

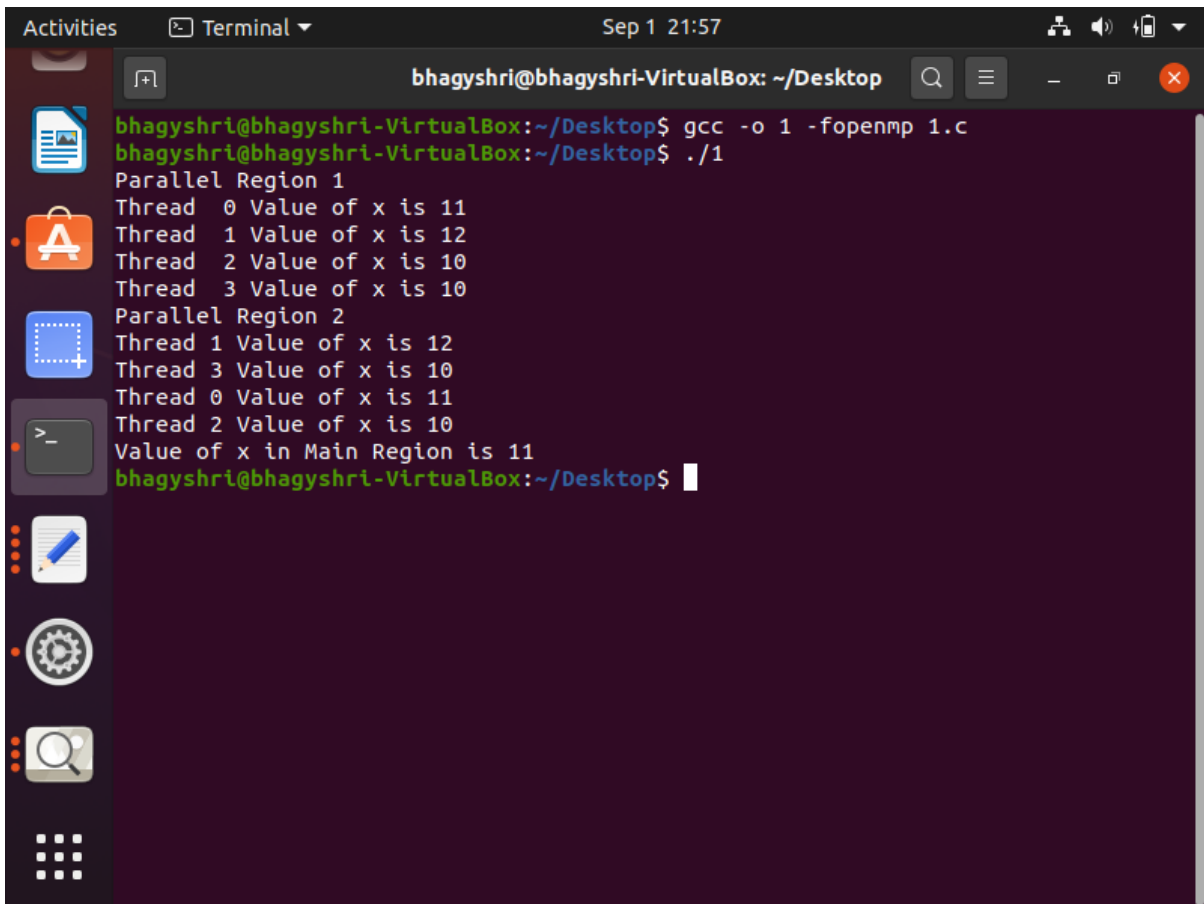
NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA SURATHKAL
DEPARTMENT OF INFORMATION TECHNOLOGY
IT 301 Parallel Computing LAB 3

26th August 2020

Faculty: Dr. Geetha V and Mrs. Tanmayee

Bhagyashri Bhamare 181IT111

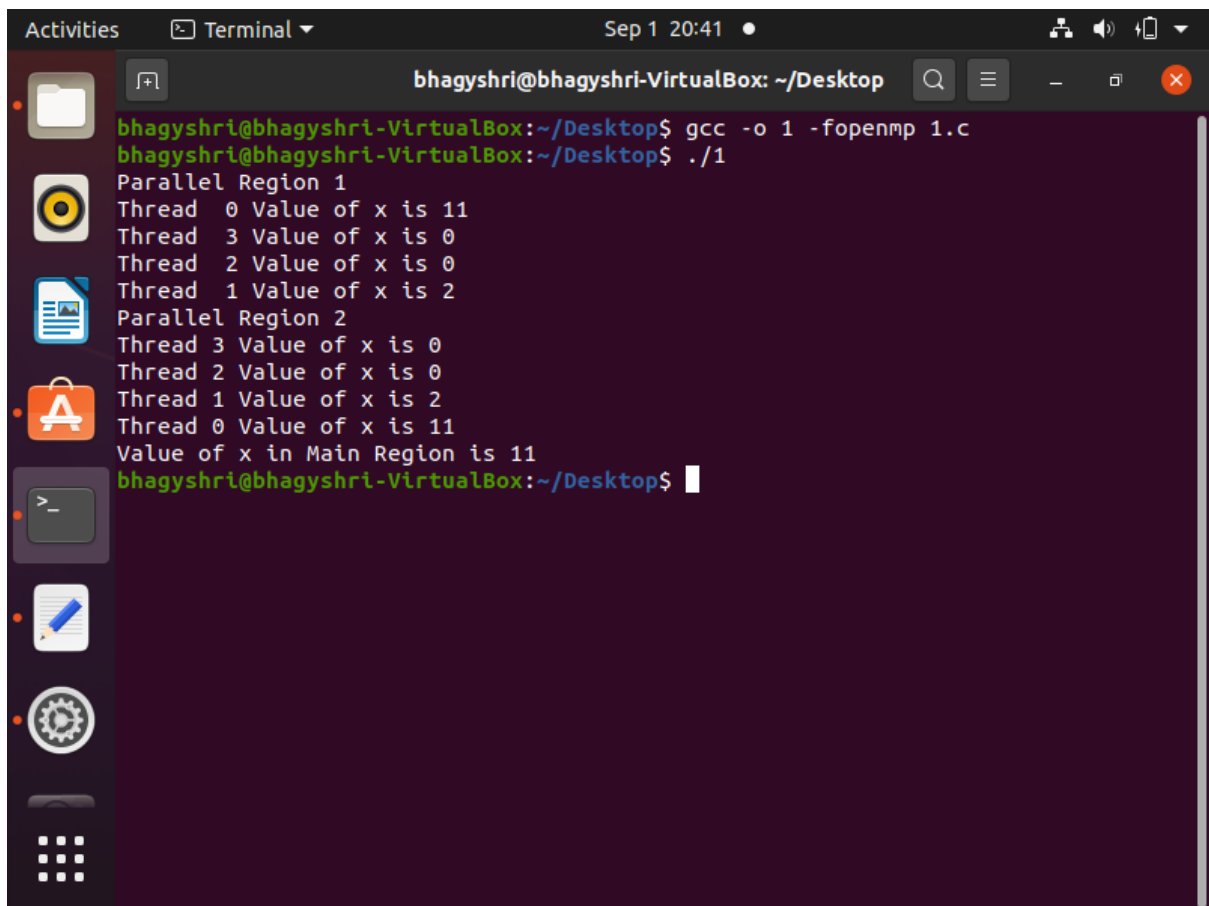
Q1 Execute following code and observe the working of threadprivate directive and copyin clause:



```
bhagyashri@bhagyashri-VirtualBox: ~/Desktop
bhagyashri@bhagyashri-VirtualBox:~/Desktop$ gcc -o 1 -fopenmp 1.c
bhagyashri@bhagyashri-VirtualBox:~/Desktop$ ./1
Parallel Region 1
Thread 0 Value of x is 11
Thread 1 Value of x is 12
Thread 2 Value of x is 10
Thread 3 Value of x is 10
Parallel Region 2
Thread 1 Value of x is 12
Thread 3 Value of x is 10
Thread 0 Value of x is 11
Thread 2 Value of x is 10
Value of x in Main Region is 11
bhagyashri@bhagyashri-VirtualBox:~/Desktop$
```

The `copyin` clause provides a mechanism to copy the value of a threadprivate variable of the master thread to the threadprivate variable of each other member of the team that is executing the parallel region.

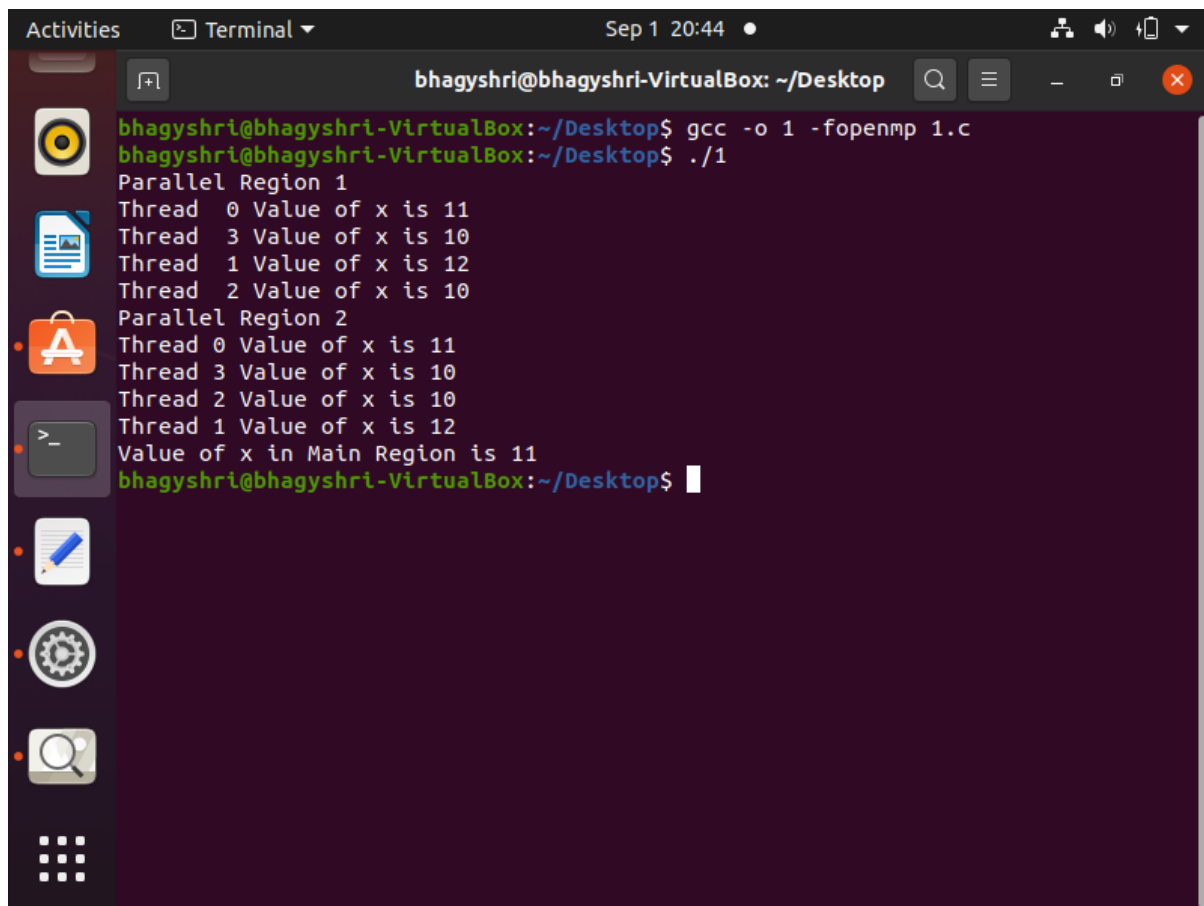
Remove copyin



```
Activities Terminal Sep 1 20:41
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 1 -fopenmp 1.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./1
Parallel Region 1
Thread 0 Value of x is 11
Thread 3 Value of x is 0
Thread 2 Value of x is 0
Thread 1 Value of x is 2
Parallel Region 2
Thread 3 Value of x is 0
Thread 2 Value of x is 0
Thread 1 Value of x is 2
Thread 0 Value of x is 11
Value of x in Main Region is 11
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

The `copyin` clause provides a mechanism to copy the value of a threadprivate variable of the master thread to the threadprivate variable of each other member of the team that is executing the parallel region. Therefore removing `copyin` results in value of `x` for threads other than master thread (i.e.thread 0) to be modified w.r.t. 0 and not w.r.t. 10.

Remove `copyin` clause and initialize `x` globally.



```
Activities Terminal Sep 1 20:44
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 1 -fopenmp 1.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./1
Parallel Region 1
Thread 0 Value of x is 11
Thread 3 Value of x is 10
Thread 1 Value of x is 12
Thread 2 Value of x is 10
Parallel Region 2
Thread 0 Value of x is 11
Thread 3 Value of x is 10
Thread 2 Value of x is 10
Thread 1 Value of x is 12
Value of x in Main Region is 11
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

Analysis--Even if copyin is removed, as x is defined globally so output which we got is same as that of having copyin clause.

Q2)Learn the concept of firstprivate() and threadprivate()

```
Activities Terminal Sep 1 20:47
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./2
1. count=0
tid=0,a[0]=0, count=1 x=11
tid=0,a[1]=2, count=2 x=12
tid=0,a[2]=4, count=3 x=13
tid=0,a[3]=6, count=4 x=14
tid=0,a[4]=8, count=5 x=15
tid=1,a[5]=10, count=1 x=11
tid=1,a[6]=12, count=2 x=12
tid=1,a[7]=14, count=3 x=13
tid=1,a[8]=16, count=4 x=14
tid=1,a[9]=18, count=5 x=15
2. before copyprivate count=5 x=10 tid=0
2. before copyprivate count=5 x=10 tid=1
3. after copyprivate count=25 x=10 tid=1
tid=1,a[5]=25, count=26, x=11
tid=1,a[6]=36, count=27, x=12
tid=1,a[7]=49, count=28, x=13
tid=1,a[8]=64, count=29, x=14
tid=1,a[9]=81, count=30, x=15
3. after copyprivate count=25 x=10 tid=0
tid=0,a[0]=0, count=26, x=11
tid=0,a[1]=1, count=27, x=12
tid=0,a[2]=4, count=28, x=13
tid=0,a[3]=9, count=29, x=14
tid=0,a[4]=16, count=30, x=15
4. count=30 x=10
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

Q3) Program to understand the concept of collapse()

collapse() allows parallelization of perfectly nested loops without using nested parallelism

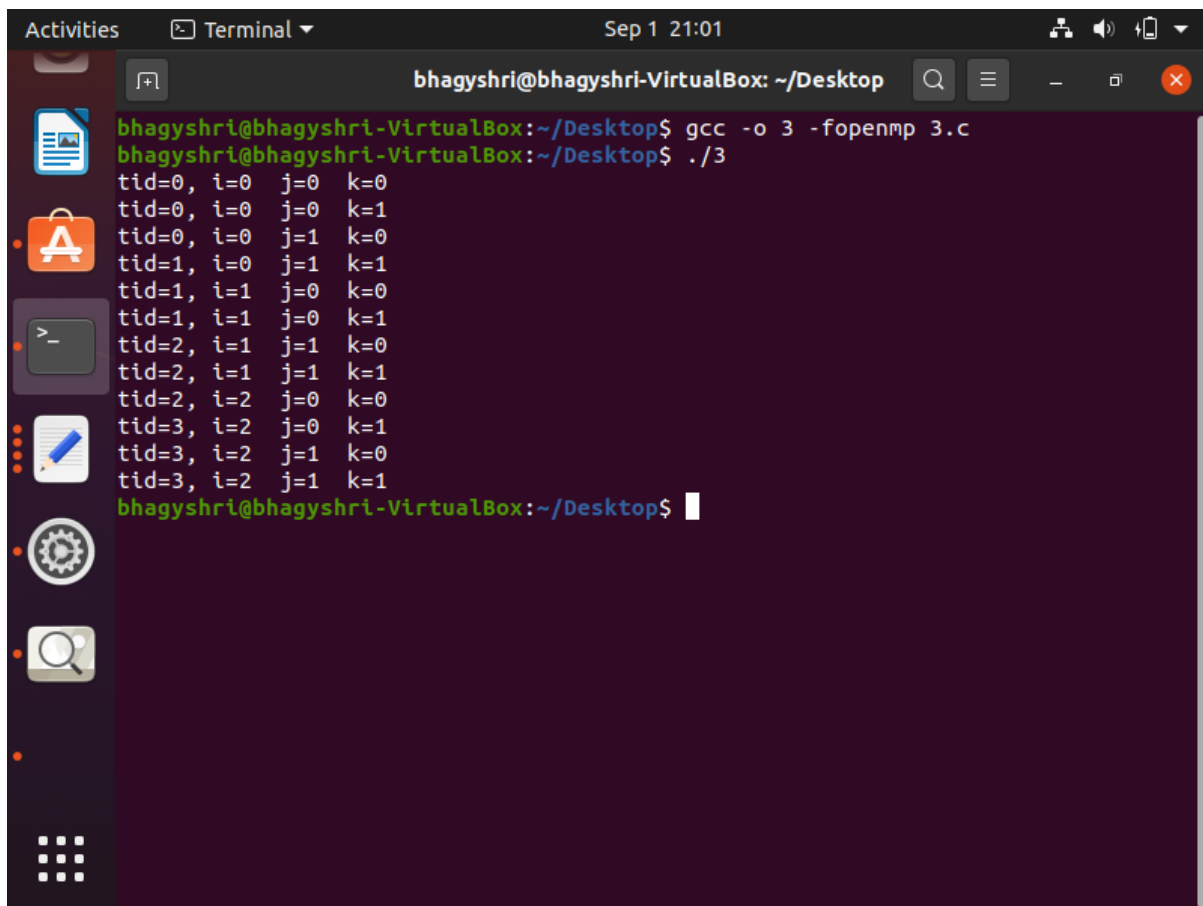
NO collapse()

```
Activities  Terminal  Sep 1 20:59
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 3 -fopenmp 3.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./3
tid=0, i=0 j=0 k=0
tid=0, i=0 j=0 k=1
tid=0, i=0 j=1 k=0
tid=0, i=0 j=1 k=1
tid=0, i=1 j=0 k=0
tid=0, i=1 j=0 k=1
tid=0, i=1 j=1 k=0
tid=0, i=1 j=1 k=1
tid=0, i=2 j=0 k=0
tid=0, i=2 j=0 k=1
tid=0, i=2 j=1 k=0
tid=0, i=2 j=1 k=1
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

collapse(2)

```
Activities  Terminal  Sep 1 21:00
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 3 -fopenmp 3.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./3
tid=0, i=0 j=0 k=0
tid=0, i=0 j=0 k=1
tid=0, i=0 j=1 k=0
tid=0, i=0 j=1 k=1
tid=0, i=1 j=0 k=0
tid=0, i=1 j=0 k=1
tid=1, i=1 j=1 k=0
tid=1, i=1 j=1 k=1
tid=1, i=2 j=0 k=0
tid=1, i=2 j=0 k=1
tid=1, i=2 j=1 k=0
tid=1, i=2 j=1 k=1
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

collapse(3)



The screenshot shows a terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop". The user has compiled a program named "3.c" using the command `gcc -o 3 -fopenmp 3.c` and then executed it with `./3`. The output displays 12 lines of thread identifiers and their indices: `tid=0, i=0 j=0 k=0` through `tid=3, i=2 j=1 k=1`. The terminal window includes a sidebar with application icons and a top bar with system status and window controls.

```
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 3 -fopenmp 3.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./3
tid=0, i=0 j=0 k=0
tid=0, i=0 j=0 k=1
tid=0, i=0 j=1 k=0
tid=1, i=0 j=1 k=1
tid=1, i=1 j=0 k=0
tid=1, i=1 j=0 k=1
tid=2, i=1 j=1 k=0
tid=2, i=1 j=1 k=1
tid=2, i=2 j=0 k=0
tid=3, i=2 j=0 k=1
tid=3, i=2 j=1 k=0
tid=3, i=2 j=1 k=1
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

3. Write a sequential program to find the smallest element in an array. Convert the same program for parallel execution. Initialise array with random numbers. Consider an array size as 10k, 50k and 100k. Analyse the result for maximum number of threads and various `schedule()` function. Based on observation, perform analysis of the total execution time and explain the result by plotting the graph. [increase array size until parallel execution time is less than sequential execution.

Sequential Program

```
#include <stdio.h>

#include <sys/time.h>

#include <omp.h>

#include <stdlib.h>

#include <limits.h>

#define n 5000

int main(void)

{
```

```

struct timeval TimeValue_Start;

struct timezone TimeZone_Start;

struct timeval TimeValue_Final;

struct timezone TimeZone_Final;

long time_start, time_end;

double time_overhead;

int i;

int array[n];

for(i = 0; i<=n; i++)

{

    array[i] = rand();

}

gettimeofday(&TimeValue_Start, &TimeZone_Start);

int small = INT_MAX;

for(i = 0; i<=n; i++)

{

    if(array[i]<small) small = array[i];

}

gettimeofday(&TimeValue_Final, &TimeZone_Final);

time_start = TimeValue_Start.tv_sec * 1000000 + TimeValue_Start.tv_usec;

time_end = TimeValue_Final.tv_sec * 1000000 + TimeValue_Final.tv_usec;

time_overhead = (time_end - time_start)/1000000.0;

printf("\n\nTime in Seconds (T) : %lf\n",time_overhead);

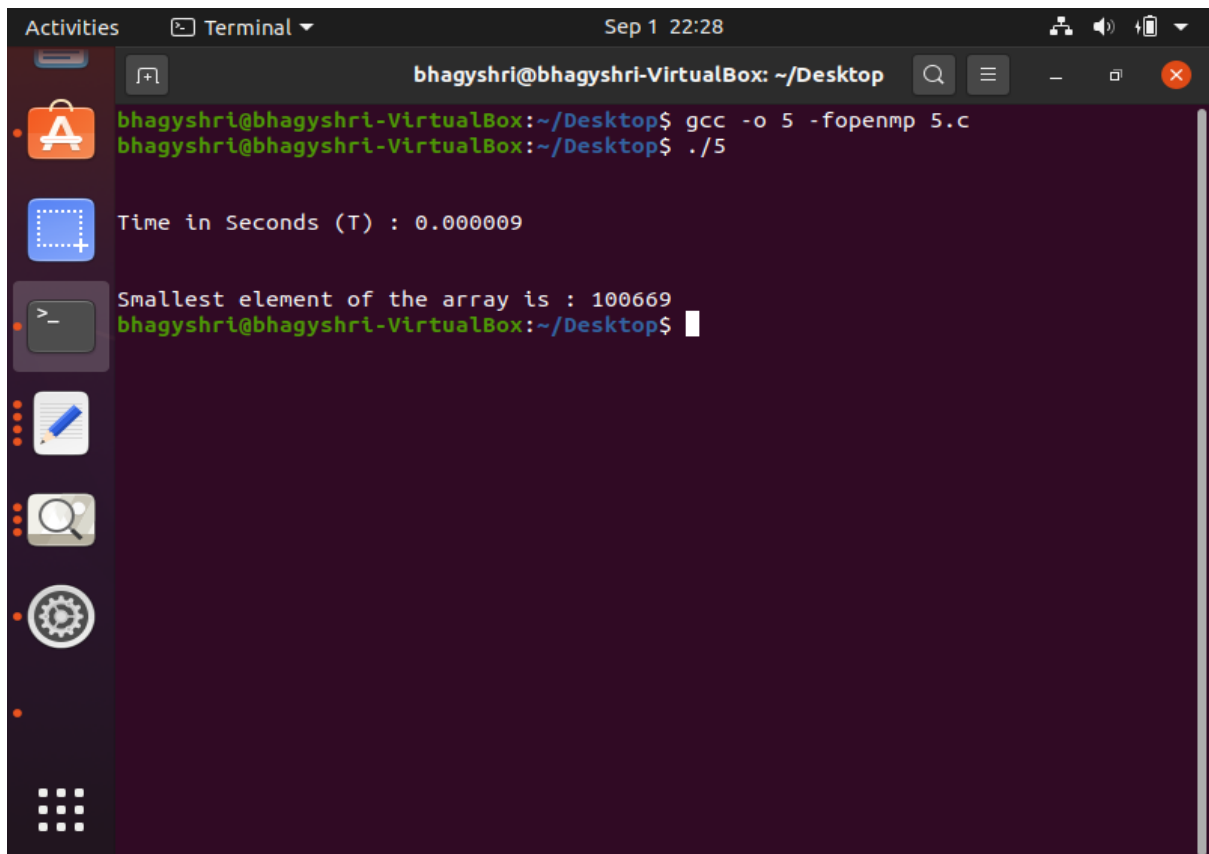
printf("\n\nSmallest element of the array is : %d\n",small);

return 0;

}

```

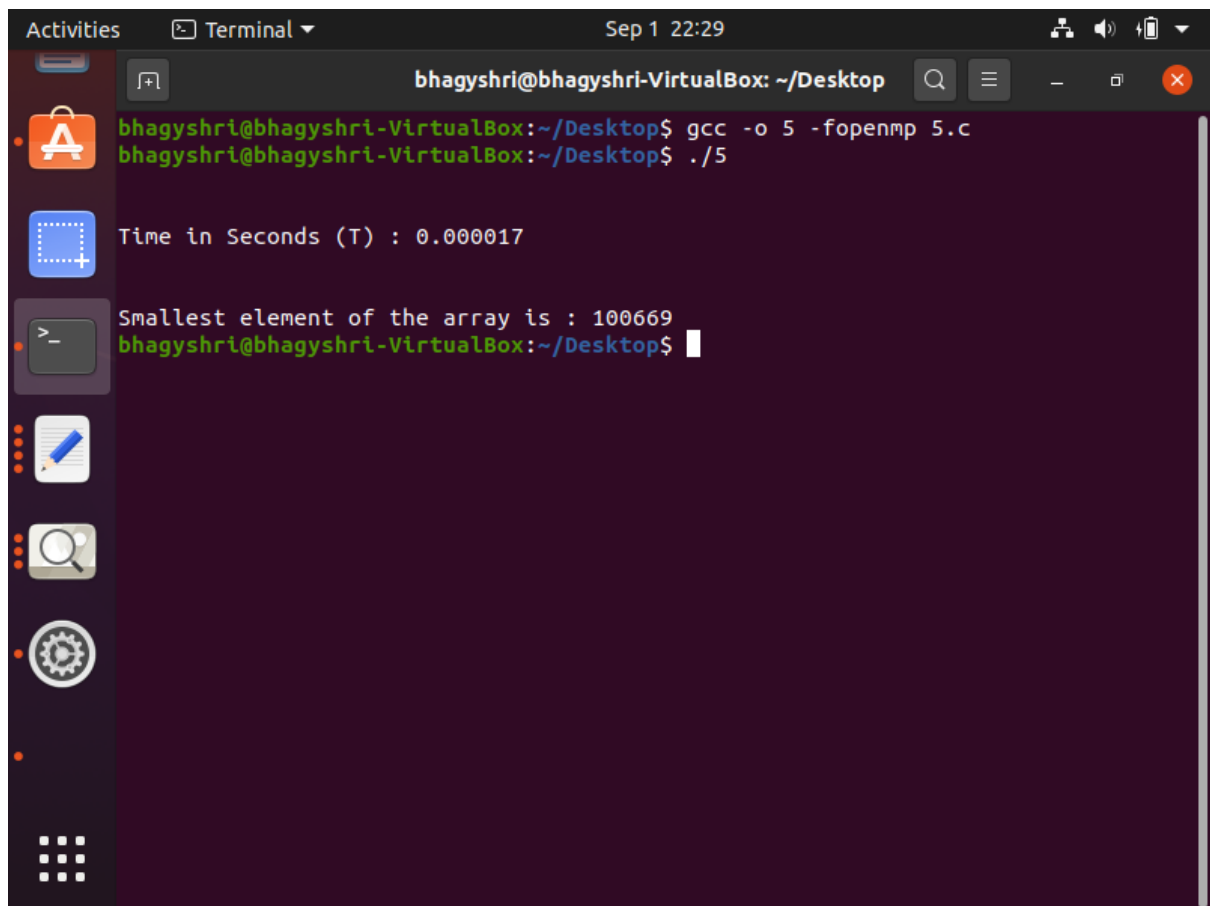

For 5k



A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background and a light-colored text. The terminal output is as follows:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 5 -fopenmp 5.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./5
Time in Seconds (T) : 0.000009
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

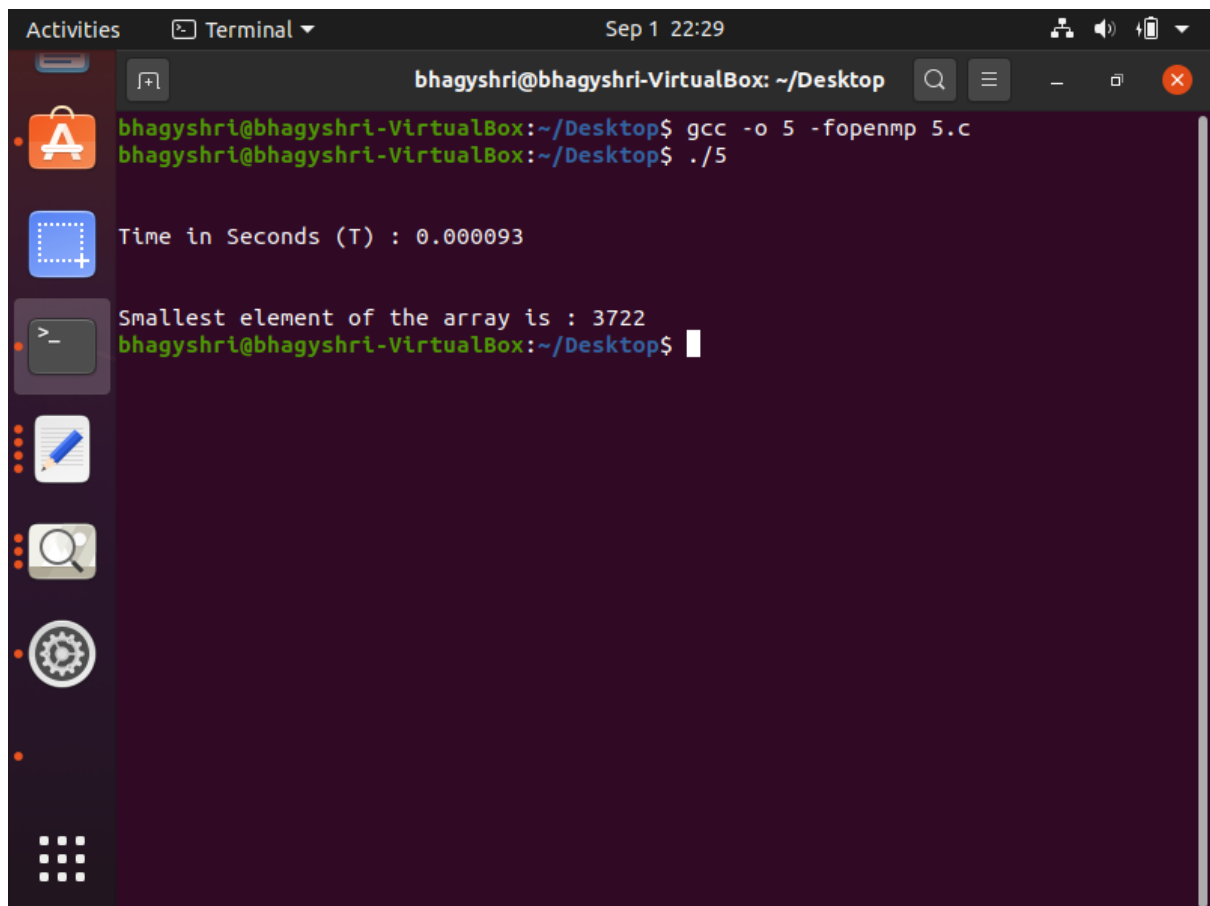
The terminal window includes a sidebar on the left with various application icons (e.g., file manager, web browser, terminal, settings) and a top bar with system status icons (e.g., network, volume, battery) and the date/time "Sep 1 22:28".



A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" with a search icon, menu icon, and window control buttons. The terminal shows the execution of a C program. The user enters the command `gcc -o 5 -fopenmp 5.c` to compile the program. Then, they enter `./5` to run it. The program outputs "Time in Seconds (T) : 0.000017" and "Smallest element of the array is : 100669". The prompt `bhagyshri@bhagyshri-VirtualBox:~/Desktop$` is visible at the end of the line.

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 5 -fopenmp 5.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./5
Time in Seconds (T) : 0.000017
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

For 10k

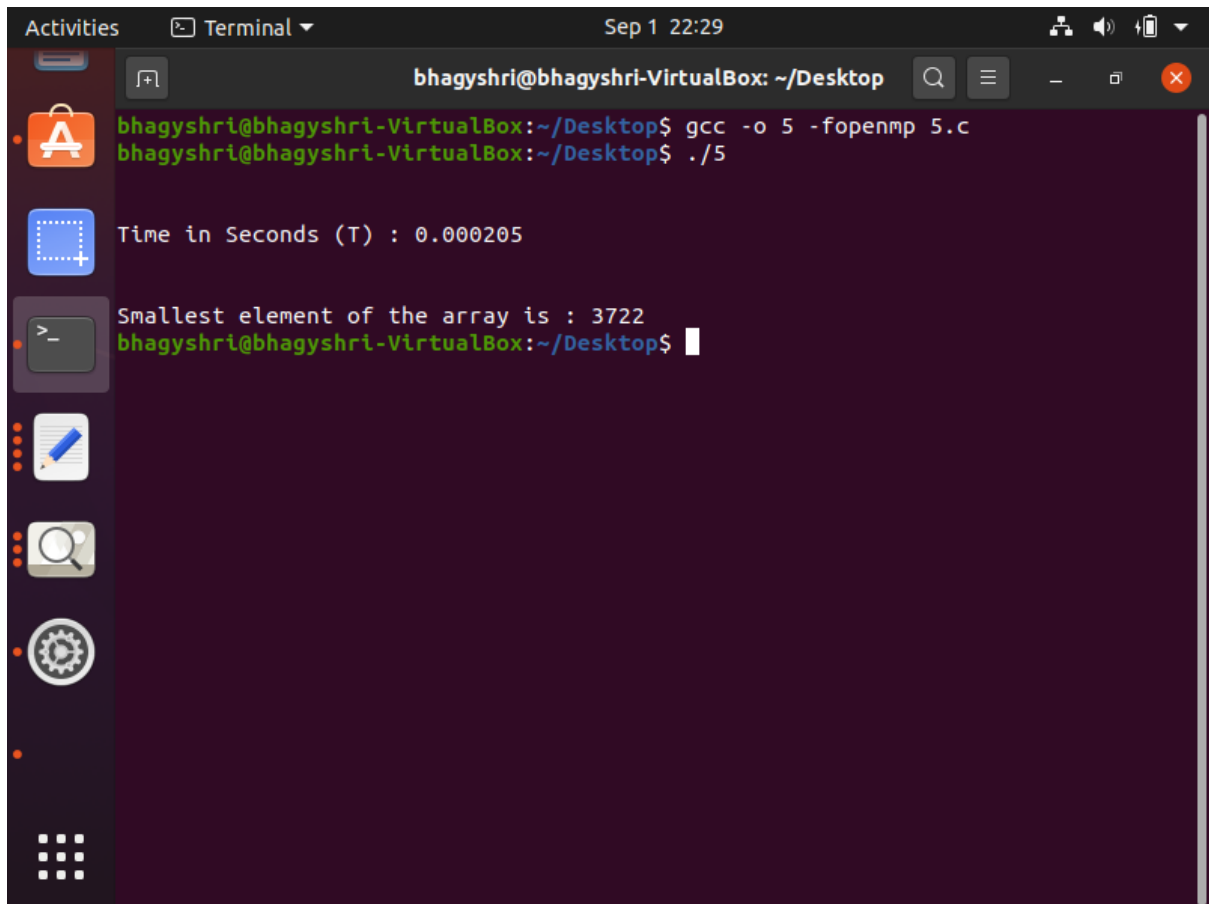


A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark theme. The terminal output is as follows:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 5 -fopenmp 5.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./5
Time in Seconds (T) : 0.000093
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

The left sidebar of the terminal window contains several icons: a red application icon, a blue icon with a plus sign, a terminal icon (highlighted), a notepad icon, a magnifying glass icon, a gear icon, and a grid icon at the bottom.

For 50k



```
Activities Terminal Sep 1 22:29
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 5 -fopenmp 5.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./5
Time in Seconds (T) : 0.000205
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

For 100k

Parallel Program

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

```
#include <sys/time.h>
```

```
#include <omp.h>
```

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

```
#define n 100000
```

```
#include <limits.h>
```

```
int main(void)
```

```
{
```

```
    struct timeval TimeValue_Start;
```

```

struct timezone TimeZone_Start;

struct timeval TimeValue_Final;

struct timezone TimeZone_Final;

long time_start, time_end;

double time_overhead;double pi,x;

int i;

int array[n];

for(i = 0; i<=n; i++)

{

    array[i] = rand();

}

gettimeofday(&TimeValue_Start, &TimeZone_Start);

int small =INT_MAX;

/*schedule parameter can be changed to static, dynamic,(static,1),(dynamic,1),guided,
runtime*/

#pragma omp parallel for schedule(static) reduction(min:small)

    for(i = 0; i<=n; i++)

    {

        if(array[i]<small) small = array[i];

    }

gettimeofday(&TimeValue_Final, &TimeZone_Final);

time_start = TimeValue_Start.tv_sec * 1000000 + TimeValue_Start.tv_usec;

time_end = TimeValue_Final.tv_sec * 1000000 + TimeValue_Final.tv_usec;

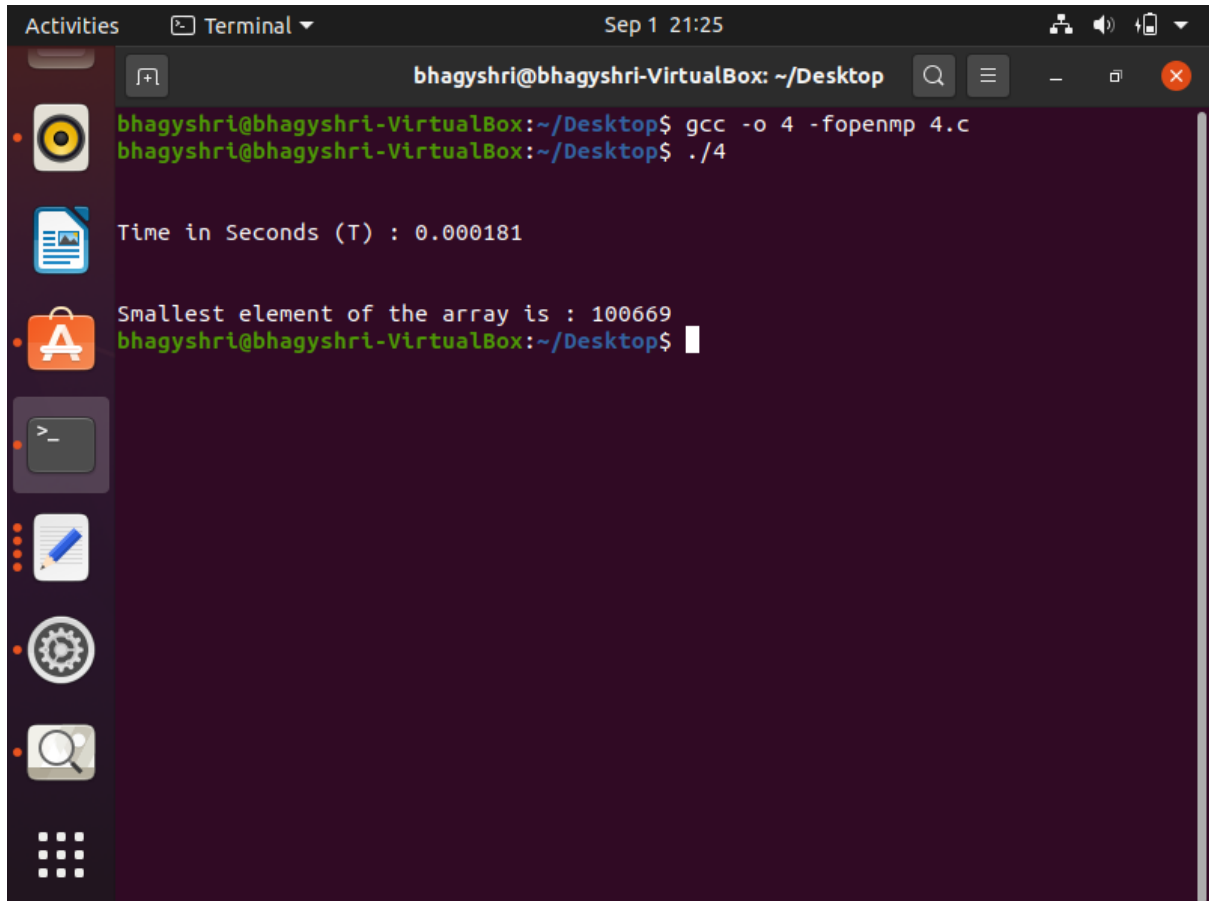
time_overhead = (time_end - time_start)/1000000.0;

printf("\n\nTime in Seconds (T) : %lf\n",time_overhead);

```

```
printf("\n\nSmallest element of the array is : %d\n",small);  
  
return 0;  
  
}
```

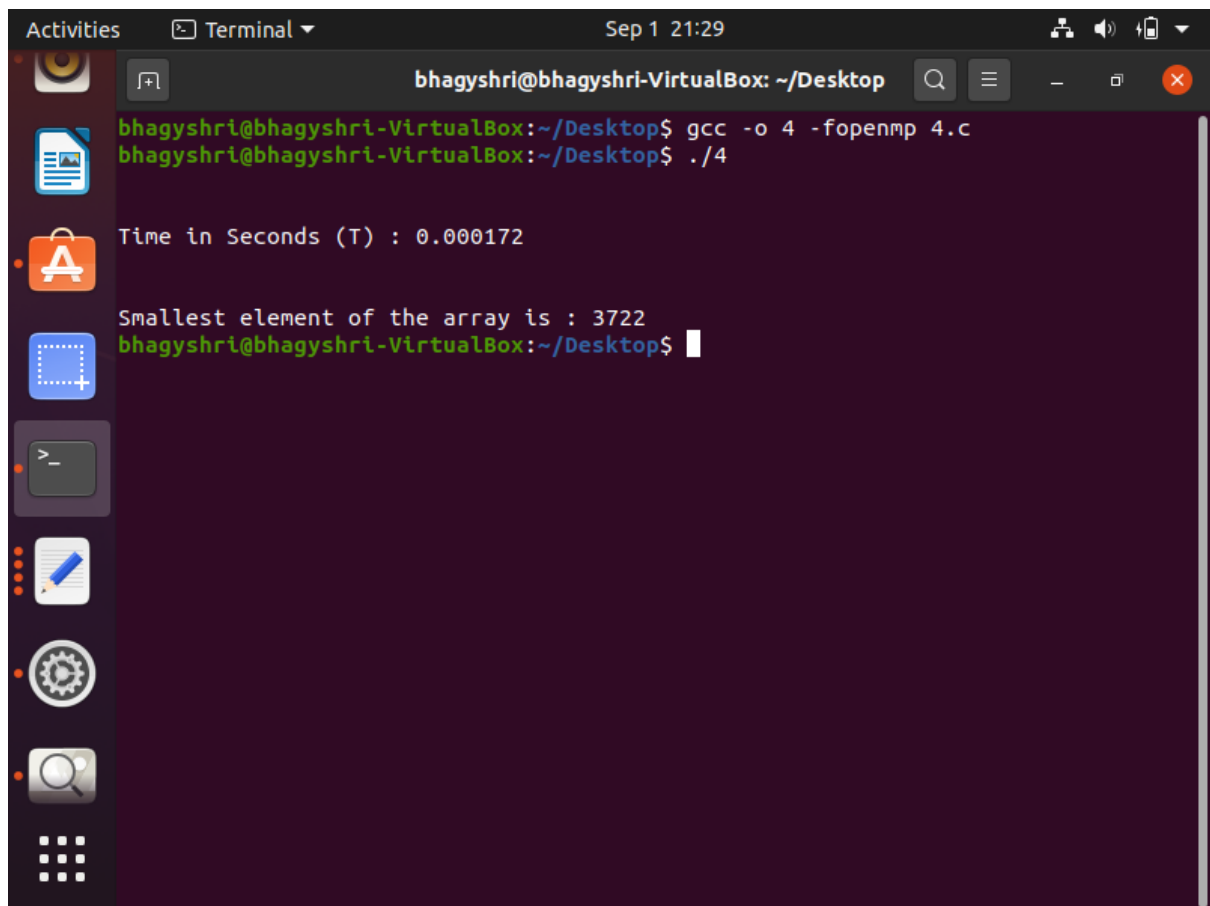
For static



The screenshot shows a terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop". The user has compiled a C program named "4.c" using the command `gcc -o 4 -fopenmp 4.c` and then executed it with `./4`. The output of the program is displayed on two lines: "Time in Seconds (T) : 0.000181" and "Smallest element of the array is : 100669". The terminal window has a dark purple background and a sidebar on the left with various application icons.

```
bhagyshri@bhagyshri-VirtualBox: ~/Desktop  
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c  
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4  
  
Time in Seconds (T) : 0.000181  
  
Smallest element of the array is : 100669  
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

Output for 5k

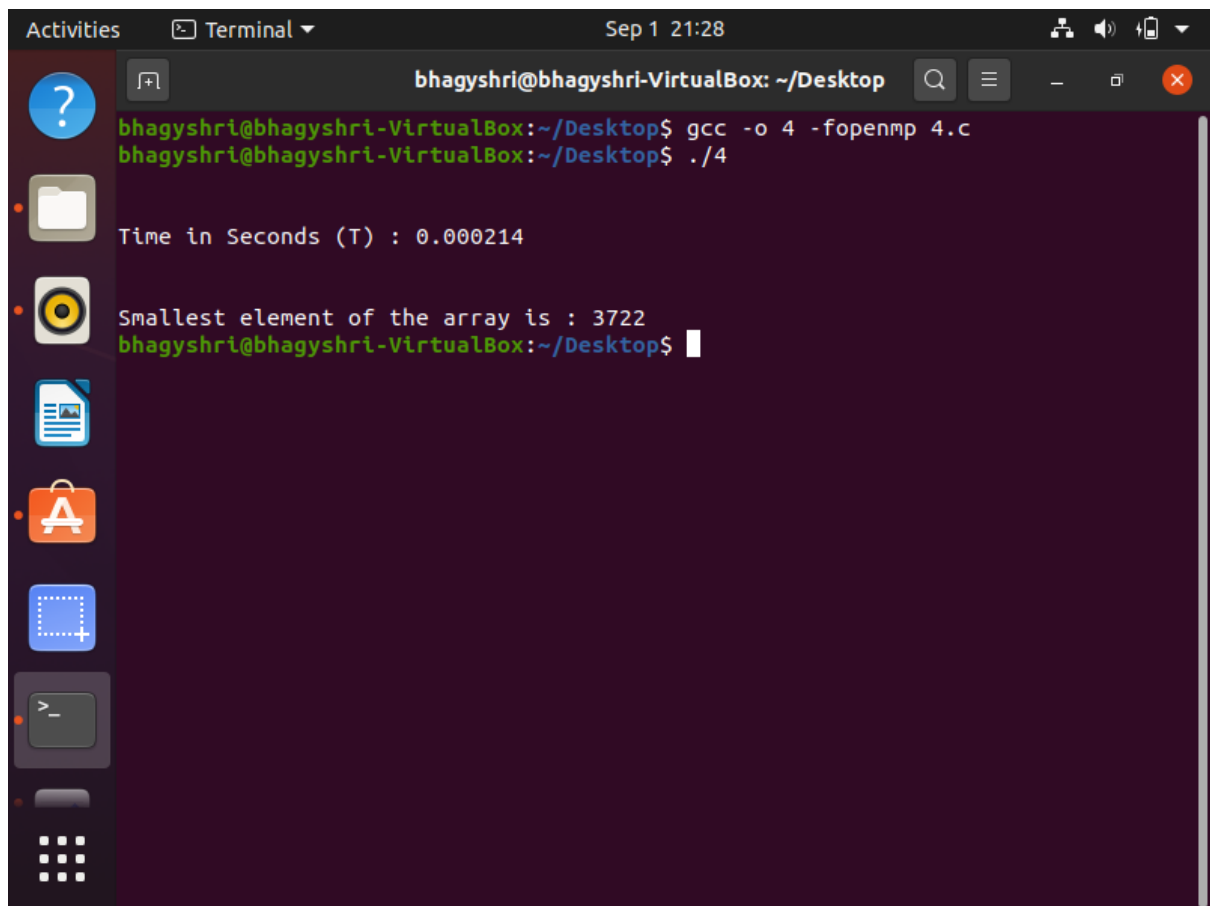


A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" with a search icon, a menu icon, and window control buttons. The terminal shows the following commands and output:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000172
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

The left sidebar of the window contains icons for Activities, a file manager, an application store, a workspace manager, a terminal, a text editor, system settings, and a search utility.

Output for 100k

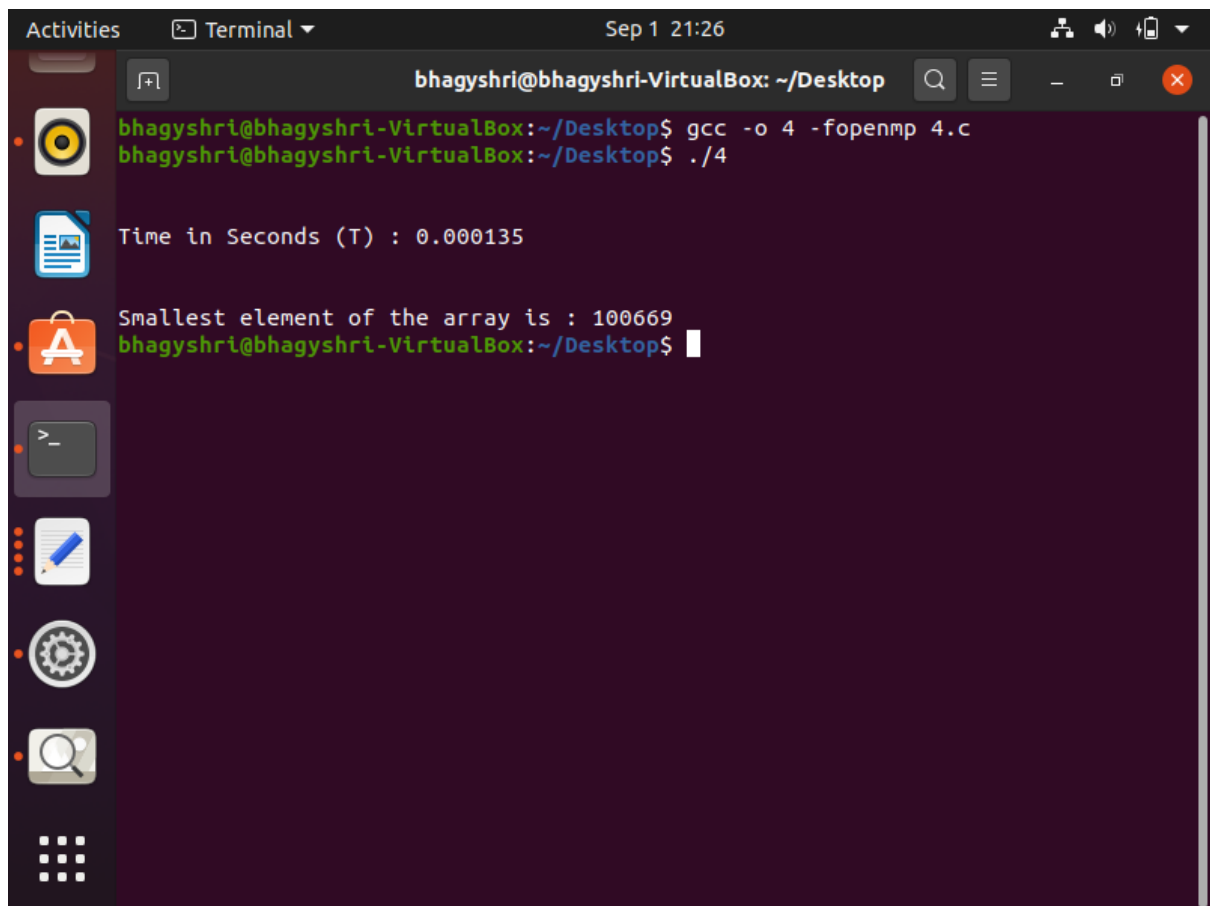


A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" with a search icon, menu icon, and window control buttons. The terminal shows the following commands and output:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000214
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

The left sidebar of the terminal window contains several icons: a question mark, a folder, a speaker, a document with a magnifying glass, an application icon, a window icon, a terminal icon, and a keyboard icon.

Output for 50k

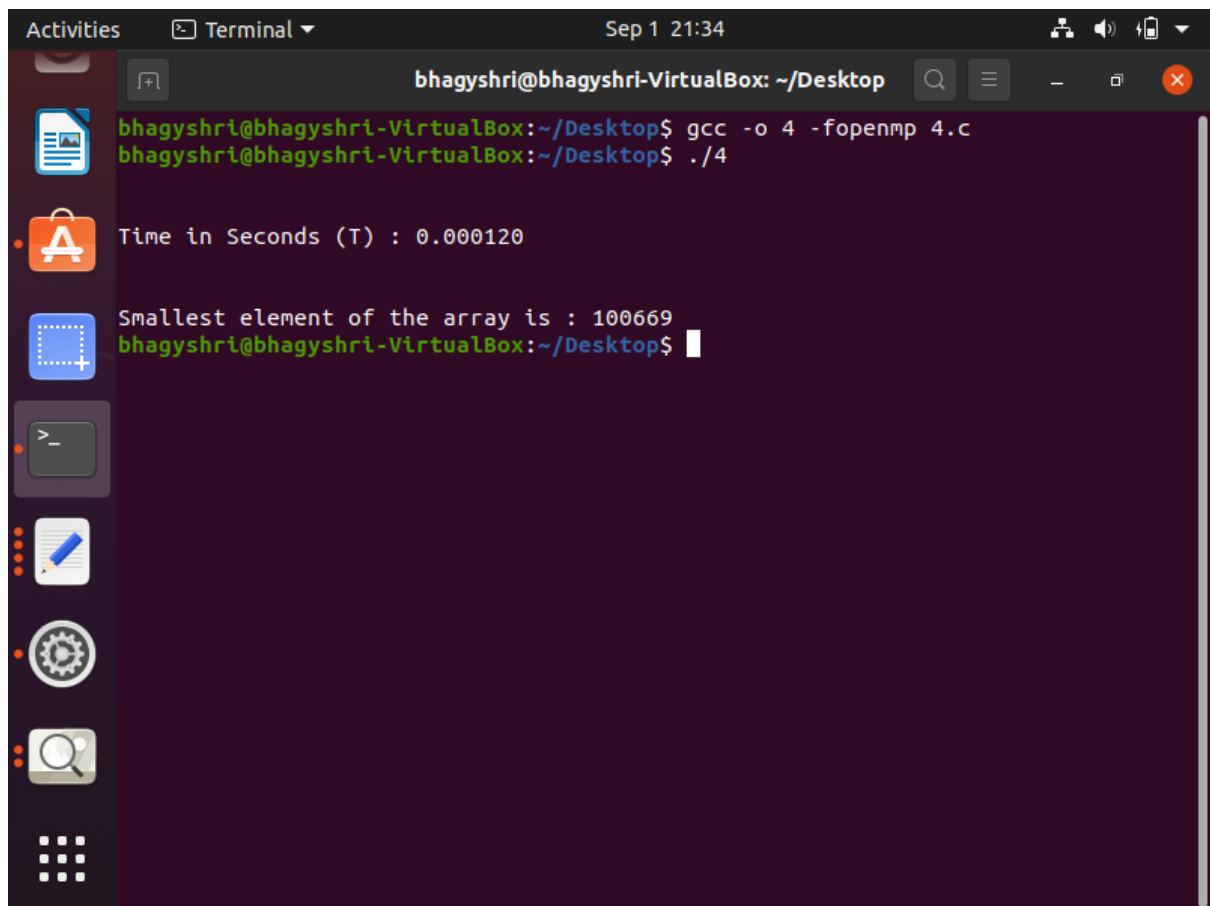


A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background and a light-colored title bar. The terminal output is as follows:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000135
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

Output for 10k

Output for static,chunksize=1

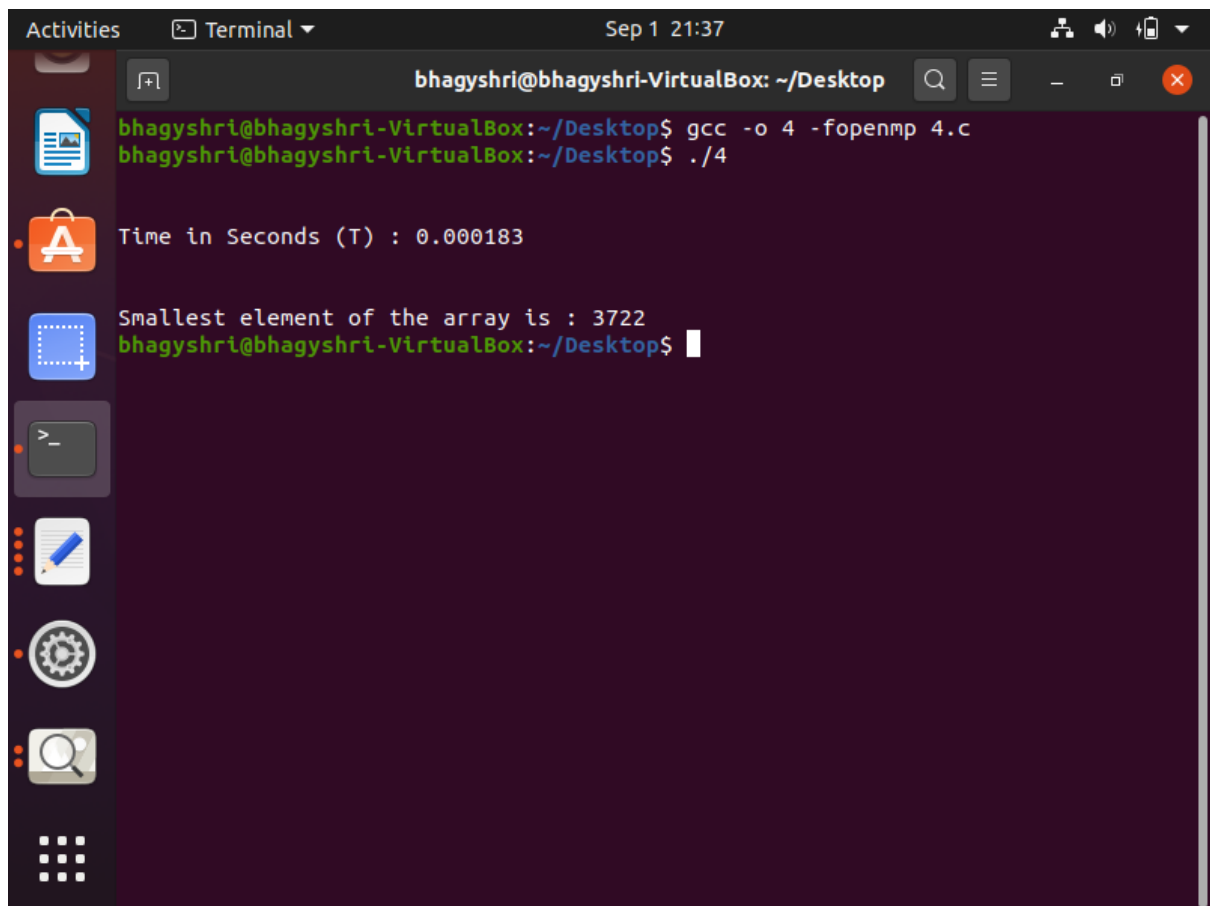


A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background and a light-colored title bar. The terminal displays the following commands and output:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000120
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

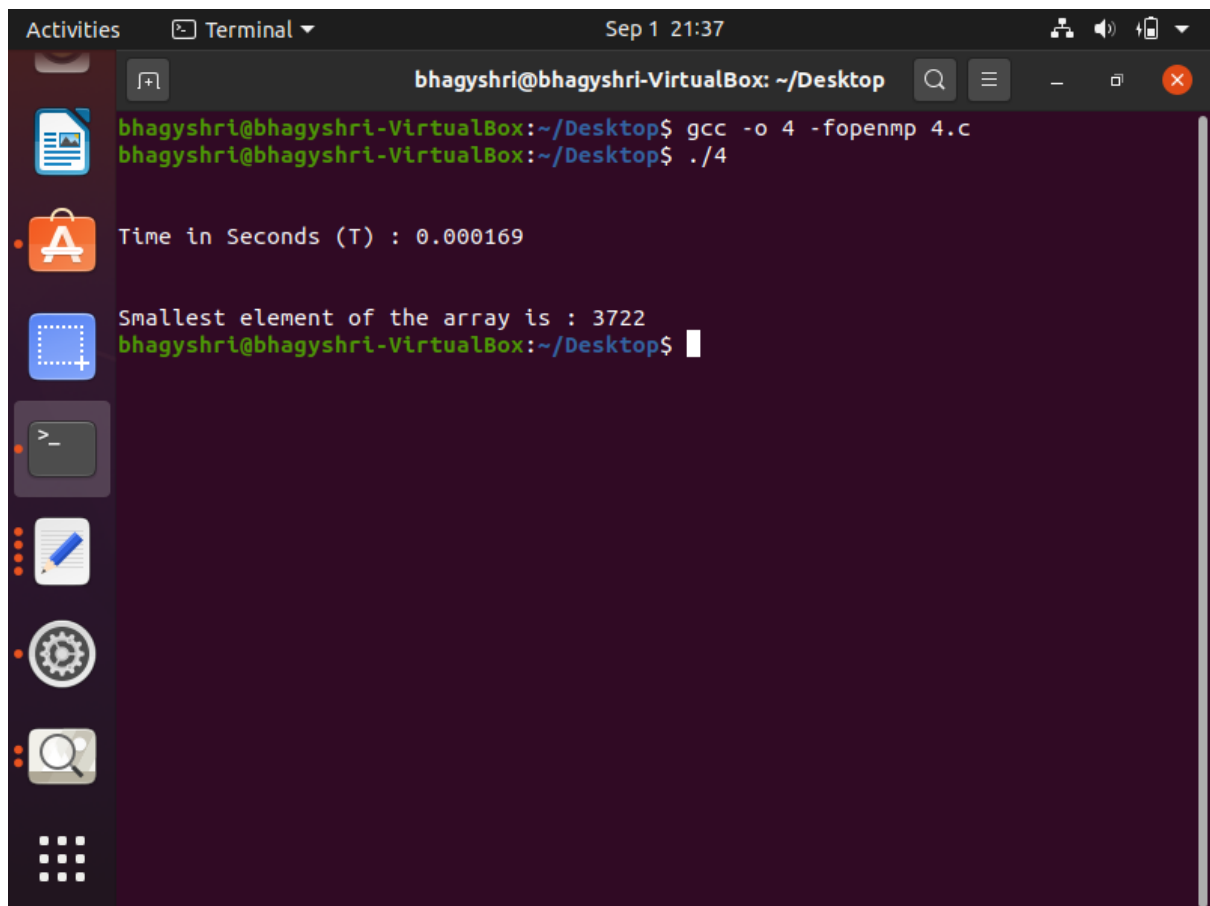
The left sidebar of the terminal window shows various application icons, including a file manager, a terminal, a text editor, and a settings icon.

Output for 5k

A terminal window titled 'bhagyshri@bhagyshri-VirtualBox: ~/Desktop' with a dark purple background. The window shows the execution of a C++ program. The first command is 'gcc -o 4 -fopenmp 4.c', followed by './4'. The output consists of two lines: 'Time in Seconds (T) : 0.000183' and 'Smallest element of the array is : 3722'. The prompt 'bhagyshri@bhagyshri-VirtualBox:~/Desktop\$' is visible at the end of the second line. On the left side of the terminal, there is a vertical dock with icons for a file manager, application store, development tools, and system settings. The top of the window shows system status icons and the date 'Sep 1 21:37'.

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000183
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

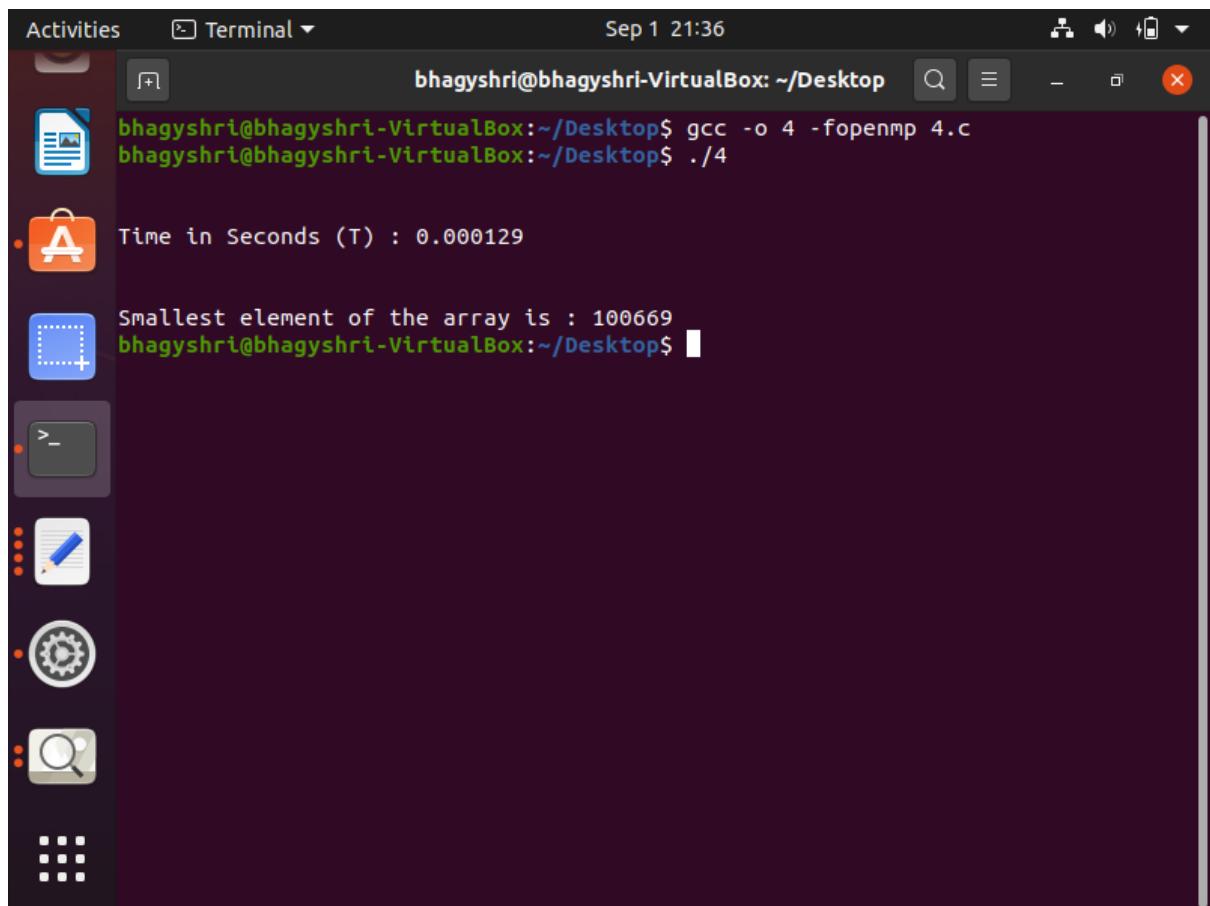
Output for 100k



A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background with green and white text. The left sidebar contains icons for various applications. The terminal output shows the compilation of a C program named "4.c" using "gcc" with flags "-o 4 -fopenmp". After running the program with "./4", it outputs "Time in Seconds (T) : 0.000169" and "Smallest element of the array is : 3722". The prompt "bhagyshri@bhagyshri-VirtualBox: ~/Desktop\$" is visible at the end of the output.

```
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$ ./4
Time in Seconds (T) : 0.000169
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$
```

Output for 50k

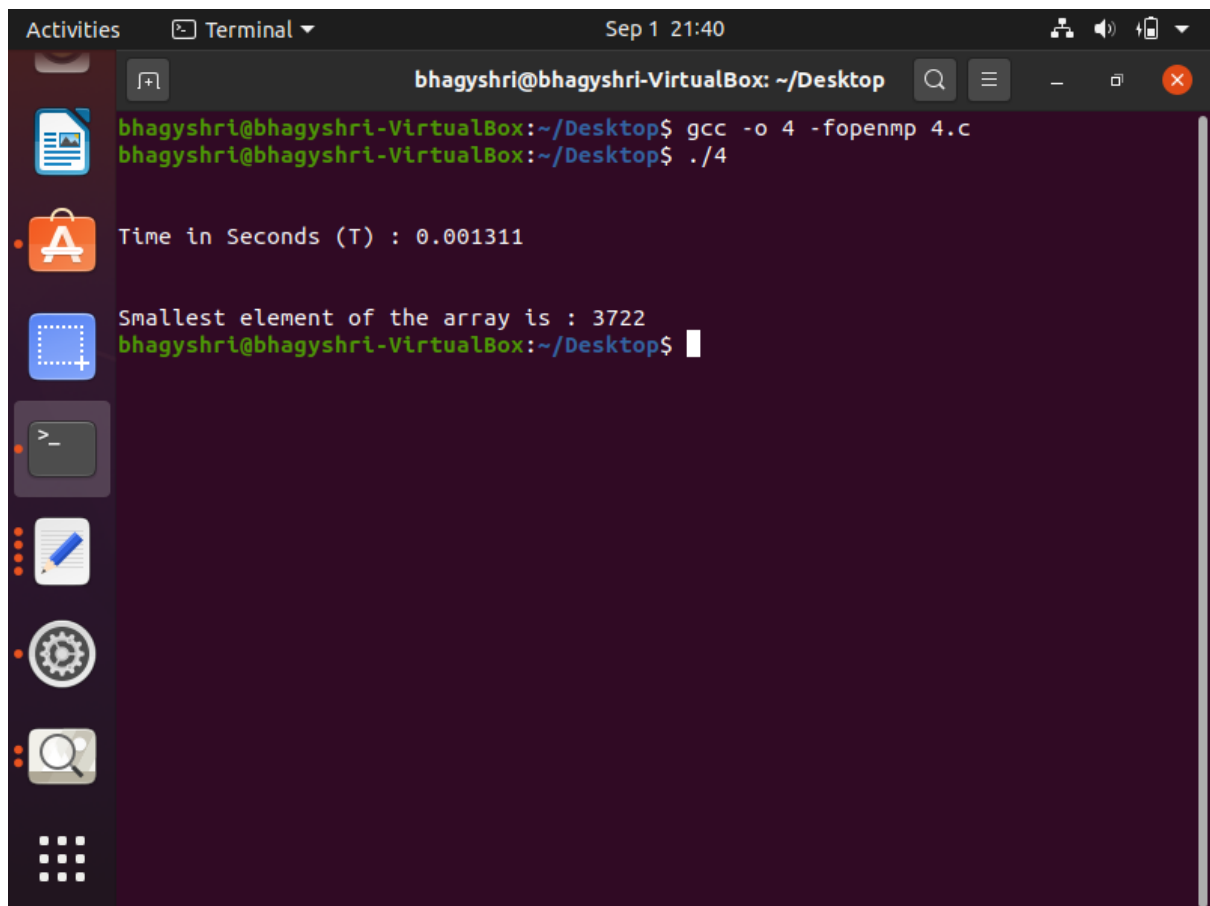


A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background and a light-colored text. The terminal output is as follows:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000129
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

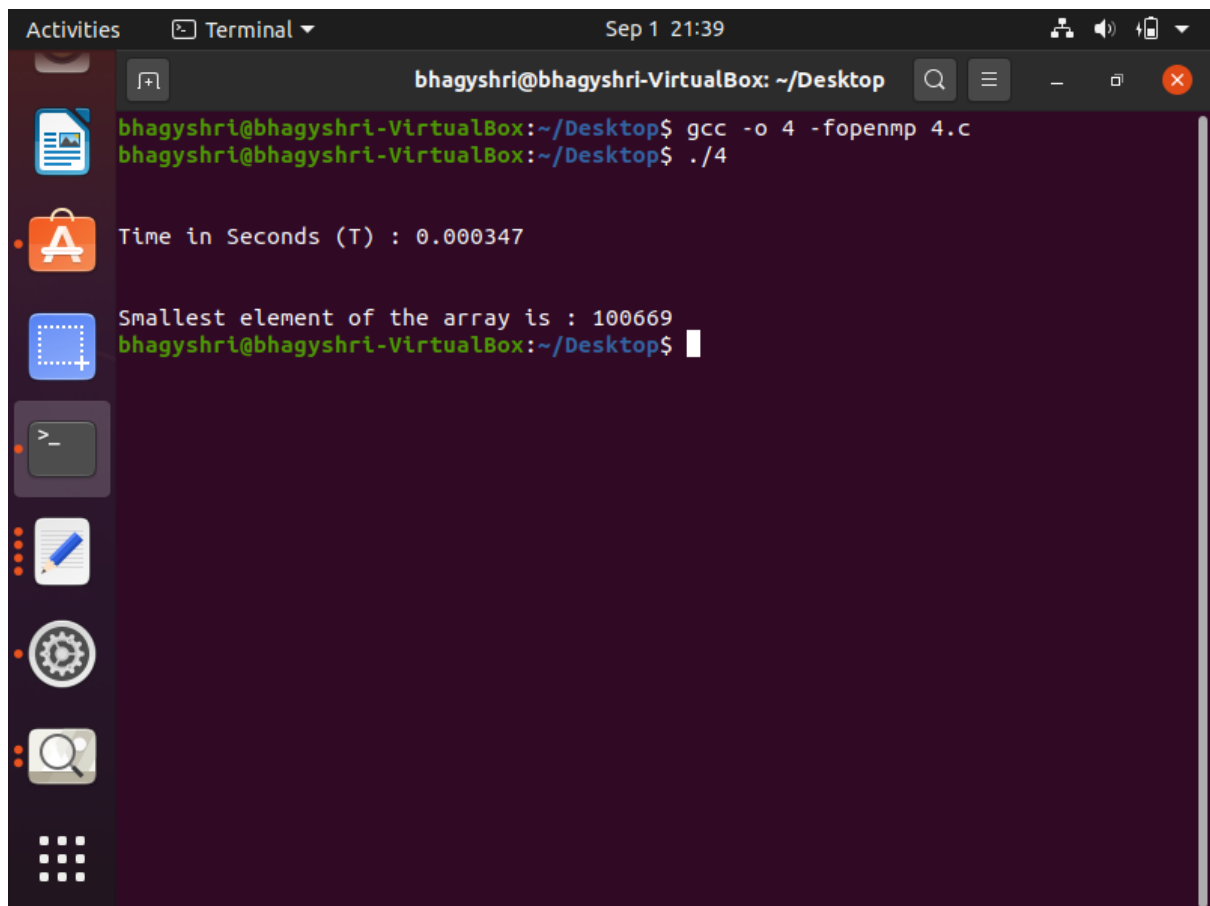
Output for 10k

Output for dynamic chunksize=1

A terminal window titled 'bhagyshri@bhagyshri-VirtualBox: ~/Desktop' with a dark background. The window shows the execution of a C++ program. The first command is 'gcc -o 4 -fopenmp 4.c', followed by './4'. The output consists of two lines: 'Time in Seconds (T) : 0.001311' and 'Smallest element of the array is : 3722'. The prompt 'bhagyshri@bhagyshri-VirtualBox:~/Desktop\$' is visible at the end of the second line. On the left side of the terminal, there is a vertical dock with several application icons: a document, a shopping bag, a square with a plus sign, a terminal icon, a notepad, a gear, a magnifying glass, and a grid of dots. The top of the window has a header bar with 'Activities', 'Terminal', and the date 'Sep 1 21:40'. On the right side of the header bar, there are icons for network, volume, and battery status.

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.001311
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

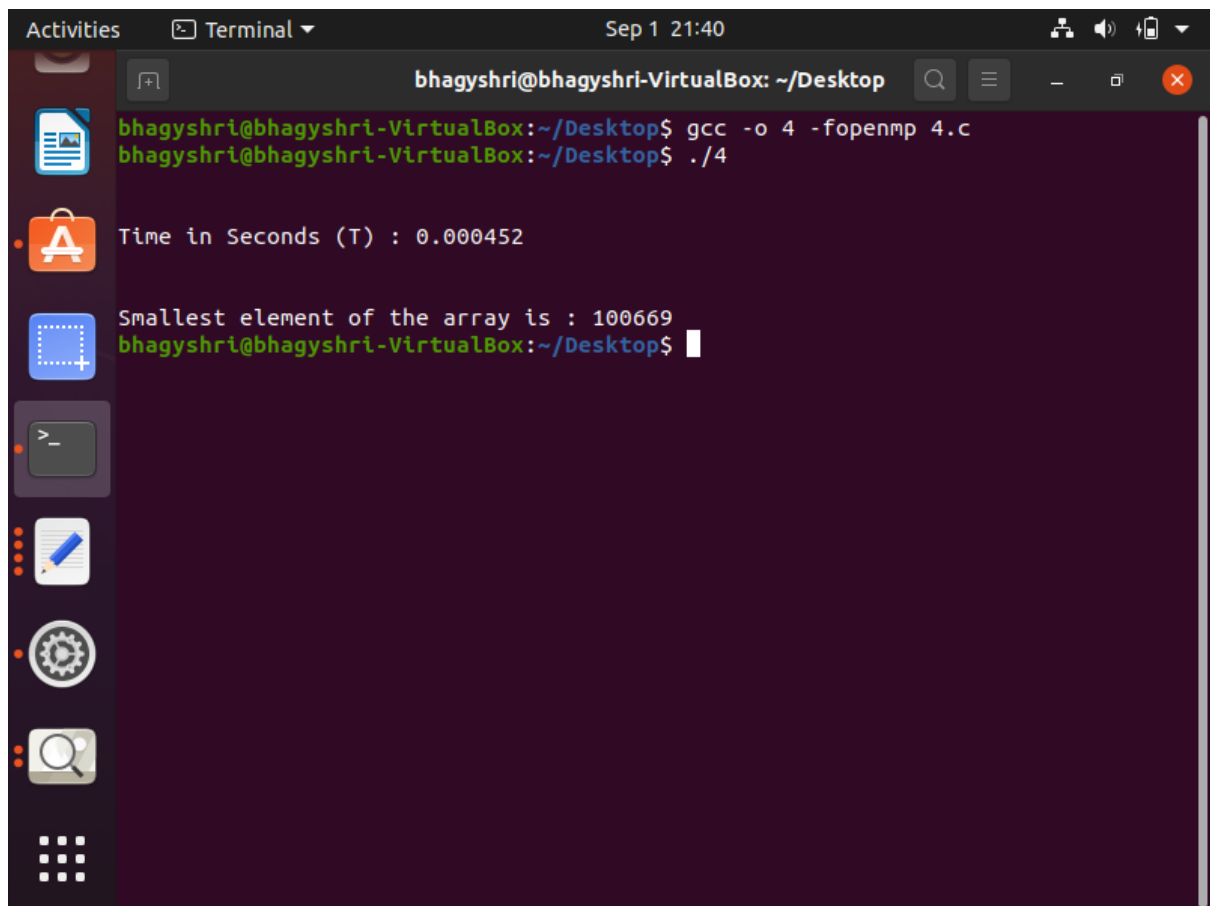
Output for 50k



A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background with green and white text. The left sidebar contains icons for various applications. The terminal output shows the compilation of a C program named "4.c" using "gcc" with flags "-o 4 -fopenmp". The program is then executed with "./4", resulting in the output "Time in Seconds (T) : 0.000347" and "Smallest element of the array is : 100669". The prompt "bhagyshri@bhagyshri-VirtualBox: ~/Desktop\$" is visible at the end of the output.

```
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$ ./4
Time in Seconds (T) : 0.000347
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$
```

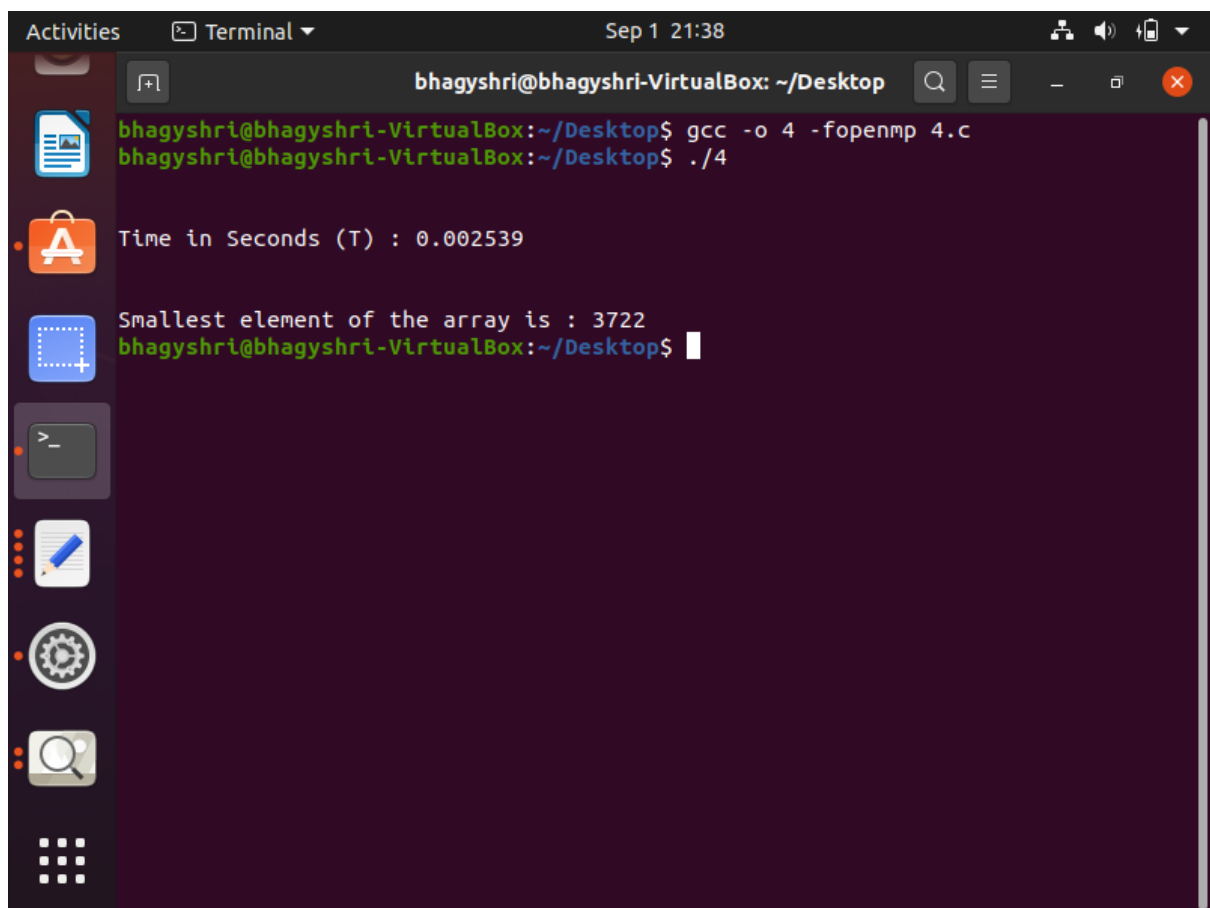
Output for 10k



A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background with green and white text. The left sidebar contains icons for various applications. The terminal output shows the compilation of a C program named "4.c" using "gcc" with flags "-o 4 -fopenmp". The program is then executed with "./4", resulting in the output "Time in Seconds (T) : 0.000452" and "Smallest element of the array is : 100669". The prompt "bhagyshri@bhagyshri-VirtualBox: ~/Desktop\$" is visible at the end of the output.

```
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$ ./4
Time in Seconds (T) : 0.000452
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$
```

Output for 5k



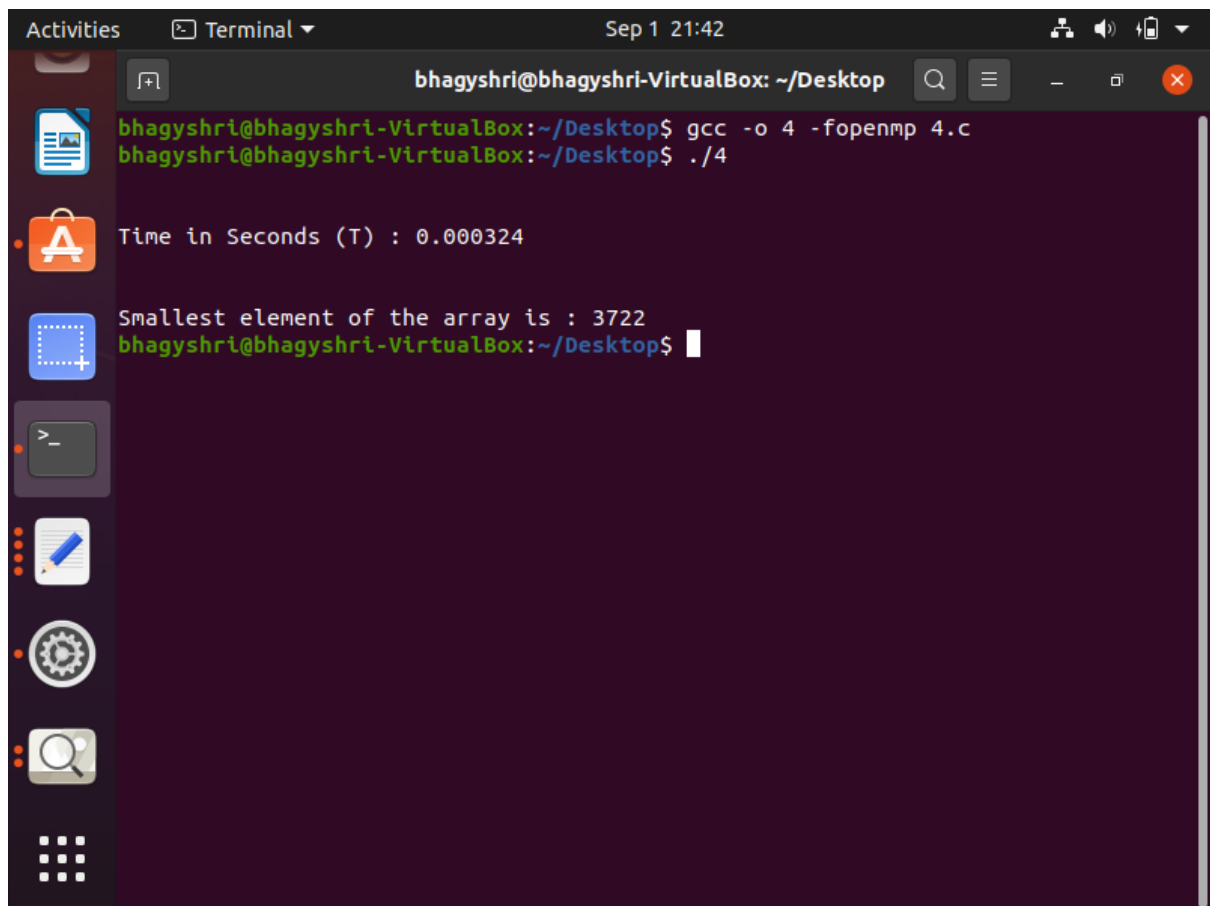
A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background with green and white text. The user has entered the following commands and received the following output:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.002539
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

The terminal window includes a sidebar on the left with various application icons and a top bar with system status icons and the date/time "Sep 1 21:38".

Output for 100k

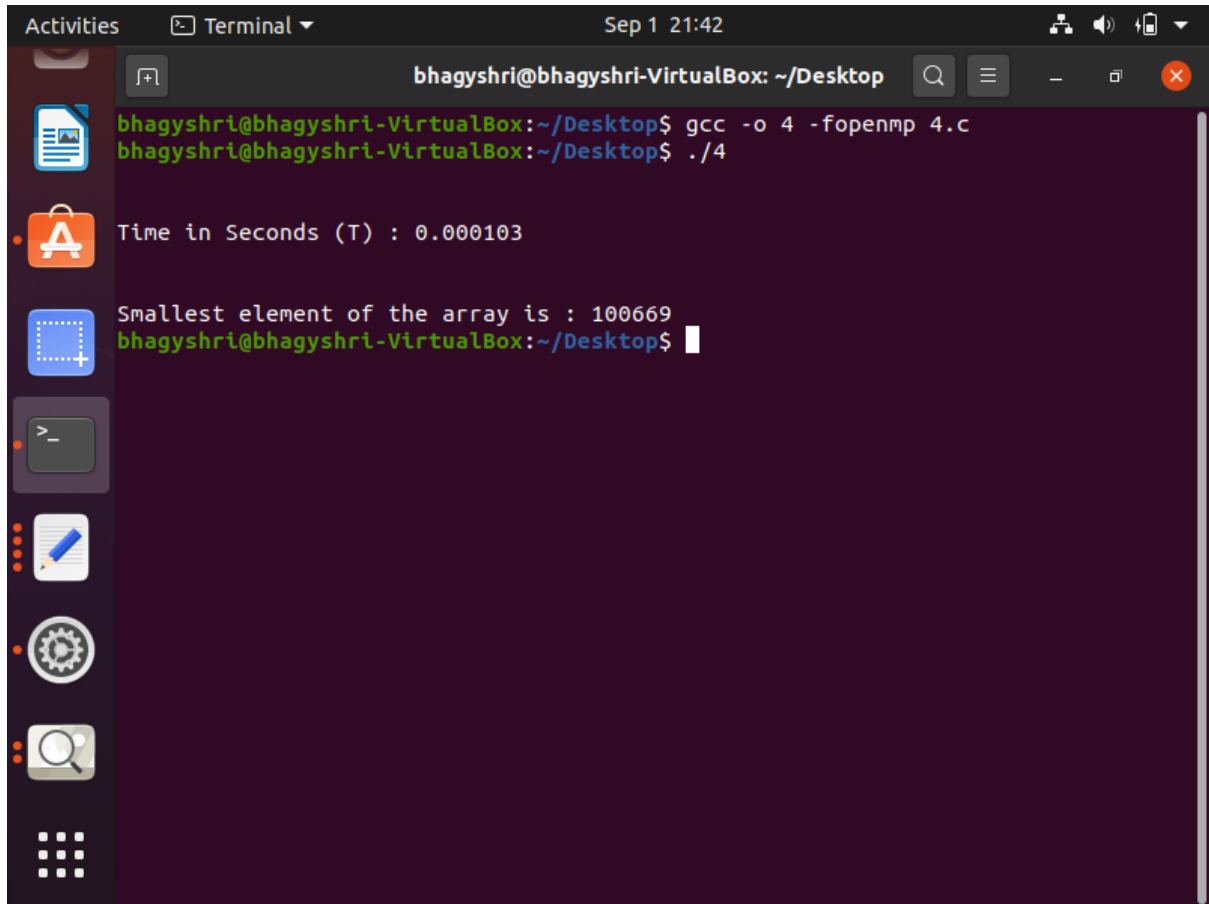
Output for guided

A terminal window titled 'bhagyshri@bhagyshri-VirtualBox: ~/Desktop' with a dark purple background. The window shows the execution of a C++ program. The first command is 'gcc -o 4 -fopenmp 4.c', followed by './4'. The output consists of two lines: 'Time in Seconds (T) : 0.000324' and 'Smallest element of the array is : 3722'. The prompt 'bhagyshri@bhagyshri-VirtualBox:~/Desktop\$' is visible at the end of the second line. On the left side of the terminal, there is a vertical dock with icons for a file manager, application store, development tools, and system settings. The top of the window shows a status bar with 'Activities', 'Terminal', and the date 'Sep 1 21:42'.

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000324
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

Output for 50k

k

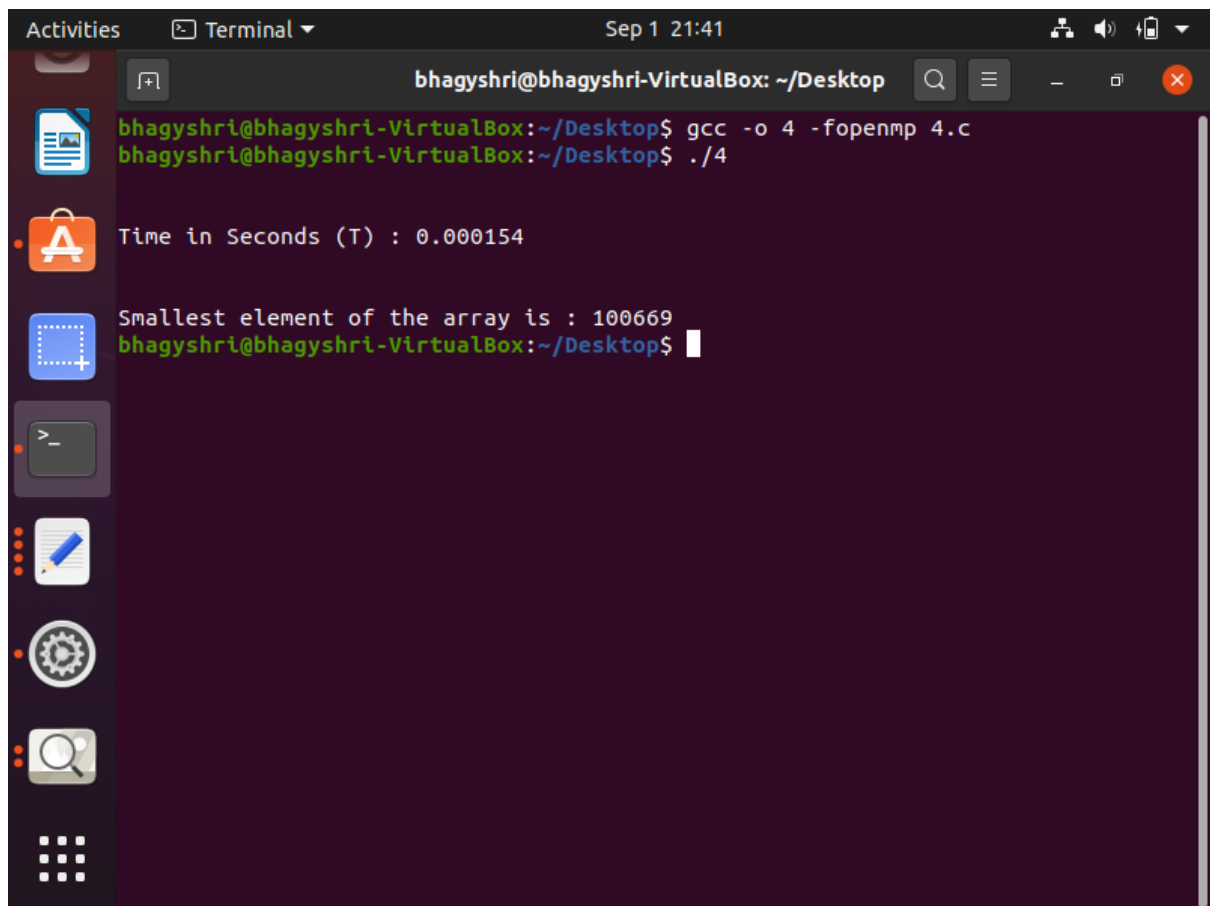


A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background and a light-colored title bar. The terminal output is as follows:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000103
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

The terminal window includes a sidebar on the left with various application icons (e.g., file manager, terminal, settings) and a top bar with system status icons (e.g., network, volume, battery).

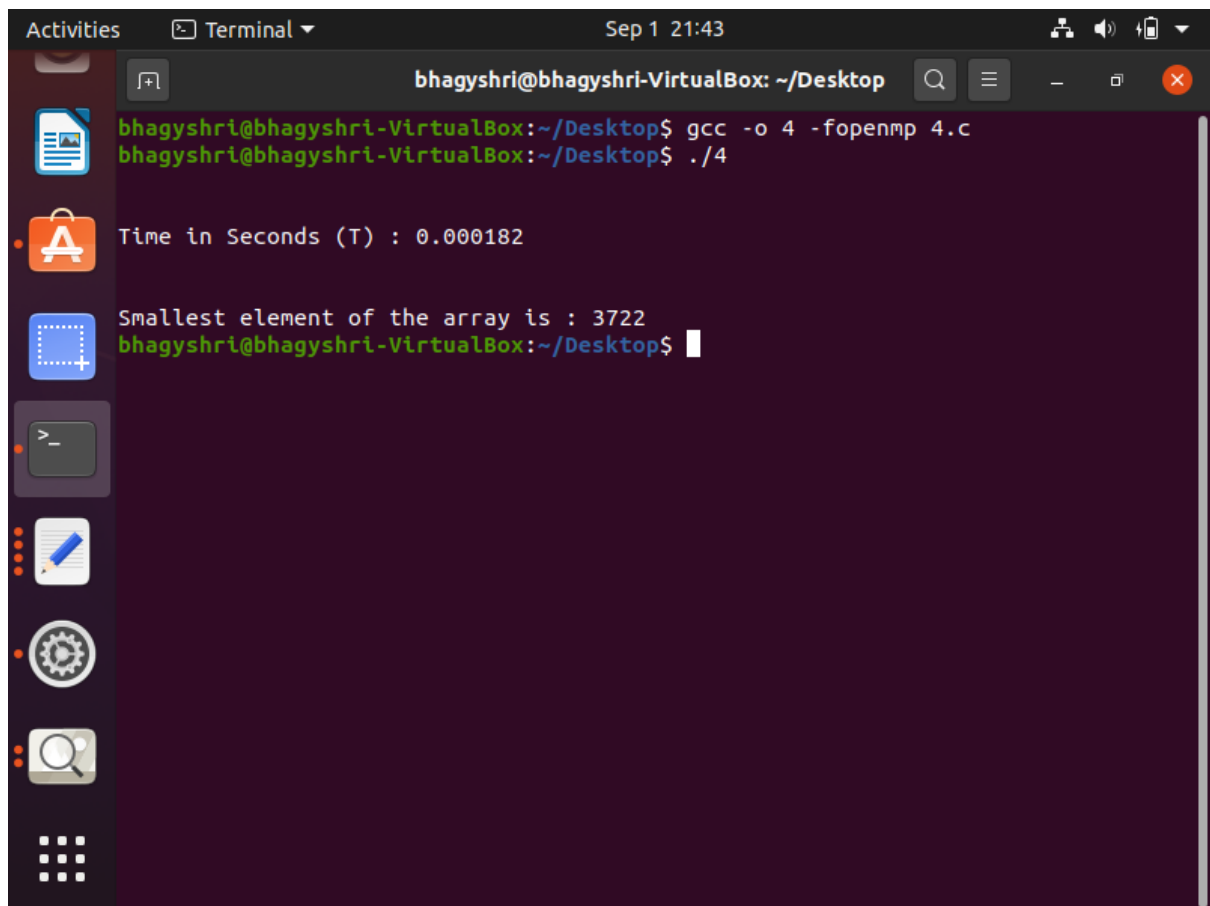
Output for 10k



A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background with green and white text. The left sidebar contains icons for various applications. The terminal output shows the compilation of a C program named "4.c" using "gcc" with flags "-o 4 -fopenmp". The program is then executed with "./4", resulting in the output "Time in Seconds (T) : 0.000154" and "Smallest element of the array is : 100669". The prompt "bhagyshri@bhagyshri-VirtualBox: ~/Desktop\$" is visible at the end of the output line.

```
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$ ./4
Time in Seconds (T) : 0.000154
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox: ~/Desktop$
```

Output for 5k

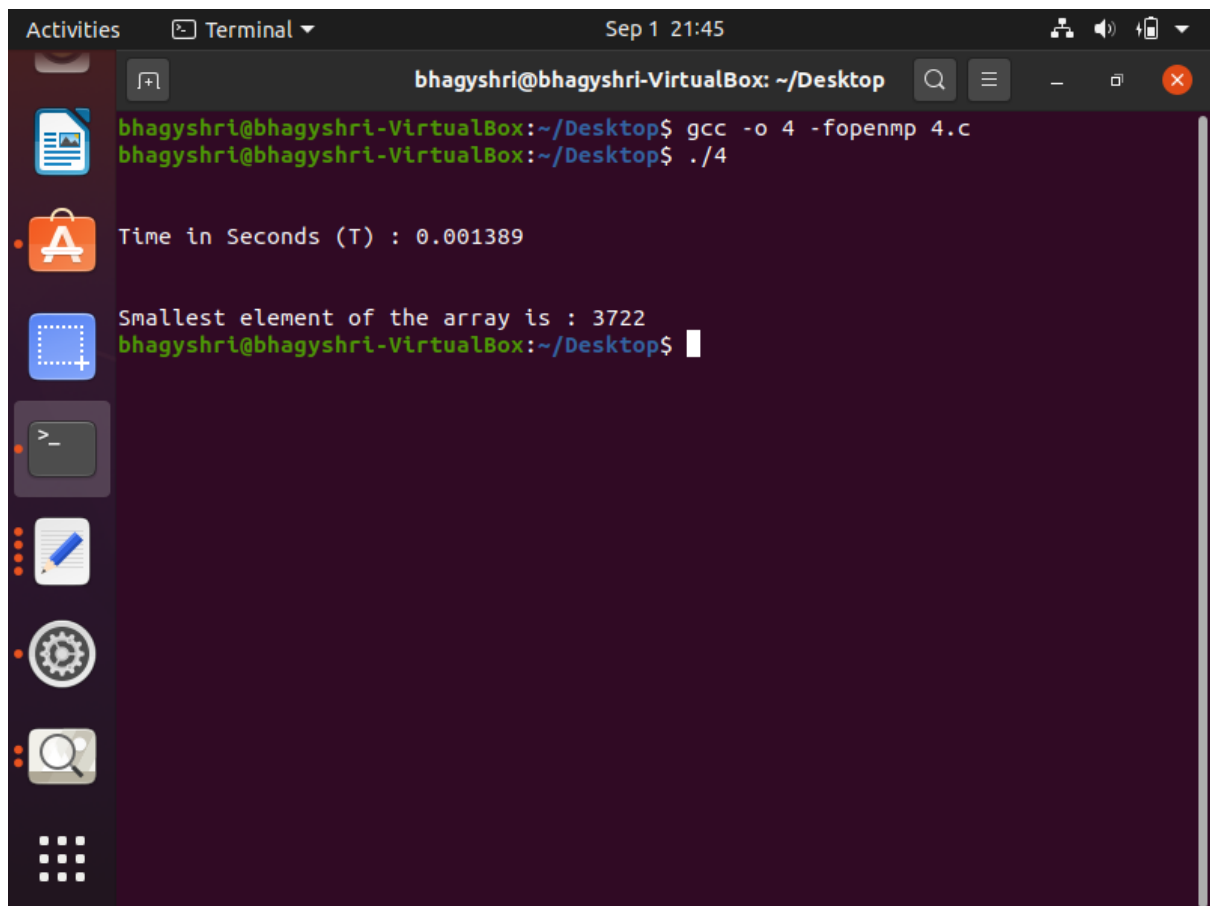


A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" is shown. The window has a dark background with green and white text. The left sidebar contains icons for various applications. The terminal output shows the compilation of a C program named "4.c" using "gcc" with flags "-o 4 -fopenmp". The program is then executed with "./4", resulting in the output "Time in Seconds (T) : 0.000182" and "Smallest element of the array is : 3722".

```
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000182
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

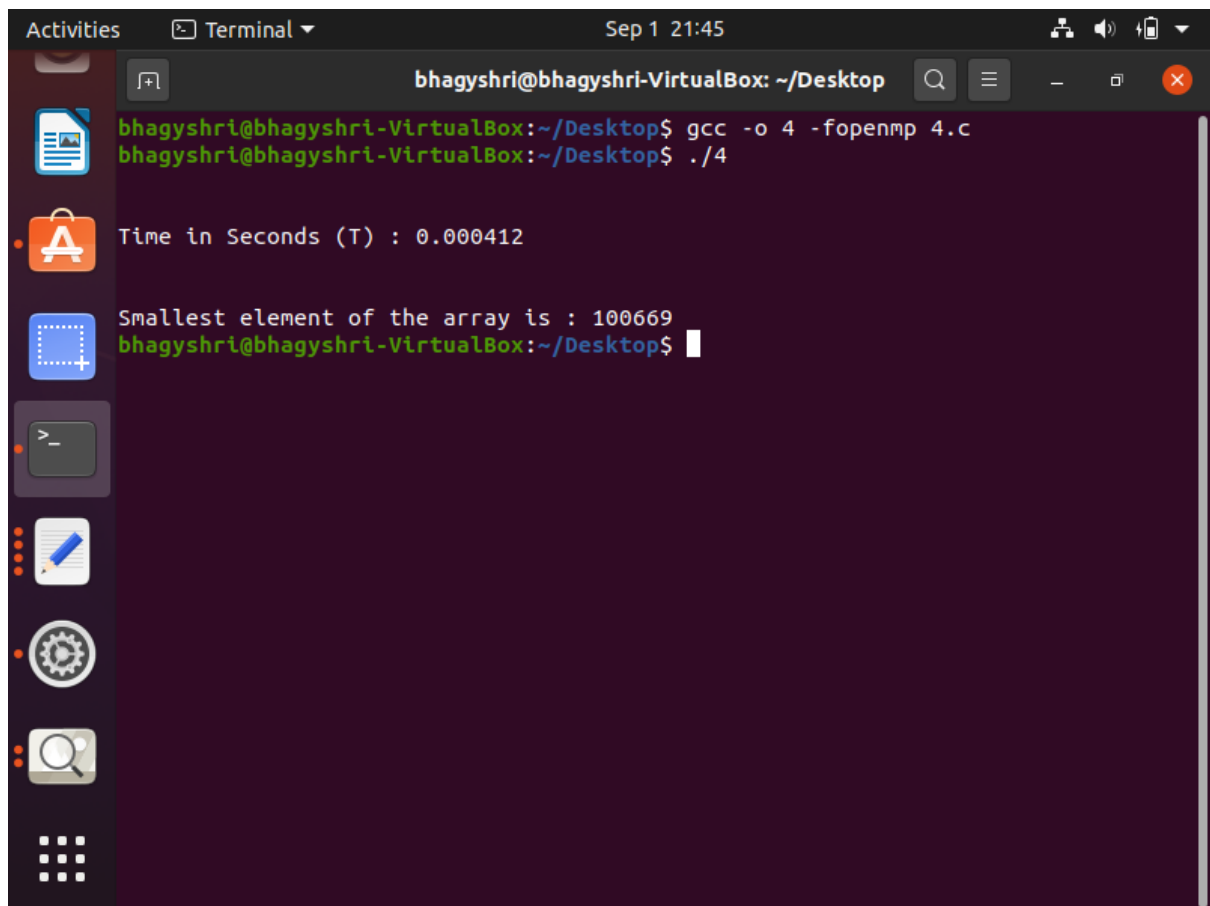
Output for 100k

Output for runtime

A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" with a dark purple background. The window shows the execution of a C program. The first command is "gcc -o 4 -fopenmp 4.c", followed by the execution command "./4". The output shows "Time in Seconds (T) : 0.001389" and "Smallest element of the array is : 3722". The prompt "bhagyshri@bhagyshri-VirtualBox:~/Desktop\$" is visible at the end of the line.

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.001389
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

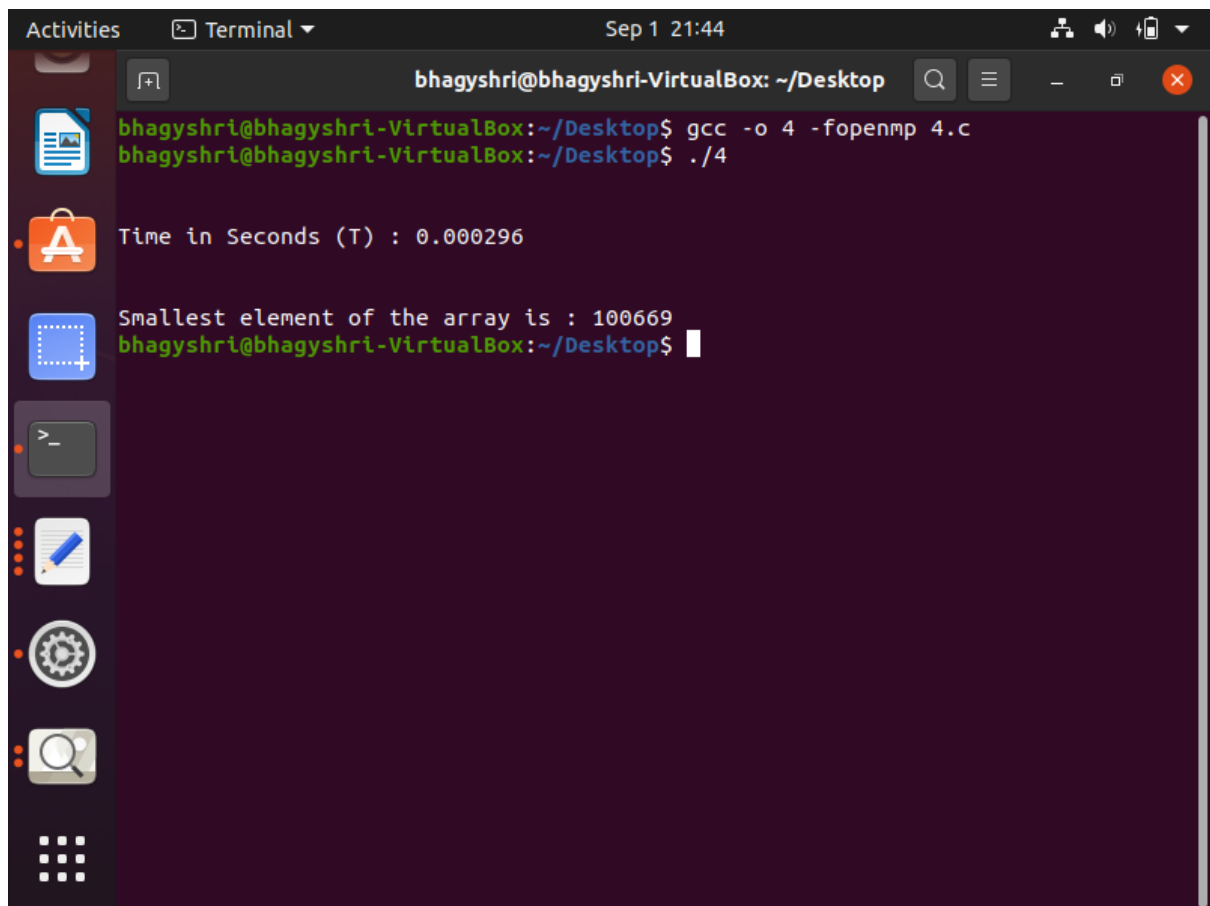
Out for 50k



A terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop" with a dark purple background. The window shows the compilation of a C++ program using `gcc -o 4 -fopenmp 4.c` and its execution. The output indicates the time taken was 0.000412 seconds and the smallest element of the array is 100669. The terminal has a sidebar on the left with icons for various applications and a top bar with system status icons.

```
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000412
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

Output for 10k



The image shows a terminal window titled "bhagyshri@bhagyshri-VirtualBox: ~/Desktop". The terminal output is as follows:

```
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.000296
Smallest element of the array is : 100669
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

The terminal window includes a sidebar with application icons (Files, Applications, Home, Dash, Dash to Dock, Dash to Dock with Favorites, Dash to Dock with Recent, Dash to Dock with Favorites and Recent, Dash to Dock with Favorites and Recent and Favorites, Dash to Dock with Favorites and Recent and Favorites and Recent) and a top bar with "Activities", "Terminal", and the date/time "Sep 1 21:44".

Output for 5k


```
Activities Terminal Sep 1 21:45
bhagyshri@bhagyshri-VirtualBox: ~/Desktop
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ gcc -o 4 -fopenmp 4.c
bhagyshri@bhagyshri-VirtualBox:~/Desktop$ ./4
Time in Seconds (T) : 0.002802
Smallest element of the array is : 3722
bhagyshri@bhagyshri-VirtualBox:~/Desktop$
```

Output for 100k

Schedule()	Total Execution time for number of iterations 5K	Total execution for number of iterations 10K	Total execution for number of iterations 50K	Total execution for number of iterations 100K
Sequential execution	0.00009s	0.000017s	0.000093s	0.000205s
static	0.000181s	0.000135s	0.000214s	0.000172s
Static, chunksize	0.000120s	0.000129s	0.000169s	0.000183
Dynamic, chunksize	0.000452	0.000347	0.001311	0.002539
Guided	0.000154	0.000103	0.000324	0.000182
runtime	0.000296	0.000412	0.001389	0.002802

