are known> will be placed at t[13][0]

String <Cuckoo hashing is fun!> will be placed at t[11][0] replacing <String Matching>

String <String Matching> will be placed at t[15][1] replacing <Monge Properties>

String <Monge Properties> will be placed at t[0][0] replacing <emphasis on>

String <emphasis on> will be placed at t[6][1]