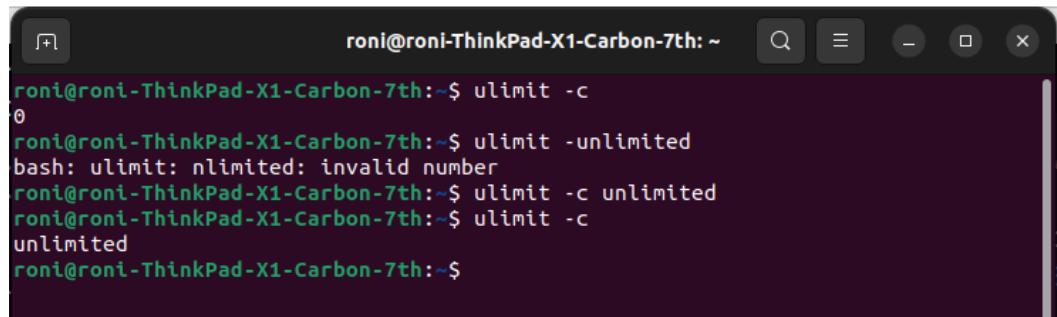


מטלה 1
קורס מערכות הפעלה

מגישיים
322530080_207199282

תרגיל 1-יצירת core

ראשית, נקצת מקום לcore החדש שנייצר בזמן ההרצה:



```
roni@roni-ThinkPad-X1-Carbon-7th:~$ ulimit -c
0
roni@roni-ThinkPad-X1-Carbon-7th:~$ ulimit -unlimited
bash: ulimit: nlimited: invalid number
roni@roni-ThinkPad-X1-Carbon-7th:~$ ulimit -c unlimited
roni@roni-ThinkPad-X1-Carbon-7th:~$ ulimit -c
unlimited
roni@roni-ThinkPad-X1-Carbon-7th:~$
```

עיף ראשון- השגיאה: stack overflow

הקוד:

```
C++ stackOverFlow.cpp > ...
1 #include <iostream>
2 #include<vector>
3 using namespace std;
4
5 int infinityRecursion(int a) {
6     return infinityRecursion(a*2);
7 }
8
9 int main (){
10    infinityRecursion(5);
11    return 0;
12 }
```

לאחר הפקaza נרץ את התוכנית הראשונה ללא דגל -g, נשים לב כי נוצר לנו קובץ core (בצד ימני היקן שנמצאיםשאר הקבצים בתיקייה), כמו כן לאחר הפעלת הפעולה where נקבל את השורה שבה נפלה השגיאה והתוכנית קרסה.

```

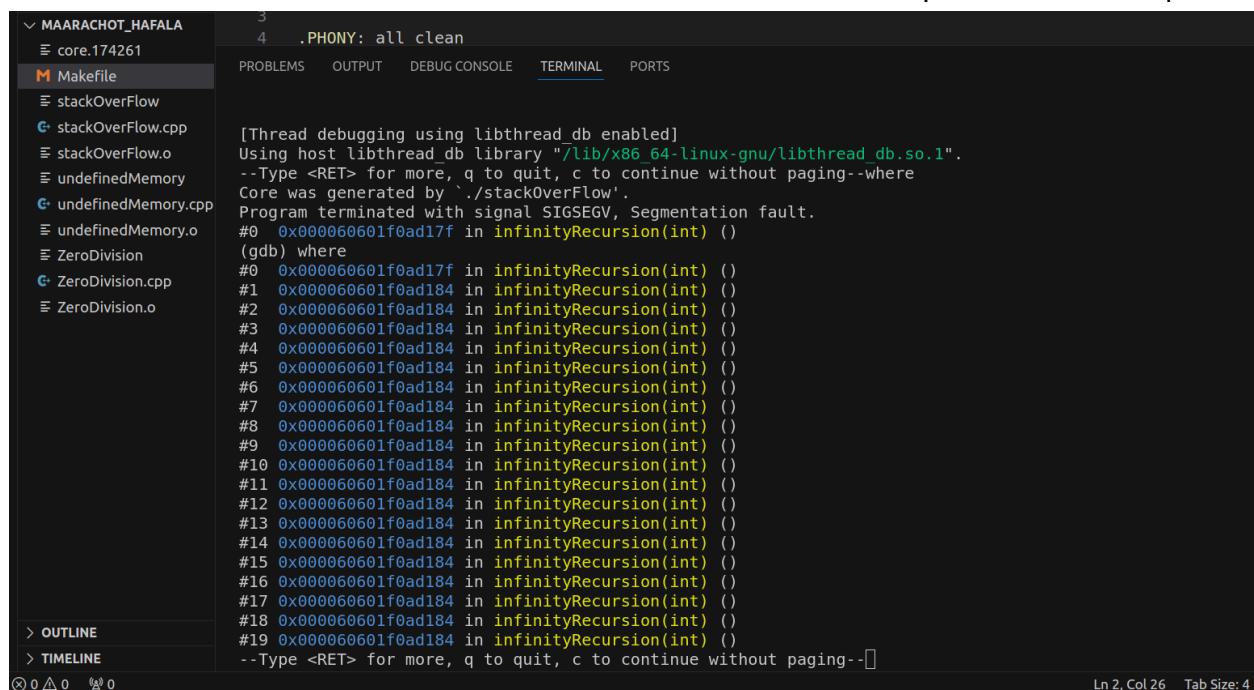
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ulimit -c unlimited
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./stackOverflow
Segmentation fault (core dumped)
○ roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ gdb stackOverflow core.174261
GNU gdb (Ubuntu 12.1-0ubuntu1-22.04) 12.1
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from stackOverflow...
(No debugging symbols found in stackOverflow)
[New LWP 174261]

```

Ln 2, Col 26

מכיוון שהרכינו את הפקודות ללא הדגל g- ניתן לראות כי בבדיקה הטקסטואלי אנחנו לא רואים את המיקום המדויק בו יצאנו מעבר לזכרון במחסנית.



```

3
4 .PHONY: all clean
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
--Type <RET> for more, q to quit, c to continue without paging--where
Core was generated by './stackOverflow'.
Program terminated with signal SIGSEGV, Segmentation fault.
#0 0x000060601f0ad17f in infinityRecursion(int) ()
(gdb) where
#0 0x000060601f0ad17f in infinityRecursion(int) ()
#1 0x000060601f0ad184 in infinityRecursion(int) ()
#2 0x000060601f0ad184 in infinityRecursion(int) ()
#3 0x000060601f0ad184 in infinityRecursion(int) ()
#4 0x000060601f0ad184 in infinityRecursion(int) ()
#5 0x000060601f0ad184 in infinityRecursion(int) ()
#6 0x000060601f0ad184 in infinityRecursion(int) ()
#7 0x000060601f0ad184 in infinityRecursion(int) ()
#8 0x000060601f0ad184 in infinityRecursion(int) ()
#9 0x000060601f0ad184 in infinityRecursion(int) ()
#10 0x000060601f0ad184 in infinityRecursion(int) ()
#11 0x000060601f0ad184 in infinityRecursion(int) ()
#12 0x000060601f0ad184 in infinityRecursion(int) ()
#13 0x000060601f0ad184 in infinityRecursion(int) ()
#14 0x000060601f0ad184 in infinityRecursion(int) ()
#15 0x000060601f0ad184 in infinityRecursion(int) ()
#16 0x000060601f0ad184 in infinityRecursion(int) ()
#17 0x000060601f0ad184 in infinityRecursion(int) ()
#18 0x000060601f0ad184 in infinityRecursion(int) ()
#19 0x000060601f0ad184 in infinityRecursion(int) ()
--Type <RET> for more, q to quit, c to continue without paging--[]

```

Ln 2, Col 26 Tab Size: 4

כעת נוסיף את הדגל g לסדר flags וכן בהמשך כי לאחר ההוספה אנחנו מקבלים את המיקום שבו יצאנו מזמן המחסנית:

The screenshot shows a code editor interface with a sidebar labeled "OPEN EDITORS". In the main area, there is a "Makefile" tab and several source files under the folder "MAARACHOT_HAFALA". The terminal tab shows the following output:

```

M Makefile
1 CXX = g++
2 CXXFLAGS = -Wall -Wextra -g
3
4 .PHONY: all clean
5
6 all: undefinedMemory stackOverflow ZeroDivision
7

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ulimit -c unlimited
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./stackOverflow
Segmentation fault (core dumped)
○ roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ gdb stackOverflow core.175267
GNU gdb (Ubuntu 12.1-1ubuntu1-22.04) 12.1
Core was generated by `./stackOverflow'.
Program terminated with signal SIGSEGV, Segmentation fault.
#0 0x00005fa9d1a05175 in infinityRecursion (
    a=<error reading variable: Cannot access memory at address 0x7ffc4cd97ffc>
    at stackOverflow.cpp:5
--Type <RET> for more, q to quit, c to continue without paging--where

```

לאחר הריצה בדיבאגר הגרפי (ddd) ניתן לראות כי השגיאה נפלה בשורה של return infinityRecursion (כפ' שציגו).

The screenshot shows a code editor interface with a sidebar labeled "OPEN EDITORS". In the main area, there is a "Makefile" tab and several source files under the folder "MAARACHOT_HAFALA". The terminal tab shows a much longer stack trace from GDB:

```

M Makefile
1 CXX = g++
2 CXXFLAGS = -g -Wall -Wextra
3

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ulimit -c unlimited
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./stackOverflow
Segmentation fault (core dumped)
○ roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ gdb stackOverflow core.177308
GNU gdb (Ubuntu 12.1-1ubuntu1-22.04) 12.1
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from stackOverflow...
[New LWP 177308]
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
Core was generated by `./stackOverflow'.
Program terminated with signal SIGSEGV, Segmentation fault.
#0 0x00005fa9d1a05175 in infinityRecursion (
    a=<error reading variable: Cannot access memory at address 0x7ffc4cd97ffc>
    at stackOverflow.cpp:5
--Type <RET> for more, q to quit, c to continue without paging--where

```

The screenshot shows the VS Code interface with the following details:

- Open Editors:** Shows "MAARACHOT_HAFALA" as the active editor.
- Terminal:** The title bar says "Makefile" and the content shows a C++ code snippet and a stack overflow error from the "infinityRecursion" function in "stackOverflow.cpp".
- Bottom Status Bar:** Displays "100% CPU usage" and "100% Disk I/O".

```
1 CXX = g++
2 CXXFLAGS = -g -Wall -Wextra
3

at stackOverflow.cpp:5
--Type <RET> for more, q to quit, c to continue without paging--where
5     int infinityRecursion(int a) {
(gdb) where
#0  0x00005fa9d1a05175 in infinityRecursion (
    a=<error reading variable: Cannot access memory at address 0x7ffc4cd97ffc>
) at stackOverflow.cpp:5
#1  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#2  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#3  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#4  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#5  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#6  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#7  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#8  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#9  0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#10 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#11 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#12 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#13 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#14 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#15 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#16 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#17 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#18 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#19 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#20 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
#21 0x00005fa9d1a05184 in infinityRecursion (a=0) at stackOverflow.cpp:6
-- Type <RET> for more, q to quit, c to continue without paging--
```

כעת לאחר הרצאה עם הדיבاجر הגרפי נראה כי השגיאה פוליה בשורה (`return Infinity`)`Recurseon` (return InfinityRecurseon) נמצאה.

The screenshot shows the DDD (Debian Debug) debugger running on a Linux desktop. The main window displays a C++ file named `stackOverflow.cpp` with the following code:

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

int infinityRecursion(int a) {
    return infinityRecursion(a+2);
}

int main () {
    infinityRecursion(5);
    return 0;
}

//ddd ./ex1 core

Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
```

Program received signal SIGSEGV, Segmentation fault.
0x0000555555555517 in infinityRecursion (a=0) at stackOverflow.cpp:6
(gdb)
↳ Disassembling location 0x555555555517...done.

The terminal pane shows the following command-line session:

- roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala\$ ulimit -c unlimited
- roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala\$./stackOverflow

Segmentation fault (core dumped)

- roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala\$ ddd stackOverflow core.178327

Warning: Cannot convert string "-*-helvetica-medium-r-*-*-120-*-*-*-iso8859-*" to type FontStruct (Annoyed? Try 'Edit->Preferences->General->Suppress X Warnings!')

Warning: Cannot convert string "-*-helvetica-medium-r-*-*-100-*-*-*-iso8859-*" to type FontStruct

Warning: Cannot convert string "-*-lucidatypewriter-medium-r-*-*-120-*-*-*-iso8859-*" to type Struct

Warning: Cannot convert string "-*-lucidatypewriter-bold-r-*-*-120-*-*-*-iso8859-*" to type FontStruct

Warning: Cannot convert string "-*-helvetica-bold-r-*-*-120-*-*-*-iso8859-*" to type FontStruct

Warning: Cannot convert string "-*-helvetica-medium-r-*-*-120-*-*-*-iso8859-*" to type FontStruct

Warning: Cannot convert string "-*-helvetica-bold-r-*-*-120-*-*-*-iso8859-*" to type FontStruct

Warning: Cannot convert string "-*-helvetica-bold-r-*-*-180-*-*-*-iso8859-*" to type FontStruct

סעיף שני - השגיאה - גישה לזכרן שגוי
באופן דומה לסעיף הקודם הריצה ללא דגל -g:

The screenshot shows the VS Code interface with the following details:

- OPEN EDITORS:** Shows files: Makefile, undefinedMemory.cpp, stackOverflow.cpp, core.174261, core.175267, core.176043, core.177308, core.178327, core.180565.
- MAARACHOT_HAFALA:** Shows files: core.174261, core.175267, core.176043, core.177308, core.178327, core.180565, Makefile, stackOverflow.cpp, stackOverflow.o, undefinedMemory.cpp, undefinedMemory.o, ZeroDivision.cpp, ZeroDivision.o.
- TERMINAL:**

```

M Makefile
1 CXX = g++
2 CXXFLAGS = -Wall -Wextra
3
4 .PHONY: all clean

roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./undefinedMemory
Segmentation fault (core dumped)
roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ gdb undefinedMemory core.180565
GNU gdb (Ubuntu 12.1-0ubuntu1-22.04) 12.1
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from undefinedMemory...
(No debugging symbols found in undefinedMemory)
[New LWP 180565]
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
--Type <RET> for more, q to quit, c to continue without paging--where
Core was generated by `./undefinedMemory'.
Program terminated with signal SIGSEGV, Segmentation fault.
#0 0x00005926923d72fa in main ()
(gdb) where
#0 0x00005926923d72fa in main () at undefinedMemory.cpp:8
8         return a[10000000000000000];
(gdb) 
```

הריצה עם דגל -g כאשר הנפילה היא בשורה 8.

The screenshot shows the VS Code interface with the following details:

- OPEN EDITORS:** Shows files: Makefile, undefinedMemory.cpp, stackOverflow.cpp, core.174261, core.175267, core.176043, core.177308, core.178327, core.180565.
- MAARACHOT_HAFALA:** Shows files: core.174261, core.175267, core.176043, core.177308, core.178327, core.180565, Makefile, stackOverflow.cpp, stackOverflow.o, undefinedMemory.cpp, undefinedMemory.o, ZeroDivision.cpp, ZeroDivision.o.
- TERMINAL:**

```

M Makefile
1 CXX = g++
2 CXXFLAGS = -g -Wall -Wextra
3
4 .PHONY: all clean

roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./undefinedMemory
Segmentation fault (core dumped)
roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ gdb undefinedMemory core.181716
GNU gdb (Ubuntu 12.1-0ubuntu1-22.04) 12.1
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
--Type <RET> for more, q to quit, c to continue without paging--where
Type "apropos word" to search for commands related to "word"...
Reading symbols from undefinedMemory...
[New LWP 181716]
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
Core was generated by `./undefinedMemory'.
Program terminated with signal SIGSEGV, Segmentation fault.
#0 0x000064f1aa3132fa in main () at undefinedMemory.cpp:8
8         return a[10000000000000000];
(gdb) where
#0 0x000064f1aa3132fa in main () at undefinedMemory.cpp:8
(gdb) 
```

לאחר הריצה עם הדיבאגר הגרפי ניתן לראות לטא לא חוקי והתוכנית קרסה בשורה שבה ניסינו לגשת לטא לא חוקי והתוכנית קרסה בשורה שבה ניסינו

לגשת לטא הנ"ל במערך.

The screenshot shows the DDD debugger interface. On the left, the project tree shows files like core.* and Makefile under MAARACHOT_HAFALA. The main window displays the code for undefinedMemory.cpp:

```

M Makefile
1 CXX = g++
2 CXXFLAGS = -g -Wall -Wextra
3
4
5 #include <iostream>
6 #include <vector>
7 using namespace std;
8
9 int main()
10 {
11     vector<int> a = {3,0};
12     return a[10000000000000000];
13 }

```

Below the code, an error message is shown:

```

Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
Program received signal SIGSEGV, Segmentation fault.
0xb0000555555552fa in main () at undefinedMemory.cpp:8
(gdb)

```

A tooltip indicates the disassembly location: `Disassembling location 0x5555555552fa...done.`

The bottom part of the interface shows the terminal output:

```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ulimit -c unlimited
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./undefinedMemory
bash: ./undefinedMemory: No such file or directory
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./undefinedMemory
Segmentation fault (core dumped)
○ roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ddd undefinedMemory core.182874
ddd: Cannot create ProgramInfo, no source view.
Warning: Cannot convert string "-*-helvetica-medium-r-*-*-120-*-*-*-iso8859-*" to type FontStru
(Annoyed? Try 'Edit->Preferences->General->Suppress X Warnings!')
Warning: Cannot convert string "-*-helvetica-medium-r-*-*-100-*-*-*-iso8859-*" to type FontStru
Warning: Cannot convert string "-*-lucidatypewriter-medium-r-*-*-120-*-*-*-iso8859-*" to type F

```

סעיף שלישי - השגיאה - חלוקה בז' בדומה לטעיפים הקודמים ללא דגלו:

The screenshot shows the DDD debugger interface. On the left, the project tree shows files like core.* and Makefile under MAARACHOT_HAFALA. The main window displays the code for ZeroDivision.cpp:

```

M Makefile
1 CXX = g++
2 CXXFLAGS = -Wall -Wextra
3
4
5 #include <iomanip>
6
7
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```

The bottom part of the interface shows the terminal output:

```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./ZeroDivision
Floating point exception
○ roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ gdb ZeroDivision core.182874
GNU gdb (Ubuntu 12.1-0ubuntu1-22.04) 12.1
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
--Type <RET> for more, q to quit, c to continue without paging--where
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from ZeroDivision...
(No debugging symbols found in ZeroDivision)

warning: core file may not match specified executable file.
[New LWP 182874]
Core was generated by `./ZeroDivision'.
Program terminated with signal SIGSEGV, Segmentation fault.
--Type <RET> for more, q to quit, c to continue without paging--where
#0 0x00005c096f4df2fa in ?? ()
(gdb) 

```

כעת לאחר הריצה עם דגל `-g` ניתן לראות כי התוכנית בשורה ה-6.

```

M Makefile
1 CXX = g++
2 CXXFLAGS = -g -Wall -Wextra
3

roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ulimit -c unlimited
roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ./ZeroDivision
Floating point exception (core dumped)
roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ gdb ZeroDivision core.184784
GNU gdb (Ubuntu 12.1-0ubuntu1-22.04) 12.1
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from ZeroDivision...
[New LWP 184784]
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
Core was generated by `./ZeroDivision'.
--Type <RET> for more, q to quit, c to continue without paging--where
Program terminated with signal SIGFPE, Arithmetic exception.
#0 0x000063c71ef5917c in main () at ZeroDivision.cpp:6
6      return 6 / 0;
(gdb) 

```

. לאחר הריצה עם הדיבאגר הגרפי ניתן לראות כי השגיאה נפלה בשורה ה-6/0.

```

M Makefile
1 CXX = g++
2 CXXFLAGS = -g -Wall -Wextra
3

roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala$ ddd ZeroDivision core.184784
DDD: /home/roni/Desktop/maarachot_hafala/ZeroDivision.cpp
File Edit View Program Commands Status Source Data
O: main
#include <iostream>
using namespace std;
int main()
{
    return 6 / 0;
}

Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
Program received signal SIGFPE, Arithmetic exception.
0x00005555555517c in main () at ZeroDivision.cpp:6
(gdb) 

```

תרגיל 2 - expf

יצירת התוכנית ופונקציית עזר
הרצה ע"י poisson/.exe

```
Poisson.cpp > main(int, char *[])
1 #include <cmath>
2 #include <iostream>
3 #include <cstdlib>
4 using namespace std;
5
6 float factorial(int a){
7     if(a == 0){
8         return 1;
9     }
10    return a* factorial(a-1);
11 }
12
13 int main(int argc, char *argv[]){
14     if(argc !=3){
15         cout << "Error" << endl;
16         exit(1);
17     }
18     float lambda= atof(argv[1]);
19     int k = atoi(argv[2]);
20     cout<< (pow(lambda,k) / factorial(k)) * expf(-lambda) << endl;
21     return 0;
22 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex2$ make clean
rm -f *.o poisson
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex2$ make all
g++ -g -Wall -lm -c Poisson.cpp -o Poisson.o
g++ -g -Wall -lm Poisson.o -o poisson
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex2$ ./poisson 2.5 3
0.213763
○ roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex2$ █
```

קיבלנו את הערך 0.213763 . אימות:

Poisson Distribution
 $X \sim Pois(\lambda)$

$\lambda =$

$x =$ $P(X=x) =$

תרגיל dynamic library-3

הקוד:

The screenshot shows a VS Code interface with a terminal window. The terminal displays the following output:

- **roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex3\$ make all**
make: Nothing to be done for 'all'.
- **roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex3\$./q3**
K=1, lambda=2, Poisson dist= 0.270671
K=10, lambda=2, Poisson dist= 3.81898e-05
K=2, lambda=2, Poisson dist= 0.270671
K=3, lambda=3, Poisson dist= 0.224042
K=3, lambda=100, Poisson dist= 6.30584e-39
- **roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex3\$**

ניתן לראות דוגמת הריצה בטרמינל
ואת הקובץ של הספריה הדינמית הנוצר בצד שמאל.

תרגיל 4- אלגוריתם דיאקسطה וגרפים,lcov()

סעיף זה מתיחס לשולשה סוגים של קלט לא תקין בקבלת ערכים למטריצת השכניםות של הגרף:

1. יותר מדי ערכים לשורה.
2. פחות מדי ערכים לשורה
3. קלט של מספר שלילי - לא תקין עבור דיאקسطה.
עבור כל אלו, תזרק שגיאה.
מוסיפים למקפיאל:

Makefile

```
1 CXX = g++
2 CXXFLAGS = -g -Wall -fprofile-arcs -ftest-coverage
3
11 %.o: %.cpp
12 | $(CXX) $(CXXFLAGS) -lgcov -c $< -o $@
13 |
```

מראיצים את הקוד:

```
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ make all
g++ -g -Wall -fprofile-arcs -ftest-coverage -lgcov -c Dijkstra.cpp -o Dijkstra.o
g++ -g -Wall -fprofile-arcs -ftest-coverage Dijkstra.o -o dijkstra
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ ./dijkstra
The size of the matrix is : 4
Enter 16 numbers of the graph:
Enter only 0 in the diagonal
0 1 1 1
1 0 1 1
1 1 0 1
1 1 1 0
Vertex   Distance from Source
```

מראיצים את הפקודה:

```
No executable lines
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ gcov Dijkstra.cpp
File: 'Dijkstra.cpp'
```

הרצה ראשונה עם ערכים תקינים, ניתן לראות כי יש שימוש ב 93.33% מהקוד שכן הקוד אשר חלקן נמצא בבלוקים של השגיאות לא שימוש.

```
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ ./dijkstra
The size of the matrix is : 4
Enter 16 numbers of the graph:
Enter only 0 in the diagonal
0 1 1 1
1 0 1 1
1 1 0 1
1 1 1 0
Vertex   Distance from Source
0                   0
1                   1
2                   1
3                   1
```

```
No executable lines
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ gcov Dijkstra.cpp
File 'Dijkstra.cpp'
Lines executed:93.33% of 60
Creating 'Dijkstra.cpp.gcov'
```

לאחר שימוש בפקודה `cat` נוכל לראות באילו שורות לא בוצע הxisוי של הקוד בהרצה. כפי שניתן לראות השורות אשר לא כוינו הן שורות שהקוד נכנס אליהן במצב שהקלט לא תקין ולכן נריץ את הפקודה גם עם קלט לא תקין קיבל 100 אחוזxisוי.

```
Lines executed:93.33% of 60
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ cat Dijkstra.cpp.gcov
-: 0:Source:Dijkstra.cpp
-: 0:Graph:Dijkstra.gcno
-: 0:Data:Dijkstra.gcda
-: 0:Runs:1
```

```
#####: 120:           cout << "Error - not valid number of edges" << endl;
#####: 121:           exit(1);
-: 122:       }
4: 123:       vector<int> line = countWords2(s, V);
20: 124:       for (int j = 0; j < V; j++)
-: 125:       {
16: 126:           if (line[j] < 0)
-: 127:           {
#####: 128:               cout << "Error-negative number" << endl;
#####: 129:               exit(1);
```

הרצה שנייה- עם מספר שלילי(ערך לא חוקי) להעלאת אחוזxi מימוש הקוד- נקבל CUT 96.67%xisוי.

```
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ ./dijkstra
The size of the matrix is : 4
Enter 16 numbers of the graph:
Enter only 0 in the diagonal
0 1 -2 1
Error-negative number
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ gcov Dijkstra.cpp
File 'Dijkstra.cpp'
Lines executed:96.67% of 60
Creating 'Dijkstra.cpp.gcov'
```

הרצה שלישיית- עם מספר גדול יותר של מספרים בשורה - מקבלים לבסוף 100 אחוזxisוי בקוד.

```
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ ./dijkstra
The size of the matrix is : 4
Enter 16 numbers of the graph:
Enter only 0 in the diagonal
-2 -2 -2 -2 -2
Error - not valid number of edges
● roni@roni-ThinkPad-X1-Carbon-7th:~/Desktop/maarachot_hafala/EXCERCISE_1/ex4$ gcov Dijkstra.cpp
File 'Dijkstra.cpp'
Lines executed:100.00% of 60
Creating 'Dijkstra.cpp.gcov'
```

הקבצים אשר נוצרים לאחר הרצת הפקודות הרלוונטיות לשאלת:

- ⌚ Dijkstra.cpp
- Ξ Dijkstra.cpp.gcov
- Ξ Dijkstra.gcda
- Ξ Dijkstra.gcno
- Ξ Dijkstra.o
- Ξ initializer_list.gcov
- Ξ ios_base.h.gcov
- Ⓜ Makefile

שאלה 5-מציאת תת מערך מקסימלי, (gprof)

הוספה דגלים מתאימים בMakefile

```
makefile
1 CXX = g++
2 CXXFLAGS = -g -Wall -lm -pg
3
4 .PHONY: all clean
5
6 all: sub1 sub2 sub3
7
8 sub1: subArray1.cpp
9 | $(CXX) $(CXXFLAGS) -o $@ $^
10
11 sub2: subArray2.cpp
12 | $(CXX) $(CXXFLAGS) -o $@ $^
13
14 sub3: subArray3.cpp
15 | $(CXX) $(CXXFLAGS) -o $@ $^
16
17
18 clean:
19 | rm -f *.o *.txt *out sub1 sub2 sub3
20
```

יצרנו 3 תוכניות שונות- כל אחת בסביבות שונה.
נريץ כל אחת מהתוכניות על מערכם רנדומליים בגודלים 100, 1000, 10000.
המיין אשר מריץ את הקבצים דומה בשלושתם, הפרדה לפונקציית return_random_number על מנת
שנוכל לבדוק את זמן היזירה של המספרים האקראיים בכל הריצה:

```
19 int return_random_number(){
20     ...return rand();
21 }
22
23 int main(int argc, char *argv[])
24 {
25     int random_seed = atoi(argv[1]);
26     int size_of_arr = atoi(argv[2]);
27     int lower_bound = -25;
28     int upper_bound = 30;
29     srand(random_seed);
30     vector<int> arr(size_of_arr);
31     for (int i = 0; i < size_of_arr; i++)
32     {
33         int random_number = return_random_number() % (upper_bound - lower_bound + 1) + lower_bound;
34         arr[i] = random_number;
35     }
36     cout << "max subArray sum:" << maxSubArray(arr, size_of_arr);
37     return 0;
38 }
```

תוכנית ראשונה (O(n))

```

8 int maxSubArray([vector<int> array, int size]
9 {
10     int best = 0, sum = 0;
11     for (int k = 0; k < size; k++)
12     {
13         sum = max(array[k], sum + array[k]);
14         best = max(best, sum);
15     }
16     return (best);
17 }
```

פקודת ריצה לתוכנית הנל:

```

● avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ ./sub1 1 100
● avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub1 gmon.out > sub1_100.txt
● avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ ./sub1 1 1000
● max subArray sum:2347avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub1 gmon.out > sub1_1000.txt
● avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ ./sub1 1 10000
● max subArray sum:24697avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub1 gmon.out > sub1_10000.txt
○ avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ 
```

קבצי gprof

מערך בגודל 100:

```

# sub1_100.txt
1 Flat profile:
2
3 Each sample counts as 0.01 seconds.
4 no time accumulated
5
6 % cumulative self      self      total
7 time    seconds   seconds   calls  Ts/call  Ts/call  name
8 0.00    0.00    0.00    300    0.00    0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long
9 0.00    0.00    0.00    200    0.00    0.00  int const& std::max<int>(int const&, int const&)
10 0.00   0.00    0.00    100    0.00    0.00  return_random_number()
11 0.00   0.00    0.00      5    0.00    0.00  __gnu_cxx::new_allocator<int>::__new_allocator()
12 0.00   0.00    0.00      5    0.00    0.00  std::allocator<int>::__allocator()
13 0.00   0.00    0.00      4    0.00    0.00  __gnu_cxx::new_allocator<int>::__new_allocator(__gnu_cxx::new_allocat
14 0.00   0.00    0.00      4    0.00    0.00  std::allocator<int>::__allocator(std::allocator<int> const&)
15 0.00   0.00    0.00      4    0.00    0.00  std::_Vector_base<int, std::allocator<int> >::__M_get_Tp_allocator
16 0.00   0.00    0.00      3    0.00    0.00  __gnu_cxx::new_allocator<int>::__M_max_size() const
17 0.00   0.00    0.00      2    0.00    0.00  __gnu_cxx::new_allocator<int>::__deallocate(int*, unsigned long)
18 0.00   0.00    0.00      2    0.00    0.00  __gnu_cxx::new_allocator<int>::__allocate(unsigned long, void const*
19 0.00   0.00    0.00      2    0.00    0.00  __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::a
20 0.00   0.00    0.00      2    0.00    0.00  __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::a
21 0.00   0.00    0.00      2    0.00    0.00  void std::__Destroy_aux<true>::__destroy<int*>(int*, int*)
22 0.00   0.00    0.00      2    0.00    0.00  std::_Vector_base<int, std::allocator<int> >::__M_allocate(unsign
23 0.00   0.00    0.00      2    0.00    0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__Vec
24 0.00   0.00    0.00      2    0.00    0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__Vec
25 0.00   0.00    0.00      2    0.00    0.00  std::_Vector_base<int, std::allocator<int> >::__M_deallocate(int*)
26 0.00   0.00    0.00      2    0.00    0.00  std::_Vector_base<int, std::allocator<int> >::__M_create_storage(
27 0.00   0.00    0.00      2    0.00    0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl_data:
28 0.00   0.00    0.00      2    0.00    0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_base(unsig
```

מערך בגודל 1000

```

≡ sub1_1000.txt
1 Flat profile:
2
3 Each sample counts as 0.01 seconds.
4 no time accumulated
5
6   % cumulative self          self      total
7   time    seconds   seconds  calls  Ts/call  Ts/call  name
8   0.00     0.00     0.00      3000    0.00     0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long
9   0.00     0.00     0.00      2000    0.00     0.00  int const& std::max<int>(int const&, int const&)
10  0.00     0.00     0.00      1000    0.00     0.00  return_random_number()
11  0.00     0.00     0.00       5    0.00     0.00  __gnu_cxx::new_allocator<int>::__new_allocator()
12  0.00     0.00     0.00       5    0.00     0.00  std::allocator<int>::~allocator()
13  0.00     0.00     0.00       4    0.00     0.00  __gnu_cxx::new_allocator<int>::__new_allocator(__gnu_cxx::new_allocat
14  0.00     0.00     0.00       4    0.00     0.00  std::allocator<int>::allocator(std::allocator<int> const&)
15  0.00     0.00     0.00       4    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__M_get_Tp_allocator
16  0.00     0.00     0.00       3    0.00     0.00  __gnu_cxx::new_allocator<int>::__M_max_size() const
17  0.00     0.00     0.00       2    0.00     0.00  __gnu_cxx::new_allocator<int>::deallocate(int*, unsigned long)
18  0.00     0.00     0.00       2    0.00     0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*
19  0.00     0.00     0.00       2    0.00     0.00  __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
20  0.00     0.00     0.00       2    0.00     0.00  __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
21  0.00     0.00     0.00       2    0.00     0.00  void std::Destroy_aux<true>::__destroy<int*>(int*, int*)
22  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__M_allocate(unsign
23  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__Vec
24  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__~Ve
25  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__M_deallocate(int*
26  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__M_create_storage(
27  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl_data:
28  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_base(unsig

```

מערך בגודל 10000

```

≡ sub1_10000.txt
1 Flat profile:
2
3 Each sample counts as 0.01 seconds.
4 no time accumulated
5
6   % cumulative self          self      total
7   time    seconds   seconds  calls  Ts/call  Ts/call  name
8   0.00     0.00     0.00      30000    0.00     0.00  std::vector<int, std::allocator<int> >::operator[](unsigned long
9   0.00     0.00     0.00      20000    0.00     0.00  int const& std::max<int>(int const&, int const&)
10  0.00     0.00     0.00      10000    0.00     0.00  return_random_number()
11  0.00     0.00     0.00       5    0.00     0.00  __gnu_cxx::new_allocator<int>::__new_allocator()
12  0.00     0.00     0.00       5    0.00     0.00  std::allocator<int>::~allocator()
13  0.00     0.00     0.00       4    0.00     0.00  __gnu_cxx::new_allocator<int>::__new_allocator(__gnu_cxx::new_allocat
14  0.00     0.00     0.00       4    0.00     0.00  std::allocator<int>::allocator(std::allocator<int> const&)
15  0.00     0.00     0.00       4    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__M_get_Tp_allocator
16  0.00     0.00     0.00       3    0.00     0.00  __gnu_cxx::new_allocator<int>::__M_max_size() const
17  0.00     0.00     0.00       2    0.00     0.00  __gnu_cxx::new_allocator<int>::deallocate(int*, unsigned long)
18  0.00     0.00     0.00       2    0.00     0.00  __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*
19  0.00     0.00     0.00       2    0.00     0.00  __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
20  0.00     0.00     0.00       2    0.00     0.00  __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
21  0.00     0.00     0.00       2    0.00     0.00  void std::Destroy_aux<true>::__destroy<int*>(int*, int*)
22  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__M_allocate(unsign
23  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__Vec
24  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__~Ve
25  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__M_deallocate(int*
26  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__M_create_storage(
27  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_impl_data:
28  0.00     0.00     0.00       2    0.00     0.00  std::_Vector_base<int, std::allocator<int> >::__Vector_base(unsig

```

תוכנית שנייה ($O(n^2)$)

פקודת הרצה לתוכנית הנל:

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ ./sub2 1 100
max subArray sum:348avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub2 gmon.out > sub2_100.txt
avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ ./sub2 1 1000
max subArray sum:2347avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub2 gmon.out > sub2_1000.txt
avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ ./sub2 1 10000
max subArray sum:24697avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub2 gmon.out > sub2_10000.txt
avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$
```

קובצי gprof
מערך בגודל 100:

	%	cumulative	self	calls	Ts/call	Ts/call	name
1	time	seconds	seconds				
2	0.00	0.00	0.00	5150	0.00	0.00	std::vector<int, std::allocator<int>>::operator[](unsigned long)
3	0.00	0.00	0.00	5050	0.00	0.00	int const& std::max<int>(int const&, int const&)
4	0.00	0.00	0.00	100	0.00	0.00	return_random_number()
5	0.00	0.00	0.00	5	0.00	0.00	__gnu_cxx::__new_allocator<int>::~new_allocator()
6	0.00	0.00	0.00	5	0.00	0.00	std::allocator<int>::~allocator()
7	0.00	0.00	0.00	4	0.00	0.00	__gnu_cxx::__new_allocator<int>::new_allocator(__gnu_cxx::__new_allocator<int> const&)
8	0.00	0.00	0.00	4	0.00	0.00	std::allocator<int>::allocator(std::allocator<int> const&)
9	0.00	0.00	0.00	4	0.00	0.00	std::vector_base<int, std::allocator<int>>::_M_get_Tp_allocator
10	0.00	0.00	0.00	3	0.00	0.00	__gnu_cxx::__new_allocator<int>::_M_max_size() const
11	0.00	0.00	0.00	2	0.00	0.00	__gnu_cxx::__new_allocator<int>::deallocate(int*, unsigned long)
12	0.00	0.00	0.00	2	0.00	0.00	__gnu_cxx::__new_allocator<int>::allocate(unsigned long, void const*)
13	0.00	0.00	0.00	2	0.00	0.00	__gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocator<int>>::iterator
14	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_M_deallocate(int*, void const*)
15	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_M_create_storage(int)
16	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_impl::_Vec
17	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_impl::~_Vec
18	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_base(int)
19	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_base(int, std::allocator<int> const&)
20	0.00	0.00	0.00	2	0.00	0.00	void std::_Destroy_aux<true>::__destroy<int*>(int*, int*)
21	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_M_allocate(unsigned long)
22	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_M_deallocate(int*, void const*)
23	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_M_create_storage(int)
24	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_impl::_Vec
25	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_impl::~_Vec
26	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_base(int)
27	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_base(int, std::allocator<int> const&)
28	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_base(int, std::allocator<int> const&)
29	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_base(int, std::allocator<int> const&)
30	0.00	0.00	0.00	2	0.00	0.00	std::allocator_traits<std::allocator<int>>::deallocate(std::allocator<int> const&)
31	0.00	0.00	0.00	2	0.00	0.00	std::allocator_traits<std::allocator<int>>::allocate(std::allocator<int> const&)
32	0.00	0.00	0.00	2	0.00	0.00	std::vector<int, std::allocator<int>>::_Vector_base<int, std::allocator<int>>::_Vector_base()

מערך בגודל 1000

```

≡ sub2_1000.txt
1  Flat profile:
2
3  Each sample counts as 0.01 seconds.
4  no time accumulated
5
6  %   cumulative   self      self      total
7  time    seconds   seconds   calls  Ts/call  Ts/call  name
8  0.00     0.00     0.00  5015000    0.00     0.00 std::vector<int, std::allocator<int> >::operator[](unsigned long
9  0.00     0.00     0.00  5005000    0.00     0.00 int const& std::max<int>(int const&, int const&)
10 0.00     0.00     0.00        1000    0.00     0.00 return_random_number()
11 0.00     0.00     0.00        500    0.00     0.00 __gnu_cxx::new_allocator<int>::__new_allocator()
12 0.00     0.00     0.00        500    0.00     0.00 std::allocator<int>::~allocator()
13 0.00     0.00     0.00        400    0.00     0.00 __gnu_cxx::new_allocator<int>::__new_allocator(__gnu_cxx::new_alloc
14 0.00     0.00     0.00        400    0.00     0.00 std::allocator<int>::allocator(std::allocator<int> const&)
15 0.00     0.00     0.00        400    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__M_get_Tp_allocator
16 0.00     0.00     0.00        300    0.00     0.00 __gnu_cxx::new_allocator<int>::__M_max_size() const
17 0.00     0.00     0.00        200    0.00     0.00 __gnu_cxx::new_allocator<int>::deallocate(int*, unsigned long)
18 0.00     0.00     0.00        200    0.00     0.00 __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*
19 0.00     0.00     0.00        200    0.00     0.00 __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
20 0.00     0.00     0.00        200    0.00     0.00 __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
21 0.00     0.00     0.00        200    0.00     0.00 void std::__Destroy_aux<true>::__destroy<int*>(int*, int*)
22 0.00     0.00     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__M_allocate(unsigned long)
23 0.00     0.00     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__Vec
24 0.00     0.00     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__~Vec
25 0.00     0.00     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__M_deallocate(int*)
26 0.00     0.00     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__M_create_storage(
27 0.00     0.00     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__Vector_impl_data::__
28 0.00     0.00     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__Vector_base(unsigned long)
29 0.00     0.00     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__~Vector_base()
30 0.00     0.00     0.00        200    0.00     0.00 std::allocator_traits<std::allocator<int> >::deallocate(std::allocat
31 0.00     0.00     0.00        200    0.00     0.00 std::allocator_traits<std::allocator<int> >::allocate(std::allocat
32 0.00     0.00     0.00        200    0.00     0.00 std::vector<int, std::allocator<int> >::__vector()

```

מערך בגודל 10000 :10000

```

≡ sub2_10000.txt
1  Flat profile:
2
3  Each sample counts as 0.01 seconds.
4  %   cumulative   self      self      total
5  time    seconds   seconds   calls  ms/call  ms/call  name
6  38.89    0.04     0.04  50015000    0.00     0.00 std::vector<int, std::allocator<int> >::operator[](unsigned long
7  38.89    0.07     0.04  50005000    0.00     0.00 int const& std::max<int>(int const&, int const&)
8  22.22    0.09     0.02        1    20.00    89.99 maxSubArray2(std::vector<int, std::allocator<int> >, int)
9  0.00     0.09     0.00  10000    0.00     0.00 return_random_number()
10 0.00     0.09     0.00        500    0.00     0.00 __gnu_cxx::new_allocator<int>::__new_allocator()
11 0.00     0.09     0.00        500    0.00     0.00 std::allocator<int>::~allocator()
12 0.00     0.09     0.00        400    0.00     0.00 __gnu_cxx::new_allocator<int>::__new_allocator(__gnu_cxx::new_alloc
13 0.00     0.09     0.00        400    0.00     0.00 std::allocator<int>::allocator(std::allocator<int> const&)
14 0.00     0.09     0.00        400    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__M_get_Tp_allocator
/Desktop/SubArray/sub3 0.09     0.00        3    0.00     0.00 __gnu_cxx::new_allocator<int>::__M_max_size() const
16 0.00     0.09     0.00        200    0.00     0.00 __gnu_cxx::new_allocator<int>::deallocate(int*, unsigned long)
17 0.00     0.09     0.00        200    0.00     0.00 __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*
18 0.00     0.09     0.00        200    0.00     0.00 __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
19 0.00     0.09     0.00        200    0.00     0.00 __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
20 0.00     0.09     0.00        200    0.00     0.00 void std::__Destroy_aux<true>::__destroy<int*>(int*, int*)
21 0.00     0.09     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__M_allocate(unsigned long)
22 0.00     0.09     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__Vec
23 0.00     0.09     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__Vector_impl::__~Vec
24 0.00     0.09     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__M_deallocate(int*)
25 0.00     0.09     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__M_create_storage(
26 0.00     0.09     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__Vector_impl_data::__
27 0.00     0.09     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__Vector_base(unsigned long)
28 0.00     0.09     0.00        200    0.00     0.00 std::_Vector_base<int, std::allocator<int> >::__~Vector_base()
29 0.00     0.09     0.00        200    0.00     0.00 std::allocator_traits<std::allocator<int> >::deallocate(std::allocat
30 0.00     0.09     0.00        200    0.00     0.00 std::allocator_traits<std::allocator<int> >::allocate(std::allocat
31 0.00     0.09     0.00        200    0.00     0.00 std::vector<int, std::allocator<int> >::__vector()
32 0.00     0.09     0.00        200    0.00     0.00 gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat

```

תוכנית שנייה ($O(n^3)$) -

פקודת הרצה לתוכנית הנל:

- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$./sub3 1 100`
- `max subArray sum:348avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub3 gmon.out > sub3_100.txt`
- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$./sub3 1 1000`
- `max subArray sum:2347avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub3 gmon.out > sub3_1000.txt`
- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$./sub3 1 10000`
- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$`
- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$`
- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$`
- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$`
- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$./sub3 1 10000`
- `max subArray sum:24697avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$ gprof sub3 gmon.out > sub3_10000.txt`
- `avi@avi-HP-Laptop-14s-dq2xxx:~/Desktop/SubArray$` □

קובצי gprof

מערך בגודל 100:

```

sub3_100.txt
1  Flat profile:
2
3  Each sample counts as 0.01 seconds.
4  no time accumulated
5
6      %   cumulative   self          self    total
7      time   seconds   seconds   calls  Ts/call  Ts/call  name
8      0.00     0.00     0.00  171800    0.00    0.00 std::vector<int, std::allocator<int> >::operator[](unsigned long
9      0.00     0.00     0.00    5050    0.00    0.00 int const& std::max<int>(int const&, int const&
10     0.00     0.00     0.00     100    0.00    0.00 return_random_number()
11     0.00     0.00     0.00      5    0.00    0.00 __gnu_cxx::new_allocator<int>::~new_allocator()
12     0.00     0.00     0.00      5    0.00    0.00 std::allocator<int>::~allocator()
13     0.00     0.00     0.00      4    0.00    0.00 __gnu_cxx::new_allocator<int>::new_allocator(__gnu_cxx::new_allocat
14     0.00     0.00     0.00      4    0.00    0.00 std::allocator<int>::allocator(std::allocator<int> const&
15     0.00     0.00     0.00      4    0.00    0.00 std::Vector_base<int, std::allocator<int> >::_M_get_Tp_allocato
16     0.00     0.00     0.00      3    0.00    0.00 __gnu_cxx::new_allocator<int>::_M_max_size() const
17     0.00     0.00     0.00      2    0.00    0.00 __gnu_cxx::new_allocator<int>::deallocate(int*, unsigned long)
18     0.00     0.00     0.00      2    0.00    0.00 __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*
19     0.00     0.00     0.00      2    0.00    0.00 __gnu_cxx::__normal_iterators<int const*, std::vector<int, std::allocat
20     0.00     0.00     0.00      2    0.00    0.00 __gnu_cxx::__normal_iterators<int const*, std::vector<int, std::allocat
21     0.00     0.00     0.00      2    0.00    0.00 void std::Destroy_aux<true>::__destroy<int*>(int*, int*)
22     0.00     0.00     0.00      2    0.00    0.00 std::Vector_base<int, std::allocator<int> >::_M_allocate(unsign
23     0.00     0.00     0.00      2    0.00    0.00 std::Vector_base<int, std::allocator<int> >::_Vector_impl::Vec
24     0.00     0.00     0.00      2    0.00    0.00 std::Vector_base<int, std::allocator<int> >::Vector impl::~Vector
25     0.00     0.00     0.00      2    0.00    0.00 std::Vector_base<int, std::allocator<int> >::_M_deallocate(int*)
26     0.00     0.00     0.00      2    0.00    0.00 std::Vector_base<int, std::allocator<int> >::_M_create_storage(
27     0.00     0.00     0.00      2    0.00    0.00 std::Vector_base<int, std::allocator<int> >::_Vector_impl_data::Vec
28     0.00     0.00     0.00      2    0.00    0.00 std::Vector_base<int, std::allocator<int> >::_Vector_base(unsign
29     0.00     0.00     0.00      2    0.00    0.00 std::Vector_base<int, std::allocator<int> >::_Vector_base()
30     0.00     0.00     0.00      2    0.00    0.00 std::allocator_traits<std::allocator<int> >::deallocate(std::allocat
31     0.00     0.00     0.00      2    0.00    0.00 std::allocator_traits<std::allocator<int> >::allocate(std::allocat
32     0.00     0.00     0.00      2    0.00    0.00 std::vector<int, std::allocator<int> >::~vector()
```

מערך בגודל 1000:

```

1  Flat profile:
2
3  Each sample counts as 0.01 seconds.
4
5      % cumulative self          self      total
6      time    seconds   seconds  calls  ms/call  ms/call     name
7  46.15      0.12     0.12 167168000     0.00     0.00 std::vector<int, std::allocator<int> >::operator[](unsigned lon
8  42.31      0.23     0.11       1    110.00   260.00 maxSubArray3(std::vector<int, std::allocator<int> >, int)
9  11.54      0.26     0.03  500500     0.00     0.00 int const& std::max<int>(int const&, int const&)
10 0.00      0.26     0.00     1000     0.00     0.00 return_random_number()
11 0.00      0.26     0.00       5     0.00     0.00 __gnu_cxx::new_allocator<int>::~new_allocator()
12 0.00      0.26     0.00       4     0.00     0.00 std::allocator<int>::~allocator()
13 0.00      0.26     0.00       4     0.00     0.00 __gnu_cxx::new_allocator<int>::new_allocator(__gnu_cxx::new_all
14 0.00      0.26     0.00       4     0.00     0.00 std::allocator<int>::operator=(std::allocator<int> const&)
15 0.00      0.26     0.00       3     0.00     0.00 __gnu_cxx::new_allocator<int>::_M_max_size() const
16 0.00      0.26     0.00       2     0.00     0.00 __gnu_cxx::new_allocator<int>::deallocate(int*, unsigned long)
17 0.00      0.26     0.00       2     0.00     0.00 __gnu_cxx::new_allocator<int>::allocate(unsigned long, void const*
18 0.00      0.26     0.00       2     0.00     0.00 __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
19 0.00      0.26     0.00       2     0.00     0.00 __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat
20 0.00      0.26     0.00       2     0.00     0.00 void std::destroy_aux<true>::__destroy<int*>(int*, int*)
21 0.00      0.26     0.00       2     0.00     0.00 std::Vector_base<int, std::allocator<int> >::_M_allocate(unsigned
22 0.00      0.26     0.00       2     0.00     0.00 std::Vector_base<int, std::allocator<int> >::_Vector_impl::Vec
23 0.00      0.26     0.00       2     0.00     0.00 std::Vector_base<int, std::allocator<int> >::_Vector_impl::~Vec
24 0.00      0.26     0.00       2     0.00     0.00 std::Vector_base<int, std::allocator<int> >::_M_deallocate(int*)
25 0.00      0.26     0.00       2     0.00     0.00 std::Vector_base<int, std::allocator<int> >::_M_create_storage(
26 0.00      0.26     0.00       2     0.00     0.00 std::Vector_base<int, std::allocator<int> >::_Vector_impl_data::V
27 0.00      0.26     0.00       2     0.00     0.00 std::Vector_base<int, std::allocator<int> >::_Vector_base(unsig
28 0.00      0.26     0.00       2     0.00     0.00 std::Vector_base<int, std::allocator<int> >::~Vector_base()
29 0.00      0.26     0.00       2     0.00     0.00 std::allocator_traits<std::allocator<int> >::deallocate(std::allocat
30 0.00      0.26     0.00       2     0.00     0.00 std::allocator_traits<std::allocator<int> >::allocate(std::allocat
31 0.00      0.26     0.00       2     0.00     0.00 std::vector<int, std::allocator<int> >::~vector()
32 0.00      0.26     0.00       2     0.00     0.00 __gnu_cxx::__normal_iterator<int const*, std::vector<int, std::allocat

```

מערך בגודל 10000:

בתוכנית הנ"ל ניתן לראות בבירור כי זמן הריצה של האלגוריתם גבוהה בהרבה מאשר זמן הריצה של ייצור המספרים הרנדומליים - זאת על פי עמודת הזמן של הפונקציה random number return בקבוץ `gprof`.
36 דקוט עברו האלגוריתם לעומת הזמן הzinich של הייצרה של המספרים הרנדומליים.

שאלה 6-מספר טלפונים

תיעוד מופיע בתוך הקוד בתוכנית הראשית.