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Experiment - 4

☆ Aim

a. Write a program to implement Linear Search and analyze its time complexity

b. Write a program to implement Binary Search and analyze its time complexity.

A) Linear Search

```
#include <iostream>
using namespace std;

void LinearSearch ( int * arr, int n, int num ) {
    for ( int i = 0; i<n ; i++ ) {
        if ( arr[i] == num) {
            cout << endl << num << " found at index: " << i ;
            return ;
        }
    }
    cout << endl << num << " not found \n" ;
    return ;
}
```

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```
int main () {
        cout<<"\t\t\t\t Linear Search \n\n";
        int arr[] = { 10, 34, 12, 67, 23, 1, 5, 99, 55, 25};
        int n = size of (arr) / size of (int);
        cout<<" Array is :";
        for( int i=0; i<n; i++) {
                cout<< arr[i] <<" ";
        }
        cout<<endl;
        cout<<"Enter element to search :";
        int num;
        cin>>num;
        LinearSearch ( arr, n, num );
        return 0;
}
```

Time Complexity

$T(n) = T(n-1) + O(1)$

$T(n-1) - T(n-2) + 1$

$\vdots$

$T(2) = T(1) + 1$

$\Rightarrow T_n = 1 + 1 \ldots\ldots + 1$

$T_n = n$

Time Complexity $= O(n)$

Space Complexity $= O(1)$

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b) Binary Search

```
#include <iostream>
using namespace std;

void BinarySearch (int* arr, int n, int num) {

int s=0;
int l=n-1;
while (s<=l) {
int mid = s + (l-s)/2 ;
if (arr[mid] == num) {
                    cout<< endl << num <<" found at index:"
                        << mid ;
                    return ;
                    }
else if (arr[mid] > num) {
                    l = mid -1;
                    }
else {
        s= mid +1;
        }
}
    cout<< endl << num << "not found";
    return;

}
```

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```
int main () {
        cout << "\t\t\t\t Binary Search \n\n";
        int arr[] = { 10,20, 30, 40,50, 60,70, 80,90, 100};
        int n = sizeof (arr) / size of (int);
        cout << " Array is :";
        for (int i=0; i<n; i++) {
            cout << 'arr[i] << " ";
        cout << endl;
        cout << "enter number of search";
        int num;
        cin >> num;
        BinarySearch ( arr, n, num);
        return 0;
    }
```

Complexity

$T(n) = T(n/2) + C$

$= T(n/4) + 2C$

$= T(n/8) + 3C$

$T(n) = T\left(\frac{n}{2k}\right) + kC$

$\frac{n}{2k} = 1 \qquad k = \log_2 n$

$T(n) = T(1) + \log_2 n \times C$

$T(n) = O(\log_2 n)$

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Experiment - 5

☆ Aim: Write a program to implement matrix Chain Multiplication

```
#include <iostream>

using namespace std;

int m [10][10] = {0}, s[10][10] = {0}, l, k, i, j, q, p[8], n, min, d;
void mat_ch (int);
void optimal (int, int);

void mat_ch (int n) {
        for(d=1; d<n; d++) {
            for (i=1; i<=n-d; i++) {
            j= i+d;
            min = INT_MAX;
            for (k=1; k<=j-1; k++) {

            q=m[i][k] + m[k+1][j] + p[i-1]*p[k]*p[j];
            if (q < min) {
                    min = q;
                    s[i][j] = k;
                }
            m[i][j] = min;
        } } } }
```

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```
void optimal (int i, int j) {
                    if (i==j) {
                        printf ("A %d" , i);
                    }
                    else {
                        printf ("(");
                        optimal ( i, s[i][j] );
                        optimal ((s[i][j] +1), j );
                        printf (")");
                    }
                }

int main() {
        printf ("enter the matrix size:");
        scanf ("%d", &n);
        printf (" enter the matrix elements:");

        for (i=0; i<n ; i++)
            scanf ("%d", &p[i]);
        for (i=1; i<n; i++)
            printf ("A %d  %d * %d \n", i, p[i-1], p[i] );
        mat-ch (n);
        printf (" the M Matrix \n");
        for (i=0; i<n; i++) {
            for (j=0 ; j<=n; j++) {
                if (i>j)
                printf (" -\t");
```

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```
                else
                    printf("%d\t", m[i][j]);
            }
            printf("\n");
        }

printf("The S matrix \n");
for(i=0 ; i<=n ; i++) {
    for(j=0; j<=n; j++) {
                if (i > j)
                    printf("-\t");
                else
                    printf("%d\t" s[i][j]);
            }
            printf("\n");
        }

optimal (1,n);
printf("\n Min product = %d", m[1][n]);

return 0;
}
```

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Experiment - 6

☆ Aim: Write a program to implement Longest Common Subsequence

```
#include <iostream>
using namespace std;

void lcsAlgo( char *S1, char *S2, int m, int n) {
    int LCS_table [m+1][n+1];

  for( int i=0; i<=m; i++) {
      for ( int j=0; j<=n; j++) {

          if (i==0 || j==0)
              LCS_table[i][j] = 0;
          else if ( S1[i-1] == S2[j-1])
              LCS_table [i][j] = LCS_table [i-1][j-1] + 1;
          else
          LCS_table [i][j] = max(LCS_table [i-1][j], LCS_table
          [i] [j-1]));
      }
  }
```

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```
int index = LCS-table[m][n];
char lcsAlgo [index+1];
lcsAlgo[index] = '\0';

int i=m, j=n;

while (i>0 && j>0) {
                    if (S1[i-1] == S2[j-1]) {

                    lcsAlgo [index-1]= S1[i-1];
                    i--;
                    j--;
                    index--;
                    }
                    else if (LCS-table [i-1][j] > LCS-table [i][j-1])
                    i--;
                    else

                    j--;
                }
            cout<<"S1: "<<S1<<"\nS2: "<<S2<<"\nLCS:"
                <<lcsAlgo <<"\n";
        }
int main() {
            char S1[] = "ACADBDA",
            char S2[] = "CBDA";
            int m = strlen(S1);
            int n = strlen(S2);
            lcsAlgo (S1, S2, m, n); }
```

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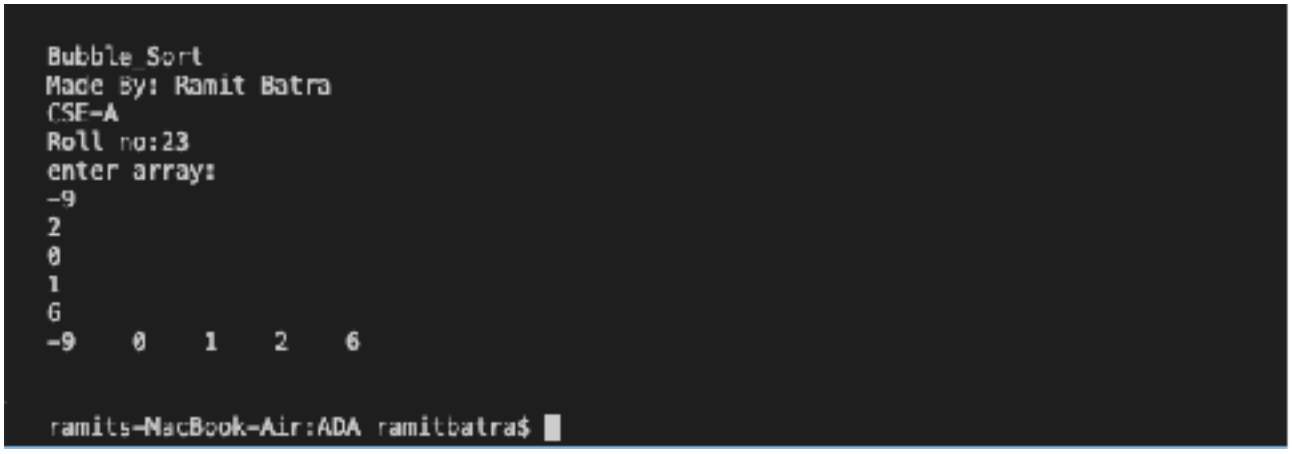
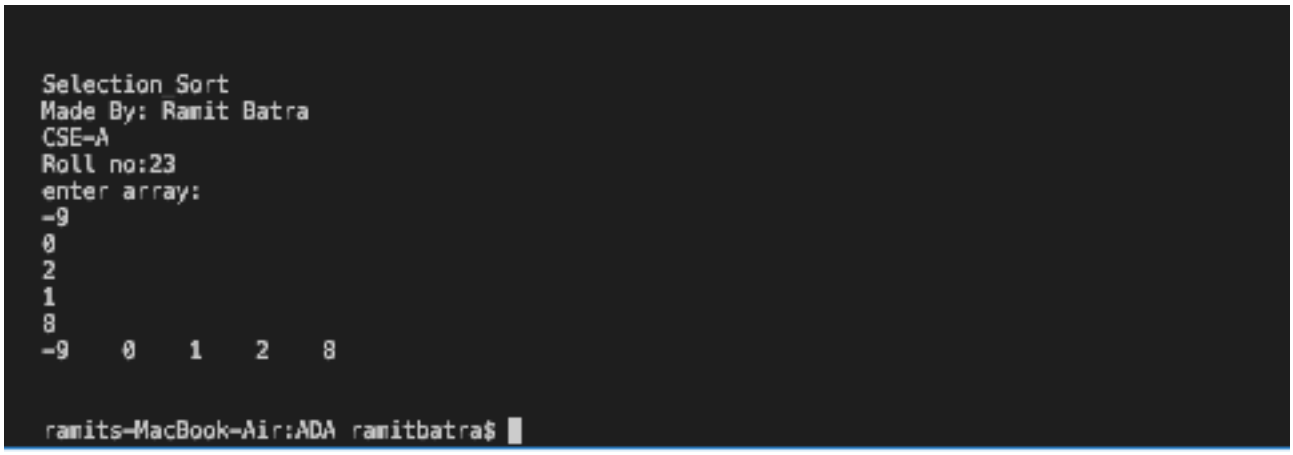
Bubble Sort

```
#include <stdio.h>
#include<iostream>
using namespace std;
int main()
{  int n=5;
    int arr[5];
    cout<<endl<<endl<<endl;
    cout<<"Bubble_Sort\nMade By: Ramit Batra\nCSE-A\nRoll
no:23\nenter array:\n";

    for(int i=0;i<n;i++)
    cin>>arr[i];


for(int j=n-1;j>=0;j--){
     for(int k=0;k<j;k++)
    {
    if(arr[k]>arr[k+1]){

    int temp=arr[k];
    arr[k]=arr[k+1];

    arr[k+1]=temp;}}
}
for(int i=0;i<n;i++)
    cout<<arr[i]<<"     ";
cout<<endl<<endl<<endl;

    return 0;
}
```



Selection Sort

```
#include <stdio.h>
#include<iostream>
using namespace std;
int main()
{
    int n=5,arr[5],min=0;
    cout<<endl<<endl<<endl;
cout<<"Selection_Sort\nMade By: Ramit Batra\nCSE-A\nRoll
no:23\nenter array:\n";
    for(int i=0;i<n;i++)
    cin>>arr[i];
    for(int i=0;i<n;i++){
min=i;
for(int j=i;j<n;j++){
if(arr[j]<arr[min])
min=j;
    }
    int temp=arr[min];
    arr[min]=arr[i];
    arr[i]=temp;
    }
    for(int i=0;i<n;i++)
    cout<<arr[i]<<"    ";
cout<<endl<<endl<<endl;
    return 0;
}
```



Insertion Sort

```
#include <stdio.h>
#include<iostream>
using namespace std;
void insertionSort(int arr[], int n)
{
    int i, key, j;
    for (i = 1; i < n; i++)
    {
        key = arr[i];
        j = i - 1;

        /* Move elements of arr[0..i-1], that are
        greater than key, to one position ahead
        of their current position */
        while (j >= 0 && arr[j] > key)
        {
            arr[j + 1] = arr[j];
            j = j - 1;
        }
        arr[j + 1] = key;
    }
}

// A utility function to print an array of size n
void printArray(int arr[], int n)
{
    int i;
    for (i = 0; i < n; i++)
        cout << arr[i] << " ";
    cout << endl;
}

/* Driver code */
int main()
{
    int arr[5] ;
    int n = 5;
 cout<<endl<<endl<<endl;
```

```
cout<<"Insertion_Sort\nMade By: Ramit Batra\nCSE-A\nRoll
no:23\nenter array:\n";
for(int i=0;i<n;i++)
    cin>>arr[i];
    insertionSort(arr, n);
    printArray(arr, n);

    return 0;
}
```

```
Insertion_Sort
Made By: Ramit Batra
CSE-A
Roll no:23
enter array:
12
5
3
4
1
1 3 4 5 12
ramits-MacBook-Air:ADA ramitbatra$
```

Linear Search

```
#include <iostream>
#include <stdio.h>

using namespace std;

class Array {
    public:
        int linearsearch(int arr[], int size, int item) {
            for (int i=0; i<size; i++) {
                if (arr[i]==item) {
                    int pos = i+1;
                    return (pos);
                }
            }
            return (-1);
        }
};

int main() {
    int item, n;
    Array obj;

    cout << "Enter the size of array: ";
    cin >> n;

    int *arr = new int[n];

    cout << "Enter the elements of array: ";
    for (int i=0; i<n; i++)
        cin >> arr[i];

    cout << "Enter the element to be searched: ";
    cin >> item;

    int pos = obj.linearsearch(arr, n, item);
    (pos == -1)
        ? cout << "Element is not present in the array."
```

```
        : cout << "Element "<< item <<" is present at position "
<< pos;

    return 0;
}
```

Binary Search

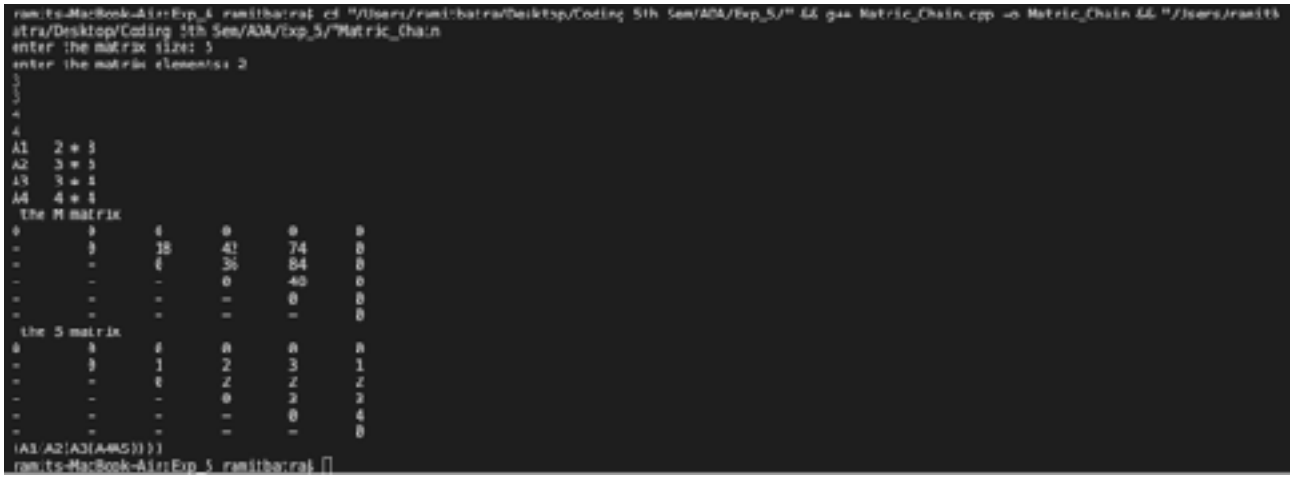
```
#include <iostream>
#include <stdio.h>
using namespace std;

class Array {
  public:
    int binarysearch(int arr[], int item, int l, int r) {
        if (r >= l) {
            int mid = l + (r - l) / 2;

            // Item in middle
            if (arr[mid] == item)
                return mid;

            // Item in left sub-array
            if (arr[mid] > item)
                return binarysearch(arr, item, l, mid - 1);

            // Item in right sub-array
            return binarysearch(arr, item, mid + 1, r);
        }
        return -1;
    }
};

int main() {
    Array obj;

    int n;
    cout << "Enter the size of array: ";
    cin >> n;
    int *arr = new int[n];
    cout << "Enter " << n*n << " elements in the array: ";

    for (int i=0; i<n; i++)
        cin >> arr[i];

    int item;
    cout << "Enter the element to be searched: ";
```

```
    cin >> item;

    int pos = obj.binarysearch(arr, item, 0, n-1);
    (pos == -1)
        ? cout << "Element is not present in the array."
        : cout << "Element "<< item <<" is present at position "
<< pos;
    return 0;
}
```

Matrix Multiplication

```
#include<stdio.h>
#include<limits.h>
#include<iostream>
int m[10][10]={0},s[10][10]={0},l,k,i,j,q,p[8],n,min,d;

void mat_ch(int);
void optimal(int ,int);

    void mat_ch(int n) {
    for(d=1;d<n;d++) {
        for(i=1;i<=n-d;i++){
            j=i+d;
            min=INT_MAX;
            for(k=i;k<=j-1;k++) {
                q=m[i][k]+m[k+1][j]+ p[i-1] * p[k] * p[j];
                if(q<min) {
                    min=q;
                    s[i][j]=k;
                }
                m[i][j]=min;
            }
        }
    }
}

void optimal(int i,int j) {
    if(i==j) {
        printf("A%d",i);
    }
    else {
        printf("(");
        optimal(i,s[i][j]);
        optimal((s[i][j]+1),j);
        printf(")");
    }
}

int main() {
    printf("enter the matrix size: ");
```

```
    scanf("%d",&n);
    printf("enter the matrix elements: ");
    for(i=0;i<n;i++)
        scanf("%d",&p[i]);
    for(i=1;i<n;i++)
        printf("A%d   %d * %d\n",i,p[i-1],p[i]);
    mat_ch(n);
    printf(" the M matrix\n");
    for(i=0;i<=n;i++) {
        for(j=0;j<=n;j++) {
            if(i>j)
                printf("-\t ");
            else
                printf("%d\t ",m[i][j]);
        }
        printf("\n");
    }
    printf(" the S matrix\n");
    for(i=0;i<=n;i++) {
        for(j=0;j<=n;j++) {
            if(i>j)
                printf("-\t ");
            else
                printf("%d\t ",s[i][j]);
        }
        printf("\n");
    }
    optimal(1,n);
    printf(" \n Minimum Product = %d",m[1][n]);
    //  getch();
    return 0;
}
```



LCS

```
#include <iostream>
using namespace std;

void lcsAlgo(char *S1, char *S2, int m, int n) {
  int LCS_table[m + 1][n + 1];


  // Building the mtrix in bottom-up way
  for (int i = 0; i <= m; i++) {
    for (int j = 0; j <= n; j++) {
      if (i == 0 || j == 0)
        LCS_table[i][j] = 0;
      else if (S1[i - 1] == S2[j - 1])
        LCS_table[i][j] = LCS_table[i - 1][j - 1] + 1;
      else
        LCS_table[i][j] = max(LCS_table[i - 1][j], LCS_table[i][j
- 1]);
    }
  }

  int index = LCS_table[m][n];
  char lcsAlgo[index + 1];
  lcsAlgo[index] = '\0';

  int i = m, j = n;
  while (i > 0 && j > 0) {
    if (S1[i - 1] == S2[j - 1]) {
      lcsAlgo[index - 1] = S1[i - 1];
      i--;
      j--;
      index--;
    }

    else if (LCS_table[i - 1][j] > LCS_table[i][j - 1])
      i--;
    else
      j--;
  }
```

```
  // Printing the sub sequences
  cout << "S1 : " << S1 << "\nS2 : " << S2 << "\nLCS: " << lcsAlgo
<< "\n";
}

int main() {
  char S1[] = "ACADBDA";
  char S2[] = "CBDA";
  int m = strlen(S1);
  int n = strlen(S2);

  lcsAlgo(S1, S2, m, n);
}
```