CPSC 535 - ADVANCED ALGORITHMS PROJECT 2

Using NIC addresses to Cluster Nodes of a Sensor Network

REPORT

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Summary

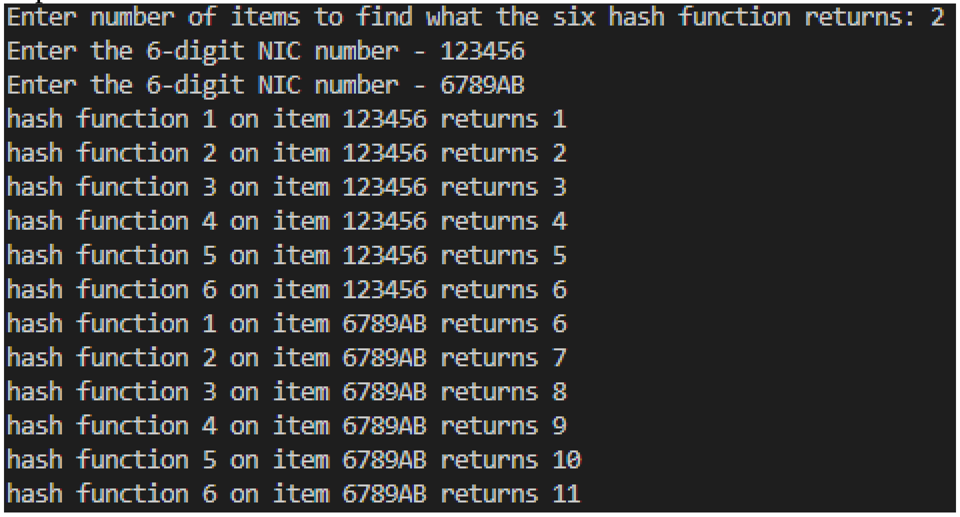
This report contains information about the work done to solve the “Using NIC addresses to Cluster Nodes of a Sensor Network” problem. The inputs are text inputs or a text file with some number of 6-digit hexadecimal numbers, representing a number of NIC addresses in a sensor network. When the hash table for the input values at a given digit location is given an input such that there is a collision of one or more items, ‘chaining’ is used to handle the collision. The objective here is to find an algorithm that minimizes the difference in distance between these chains.

Essentially, the objective is to find an algorithm that functions similarly to a Bucket Sort, such that when inputs are evenly distributed in a hash table with chaining, any non-insertion operations have an average O(n) time class.

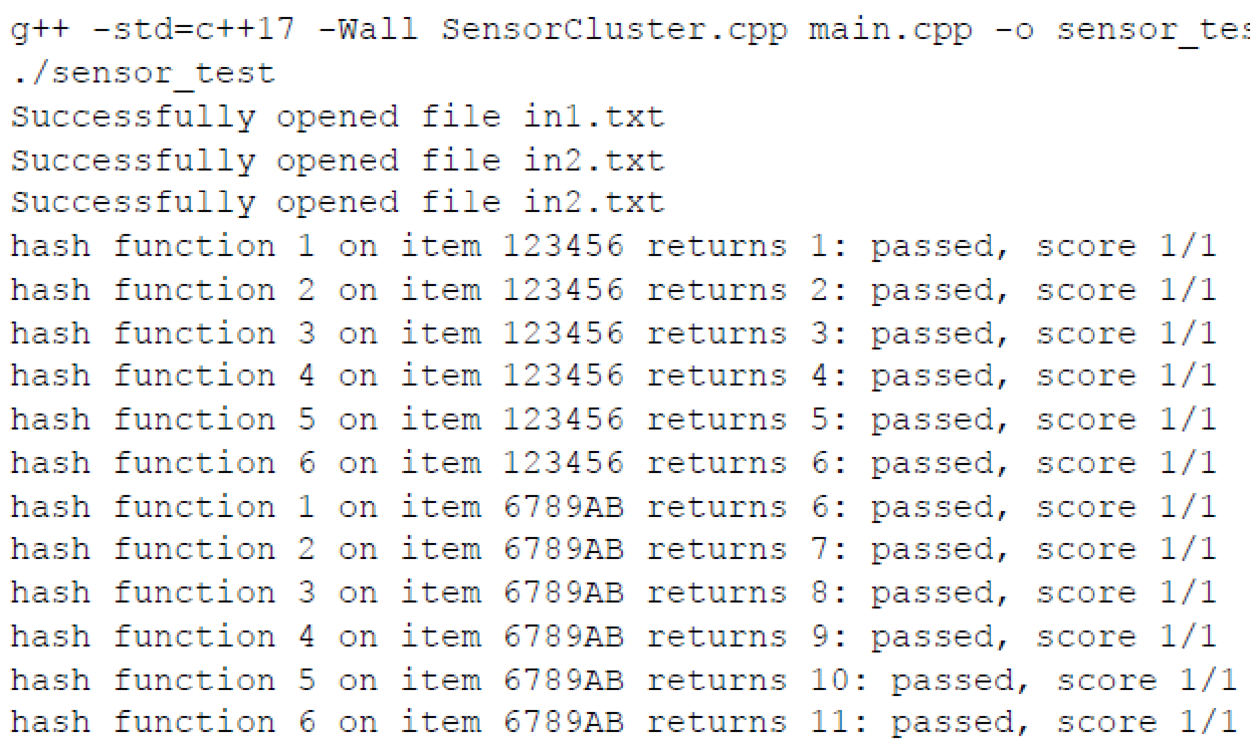
The first thing the program does is to initialize one ItemCollection object for each network: each ItemCollection will hold all the HashTables and member functions for its assigned network.

Demonstration:

Example 1: demonstrating that the program output for hashed inputs and outputs is the same as the sample outputs:
Shown in the screenshots below, the example calls a function that returns the decimal value of the hex digit at the appropriate location, i.e., hashfct4() returns the decimal value of the hex digit at position 4.

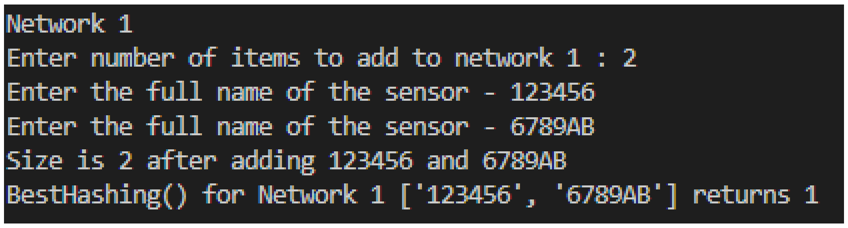


```
Enter number of items to find what the six hash function returns: 2
Enter the 6-digit NIC number - 123456
Enter the 6-digit NIC number - 6789AB
hash function 1 on item 123456 returns 1
hash function 2 on item 123456 returns 2
hash function 3 on item 123456 returns 3
hash function 4 on item 123456 returns 4
hash function 5 on item 123456 returns 5
hash function 6 on item 123456 returns 6
hash function 1 on item 6789AB returns 6
hash function 2 on item 6789AB returns 7
hash function 3 on item 6789AB returns 8
hash function 4 on item 6789AB returns 9
hash function 5 on item 6789AB returns 10
hash function 6 on item 6789AB returns 11
```



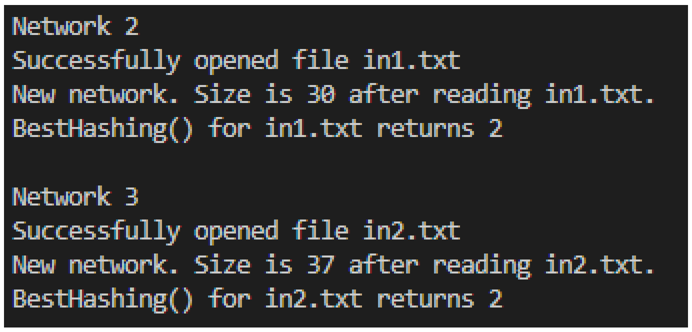
```
g++ -std=c++17 -Wall SensorCluster.cpp main.cpp -o sensor_tes
./sensor_test
Successfully opened file in1.txt
Successfully opened file in2.txt
Successfully opened file in2.txt
hash function 1 on item 123456 returns 1: passed, score 1/1
hash function 2 on item 123456 returns 2: passed, score 1/1
hash function 3 on item 123456 returns 3: passed, score 1/1
hash function 4 on item 123456 returns 4: passed, score 1/1
hash function 5 on item 123456 returns 5: passed, score 1/1
hash function 6 on item 123456 returns 6: passed, score 1/1
hash function 1 on item 6789AB returns 6: passed, score 1/1
hash function 2 on item 6789AB returns 7: passed, score 1/1
hash function 3 on item 6789AB returns 8: passed, score 1/1
hash function 4 on item 6789AB returns 9: passed, score 1/1
hash function 5 on item 6789AB returns 10: passed, score 1/1
hash function 6 on item 6789AB returns 11: passed, score 1/1
```

Example 2: demonstrating that the program evaluation to find the most even distribution is the same as the sample cases:
After this, the program allows the user to manually enter a network: the number of NICs to be entered, followed by the 6-digit NICs.



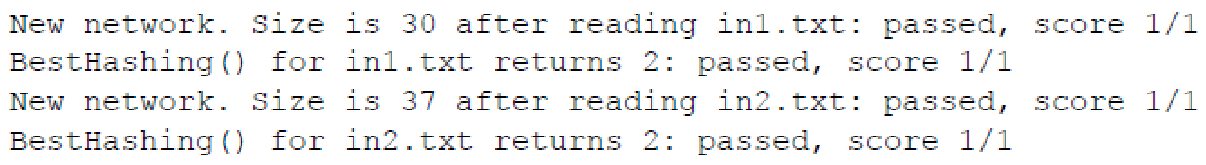
```
Network 1
Enter number of items to add to network 1 : 2
Enter the full name of the sensor - 123456
Enter the full name of the sensor - 6789AB
Size is 2 after adding 123456 and 6789AB
BestHashing() for Network 1 ['123456', '6789AB'] returns 1
```

This creates a "network" and runs the BestHashing function, which finds the smallest and largest entry on each hash table, takes the difference of each, and returns the hash table with the smallest difference.



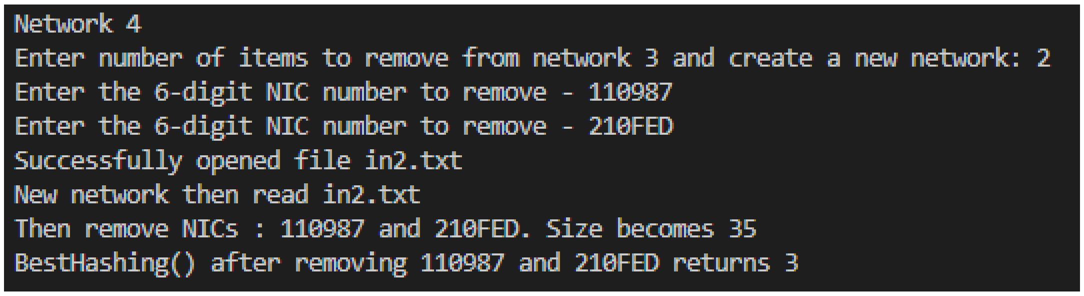
```
Network 2
Successfully opened file in1.txt
New network. Size is 30 after reading in1.txt.
BestHashing() for in1.txt returns 2

Network 3
Successfully opened file in2.txt
New network. Size is 37 after reading in2.txt.
BestHashing() for in2.txt returns 2
```



```
New network. Size is 30 after reading in1.txt: passed, score 1/1
BestHashing() for in1.txt returns 2: passed, score 1/1
New network. Size is 37 after reading in2.txt: passed, score 1/1
BestHashing() for in2.txt returns 2: passed, score 1/1
```

Example 3: showing the network can be interacted with in a way that changes the Best Hashing calculation.



```
Network 4
Enter number of items to remove from network 3 and create a new network: 2
Enter the 6-digit NIC number to remove - 110987
Enter the 6-digit NIC number to remove - 210FED
Successfully opened file in2.txt
New network then read in2.txt
Then remove NICs : 110987 and 210FED. Size becomes 35
BestHashing() after removing 110987 and 210FED returns 3
```

```
Before deletion (result of 2):
|123456 | 234567 | 345678 | 456789 | 56789A | 6789AB | 789ABC
|89ABCD | 9ABCDE | ABCDEF | BCDEF0 | CDEF01 | DEF012 | EF0123
|F01234 | 543210 | 43210F | 3210FE | 210FED | 10FEDC | FEDCBA
|EDCBA9 | DCBA98 | CBA987 | BA9876 | A98765 | 987654 | 876543
|765432 | 654321 | 776543 | 887654 | 998765 | 110987 | 221098
|332109 | 443210

After deletion:
|123456 | 234567 | 345678 | 456789 | 56789A | 6789AB | 789ABC
|89ABCD | 9ABCDE | ABCDEF | BCDEF0 | CDEF01 | DEF012 | EF0123
|F01234 | 543210 | 43210F | 3210FE |        | 10FEDC | FEDCBA
|EDCBA9 | DCBA98 | CBA987 | BA9876 | A98765 | 987654 | 876543
|765432 | 654321 | 776543 | 887654 | 998765 |        | 221098
|332109 | 443210
```

Digit count at positions:

Count of:	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Pos. 1	0	2	2	3	4	2	2	3	3	3	2	2	2	2	2	2
Pos. 2	2	0	3	3	3	2	2	3	3	3	2	2	2	2	2	1
Pos. 3	1	3	2	3	2	2	3	2	3	2	2	2	2	2	1	2
Pos. 4	2	3	3	1	2	3	3	3	2	2	2	2	2	1	2	1
Pos. 5	3	3	2	2	1	3	3	2	2	3	2	2	1	2	1	2
Pos. 6	2	2	2	2	3	2	2	2	3	3	2	1	2	1	2	2

As shown by the above table, position 1 and 2 have a maximum difference of 3, while 3 through 6 have a difference of 2 - as tie-breaker, the first position encountered is the one that is used for the hash table. In this case, the result is position 3, which matches the program's output.

Pseudocode:

```
create an Item class
    initialize the class with item dictionary

    define a class function itemKeys and pass the data as an argument:
        identify the last six digits as the key and the rest part of the data as the value
        insert into the item dictionary
        initialize a key list and ensure there are no items in this list
        insert the key in this list
        return the key of the item dictionary

create an ItemCollection class
    initialize all 6 HashTables as list of lists required for the four networks

(Note: there is one function for each of the networks, with identical functions except for the hash
table identities called on)
define a function addItem and pass the data as the argument:
    create an object of the Item class
    key = call itemKeys() function to identify the key and value for this data
    k1 = call hashfct1() and pass the key of the argument
    append this key and value in the appropriate position k1 of the HashTable1
    k2 = call hashfct2() and pass the key of the argument
    append this key and value in the appropriate position k2 of the HashTable2
    k3 = call hashfct3() and pass the key of the argument
    append this key and value in the appropriate position k3 of the HashTable3
    k4 = call hashfct4() and pass the key of the argument
    append this key and value in the appropriate position k4 of the HashTable4
    k5 = call hashfct5() and pass the key of the argument
    append this key and value in the appropriate position k5 of the HashTable5
    k6 = call hashfct6() and pass the key of the argument
    append this key and value in the appropriate position k6 of the HashTable6

define a hashfct1 and pass an argument nic:
    k = first digit of the hexadecimal nic and convert to int datatype
    return k
define a hashfct2 and pass an argument nic:
    k = second digit of the hexadecimal nic and convert to int datatype
    return k
define a hashfct3 and pass an argument nic:
    k = third digit of the hexadecimal nic and convert to int datatype
    return k
define a hashfct4 and pass an argument nic:
    k = fourth digit of the hexadecimal nic and convert to int datatype
    return k
define a hashfct5 and pass an argument nic:
    k = fifth digit of the hexadecimal nic and convert to int datatype
    return k
define a hashfct6 and pass an argument nic:
    k = sixth digit of the hexadecimal nic and convert to int datatype
    return k

define a removeItem() that takes a list of items to remove remlist[] as argument:
    call readText("in2.txt") to read the network where we need to remove items
        for every nic in remlist:
                key1 = call hashfct1(nic) to compute the hashvalue
                for every item in the list HashTable1[key1]:
                        if nic matches with the key to be deleted:
                                del the key and value and break from the loop
                remove the empty dictionary formed by the delete operation

                key2 = call hashfct2(nic) to compute the hashvalue
                for every item in the list HashTable2[key2]:
                        if nic matches with the key to be deleted:
                                del the key and value and break from the loop
                remove the empty dictionary formed by the delete operation

                key3 = call hashfct3(nic) to compute the hashvalue
                for every item in the list HashTable3[key3]:
                        if nic matches with the key to be deleted:
                                del the key and value and break from the loop
                remove the empty dictionary formed by the delete operation

                key4 = call hashfct4(nic) to compute the hashvalue
                for every item in the list HashTable4[key4]:
                        if nic matches with the key to be deleted:
                                del the key and value and break from the loop
                remove the empty dictionary formed by the delete operation

                key5 = call hashfct5(nic) to compute the hashvalue
                for every item in the list HashTable5[key5]:
                        if nic matches with the key to be deleted:
                                del the key and value and break from the loop
                remove the empty dictionary formed by the delete operation

                key6 = call hashfct6(nic) to compute the hashvalue
                for every item in the list HashTable6[key6]:
                        if nic matches with the key to be deleted:
                                del the key and value and break from the loop
                remove the empty dictionary formed by the delete operation
```

(Note: there is one function for each of the networks, with identical functions except for the hash table identities called on)

```
define function bestHashing() which takes the network number as argument:
    initialize an empty dict{} and set j = 1
        Run a for loop for all tables in HashTable1, HashTable2, HashTable3, HashTable4, HashTable5, HashTable6:
            set maxcount = 0 and mincount = sys.maxsize
            for items in the list of the table:
                count = length of that list
                if the count is less than the mincount, update mincount
                if count is greater than the maxcount, update maxcount.
                set diff as difference between maxcount & mincount
            insert the diff as value and j as key in the dict{}
            increment j by 1
        determine the key with minimum value in the dict{}
        return the key
```

```
define function readText and pass the filename as an argument:
        initilalize list = []
        if the filename is "in1.txt":
            clear list
            fl = open the file in readmode
            print “Successfully opened in1.txt”
            datainput = read the content of the file
            datainput = update the list of data read delimited as new line
            close the file
            for every value in the datainput:
                append it in the list[]
            for every l in list:
                call addItem2(l) to add ‘l’ to the table for Network 2
            size of the network is the length of the list[] after reading in1.txt
            print size of network and the file name

        if the filename is "in2.txt":
            clear list
            fl = open the file in readmode
            print “Successfully opened in2.txt”
            datainput = read the content of the file
            datainput = update the list of data read delimited as new line
            close the file
            for every value in the datainput:
                append it in the list[]
            for every l in list:
                call addItem3(l) to add items to the table for Network 3
            size of the Network is the length of the list[] after reading in2.txt
            print size of Network 3 and the file name
        return filename and size
```

inside the *main()* function

```
    create three objects of ItemCollection class for the four networks – item1 for Network 1, item2 for Network 2, item3 for Network 3 and item3 will be re-used for Network 4
    initialize itemsfind = []
    num1 = The number of items to find what the six hashfct() methods return
    enter ‘num1’ NICs to find the returned hash value and append these to itemsfind
    for every nic in itemsfind:
        k1 = call hashfct1()
        print the hash value returned
        k2 = call hashfct2()
        print the hash value returned
        k3 = call hashfct3()
        print the hash value returned
        k4 = call hashfct4()
        print hash value returned
        k5 = call hashfct5()
        print the hash value returned
        k6 = call hashfct6()
        print the hash value returned

        print 'Network 1'
        initialize itemsadd = []
        set num2 = The number of records to add to form Network 1
        Enter num2 names of sensors to add and append to itemsadd[]
        for every item in itemsadd:
            Call the addItem1() to add the items individually to the network
            print the number of elements in the network
            Call the bestHashing() method on Network 1
            Print the table which is the most balanced cluster for Network 1

        print 'Network 2'
        call the readText() through item2 object to read the sensors in file "in1.txt" and form Network 2

        call the bestHashing() method on Network 2
        print the table which is the most balanced cluster for Network 2

        print 'Network 3'
        call the readText() through item3 object to read the sensors in file "in2.txt" and form Network 2

        call the bestHashing() method on Network 3
        print the table which is the most balanced cluster for Network 3

         print 'Network 4'
         initialize itemsremove = []
         set num4 = The number of NICs user wants to remove from Network 3
         enter ‘num4’ number of NICs to remove and append them to itemsremove[]
```

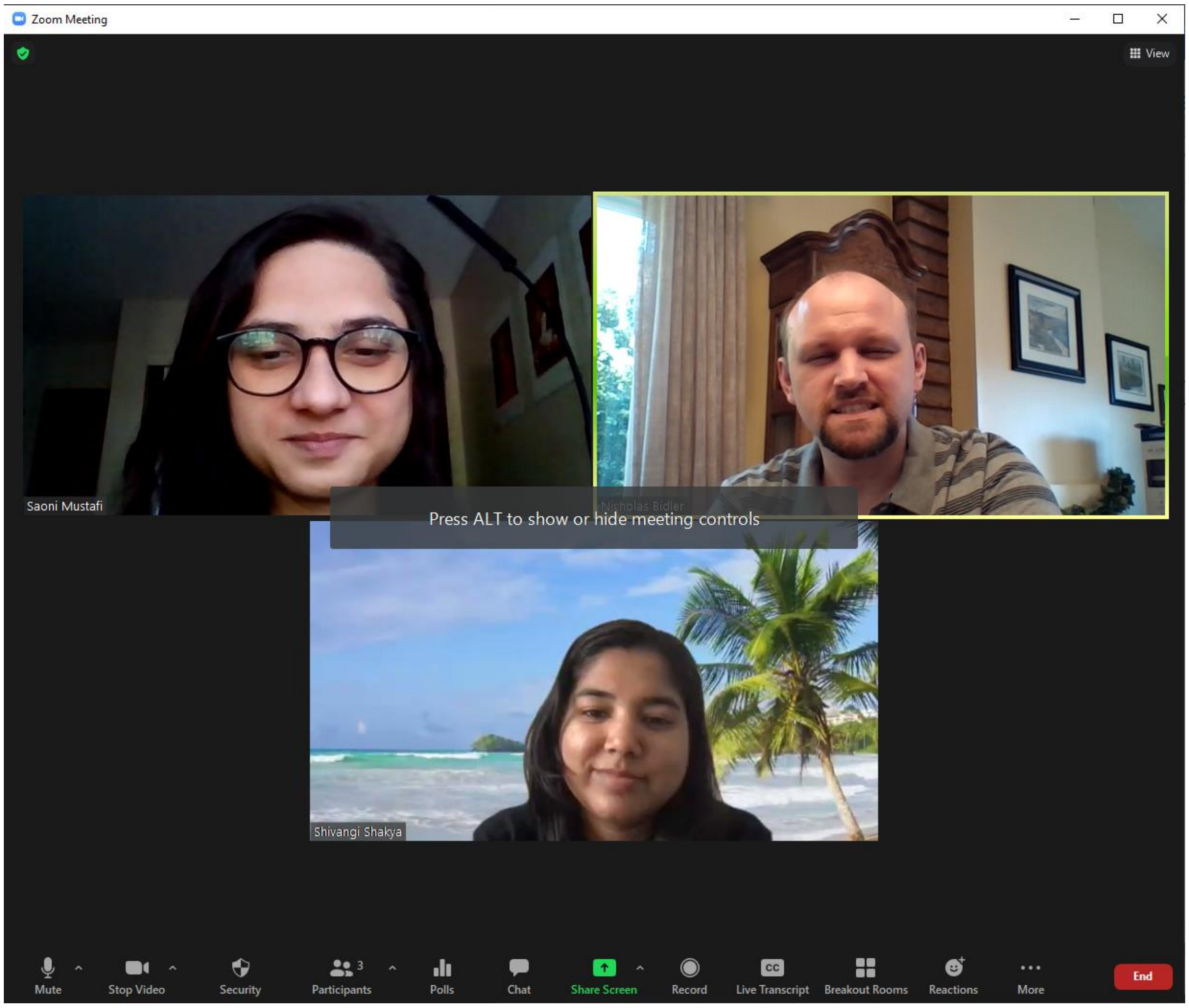
call the *removeItem()* and pass *itemsremove[]* in the argument
call *bestHashing()* method on Network 3 and print the most balanced table

Instructions to run the Code:

The code has been implemented in Python. The name of the file is *'advanceAlgoProj2finalv1.py'*.

The two input files are located in the same directory as "*in1.txt*" and "*in2.txt*".

1. Save the advanceAlgoProj2finalv1.py, in1.txt, and in2.txt in your desired location.
2. In the terminal, change the directory to the folder where you have saved these files using the command *cd <pathname>*.
3. Type *'python3 advanceAlgoProj2finalv1.py'.*
4. Enter the number of items you want to test the hash function on for correctness.
    a. Input a corresponding number of 6-digit hexadecimal numbers
    b. The output should display each digit's value at the corresponding location in decimal
5. Enter the number of items to add to a test network
    a. Input a corresponding number of 6-digit hexadecimal numbers
    b. The output should display which digit produces the smallest variance in hash table chain length
6. The program will at this point output its evaluations for the .txt files, which should both be that the second digit is preferred
7. Enter the number of items to remove from the input set from in2.txt
    a. Be sure it is a valid value before submitting, but similar to 4a and 5a, input the appropriate amount of 6-digit hex numbers


Zoom Meeting
View
Saoni Mustafi
Nicholas Bidler
Press ALT to show or hide meeting controls
Shivangi Shakya
Mute
Stop Video
Security
Participants
Polls
Chat
Share Screen
Record
Live Transcript
Breakout Rooms
Reactions
More
End