IIT Roorkee
CSN 261:Data Structures Laboratory

Assingment 2

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Problem 1-

In this Problem, you have to implement a simple transposition cipher, where this cipher
encrypts and decrypts a sequence of characters by dividing the sequence into blocks of size
n, where n is specified by the encryption key. If the input text has a length that is not a multiple
of n, the last block is padded with null characters ('\0').
In addition to n, the key also specifies two parameters a and b. For each block, the i-th output
character, starting from 0 as usual, is set to the j-th input character, where j = (ai + b) mod n.
For appropriate choices of a and b, this will reorder the characters in the block in a way that
can be reversed by choosing a corresponding decryption key (n, a′, b′).

Task to Perform
Write a program transpose.c that takes n, a, b, inputfile.txt in argv[1], argv[2], argv[3], and
argv[4], respectively, applies the above encryption; and writes the result to outputfile.txt.
Further, write a program inverseTranspose.c that decrypt the outputfile.txt and result in a new
file named decryptedOutputfile.txt. Finally, write a program compareFiles.c to find the
equivalence between the inputfile.txt and decryptedOutputfile.txt files.
You may assume that n, a, and b are all small enough to fit into variables of type int. Your
program should exit with a nonzero exit code if n is not at least 1 or if it is not given exactly

four arguments, but you do not need to do anything to test for badly-formatted arguments. You
should not make any other assumptions about the values of n, a, or b; for example, either of
a or b could be zero or negative.

Program Files:

1.transpose.c
2.inverseTranspose.c
3.compareFiles.c

Algorithm Used:

In transpose.c ,I have used FILE function of C to read and write data.Also I have used j=(a*i+b)%n to encrypt the file.
In the inverseTranspose.c,I have used algos similar as above.In this the file get decrypted for a key provided by user.
In compareFiles.c I have used strcmp to compare the two files

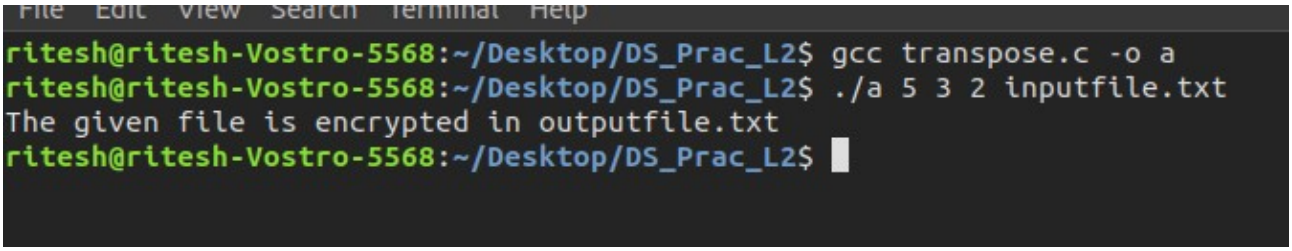
Data-Structures Used:

1.Character Arrays

Snapshots:

Starting Programs:

transpose.c-



inverseTranspose.c

```
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ gcc inverseTranspose.c -o b
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ ./b 5 2 1 outputfile.txt
The given file is decrypted in decryptedOutputfile.txt
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$
```

compareFiles.c

```
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ gcc compareFiles.c -o c
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ ./c
The input and output files are EQUAL
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$
```

Input ,Output and Decrypted Files:

```
Hello, world!
CSN-261
```

```
lHleow,o r!l$d$
NC-S2$6$1$!l$d$
```

```
Hello, world!
CSN-261
```

Time:

```
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ time ./a 5 3 2 inputfile.txt
The given file is encrypted in outputfile.txt

real    0m0.003s
user    0m0.003s
sys     0m0.000s
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ time ./b 5 2 1 outputfile.txt
The given file is decrypted in decryptedOutputfile.txt

real    0m0.003s
user    0m0.001s
sys     0m0.003s
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ time ./c
The input and output files are EQUAL

real    0m0.003s
user    0m0.001s
sys     0m0.003s
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$
```

Problem 2-

A region can be represented either by its interior or by its boundary. Here we represent the
region by its interior using one of the most common methods called image array. In this case
we have a collection of pixels. Since the number of elements in the array can be quite large,
the main objective is to reduce its size by aggregating equal-valued pixels.

A general approach is to treat the region as a quadtree, where the region is represented as a
union of maximal non-overlapping square blocks whose sides are in power of 2. The quadtree
can be generated by successive subdivision of the image array into four equal sized
quadrants. If the sub-array does not consist entirely of 1s or entirely of 0s, it is then further
subdivided into quadrants and sub-quadrants, etc.

Example:
The above figures represent a region and its corresponding quadtree representation,
(a) Defined as the Sample region having all the bit value to 1.
(b) Defined as the binary array of size 8*8 which having bit value other than sample region
within it is 0.
(c) Represent the conversion of binary array into the blocks where each block is formed
as a union of maximal square having the same bit value. This kind of array is called a
maximal square array.

(d) Quadtree representation, where the root node corresponds to the entire array. Each
son of a node represents a quadrant of the region represented by that node. The leaf
nodes of the tree correspond to those blocks for which no further subdivision is
necessary. A leaf node is said to be black or white, depending on whether itscorresponding block is entirely inside or entirely outside of the represented region. All
non-leaf nodes are said to be gray.

Task to perform:

Write a C program, MAT.c to represent any region (in image array representation), into
its quadtree form.

Input:

Sample region is represented as n x n array (as shown in Fig. 1 using 6 x 6 matrix).

The format of the input file should be as follows:

the pixel values in the input file are separated by a single space and rows are separated
by a newline character (refer to the sample L2_P2_inputsample.txt file shared in
Piazza).

(Note: The 6x6 region array should be mapped at the bottom-left corner of a 8x8 binary
array as shown in Fig. 2(b))

Output:

1. Print the Maximal square array where it should be filled in the following order:
top-right, top-left, bottom-right and bottom-left quadrant, this should be done
recursively for all the sub-quadrants. All the cells within a maximal square block
should be filled with its corresponding block number.

2. Print the quadtree in the following manner, labels of leaf nodes, corresponding
bit value and their level information (assuming the level of the root node to be
0), while traversing the quadtree in postorder. For example, in Fig. 2(d) the leaf
node 3 having bit value 0 at level 2 and should be printed as (3,0,2).

Algorithm Used:

1.I have used recurrsion to build the Quad tree.The break point of the recurrsion is that when all the elements of the array will be equal then the recurrsion will stop.

2.For maximal array,I have divided the array into four arrays recursively until I get the 2*2 array.Now if all elements are same then I have stored the same value of bit in the array else I have stored different value of bits.

3.I have used a power method to calculate the power indices of 2

Data Structure Used:

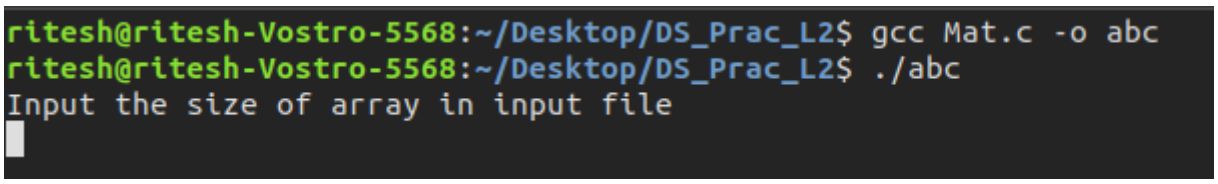
1.Quad-Tree Node which contains one 2d array and 4 pointers

2.POS Node whic contains the data of height of tree and the value contained in it.

3.Arrays

Snapshots:

Starting the Program:



Output:

```
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ gcc Mat.c -o abc
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$ ./abc
Input the size of array in input file
6

01 01 01 01 02 02 03 03
01 01 01 01 02 02 03 03
01 01 01 01 04 04 05 05
01 01 01 01 04 04 05 05
06 06 07 09 13 13 14 14
06 06 08 10 13 13 14 14
11 11 12 12 15 17 19 19
11 11 12 12 16 18 19 19

(1,0,1)
(2,0,2)
(3,0,2)
(4,1,2)
(5,1,2)
(6,0,2)
(7,0,3)
(8,1,3)
(9,1,3)
(10,1,3)
(11,0,2)
(12,1,2)
(13,1,2)
(14,1,2)
(15,1,3)
(16,1,3)
(17,1,3)
(18,0,3)
(19,0,2)
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$
```

Time:

```
real    0m1.426s
user    0m0.003s
sys     0m0.000s
ritesh@ritesh-Vostro-5568:~/Desktop/DS_Prac_L2$
```