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Implementation and Application of Binary Search in 2-D Array

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Abstract: **Linear and Binary search are the basic searching techniques to search an element in one dimensional array. Here, Binary search is applied on a two Dimensional sorted array in which every row is progressively sorted from left to right, and the last number in each row is less than the first number of the next row. However, the primitive solution for this problem is to scan all elements stored in the input matrix to search for the particular element. This linear search approach costs O(PQ) time if the size of the matrix is P*Q . But, as we can see each row in the matrix is sorted and the first element of a row is greater than or equal to the last number of the preceding row, therefore, the matrix can be viewed as a sorted one dimensional array. If all rows in the input matrix are concatenated in top down order, it forms a sorted one dimensional array. And, in that case binary search algorithm is suitable for this 2-D array. We also have compared the two Dimension Binary searching algorithm with Linear Search Algorithm. Here, we have implemented binary search in 2-D using C and analyzed and compared it with linear search.**

Keywords: **Matrix Searching algorithms; 2D Array Searching algorithms; 2D Array Linear Searching; Complexity Analysis; Algorithms; Searching Algorithms;**

1. Introduction

The prerequisite for binary search is that the array should be sorted. Though it is a primitive and basic searching technique, but it is widely used in different fields. Fields include Bio-medical image processing, Rasterization techniques, Electro-optical displays, Pixel tracing and many more [1]. In this paper we have developed a new searching technique based on the existing limitations of the 2D array linear/sequential search algorithm. In 2D array searching an iterator1 traverses sequentially from left to right (row major) or top to down (column major)[1] . When it encounters an element which is equal to the item to be searched, the search stops and the index of the element is returned, but if the element is not present in the 2D array the function will return 0, implying that the search is unsuccessful . Sequential search or linear search is the basic search algorithm used in data structures for 2D array[1] with unsorted data. For a binary search to work, it is mandatory for the target array to be sorted.

2. Algorithm Of 2-D Binary Search

2D_BINARY_SEARCH
(MAT,START,END,KEY,MID)
Here MAT is a sorted 2D array of size P*Q with START and END indexes and KEY is a given item of information. The variables START, END and MID denotes, respectively, the beginning, end and middle location of elements of MAT. This algorithm finds the location of item in the MAT matrix.

1. [Initialize segment variables]
   Set START=0 and END=ROWS*COLS-1.
2. Repeat steps 2 to 4 while START<=END
   MID:=START+(END-START)/2
   row:= MID/COLS
   col:=MID%COLS
   value:=MAT[ROWS][COLS]
3. If value ==KEY
   Then search successful and return 1
4. If value > KEY
   Then END:=MID-1
   Else START:=MID+1
5. Exit

2.1 Example of 2-D Binary Search

Here we assume a 2-D array of size 5*5. ROWS=5, COLS=5. Assume that we are searching for item **19**. First, we shall determine the start and end index of the 2-D array.

3	**6**	**7**	**9**	**11**
15	**17**	**19**	**21**	**23**
25	**28**	**31**	**34**	**39**
45	**49**	**54**	**58**	**64**
67	**70**	**73**	**77**	**83**

Figure 1: Matrix of size 5*5

Assume that we are searching for item **19**. First, we shall determine the start and end index of the 2-D array.

1. START=0 and END = ROWS*COLS-1. Here END = 24 .Now we will find the middle element of the 2-D array. Mid = START+(END-START)/2, now the value of MID=12, KEY=19.
2. row = MID/COLS
   col = MID%COLS

3	6	7	9	11
15	17	19	21	23
25	28	**31**	34	39
45	49	54	58	64
67	70	73	77	83

Figure2:Display Middle Element (iteration 1)

3. Row= 2 and col = 2 and value=31.
4. Now compare value of the matrix with the searched element. Value=MAT[2][2].
5. If value >KEY then we change our ENDto MID– 1 which is 11 and find the new MID value.
6. Now the new value of MID =5 and ROW = 1 and COL = 0 and value of MAT[1][0]= 15.

3	6	7	9	11
15	17	19	21	23
25	28	31	34	39
45	49	54	58	64
67	70	73	77	83

Figure 3: Display Middle Element (iteration 2)

Now we compare value of the matrix with the searched element i.e. KEY=19 . The value of matrix is less than the key element .So we recalculated the value of START which is 6.

7. Now new value of START is 6 , END=11, MID = 8, ROW = 1 and COL =3.

3	6	7	9	11
15	17	**19**	21	23
25	28	31	34	39
45	49	54	58	64
67	70	73	77	83

Figure 4:Element Found (iteration 3)

8. We compare the value stored at row=1and col=3 with our KEY value. We find that it is a match.

3. Results and simulation

Input data

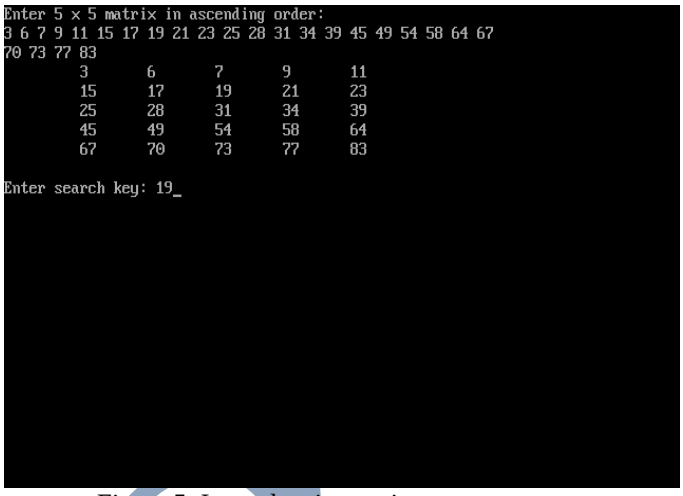

Figure 5: Input data in matrix

Output Data:

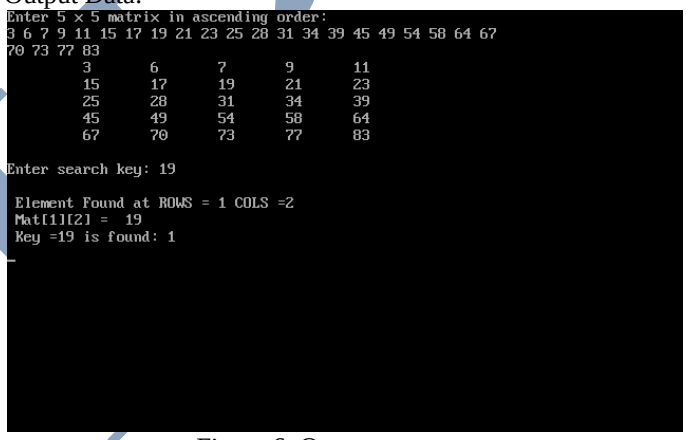

Figure 6: Output

4. Conclusions

In this paper we have implemented binary search on 2-D array and analysed its time complexity . Binary search is more specialized algorithm than linear search as it take advantage of data that has been sorted . The time complexity of the proposed algorithm is O(n log n) . If linear serach is applied on 2-D array , the time complexity is O(n*n) , which is much more than binary search. Hence the performance of binary search on 2 D array is superior than linear search.

References

[1]. Rehan Guha, GRID SEARCHING Novel way of Searching 2D Array, International Journal of Computer Applications Technology and Research Volume 5– Issue 1, 26 - 33, 2016, ISSN:- 2319–8656

[2]. Sapinder,Ritu,Arvinder Singh, Analysis of Linear and Binary Search Algorithms , International Journal of Computers & Distributed Systems ,Volume 1, No.1, Jun 2012

[3]. Ancy Oommen, Chanchal Pal, Binary Search Algorithm", IJIRT, Vol1, issue 5,2014

[4]. Sylvia da Rosa, The Construction of the Concept of Binary Search Algorithm, educational institution of computer science in Montevideo, Uruguay.

