DAA – LAB 3

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Q1 Maximum Sum Sub-Array Problem with brute force

Code:

```
#include <iostream>
#include <vector>
#include <climits>
#include <chrono>
using namespace std;
int maxSubarrayBruteforce(const vector<int>& numbers) {
    int size = numbers.size();
    int maxSum = INT_MIN;
    for (int start = 0; start < size; ++start) {
        for (int end = start; end < size; ++end) {
            int currentSum = 0;
            for (int k = start; k <= end; ++k) {
                currentSum += numbers[k];
            }
            maxSum = max(maxSum, currentSum);
        }
    }
    return maxSum;
}
int main() {
    int numElements;
    cout << "Enter number of elements: ";
    cin >> numElements;
    vector<int> numbers(numElements);
    cout << "Enter the elements: ";
    for (int i = 0; i < numElements; ++i) {
```

```
        cin >> numbers[i];
    }
    auto startTime = chrono::high_resolution_clock::now();
    int result = maxSubarrayBruteforce(numbers);
    auto endTime = chrono::high_resolution_clock::now();
    chrono::duration<double, micro> duration = endTime - startTime;
    cout << "Brute Force: " << result << endl;
    cout << "Time taken: " << duration.count() << " microseconds" << endl;
    return 0;
}
```

Output:

Q2 Maximum Sum Sub-Array Problem with Divide n Conquer

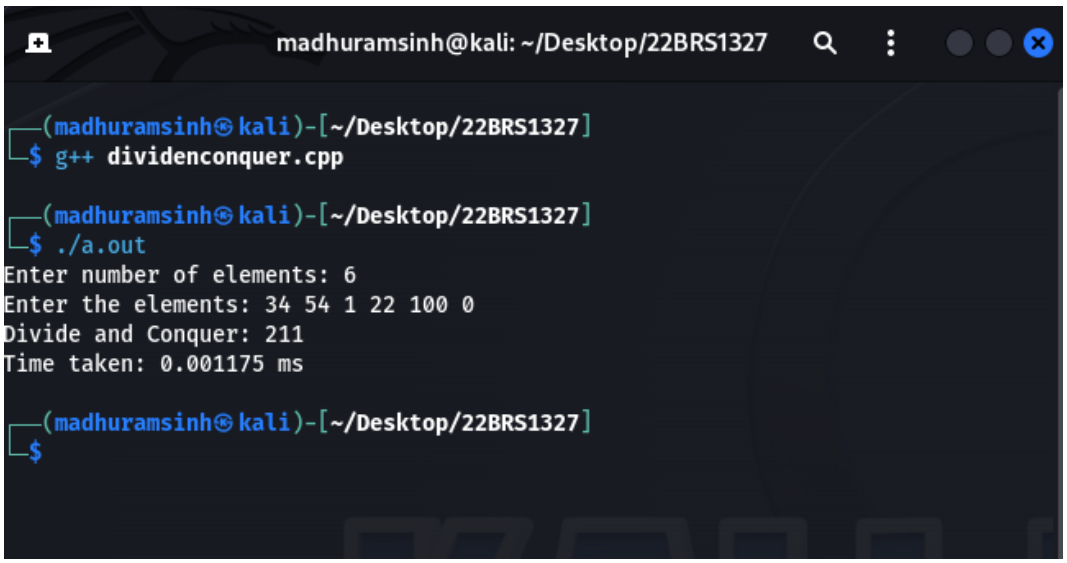
Code:

```
#include <iostream>
#include <vector>
#include <climits>
#include <chrono>
#include <algorithm> // Required for std::max
using namespace std;
int maxCrossingSum(const vector<int>& numbers, int left, int middle, int right) {
    int leftSum = INT_MIN;
```

```
    int rightSum = INT_MIN;
    int sum = 0;
    for (int i = middle; i >= left; --i) {
        sum += numbers[i];
        leftSum = max(leftSum, sum);
    }
    sum = 0;
    for (int i = middle + 1; i <= right; ++i) {
        sum += numbers[i];
        rightSum = max(rightSum, sum);
    }
    return leftSum + rightSum;
}
int maxSubarrayDivideConquer(const vector<int>& numbers, int left, int right) {
    if (left == right) {
        return numbers[left];
    }
    int middle = (left + right) / 2;
    int leftSum = maxSubarrayDivideConquer(numbers, left, middle);
    int rightSum = maxSubarrayDivideConquer(numbers, middle + 1, right);
    int crossSum = maxCrossingSum(numbers, left, middle, right);
    return max({leftSum, rightSum, crossSum});
}
int main() {
    int numElements;
    cout << "Enter number of elements: ";
    cin >> numElements;
    vector<int> numbers(numElements);
    cout << "Enter the elements: ";
    for (int i = 0; i < numElements; ++i) {
        cin >> numbers[i];
    }
    auto startTime = chrono::high_resolution_clock::now();
    int result = maxSubarrayDivideConquer(numbers, 0, numElements - 1);
    auto endTime = chrono::high_resolution_clock::now();
```

```
    chrono::duration<double, milli> duration = endTime - startTime;
    cout << "Divide and Conquer: " << result << endl;
    cout << "Time taken: " << duration.count() << " ms" << endl;
    return 0;
}
```

Output:



Q3) Maximum Sum Sub-Array Problem with Kadane's

Code:

```
#include <iostream>
#include <vector>
#include <climits>
#include <chrono>
#include <algorithm>
using namespace std;
int maxSubarrayKadane(const std::vector<int>& array) {
    int maxCurrent = array[0];
    int maxGlobal = array[0];
    for (size_t i = 1; i < array.size(); ++i) {
        maxCurrent = std::max(array[i], maxCurrent + array[i]);
        if (maxCurrent > maxGlobal) {
            maxGlobal = maxCurrent;
        }
```

```
    }

    return maxGlobal;
}
int main() {
    int numElements;
    cout << "Enter number of elements: ";
    cin >> numElements;
    vector<int> array(numElements);
    cout << "Enter the elements: ";
    for (int i = 0; i < numElements; ++i) {
        cin >> array[i];
    }
    auto startTime = chrono::high_resolution_clock::now();
    int result = maxSubarrayKadane(array);
    auto endTime = chrono::high_resolution_clock::now();
    chrono::duration<double, std::micro> duration = endTime - startTime;
    cout << "Kadane's Algorithm: " << result << endl;
    cout << "Time taken: " << duration.count() << " microseconds" << std::endl;
    return 0;
}
```

Output:

Q4) Kadane's with starting and ending index of subarray

Code:

```
#include <iostream>

#include <vector>

#include <climits>

#include <chrono>

using namespace std;

struct Result {

    int maxSum;

    int startIndex;

    int endIndex;

};

Result maxSubarrayKadane(const vector<int>& array) {

    Result result;

    result.maxSum = array[0];

    result.startIndex = 0;

    result.endIndex = 0;

    int maxCurrent = array[0];

    int maxGlobal = array[0];

    int tempStart = 0;

    for (size_t i = 1; i < array.size(); ++i) {

        if (array[i] > maxCurrent + array[i]) {

            maxCurrent = array[i];

            tempStart = i;

        } else {

            maxCurrent += array[i];

        }

        if (maxCurrent > maxGlobal) {

            maxGlobal = maxCurrent;

            result.startIndex = tempStart;

            result.endIndex = i;

        }

    }

    result.maxSum = maxGlobal;
```

```
    return result;
}
int main() {
    int numElements;
    cout << "Enter number of elements: ";
    cin >> numElements;
    vector<int> array(numElements);
    cout << "Enter the elements: ";
    for (int i = 0; i < numElements; ++i) {
        cin >> array[i];
    }
    auto startTime = chrono::high_resolution_clock::now();
    Result result = maxSubarrayKadane(array);
    auto endTime = chrono::high_resolution_clock::now();
    chrono::duration<double, micro> duration = endTime - startTime;
    cout << "Kadane's Algorithm: " << result.maxSum << endl;
    cout << "Start index: " << result.startIndex << endl;
    cout << "End index: " << result.endIndex << endl;
    cout << "Time taken: " << duration.count() << " microseconds" << endl;
    return 0;
}
```

Output: