Bomb Lab

```
karthikeya@DESKTOP-6IENM0S:~/ug/sem3/ca/labs/lab5/bomb91$ ./bomb
Welcome to my fiendish little bomb. You have 6 phases with
which to blow yourself up. Have a nice day!
I turned the moon into something I call a Death Star.
Phase 1 defused. How about the next one?
0 1 1 2 3 5
That's number 2.  Keep going!
1 u 570
Halfway there!
8 35
So you got that one.  Try this one.
jebbig
Good work!  On to the next...
4 6 2 5 3 1
Congratulations! You've defused the bomb!
```

Phase 1:

Test input: Hello
From the logic we can see that input string is passed into function strings_not_equal
As we examine the other argument it is also a string.
In the functions strings_not_equal both strings are compared.

```
Reading symbols from bomb...
(gdb) break phase_1
Breakpoint 1 at 0x400e8d
(gdb) run
Starting program: /home/karthikeya/ug/sem3/ca/labs/lab5/bomb91/bomb
Welcome to my fiendish little bomb. You have 6 phases with
which to blow yourself up. Have a nice day!
Hello

Breakpoint 1, 0x0000000000400e8d in phase_1 ()
(gdb) disass phase_1
Dump of assembler code for function phase_1:
=> 0x0000000000400e8d <+0>:     sub    $0x8,%rsp
   0x0000000000400e91 <+4>:     mov    $0x402450,%esi
   0x0000000000400e96 <+9>:     callq  0x4013bc <strings_not_equal>
   0x0000000000400e9b <+14>:    test   %eax,%eax
   0x0000000000400e9d <+16>:    je     0x400ea4 <phase_1+23>
   0x0000000000400e9f <+18>:    callq  0x4014bb <explode_bomb>
   0x0000000000400ea4 <+23>:    add    $0x8,%rsp
   0x0000000000400ea8 <+27>:    retq
End of assembler dump.
(gdb) break strings_not_equal
Breakpoint 2 at 0x4013bc
(gdb) cont
Continuing.

Breakpoint 2, 0x00000000004013bc in strings_not_equal ()
(gdb) x/s $rdi
0x6047a0 <input_strings>:       "Hello"
(gdb) x/s $rsi
0x402450:       "I turned the moon into something I call a Death Star."
```

Answer: `I turned the moon into something I call a Death Star.`

Phase 2:

From the logic:
The programs reads 6 integers using function read_six_numbers
The first 2 numbers must be 0, 1 we know by compare instructions at <+30> and <+36>
Next logic is a for loop which iterate through the next 4 integers
From the logic we come to know that present number is sum of previous two numbers

0
1
0+1 = 1
1+1 = 2
2+1 = 3
3+2 = 5

```
Breakpoint 1, 0x0000000000400ea9 in phase_2 ()
(gdb) disass phase_2
Dump of assembler code for function phase_2:
=> 0x0000000000400ea9 <+0>:     push   %rbp
   0x0000000000400eaa <+1>:     push   %rbx
   0x0000000000400eab <+2>:     sub    $0x28,%rsp
   0x0000000000400eaf <+6>:     mov    %fs:0x28,%rax
   0x0000000000400eb8 <+15>:    mov    %rax,0x18(%rsp)
   0x0000000000400ebd <+20>:    xor    %eax,%eax
   0x0000000000400ebf <+22>:    mov    %rsp,%rsi
   0x0000000000400ec2 <+25>:    callq  0x4014dd <read_six_numbers>
   0x0000000000400ec7 <+30>:    cmpl   $0x0,(%rsp)
   0x0000000000400ecb <+34>:    jne    0x400ed4 <phase_2+43>
   0x0000000000400ecd <+36>:    cmpl   $0x1,0x4(%rsp)
   0x0000000000400ed2 <+41>:    je     0x400ed9 <phase_2+48>
   0x0000000000400ed4 <+43>:    callq  0x4014bb <explode_bomb>
   0x0000000000400ed9 <+48>:    mov    %rsp,%rbx
   0x0000000000400edc <+51>:    lea    0x10(%rsp),%rbp
   0x0000000000400ee1 <+56>:    mov    0x4(%rbx),%eax
   0x0000000000400ee4 <+59>:    add    (%rbx),%eax
   0x0000000000400ee6 <+61>:    cmp    %eax,0x8(%rbx)
   0x0000000000400ee9 <+64>:    je     0x400ef0 <phase_2+71>
   0x0000000000400eeb <+66>:    callq  0x4014bb <explode_bomb>
   0x0000000000400ef0 <+71>:    add    $0x4,%rbx
--Type <RET> for more, q to quit, c to continue without paging--
   0x0000000000400ef4 <+75>:    cmp    %rbp,%rbx
   0x0000000000400ef7 <+78>:    jne    0x400ee1 <phase_2+56>
   0x0000000000400ef9 <+80>:    mov    0x18(%rsp),%rax
   0x0000000000400efe <+85>:    xor    %fs:0x28,%rax
   0x0000000000400f07 <+94>:    je     0x400f0e <phase_2+101>
   0x0000000000400f09 <+96>:    callq  0x400b00 <__stack_chk_fail@plt>
   0x0000000000400f0e <+101>:   add    $0x28,%rsp
   0x0000000000400f12 <+105>:   pop    %rbx
   0x0000000000400f13 <+106>:   pop    %rbp
   0x0000000000400f14 <+107>:   retq
End of assembler dump.
```

Answer: 0 1 1 2 3 5

Phase 3:

```
Dump of assembler code for function phase_3:
=> 0x0000000000400f15 <+0>:     sub    $0x28,%rsp
   0x0000000000400f19 <+4>:     mov    %fs:0x28,%rax
   0x0000000000400f22 <+13>:    mov    %rax,0x18(%rsp)
   0x0000000000400f27 <+18>:    xor    %eax,%eax
   0x0000000000400f29 <+20>:    lea    0x14(%rsp),%r8
   0x0000000000400f2e <+25>:    lea    0xf(%rsp),%rcx
   0x0000000000400f33 <+30>:    lea    0x10(%rsp),%rdx
   0x0000000000400f38 <+35>:    mov    $0x4024ae,%esi
   0x0000000000400f3d <+40>:    callq  0x400bb0 <__isoc99_sscanf@plt>
(gdb) x/s 0x4024ae
0x4024ae:       "%d %c %d"
```

From screen shot we can see that it is reading in put in the form of "%d %c %d"

```
0x0000000000400f7f <+106>:    jmpq   0x40105a <phase_3+325>
0x0000000000400f84 <+111>:    mov    $0x75,%eax
0x0000000000400f89 <+116>:    cmpl   $0x23a,0x14(%rsp)
0x0000000000400f91 <+124>:    je     0x40105a <phase_3+325>
0x0000000000400f97 <+130>:    callq  0x4014bb <explode_bomb>
0x0000000000400f9c <+135>:    mov    $0x75,%eax
```

We can see in the above screenshot that it is comparing 2nd %d with 0x23a(570)

```
   0x000000000040105a <+325>:    cmp    0xf(%rsp),%al
   0x000000000040105e <+329>:    je     0x401065 <phase_3+336>
=> 0x0000000000401060 <+331>:    callq  0x4014bb <explode_bomb>
   0x0000000000401065 <+336>:    mov    0x18(%rsp),%rax
   0x000000000040106a <+341>:    xor    %fs:0x28,%rax
   0x0000000000401073 <+350>:    je     0x40107a <phase_3+357>
   0x0000000000401075 <+352>:    callq  0x400b00 <__stack_chk_fail@plt>
   0x000000000040107a <+357>:    add    $0x28,%rsp
   0x000000000040107e <+361>:    retq
End of assembler dump.
(gdb) x/c $rsp+0xf
0x7fffffffdeff: 97 'a'
(gdb) i r
rax            0x75               117
```

From the above screenshot we can see it is comparing our test input character ‘a’ with ‘u’ 117.

Answer: 1 u 570

Phase 4:

```
   0x000000000040110b <+89>:    mov    0x8(%rsp),%rax
   0x0000000000401110 <+94>:    xor    %fs:0x28,%rax
   0x0000000000401119 <+103>:   je     0x401120 <phase_4+110>
   0x000000000040111b <+105>:   callq  0x400b00 <__stack_chk_fail@plt>
   0x0000000000401120 <+110>:   add    $0x18,%rsp
   0x0000000000401124 <+114>:   retq
End of assembler dump.
(gdb) x/s 0x40264f
0x40264f:       "%d %d"
```

From the screenshot, we can see that our input is two integers

```
Dump of assembler code for function phase_4:
   0x00000000004010b2 <+0>:     sub    $0x18,%rsp
   0x00000000004010b6 <+4>:     mov    %fs:0x28,%rax
   0x00000000004010bf <+13>:    mov    %rax,0x8(%rsp)
   0x00000000004010c4 <+18>:    xor    %eax,%eax
   0x00000000004010c6 <+20>:    lea    0x4(%rsp),%rcx
   0x00000000004010cb <+25>:    mov    %rsp,%rdx
   0x00000000004010ce <+28>:    mov    $0x40264f,%esi
   0x00000000004010d3 <+33>:    callq  0x400bb0 <__isoc99_sscanf@plt>
   0x00000000004010d8 <+38>:    cmp    $0x2,%eax
   0x00000000004010db <+41>:    jne    0x4010e3 <phase_4+49>
=> 0x00000000004010dd <+43>:    cmpl   $0xe,(%rsp)
   0x00000000004010e1 <+47>:    jbe    0x4010e8 <phase_4+54>
   0x00000000004010e3 <+49>:    callq  0x4014bb <explode_bomb>
   0x00000000004010e8 <+54>:    mov    $0xe,%edx
```

From the screenshot, we can see that our first input must be less than 0xe (14).
Based on our first input func4 returns a specific value, which must be equal to 0x23 (35) as you can see in the below screenshot.

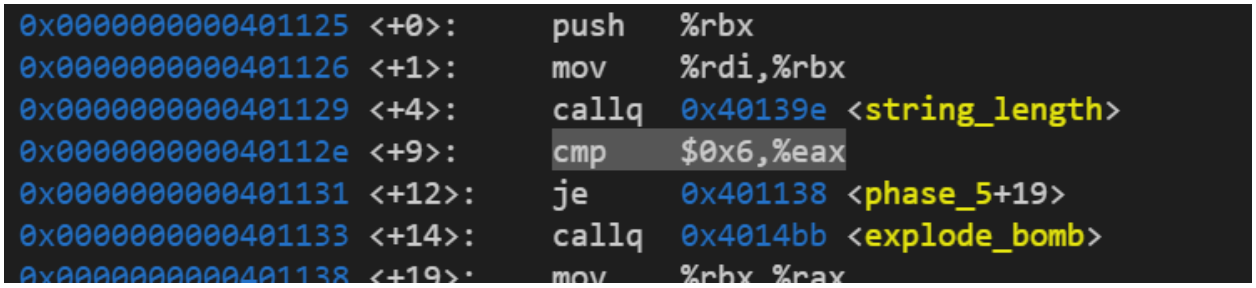
```
   0x00000000004010f5 <+67>:    callq  0x40107f <func4>
   0x00000000004010fa <+72>:    cmp    $0x23,%eax
   0x00000000004010fd <+75>:    jne    0x401106 <phase_4+84>
   0x00000000004010ff <+77>:    cmpl   $0x23,0x4(%rsp)
   0x0000000000401104 <+82>:    je     0x40110b <phase_4+89>
--Type <RET> for more, q to quit, c to continue without paging--
   0x0000000000401106 <+84>:    callq  0x4014bb <explode_bomb>
```

From the logic of func4 we can see it is 8.

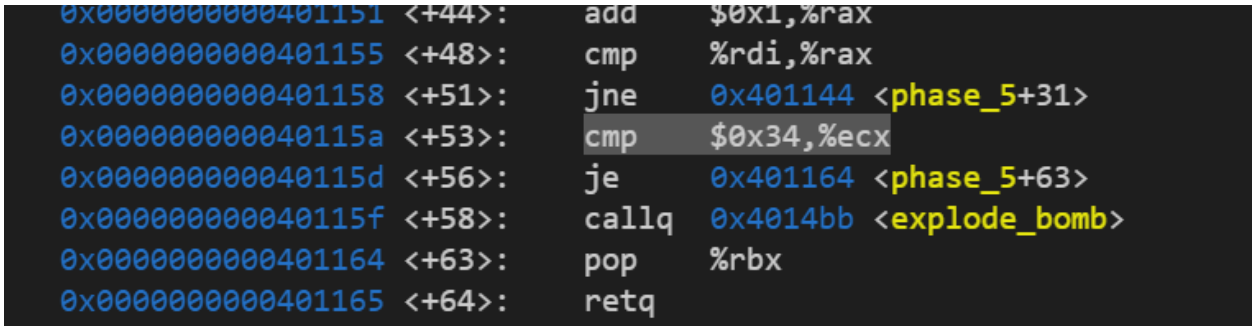
Answer: 8 35

Phase 5:

As I examine the logic of phase_5, it is clear that we need a string of 6 characters



And every character has a specific value and we add the values of each character of our string. Finally the total must be equal to 0x34 (52)
I had found the values of some characters by giving inputs such as a b c d e f and g h i j k l.



And finally made a string which defuses phase_5 “jebbig”, there can be multiple strings that can defuse phase_5.

Answer: jebbig

Phase 6:

From the screenshot below we can say that it reads 6 numbers as in phase_2 otherwise the bomb explodes.
And from the compare instruction it is clear the numbers must be less than 6.

```
Dump of assembler code for function phase_6:
   0x0000000000401166 <+0>:     push   %r14
   0x0000000000401168 <+2>:     push   %r13
   0x000000000040116a <+4>:     push   %r12
   0x000000000040116c <+6>:     push   %rbp
   0x000000000040116d <+7>:     push   %rbx
   0x000000000040116e <+8>:     sub    $0x60,%rsp
   0x0000000000401172 <+12>:    mov    %fs:0x28,%rax
   0x000000000040117b <+21>:    mov    %rax,0x58(%rsp)
   0x0000000000401180 <+26>:    xor    %eax,%eax
   0x0000000000401182 <+28>:    mov    %rsp,%rsi
   0x0000000000401185 <+31>:    callq  0x4014dd <read_six_numbers>
   0x000000000040118a <+36>:    mov    %rsp,%r12
   0x000000000040118d <+39>:    mov    %rsp,%r13
   0x0000000000401190 <+42>:    mov    $0x0,%r14d
   0x0000000000401196 <+48>:    mov    %r13,%rbp
   0x0000000000401199 <+51>:    mov    0x0(%r13),%eax
   0x000000000040119d <+55>:    sub    $0x1,%eax
   0x00000000004011a0 <+58>:    cmp    $0x5,%eax
   0x00000000004011a3 <+61>:    jbe    0x4011aa <phase_6+68>
   0x00000000004011a5 <+63>:    callq  0x4014bb <explode_bomb>
```

From the iterative part I found that the numbers should not repeat.
At 0x6042f0 there is a linked list of 6 integers

```
(gdb) x/100x 0x6042f0
0x6042f0 <node1>:       0xee    0x02    0x00    0x00    0x01    0x00    0x00    0x00
0x6042f8 <node1+8>:     0x00    0x43    0x60    0x00    0x00    0x00    0x00    0x00
0x604300 <node2>:       0x2f    0x02    0x00    0x00    0x02    0x00    0x00    0x00
0x604308 <node2+8>:     0x10    0x43    0x60    0x00    0x00    0x00    0x00    0x00
0x604310 <node3>:       0x38    0x03    0x00    0x00    0x03    0x00    0x00    0x00
0x604318 <node3+8>:     0x20    0x43    0x60    0x00    0x00    0x00    0x00    0x00
0x604320 <node4>:       0x4d    0x00    0x00    0x00    0x04    0x00    0x00    0x00
0x604328 <node4+8>:     0x30    0x43    0x60    0x00    0x00    0x00    0x00    0x00
0x604330 <node5>:       0x9a    0x02    0x00    0x00    0x05    0x00    0x00    0x00
0x604338 <node5+8>:     0x40    0x43    0x60    0x00    0x00    0x00    0x00    0x00
0x604340 <node6>:       0x46    0x00    0x00    0x00    0x06    0x00    0x00    0x00
0x604348 <node6+8>:     0x00    0x00    0x00    0x00    0x00    0x00    0x00    0x00
0x604350 <bomb_id>:     0x5b    0x00    0x00    0x00
```

We can see the integers in the little endian format in the screenshot.

Node 1 - 0x02ee
Node 2 - 022f
Node 3 - 0x0338
Node 4 - 0x004d
Node 5 - 0x029a
Node 6 - 0x0046

Descending order of nodes by data in them 3 1 5 2 4 6

```
401255: bd 05 00 00 00          mov    $0x5 %ebp
40125a: 48 8b 43 08             mov    0x8(%rbx) %rax
40125e: 8b 00                   mov    (%rax) %eax
401260: 39 03                   cmp    %eax (%rbx)
401262: 7d 05                   jge    401269 <phase_6+0x103>
401264: e8 52 02 00 00          callq  4014bb <explode_bomb>
401269: 48 8b 5b 08             mov    0x8(%rbx) %rbx
```

From the above screenshot, the cmp instruction indicates that (%rbx) must be greater than the value in rax, otherwise the bomb explodes.
I had put a breakpoint at the above compare instruction and repeatedly observed the values in (%rbx) and $rax using different test inputs and drew patterns between them.
(for example if our first input is 4 the the first value in (%rbx) is the value in index 3)
It is clear that the values in memory (%rbx) and its corresponding values must be in descending order of the values in the nodes.
Our input arranges the indices in it. So that

For

4 6 2 5 3 1

Corresponding nodes in rax and %(rbx) for each iteration
(They actually store the data present in the above nodes)
$rax
1 5 2 4 6

%(rbx)
3 1 5 2 4

For every iteration value in %(rbx) greater than $rax

Answer: 4 6 2 5 3 1

```
karthikeya@DESKTOP-6IENM0S:~/ug/sem3/ca/labs/lab5/bomb-lab$ ./bomb < Solution.txt
Welcome to my fiendish little bomb. You have 6 phases with
which to blow yourself up. Have a nice day!
Phase 1 defused. How about the next one?
That's number 2.  Keep going!
Halfway there!
So you got that one.  Try this one.
Good work!  On to the next...
Congratulations! You've defused the bomb!
```