2022 Fall Data Structure - HW13

Handwriting

1. (25%) An array contains the elements shown below. Using the binary search algorithm, trace the steps followed to find 20. At each loop iteration, including the last, show the contents of `first`, `last`, and `mid`.

```
18 13 17 26 44 56 88 97
```

For question 2 to question 4, you need to store the keys shown below in an array with 19 elements. And try to answer the following questions:

(a) How many collisions occurred?
(b) What is the density of the list after all keys have been inserted?

```
224562 137456 214562
140145 214576 162145
144467 199645 234534
```

2. (25%)
   Use the digit-extraction method (first, third, and fifth digits).
   (i) Use the quadratic probing method for collisions.
   (ii) Use a linked list method for collisions.

3. (25%)
   Use the midsquare method, with the center two digits for hashing.
   (i) Use a pseudorandom-number generator for rehashing if a collision occurs
   (a = 3 and c = -1 as the factors).
   (ii) Use a key-offset method for collisions.

4. (25%)
   Use the rotation method for hashing. First rotate the far-right digits two to the left and then use digit extraction (first, third and fifth digits).
   (i) Use the linear probe method to resolve collisions.
   (ii) Use a key-offset method for collisions.

Programming

5. (100%)

Write a program that uses a hashing algorithm to create a list of inventory parts and their quantities sold in the past month. After creating the hashed list, write a simple menu-driven user interface that allows the user to select from the following options:

a. Search for an inventory item and report its quantity sold
b. Print the inventory parts and their quantities sold
c. Analyze the efficiency of the hashing algorithm

The parts data are contained in a text file, as shown in Table 13-4. The key is the three-digit part number. The quantity represents the units sold during the past month.

Part number	Quantity
112	12
130	30
156	56
173	17
197	19
150	50
166	66
113	13
123	12
143	14
167	16
189	18
193	19
117	11
176	76

TABLE 13-4 Data for Hashing Problem

Note:

- 請建立 size 為 10 的 hashed list, address 依序為 0 到 9。
- 請使用 Modulo-division method 來實作 hash, 並將 part number 當成 key, 即

```
address = key % size
```

- 請使用 Linked List Collision Resolution 來處理 Collision。
- 讀取同目錄下 input.txt 作為 input data, 每一行為 part number 及 quantity, 之間以一個空白隔開, 直到 EOF, 格式如下:

```
112 12
130 30
173 17
...
```

- 將所有 input data 插入 hashed list, 並在 terminal 中「循環」顯示功能清單, 接受使用者輸入, 並輸出資訊。功能清單需包含下列四個選項, 格式如下:

```
a) Search
b) Print
c) Analyze
q) Quit
Please select an action:
```

- Search 需要接受使用者輸入之零件編號, 再輸出此零件之銷售量, 情境如下:

```
a) Search
b) Print
c) Analyze
q) Quit
Please select an action: a
Please enter the part number: 112
Quantity sold: 12
```

- Print 要大致按照下列格式印出完整的 hashed list, 其中必須包含三個欄位:
  - Address: 即 address 0~9
  - Prime: 第一個被放進來的零件編號與其銷售量, 兩者用一個 "/" 區隔
  - Overflow: 因 collision 而被放在 overflow list 的所有零件編號與他們的銷售量, 若有多個零件則彼此用一個空白區隔

```
a) Search
b) Print
c) Analyze
q) Quit
Please select an action: b
Address    Prime    Overflow
0          130/30
1
2          112/12
3          123/12   143/14 173/17 193/19
...
```

- Analyze 用來檢視 hashed List 的使用效率，必須印出下列資訊：
  - The percentage of filled prime area: 表示有多少比例的 linked list 存在至少一個零件。
  - The address of the longest linked list: 最長 list 的地址。(若有多個最長的，那就回傳 address 最小的)
  - The length of the longest linked list: 最長 list 的長度。

```
a) Search
b) Print
c) Analyze
q) Quit
Please select an action: c
The percentage of filled prime area: xx%
The address of the longest linked list: x
The length of the longest linked list: x
```

- 為更清楚說明作業需求，下列提供一個範例：

```
112 12
130 30
156 56
173 17
197 19
150 50
```

```
a) Search
b) Print
c) Analyze
q) Quit
Please select an action: a
Please enter the part number: 112
Quantity sold: 12
a) Search
b) Print
c) Analyze
q) Quit
Please select an action: b
Address    Prime    Overflow
0          130/30   150/50
1
2          112/12
3          173/17
4
5
6          156/56
7          197/19
8
9
a) Search
b) Print
c) Analyze
q) Quit
Please select an action: c
```

```
The percentage of filled prime area: 50%
The address of the longest linked list: 0
The length of the longest linked list: 2
Please select an action: q
```

- 允許排版上與範例的些微差異，但需要能清楚明瞭的顯示輸出，以及正確計算 hashed list 的使用效率。
- input.txt 請自行產生做測試，批改的測資會隨機選取、排序 TABLE 13-4 中的資料，不會重複

Submission - Deadline: 2023/1/13 13:20

題目形式：

- 手寫題可以用手寫拍照、打字的方式完成，但最後要統一轉成.pdf檔繳交

  檔名為HW9_學號.pdf。例如：HW13_0123456.pdf
- 請於作業開頭標註學號與姓名，若無法判定作業是出自於本人，以檔名錯誤論。
- 程式題則繳交程式原始碼(.c檔/.cpp檔/.h檔 if needed，但一題限一個.h檔)

  檔名為HW13_題號_學號.c / .cpp。例如：HW13_5_0123456.c / .cpp / .h

繳交方式：

- 將上述共兩個檔案及h檔(if needed)(手寫題pdf檔*1+程式題c/cpp檔*1)直接上傳至e3
- 檔名 / 格式錯誤者扣該次作業總分10分。
- 程式部分輸出格式請照作業說明， 若不同會酌量扣分。

收作業規則：

- 遲交期限為一個禮拜可開放補交，超過就不接受補交。
- 遲交以檔案為單位，若某檔案遲交，則該檔案打七折，其餘檔案不受影響。
- 作業是否遲交會以最後繳交時間為判斷依據，因此即使在截止前就繳交檔案，若之後又去修改檔案，仍會被視為遲交。

如有任何問題，麻煩從e3來信給所有助教。

聖誕節快樂! 元旦快樂! 大家都要快樂! 期末考加油!

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