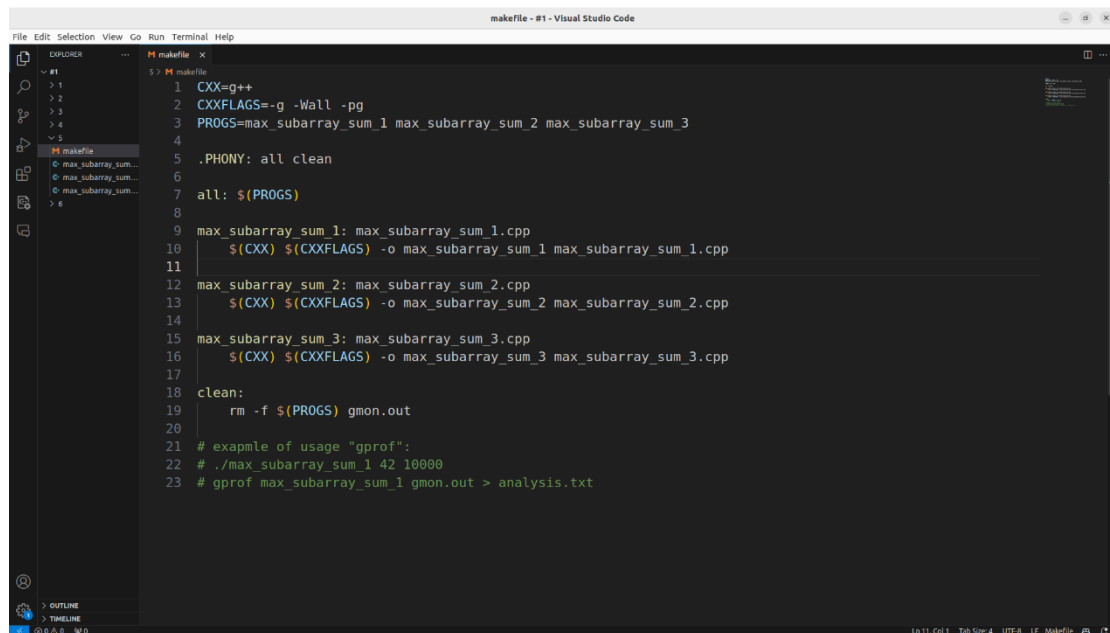


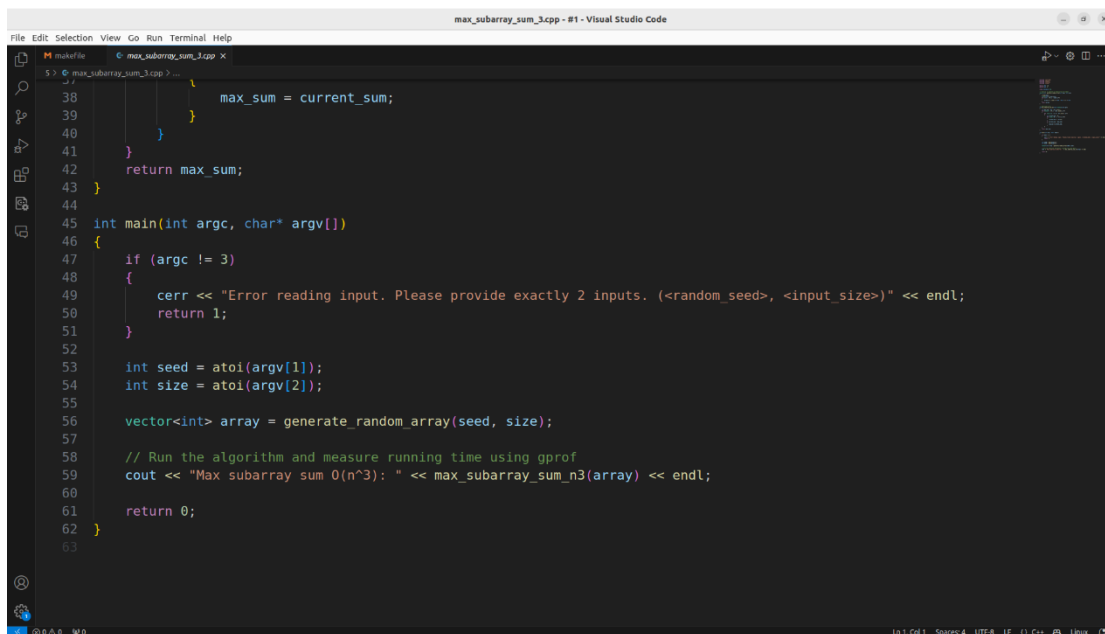
תרגיל 5 – תת מערך מקסימלי

מייקפייל:



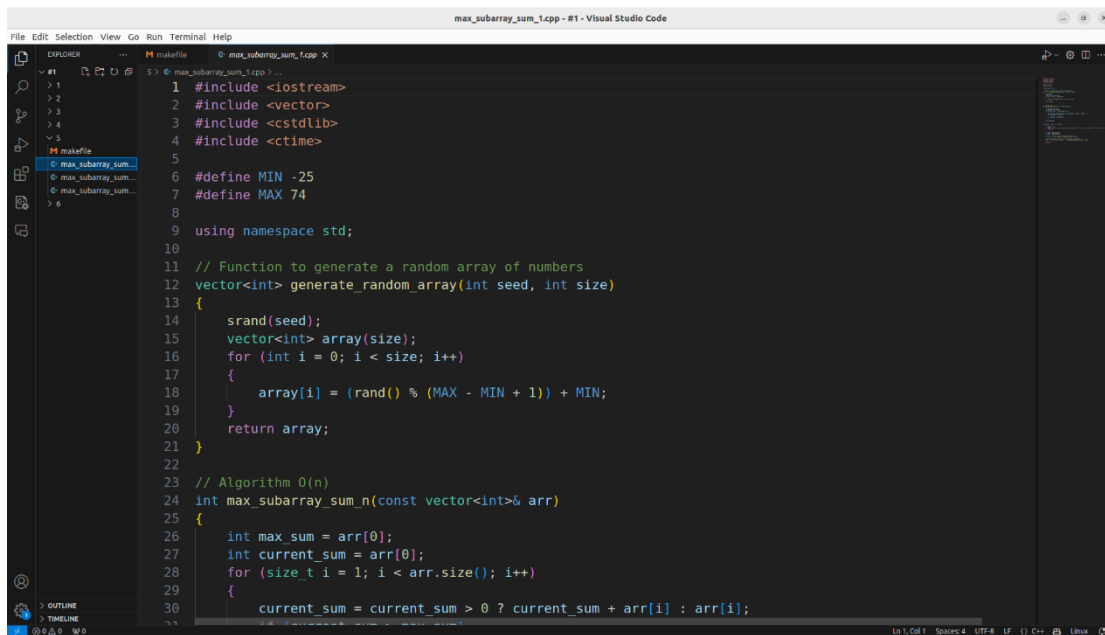
```
1 CXX=g++
2 CXXFLAGS=-g -Wall -pg
3 PROGS=max_subarray_sum_1 max_subarray_sum_2 max_subarray_sum_3
4
5 .PHONY: all clean
6
7 all: $(PROGS)
8
9 max_subarray_sum_1: max_subarray_sum_1.cpp
10     $(CXX) $(CXXFLAGS) -o max_subarray_sum_1 max_subarray_sum_1.cpp
11
12 max_subarray_sum_2: max_subarray_sum_2.cpp
13     $(CXX) $(CXXFLAGS) -o max_subarray_sum_2 max_subarray_sum_2.cpp
14
15 max_subarray_sum_3: max_subarray_sum_3.cpp
16     $(CXX) $(CXXFLAGS) -o max_subarray_sum_3 max_subarray_sum_3.cpp
17
18 clean:
19     rm -f $(PROGS) gmon.out
20
21 # example of usage "gprof":
22 # ./max_subarray_sum_1 42 10000
23 # gprof max_subarray_sum_1 gmon.out > analysis.txt
```

נראה צילום מסך של main: (כאן החישוב מתייחס לmax_subarray_sum3 לצורך ההמחשה)



```
38     max_sum = current_sum;
39 }
40 }
41 }
42 return max_sum;
43 }
44
45 int main(int argc, char* argv[])
46 {
47     if (argc != 3)
48     {
49         cerr << "Error reading input. Please provide exactly 2 inputs. (<random_seed>, <input_size>)" << endl;
50         return 1;
51     }
52
53     int seed = atoi(argv[1]);
54     int size = atoi(argv[2]);
55
56     vector<int> array = generate_random_array(seed, size);
57
58     // Run the algorithm and measure running time using gprof
59     cout << "Max subarray sum 0(n^3): " << max_subarray_sum_n3(array) << endl;
60
61     return 0;
62 }
63
```

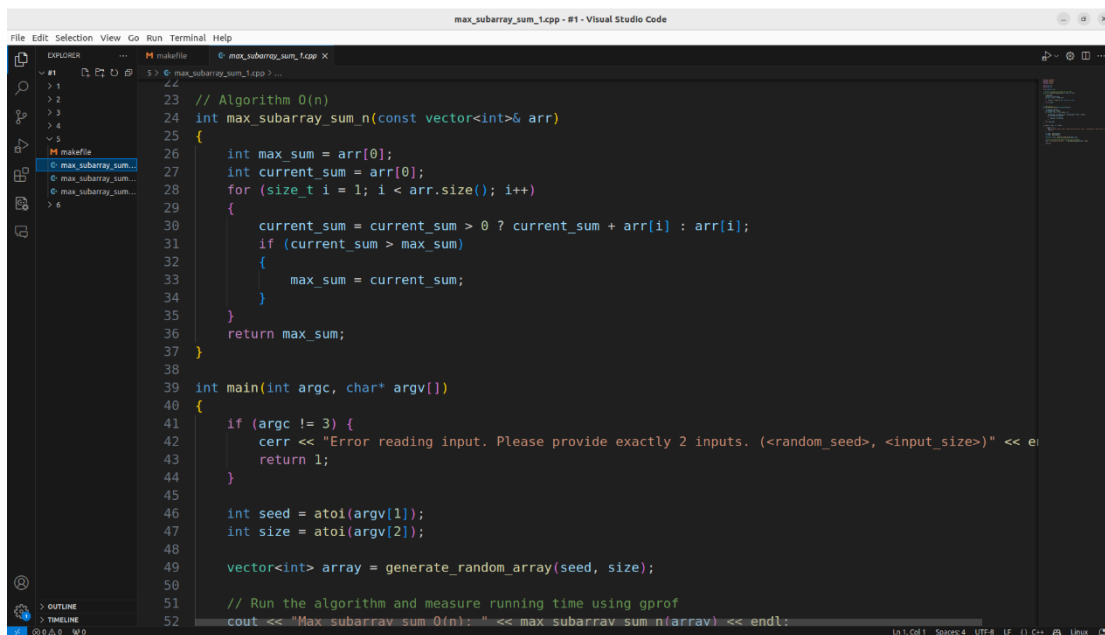
:Random seek



```
1 #include <iostream>
2 #include <vector>
3 #include <cstdlib>
4 #include <ctime>
5
6 #define MIN -25
7 #define MAX 74
8
9 using namespace std;
10
11 // Function to generate a random array of numbers
12 vector<int> generate_random_array(int seed, int size)
13 {
14     srand(seed);
15     vector<int> array(size);
16     for (int i = 0; i < size; i++)
17     {
18         array[i] = (rand() % (MAX - MIN + 1)) + MIN;
19     }
20     return array;
21 }
22
23 // Algorithm O(n)
24 int max_subarray_sum_n(const vector<int>& arr)
25 {
26     int max_sum = arr[0];
27     int current_sum = arr[0];
28     for (size_t i = 1; i < arr.size(); i++)
29     {
30         current_sum = current_sum > 0 ? current_sum + arr[i] : arr[i];
```

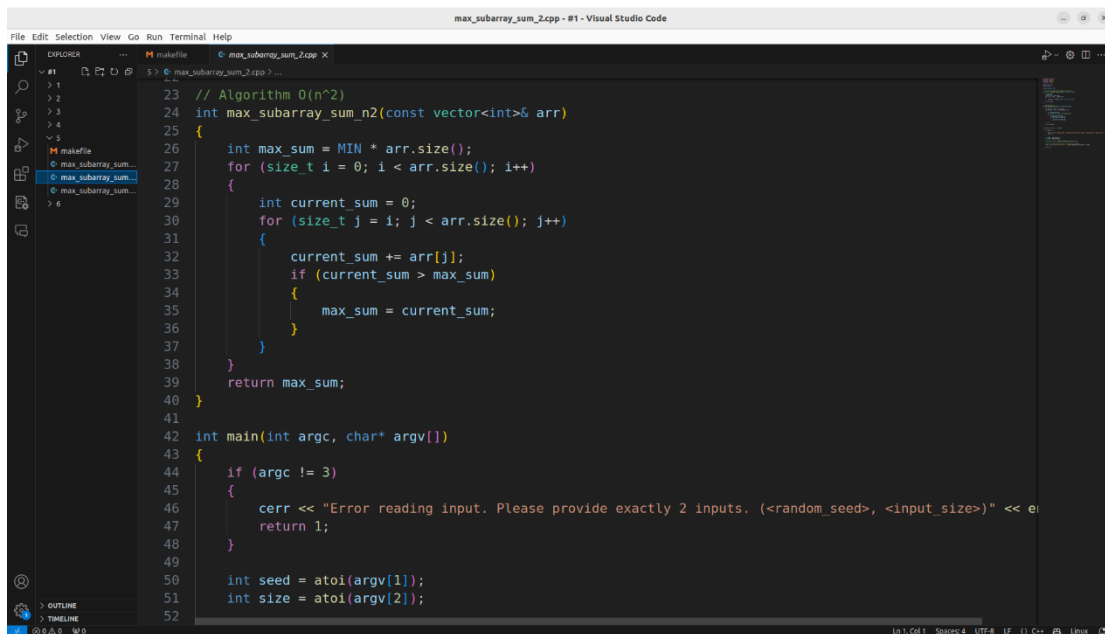
פונקציות למציאת תת מערך מקסימלי:

:O(n)



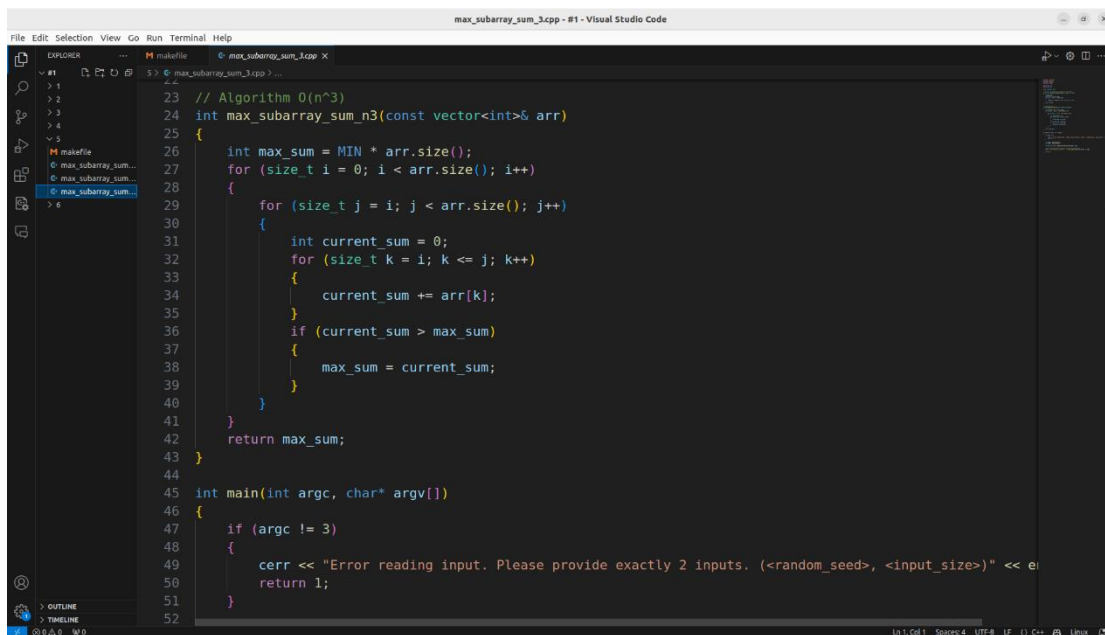
```
23 // Algorithm O(n)
24 int max_subarray_sum_n(const vector<int>& arr)
25 {
26     int max_sum = arr[0];
27     int current_sum = arr[0];
28     for (size_t i = 1; i < arr.size(); i++)
29     {
30         current_sum = current_sum > 0 ? current_sum + arr[i] : arr[i];
31         if (current_sum > max_sum)
32         {
33             max_sum = current_sum;
34         }
35     }
36     return max_sum;
37 }
38
39 int main(int argc, char* argv[])
40 {
41     if (argc != 3) {
42         cerr << "Error reading input. Please provide exactly 2 inputs. (<random_seed>, <input_size>)" << endl;
43         return 1;
44     }
45
46     int seed = atoi(argv[1]);
47     int size = atoi(argv[2]);
48
49     vector<int> array = generate_random_array(seed, size);
50
51     // Run the algorithm and measure running time using gprof
52     cout << "Max subarray sum O(n): " << max_subarray_sum_n(array) << endl;
```

: $O(n^2)$



```
23 // Algorithm  $O(n^2)$ 
24 int max_subarray_sum_n2(const vector<int>& arr)
25 {
26     int max_sum = MIN * arr.size();
27     for (size_t i = 0; i < arr.size(); i++)
28     {
29         int current_sum = 0;
30         for (size_t j = i; j < arr.size(); j++)
31         {
32             current_sum += arr[j];
33             if (current_sum > max_sum)
34             {
35                 max_sum = current_sum;
36             }
37         }
38     }
39     return max_sum;
40 }
41
42 int main(int argc, char* argv[])
43 {
44     if (argc != 3)
45     {
46         cerr << "Error reading input. Please provide exactly 2 inputs. (<random_seed>, <input_size>)" << endl;
47         return 1;
48     }
49
50     int seed = atoi(argv[1]);
51     int size = atoi(argv[2]);
52 }
```

: $O(n^3)$



```
23 // Algorithm  $O(n^3)$ 
24 int max_subarray_sum_n3(const vector<int>& arr)
25 {
26     int max_sum = MIN * arr.size();
27     for (size_t i = 0; i < arr.size(); i++)
28     {
29         for (size_t j = i; j < arr.size(); j++)
30         {
31             int current_sum = 0;
32             for (size_t k = i; k <= j; k++)
33             {
34                 current_sum += arr[k];
35             }
36             if (current_sum > max_sum)
37             {
38                 max_sum = current_sum;
39             }
40         }
41     }
42     return max_sum;
43 }
44
45 int main(int argc, char* argv[])
46 {
47     if (argc != 3)
48     {
49         cerr << "Error reading input. Please provide exactly 2 inputs. (<random_seed>, <input_size>)" << endl;
50         return 1;
51     }
52 }
```

הרצת כל התוכניות לפי גודל 100 | 1000 | 10000:

```
omer@Linux-Omer: ~/Desktop/Operating systems/#1/5$ make
g++ -g -Wall -pg -o max_subarray_sum_1 max_subarray_sum_1.cpp
g++ -g -Wall -pg -o max_subarray_sum_2 max_subarray_sum_2.cpp
g++ -g -Wall -pg -o max_subarray_sum_3 max_subarray_sum_3.cpp
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ls
makefile      max_subarray_sum_1.cpp  max_subarray_sum_2.cpp  max_subarray_sum_3.cpp
max_subarray_sum_1  max_subarray_sum_2    max_subarray_sum_3
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$
```

```
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_1 5 100
Max subarray sum 0(n): 2669
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_1 gmon.out > exe1_100.txt
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_2 5 100
Max subarray sum 0(n^2): 2669
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_2 gmon.out > exe2_100.txt
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_3 5 100
Max subarray sum 0(n^3): 2669
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_3 gmon.out > exe3_100.txt
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$
```

```
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_1 5 1000
Max subarray sum 0(n): 24146
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_1 gmon.out > exe1_1000.txt
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_2 5 1000
Max subarray sum 0(n^2): 24146
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_2 gmon.out > exe2_1000.txt
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_3 5 1000
Max subarray sum 0(n^3): 24146
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_3 gmon.out > exe3_1000.txt
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$
```

```
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_1 5 10000
Max subarray sum 0(n): 247309
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_1 gmon.out > exe1_10000.txt
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_2 5 10000
Max subarray sum 0(n^2): 247309
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_2 gmon.out > exe2_10000.txt
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ ./max_subarray_sum_3 5 10000
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ gprof max_subarray_sum_3 gmon.out > exe3_10000.txt
```

השוואות של exe1 exe2 exe3 :

נתבונן בעמודה **cumulative** :

ניתן לראות את ההשפעה של יעילות של אלגוריתם שיכולה משמעותית להפחית את הזמן ריצה של פעולה מוסימת.

גודל 100: לפי סדר : $n^3 \rightarrow n^2 \rightarrow n$

```
omer@Linux-Omer: ~/Desktop/Operating systems/#1/5$ ls
exe1_100.txt  exe3_100.txt  makefile      max_subarray_sum_1.cpp  max_subarray_sum_2.cpp  max_subarray_sum_3.cpp
exe2_100.txt  gmon.out      max_subarray_sum_1  max_subarray_sum_2      max_subarray_sum_3
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ cat exe1_100.txt
Flat profile:

Each sample counts as 0.01 seconds.
no time accumulated

%   cumulative   self           calls     self   total    name
time  seconds    seconds             Ts/call  Ts/call  name
-----
0.00      0.00      0.00             101      0.00    0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long) const
0.00      0.00      0.00             100      0.00    0.00  std::vector<int, std::allocator<int> >::size() const
0.00      0.00      0.00             100      0.00    0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
0.00      0.00      0.00              3      0.00    0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
0.00      0.00      0.00              3      0.00    0.00  std::allocator<int>::~allocator()
0.00      0.00      0.00              2      0.00    0.00  __gnu_cxx::new_allocator<int>::~new_allocator(__gnu_cxx::new_allocator<int> const&)
0.00      0.00      0.00              2      0.00    0.00  __gnu_cxx::new_allocator<int>::~M_max_size() const
0.00      0.00      0.00              2      0.00    0.00  std::allocator<int>::allocator(std::allocator<int> const&)
0.00      0.00      0.00              2      0.00    0.00  std::_Vector_base<int, std::allocator<int> >::M_get_Tp_allocator()
0.00      0.00      0.00              1      0.00    0.00  max_subarray_sum_n(std::vector<int, std::allocator<int> > const&)
0.00      0.00      0.00              1      0.00    0.00  generate_random_array(int, int)
0.00      0.00      0.00              1      0.00    0.00  static initialization and destruction 0(int, int)
0.00      0.00      0.00              1      0.00    0.00  __gnu_cxx::new_allocator<int>::~deallocate(int*, unsigned long)
0.00      0.00      0.00              1      0.00    0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
0.00      0.00      0.00              1      0.00    0.00  __gnu_cxx::new_allocator<int>::new_allocator()
0.00      0.00      0.00              1      0.00    0.00  __gnu_cxx::new_allocator<int>::max_size() const
0.00      0.00      0.00              1      0.00    0.00  std::allocator<int>::allocator()
0.00      0.00      0.00              1      0.00    0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
0.00      0.00      0.00              1      0.00    0.00  std::_Vector_base<int, std::allocator<int> >::M_allocate(unsigned long)
0.00      0.00      0.00              1      0.00    0.00  std::vector<int, std::allocator<int> >::vector_impl::vector
```

```
omer@Linux-Omer: ~/Desktop/Operating systems/#1/5
>::~vector()
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ cat exe2_100.txt
Flat profile:

Each sample counts as 0.01 seconds.
no time accumulated

%   cumulative   self           calls     self   total    name
time  seconds    seconds             Ts/call   Ts/call                  name
0.00      0.00      0.00             5252      0.00      0.00  std::vector<int, std::allocator<int> >::size() const
0.00      0.00      0.00             5050      0.00      0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long) co
nst
0.00      0.00      0.00              100      0.00      0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
0.00      0.00      0.00               3      0.00      0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
0.00      0.00      0.00               3      0.00      0.00  std::allocator<int>::~allocator()
0.00      0.00      0.00               2      0.00      0.00  __gnu_cxx::new_allocator<int>::~new_allocator(__gnu_cxx::new_allocato
r<int> const&)
0.00      0.00      0.00               2      0.00      0.00  __gnu_cxx::new_allocator<int>::~M_max_size() const
0.00      0.00      0.00               2      0.00      0.00  std::allocator<int>::allocator(std::allocator<int> const&)
0.00      0.00      0.00               2      0.00      0.00  std::_Vector_base<int, std::allocator<int> >::M_get_Tp_allocator()
0.00      0.00      0.00               1      0.00      0.00  max_subarray_sum_n2(std::vector<int, std::allocator<int> > const&)
0.00      0.00      0.00               1      0.00      0.00  generate_random_array(int, int)
0.00      0.00      0.00               1      0.00      0.00  static initialization and destruction 0(int, int)
0.00      0.00      0.00               1      0.00      0.00  __gnu_cxx::new_allocator<int>::~deallocate(int*, unsigned long)
0.00      0.00      0.00               1      0.00      0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
0.00      0.00      0.00               1      0.00      0.00  __gnu_cxx::new_allocator<int>::new_allocator()
0.00      0.00      0.00               1      0.00      0.00  __gnu_cxx::new_allocator<int>::max_size() const
0.00      0.00      0.00               1      0.00      0.00  std::allocator<int>::allocator()
0.00      0.00      0.00               1      0.00      0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
0.00      0.00      0.00               1      0.00      0.00  std::_Vector_base<int, std::allocator<int> >::_M_allocate(unsigned l
ong)
0.00      0.00      0.00               1      0.00      0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::_Vector_
impl(std::allocator<int> const&)
0.00      0.00      0.00               1      0.00      0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::~Vector_
impl()
```

```
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ cat exe3_100.txt
Flat profile:

Each sample counts as 0.01 seconds.
no time accumulated

%   cumulative   self           calls     self   total    name
time  seconds    seconds             Ts/call   Ts/call                  name
0.00      0.00      0.00            171700      0.00      0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long) co
nst
0.00      0.00      0.00             5252      0.00      0.00  std::vector<int, std::allocator<int> >::size() const
0.00      0.00      0.00              100      0.00      0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
0.00      0.00      0.00               3      0.00      0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
0.00      0.00      0.00               3      0.00      0.00  std::allocator<int>::~allocator()
0.00      0.00      0.00               2      0.00      0.00  __gnu_cxx::new_allocator<int>::~new_allocator(__gnu_cxx::new_allocato
r<int> const&)
0.00      0.00      0.00               2      0.00      0.00  __gnu_cxx::new_allocator<int>::~M_max_size() const
0.00      0.00      0.00               2      0.00      0.00  std::allocator<int>::allocator(std::allocator<int> const&)
0.00      0.00      0.00               2      0.00      0.00  std::_Vector_base<int, std::allocator<int> >::M_get_Tp_allocator()
0.00      0.00      0.00               1      0.00      0.00  max_subarray_sum_n3(std::vector<int, std::allocator<int> > const&)
0.00      0.00      0.00               1      0.00      0.00  generate_random_array(int, int)
0.00      0.00      0.00               1      0.00      0.00  static initialization and destruction 0(int, int)
0.00      0.00      0.00               1      0.00      0.00  __gnu_cxx::new_allocator<int>::~deallocate(int*, unsigned long)
0.00      0.00      0.00               1      0.00      0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
0.00      0.00      0.00               1      0.00      0.00  __gnu_cxx::new_allocator<int>::new_allocator()
0.00      0.00      0.00               1      0.00      0.00  __gnu_cxx::new_allocator<int>::max_size() const
0.00      0.00      0.00               1      0.00      0.00  std::allocator<int>::allocator()
0.00      0.00      0.00               1      0.00      0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
0.00      0.00      0.00               1      0.00      0.00  std::_Vector_base<int, std::allocator<int> >::_M_allocate(unsigned l
ong)
0.00      0.00      0.00               1      0.00      0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::_Vector_
impl(std::allocator<int> const&)
0.00      0.00      0.00               1      0.00      0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::~Vector_
impl()
```


השוואות של exe1 exe2 exe3 :

גודל 1000: לפי סדר : 3^2 n -> 2^2 n -> n

```
omer@Linux-Omer: ~/Desktop/Operating systems/#1/5$ ls
exe1_1000.txt  exe2_100.txt  gmon.out      max_subarray_sum_1.cpp  max_subarray_sum_3
exe1_100.txt   exe3_1000.txt  makefile      max_subarray_sum_2     max_subarray_sum_3.cpp
exe2_1000.txt  exe3_100.txt  max_subarray_sum_1  max_subarray_sum_2.cpp
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ cat exe1_1000.txt
Flat profile:

Each sample counts as 0.01 seconds.
no time accumulated

%   cumulative   self           calls     self        total   name
time  seconds    seconds                Ts/call     Ts/call                name
0.00      0.00      0.00             1001         0.00        0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long) const
0.00      0.00      0.00             1000         0.00        0.00  std::vector<int, std::allocator<int> >::size() const
0.00      0.00      0.00             1000         0.00        0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
0.00      0.00      0.00              3          0.00        0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
0.00      0.00      0.00              3          0.00        0.00  std::allocator<int>::~allocator()
0.00      0.00      0.00              2          0.00        0.00  __gnu_cxx::new_allocator<int>::~new_allocator(__gnu_cxx::new_allocator<int> const&)
0.00      0.00      0.00              2          0.00        0.00  __gnu_cxx::new_allocator<int>::~M_max_size() const
0.00      0.00      0.00              2          0.00        0.00  std::allocator<int>::allocator(std::allocator<int> const&)
0.00      0.00      0.00              2          0.00        0.00  std::_Vector_base<int, std::allocator<int> >::M_get_Tp_allocator()
0.00      0.00      0.00              1          0.00        0.00  max_subarray_sum_n(std::vector<int, std::allocator<int> > const&)
0.00      0.00      0.00              1          0.00        0.00  generate_random_array(int, int)
0.00      0.00      0.00              1          0.00        0.00  static_initialization and destruction 0(int, int)
0.00      0.00      0.00              1          0.00        0.00  __gnu_cxx::new_allocator<int>::~deallocate(int*, unsigned long)
0.00      0.00      0.00              1          0.00        0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
0.00      0.00      0.00              1          0.00        0.00  __gnu_cxx::new_allocator<int>::new_allocator()
0.00      0.00      0.00              1          0.00        0.00  __gnu_cxx::new_allocator<int>::max_size() const
0.00      0.00      0.00              1          0.00        0.00  std::allocator<int>::allocator()
0.00      0.00      0.00              1          0.00        0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
0.00      0.00      0.00              1          0.00        0.00  std::_Vector_base<int, std::allocator<int> >::M_allocate(unsigned long)
```

```
omer@Linux-Omer: ~/Desktop/Operating systems/#1/5$ cat exe2_1000.txt
Flat profile:

Each sample counts as 0.01 seconds.
no time accumulated

%   cumulative   self           calls     self        total   name
time  seconds    seconds                Ts/call     Ts/call                name
0.00      0.00      0.00             502502         0.00        0.00  std::vector<int, std::allocator<int> >::size() const
0.00      0.00      0.00             500500         0.00        0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long) const
0.00      0.00      0.00             1000         0.00        0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
0.00      0.00      0.00              3          0.00        0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
0.00      0.00      0.00              3          0.00        0.00  std::allocator<int>::~allocator()
0.00      0.00      0.00              2          0.00        0.00  __gnu_cxx::new_allocator<int>::~new_allocator(__gnu_cxx::new_allocator<int> const&)
0.00      0.00      0.00              2          0.00        0.00  __gnu_cxx::new_allocator<int>::~M_max_size() const
0.00      0.00      0.00              2          0.00        0.00  std::allocator<int>::allocator(std::allocator<int> const&)
0.00      0.00      0.00              2          0.00        0.00  std::_Vector_base<int, std::allocator<int> >::M_get_Tp_allocator()
0.00      0.00      0.00              1          0.00        0.00  max_subarray_sum_n2(std::vector<int, std::allocator<int> > const&)
0.00      0.00      0.00              1          0.00        0.00  generate_random_array(int, int)
0.00      0.00      0.00              1          0.00        0.00  static_initialization and destruction 0(int, int)
0.00      0.00      0.00              1          0.00        0.00  __gnu_cxx::new_allocator<int>::~deallocate(int*, unsigned long)
0.00      0.00      0.00              1          0.00        0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
0.00      0.00      0.00              1          0.00        0.00  __gnu_cxx::new_allocator<int>::new_allocator()
0.00      0.00      0.00              1          0.00        0.00  __gnu_cxx::new_allocator<int>::max_size() const
0.00      0.00      0.00              1          0.00        0.00  std::allocator<int>::allocator()
0.00      0.00      0.00              1          0.00        0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
0.00      0.00      0.00              1          0.00        0.00  std::_Vector_base<int, std::allocator<int> >::M_allocate(unsigned long)
0.00      0.00      0.00              1          0.00        0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::_Vector_
impl(std::allocator<int> const&)
0.00      0.00      0.00              1          0.00        0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::~Vector_
impl()
```

```

omer@Linux-Omer: ~/Desktop/Operating systems/#1/5$ cat exe3_1000.txt
Flat profile:

Each sample counts as 0.01 seconds.
 %   cumulative   self           self      total
time  seconds    seconds   calls   ms/call  ms/call  name
50.00      0.04      0.04 167167000     0.00     0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long) const
44.44      0.09      0.04      1      40.00    85.00  max_subarray_sum n3(std::vector<int, std::allocator<int> > const&)
 5.56      0.09      0.01      1      5.00     5.00  __gnu_cxx::new_allocator<int>::new_allocator()
 0.00      0.09      0.00 502502     0.00     0.00  std::vector<int, std::allocator<int> >::size() const
 0.00      0.09      0.00    1000     0.00     0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
 0.00      0.09      0.00      3     0.00     0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
 0.00      0.09      0.00      3     0.00     0.00  std::allocator<int>::~allocator()
 0.00      0.09      0.00      2     0.00     0.00  __gnu_cxx::new_allocator<int>::~new_allocator(__gnu_cxx::new_allocator<int> const&)
 0.00      0.09      0.00      2     0.00     0.00  __gnu_cxx::new_allocator<int>::~ M_max_size() const
 0.00      0.09      0.00      2     0.00     0.00  std::allocator<int>::allocator(std::allocator<int> const&)
 0.00      0.09      0.00      2     0.00     0.00  std::_Vector_base<int, std::allocator<int> >::_M_get_Tp_allocator()
 0.00      0.09      0.00      1     0.00     5.00  generate_random_array(int, int)
 0.00      0.09      0.00      1     0.00     0.00  _static_initialization_and_destruction_0(int, int)
 0.00      0.09      0.00      1     0.00     0.00  __gnu_cxx::new_allocator<int>::~deallocate(int*, unsigned long)
 0.00      0.09      0.00      1     0.00     0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
 0.00      0.09      0.00      1     0.00     0.00  __gnu_cxx::new_allocator<int>::max_size() const
 0.00      0.09      0.00      1     0.00     5.00  std::allocator<int>::allocator()
 0.00      0.09      0.00      1     0.00     0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
 0.00      0.09      0.00      1     0.00     0.00  std::_Vector_base<int, std::allocator<int> >::_M_allocate(unsigned long)
 0.00      0.09      0.00      1     0.00     0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::_Vector_impl(std::allocator<int> const&)
 0.00      0.09      0.00      1     0.00     0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::~_Vector_impl()
 0.00      0.09      0.00      1     0.00     0.00  std::_Vector_base<int, std::allocator<int> >::_M_deallocate(int*, unsigned long)

```


השוואות של exe1 exe2 exe3 :

גודל 10000: לפי סדר : $n^3 \rightarrow n^2 \rightarrow n$

```
omer@Linux-Omer: ~/Desktop/Operating systems/#1/5$ cat exe1_10000.txt
Flat profile:

Each sample counts as 0.01 seconds.
no time accumulated

%   cumulative   self           calls     self        total
time  seconds    seconds             Ts/call     Ts/call     name
0.00      0.00      0.00        10001         0.00         0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long) co
nst
0.00      0.00      0.00        10000         0.00         0.00  std::vector<int, std::allocator<int> >::size() const
0.00      0.00      0.00        10000         0.00         0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
0.00      0.00      0.00           3         0.00         0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
0.00      0.00      0.00           3         0.00         0.00  std::allocator<int>::~allocator()
0.00      0.00      0.00           2         0.00         0.00  __gnu_cxx::new_allocator<int>::~new_allocator(__gnu_cxx::new_allocato
r<int> const&)
0.00      0.00      0.00           2         0.00         0.00  __gnu_cxx::new_allocator<int>::~ M max size() const
0.00      0.00      0.00           2         0.00         0.00  std::allocator<int>::allocator(std::allocator<int> const&)
0.00      0.00      0.00           2         0.00         0.00  std::_Vector_base<int, std::allocator<int> >:: M_get_Tp_allocator()
0.00      0.00      0.00           1         0.00         0.00  max_subarray_sum_n(std::vector<int, std::allocator<int> > const&)
0.00      0.00      0.00           1         0.00         0.00  generate_random_array(int, int)
0.00      0.00      0.00           1         0.00         0.00  _static_initialization_and_destruction_0(int, int)
0.00      0.00      0.00           1         0.00         0.00  __gnu_cxx::new_allocator<int>::~deallocate(int*, unsigned long)
0.00      0.00      0.00           1         0.00         0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
0.00      0.00      0.00           1         0.00         0.00  __gnu_cxx::new_allocator<int>::new_allocator()
0.00      0.00      0.00           1         0.00         0.00  __gnu_cxx::new_allocator<int>::max_size() const
0.00      0.00      0.00           1         0.00         0.00  std::allocator<int>::allocator()
0.00      0.00      0.00           1         0.00         0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
0.00      0.00      0.00           1         0.00         0.00  std::_Vector_base<int, std::allocator<int> >::_M_allocate(unsigned l
ong)
0.00      0.00      0.00           1         0.00         0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::_Vector_
impl(std::allocator<int> const&)
0.00      0.00      0.00           1         0.00         0.00  std::_Vector_base<int, std::allocator<int> >::_Vector_impl::~_Vector_
impl()
```

```

omer@Linux-Omer: ~/Desktop/Operating systems/#1/5
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ cat exe2_10000.txt
Flat profile:

Each sample counts as 0.01 seconds.
   %   cumulative   self           self      total
time  seconds    seconds   calls   ms/call  ms/call  name
41.67      0.05      0.05         1       50.00   110.00  max_subarray_sum_n2(std::vector<int, std::allocator<int> > const&)
29.17      0.09      0.04  50025002       0.00     0.00  std::vector<int, std::allocator<int> >::size() const
20.83      0.11      0.03  50005000       0.00     0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long) co
nst
 4.17      0.12      0.01         1       5.00     5.00  __gnu_cxx::new_allocator<int>::new_allocator()
 4.17      0.12      0.01         1       5.00     5.00  std::_Vector_base<int, std::allocator<int> >::~~Vector_base()
 0.00      0.12      0.00      10000       0.00     0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
 0.00      0.12      0.00         3       0.00     0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
 0.00      0.12      0.00         3       0.00     0.00  std::allocator<int>::~allocator()
 0.00      0.12      0.00         2       0.00     0.00  __gnu_cxx::new_allocator<int>::new_allocator(__gnu_cxx::new_allocato
r<int> const&)
 0.00      0.12      0.00         2       0.00     0.00  __gnu_cxx::new_allocator<int>::M_max_size() const
 0.00      0.12      0.00         2       0.00     0.00  std::allocator<int>::allocator(std::allocator<int> const&)
 0.00      0.12      0.00         2       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::M_get_Tp_allocator()
 0.00      0.12      0.00         1       0.00     5.00  generate_random_array(int, int)
 0.00      0.12      0.00         1       0.00     0.00  _static_initialization_and_destruction_0(int, int)
 0.00      0.12      0.00         1       0.00     0.00  __gnu_cxx::new_allocator<int>::deallocate(int*, unsigned long)
 0.00      0.12      0.00         1       0.00     0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
 0.00      0.12      0.00         1       0.00     0.00  __gnu_cxx::new_allocator<int>::max_size() const
 0.00      0.12      0.00         1       0.00     5.00  std::allocator<int>::allocator()
 0.00      0.12      0.00         1       0.00     0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
 0.00      0.12      0.00         1       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::M_allocate(unsigned l
ong)
 0.00      0.12      0.00         1       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::Vector_impl::Vector_
impl(std::allocator<int> const&)
 0.00      0.12      0.00         1       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::Vector_impl::~~Vector
impl()
 0.00      0.12      0.00         1       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::M_deallocate(int*, un
signed long)

```

```

omer@Linux-Omer: ~/Desktop/Operating systems/#1/5
omer@Linux-Omer:~/Desktop/Operating systems/#1/5$ cat exe3_10000.txt
Flat profile:

Each sample counts as 0.01 seconds.
   %   cumulative   self           self      total
time  seconds    seconds   calls   ms/call  ms/call  name
53.20      57.17      57.17  3507912752       0.00     0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
const
36.49      96.39      39.22         1      39.22    96.40  max_subarray_sum_n3(std::vector<int, std::allocator<int> > const&)
10.30     107.46      11.07         1      11.07    11.07  __gnu_cxx::new_allocator<int>::new_allocator()
 0.01     107.47      0.01  50025002       0.00     0.00  std::vector<int, std::allocator<int> >::size() const
 0.00     107.47      0.00      10000       0.00     0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long)
 0.00     107.47      0.00         3       0.00     0.00  __gnu_cxx::new_allocator<int>::~new_allocator()
 0.00     107.47      0.00         3       0.00     0.00  std::allocator<int>::~allocator()
 0.00     107.47      0.00         2       0.00     0.00  __gnu_cxx::new_allocator<int>::new_allocator(__gnu_cxx::new_allocato
r<int> const&)
 0.00     107.47      0.00         2       0.00     0.00  __gnu_cxx::new_allocator<int>::M_max_size() const
 0.00     107.47      0.00         2       0.00     0.00  std::allocator<int>::allocator(std::allocator<int> const&)
 0.00     107.47      0.00         2       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::M_get_Tp_allocator()
 0.00     107.47      0.00         1       0.00    11.07  generate_random_array(int, int)
 0.00     107.47      0.00         1       0.00     0.00  _static_initialization_and_destruction_0(int, int)
 0.00     107.47      0.00         1       0.00     0.00  __gnu_cxx::new_allocator<int>::deallocate(int*, unsigned long)
 0.00     107.47      0.00         1       0.00     0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*)
 0.00     107.47      0.00         1       0.00     0.00  __gnu_cxx::new_allocator<int>::max_size() const
 0.00     107.47      0.00         1       0.00    11.07  std::allocator<int>::allocator()
 0.00     107.47      0.00         1       0.00     0.00  void std::_Destroy_aux<true>::_destroy<int*>(int*, int*)
 0.00     107.47      0.00         1       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::M_allocate(unsigned l
ong)
 0.00     107.47      0.00         1       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::Vector_impl::Vector_
impl(std::allocator<int> const&)
 0.00     107.47      0.00         1       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::Vector_impl::~~Vector
impl()
 0.00     107.47      0.00         1       0.00     0.00  std::_Vector_base<int, std::allocator<int> >::M_deallocate(int*, un
signed long)

```