Sort a given set of N integer elements using Heap Sort technique and compute its time taken.

Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

// Function to heapify a subtree rooted with node i
void heapify(int arr[], int n, int i) {
    int largest = i; // Initialize largest as root
    int left = 2 * i + 1; // left child
    int right = 2 * i + 2; // right child

    // If left child is larger than root
    if (left < n && arr[left] > arr[largest])
        largest = left;

    // If right child is larger than largest so far
    if (right < n && arr[right] > arr[largest])
        largest = right;

    // If largest is not root
    if (largest != i) {
        int temp = arr[i];
        arr[i] = arr[largest];
        arr[largest] = temp;

        // Recursively heapify the affected sub-tree
        heapify(arr, n, largest);
    }
}

// Main function to perform heap sort
void heapSort(int arr[], int n) {
    // Build heap (rearrange array)
    for (int i = n / 2 - 1; i >= 0; i--)
        heapify(arr, n, i);

    // Extract elements from heap one by one
    for (int i = n - 1; i >= 0; i--) {
        // Move current root to end
        int temp = arr[0];
        arr[0] = arr[i];
        arr[i] = temp;

        // Call max heapify on the reduced heap
        heapify(arr, i, 0);
    }
}

// Function to print an array
void printArray(int arr[], int n) {
    for (int i = 0; i < n; ++i)
        printf("%d ", arr[i]);
    printf("\n");
}

int main() {
    int n;
    n=1000000;
    //printf("Enter number of elements: ");
    //scanf("%d", &n);

    int *arr = (int *)malloc(n * sizeof(int));

    //printf("Enter %d integers:\n", n);
    for (int i = 0; i < n; ++i) arr[i]=rand()%1000000;
        //scanf("%d", &arr[i]);

    clock_t start, end;
    double time_taken;

    start = clock();
    heapSort(arr, n);
    end = clock();

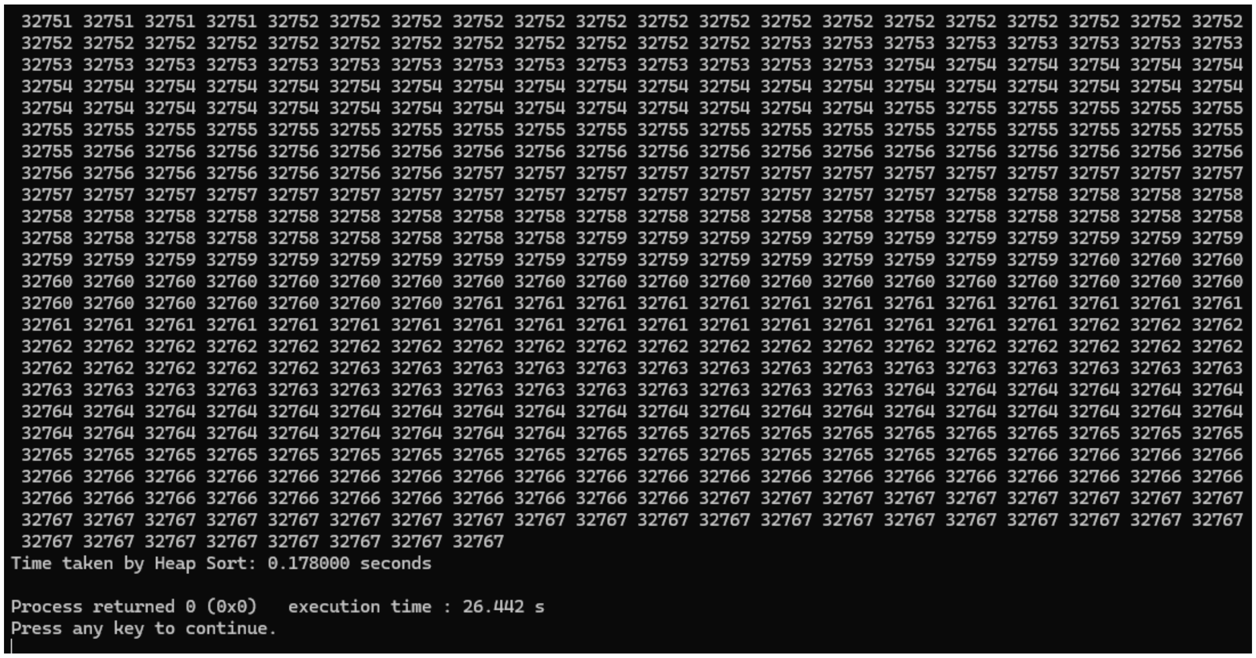
    time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;

    printf("Sorted array:\n");
    printArray(arr, n);

    printf("Time taken by Heap Sort: %f seconds\n", time_taken);

    free(arr);
    return 0;
}
```

Output:



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Time taken by Heap Sort: 0.178000 seconds

Process returned 0 (0x0)   execution time : 26.442 s
Press any key to continue.
```

Implement “N-Queens Problem” using Backtracking.

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

#define MAX 20

int board[MAX];
int N;

// Function to print the solution
void printSolution() {
    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N; j++) {
            if (board[i] == j)
                printf("Q ");
            else
                printf(". ");
        }
        printf("\n");
    }
    printf("\n");
}
```

```
// Function to check if a queen can be placed at board[row][col]
bool isSafe(int row, int col) {
    for (int i = 0; i < row; i++) {
        if (board[i] == col ||
            board[i] - i == col - row ||
            board[i] + i == col + row)
            return false;
    }
    return true;
}

// Recursive utility to solve N-Queens problem
bool solveNQueens(int row) {
    if (row == N) {
        printSolution();
        return true; // Return true to find only one solution
        // return false; // Uncomment this line and comment above to find all solutions
    }

    for (int col = 0; col < N; col++) {
        if (isSafe(row, col)) {
            board[row] = col;
            if (solveNQueens(row + 1))
                return true; // Return true to stop after first solution
        }
    }
    return false;
}

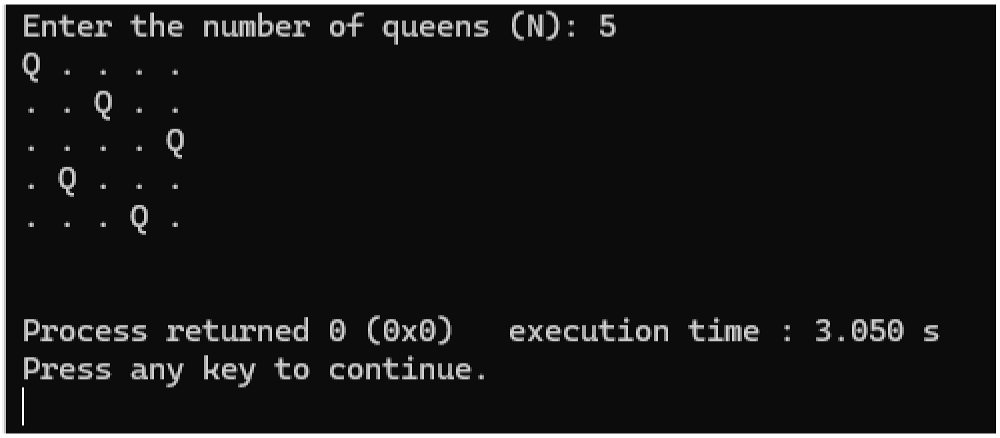
int main() {
    printf("Enter the number of queens (N): ");
    scanf("%d", &N);

    if (N <= 0 || N > MAX) {
        printf("Invalid value of N. Please use N between 1 and %d\n", MAX);
        return 1;
    }

    if (!solveNQueens(0)) {
        printf("No solution exists for %d queens.\n", N);
    }

    return 0;
}
```

Output:



```
Enter the number of queens (N): 5
Q . . . .
. . Q . .
. . . . Q
. Q . . .
. . . Q .


Process returned 0 (0x0)   execution time : 3.050 s
Press any key to continue.
```