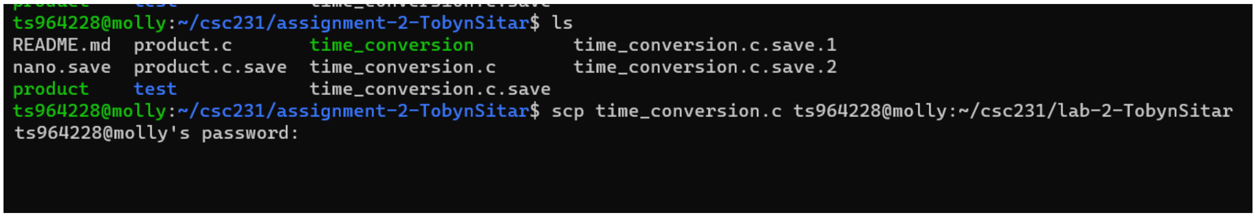
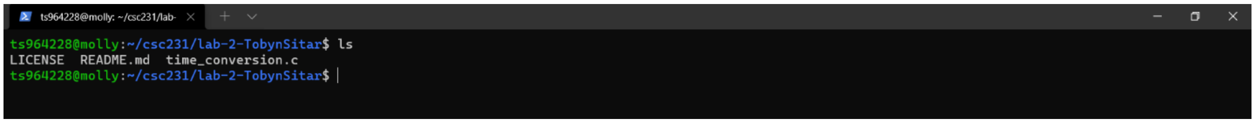
- Make a copy of time_conversion.c into lab's repository

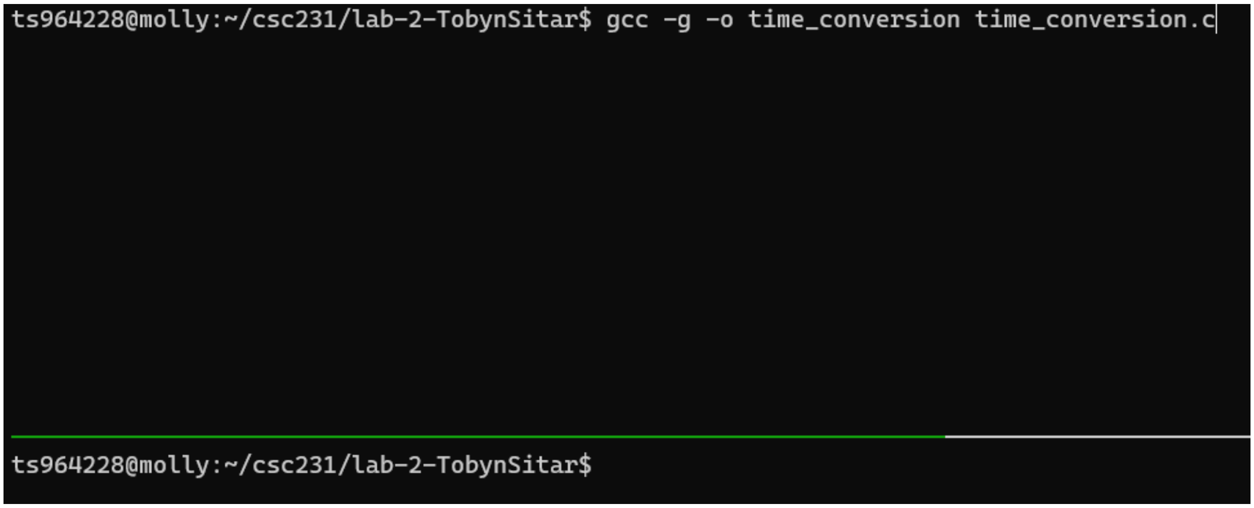


```
ts964228@molly:~/csc231/assignment-2-TobynSitar$ ls
README.md  product.c       time_conversion         time_conversion.c.save.1
nano.save  product.c.save  time_conversion.c       time_conversion.c.save.2
product    test            time_conversion.c.save
ts964228@molly:~/csc231/assignment-2-TobynSitar$ scp time_conversion.c ts964228@molly:~/csc231/lab-2-TobynSitar
ts964228@molly's password:
```



```
ts964228@molly:~/csc231/lab-2-TobynSitar$ ls
LICENSE  README.md  time_conversion.c
ts964228@molly:~/csc231/lab-2-TobynSitar$
```

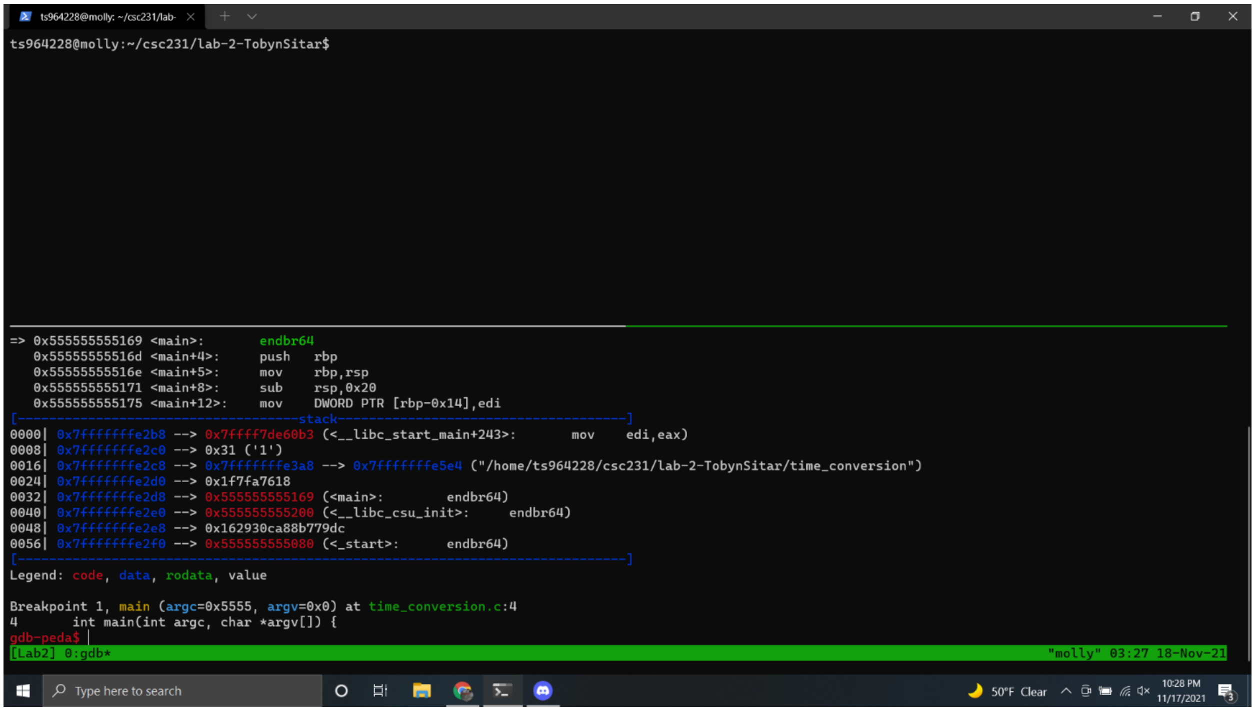
- Compile the copy so that it can be studied using gdb



```
ts964228@molly:~/csc231/lab-2-TobynSitar$ gcc -g -o time_conversion time_conversion.c
```

```
ts964228@molly:~/csc231/lab-2-TobynSitar$
```

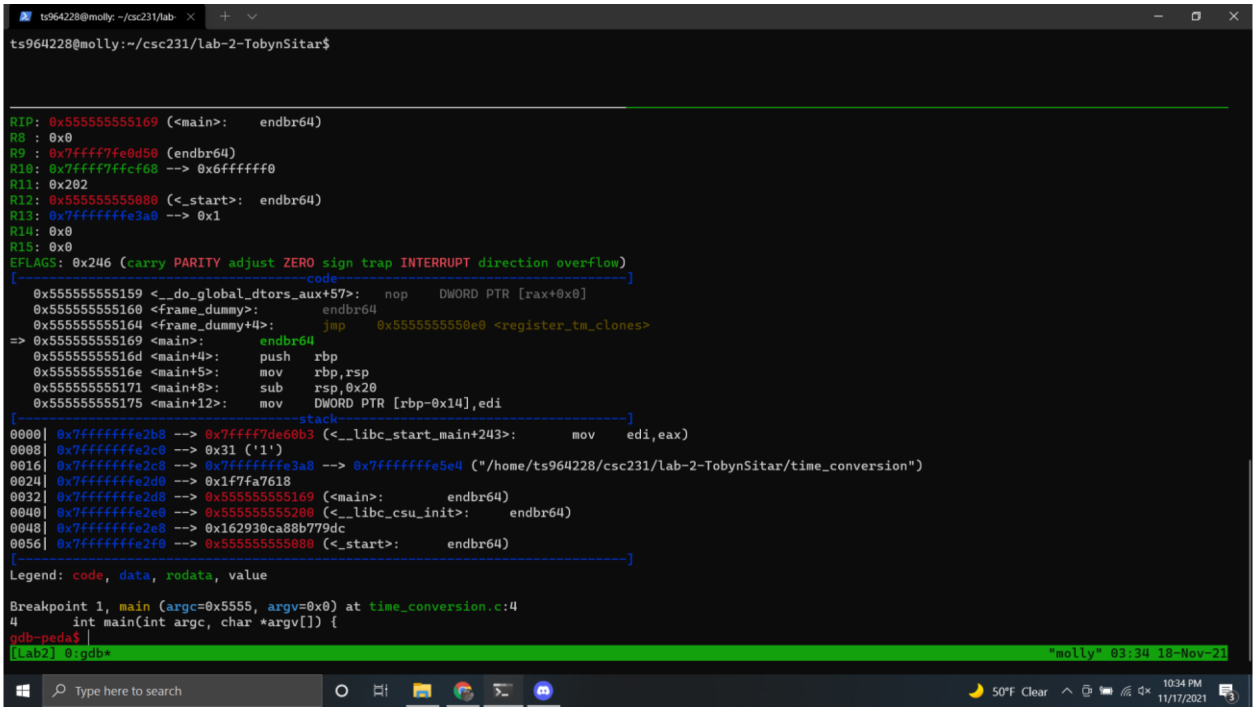
- Start debugging instance on time_conversion and set the breakpoint at the main function.



```
ts964228@molly:~/csc231/lab-2-TobynSitar$
```

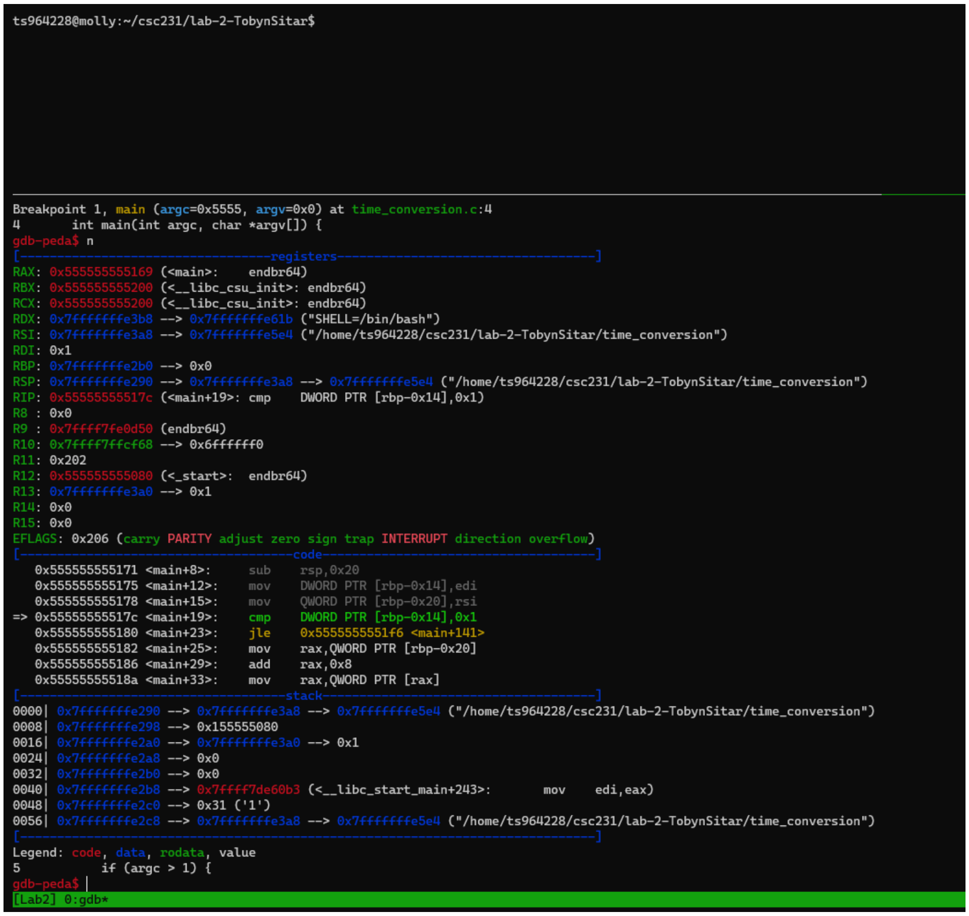
```
=> 0x555555555169 <main>:       endbr64
   0x55555555516d <main+4>:     push   rbp
   0x55555555516e <main+5>:     mov    rbp,rsp
   0x555555555171 <main+8>:     sub    rsp,0x20
   0x555555555175 <main+12>:    mov    DWORD PTR [rbp-0x14],edi
[------------------------------------stack-------------------------------------]
0000| 0x7fffffffe2b8 --> 0x7ffff7de60b3 (<__libc_start_main+243>:       mov    edi,eax)
0008| 0x7fffffffe2c0 --> 0x31 ('1')
0016| 0x7fffffffe2c8 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
0024| 0x7fffffffe2d0 --> 0x1f7fa7618
0032| 0x7fffffffe2d8 --> 0x555555555169 (<main>:        endbr64)
0040| 0x7fffffffe2e0 --> 0x555555555200 (<__libc_csu_init>:     endbr64)
0048| 0x7fffffffe2e8 --> 0x162930ca88b779dc
0056| 0x7fffffffe2f0 --> 0x555555555080 (<_start>:      endbr64)
[------------------------------------------------------------------------------]
Legend: code, data, rodata, value

Breakpoint 1, main (argc=0x5555, argv=0x0) at time_conversion.c:4
4       int main(int argc, char *argv[]) {
gdb-peda$
[Lab2] 0:gdb*                                                    "molly" 03:27 18-Nov-21
```

- Adjust your terminal windows so that it can display all components of gdb-peda, including registers, code, stack, and the instruction to be executed next.

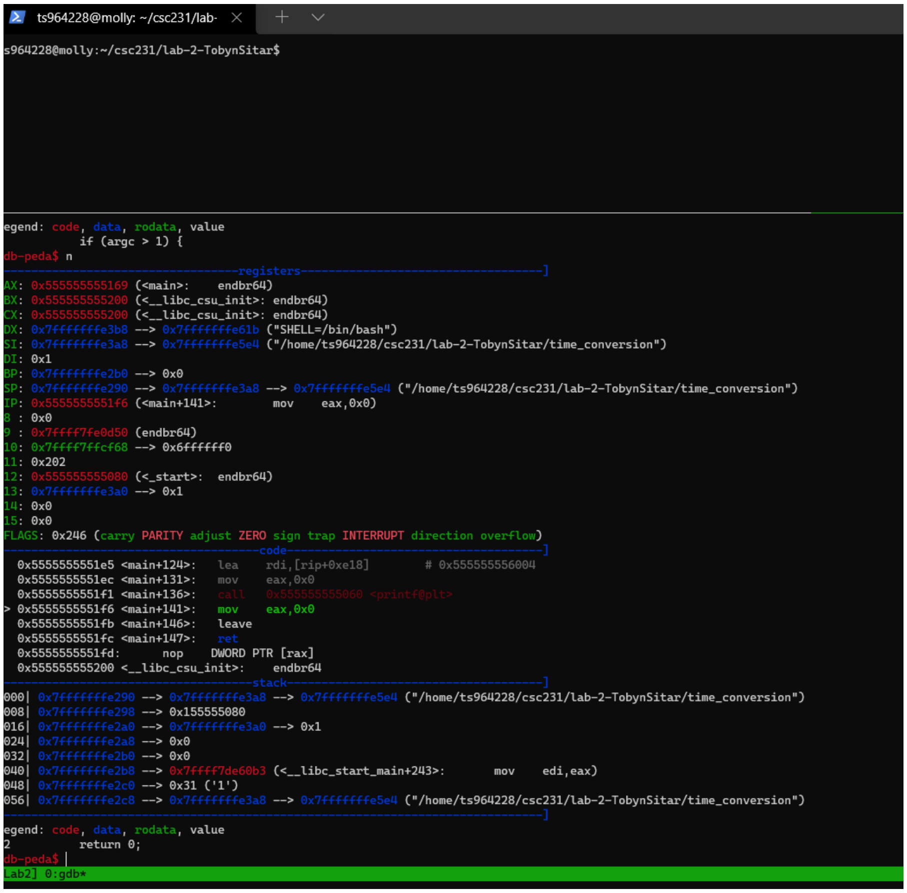


```
ts964228@molly:~/csc231/lab-2-TobynSitar$



RIP: 0x555555555169 (<main>:    endbr64)
R8 : 0x0
R9 : 0x7ffff7fe0d50 (endbr64)
R10: 0x7ffff7ffcf68 --> 0x6ffffff0
R11: 0x202
R12: 0x555555555080 (<_start>:  endbr64)
R13: 0x7fffffffe3a0 --> 0x1
R14: 0x0
R15: 0x0
EFLAGS: 0x246 (carry PARITY adjust ZERO sign trap INTERRUPT direction overflow)
[-------------------------------------code-------------------------------------]
   0x555555555159 <__do_global_dtors_aux+57>:   nop    DWORD PTR [rax+0x0]
   0x555555555160 <frame_dummy>:        endbr64
   0x555555555164 <frame_dummy+4>:      jmp    0x5555555550e0 <register_tm_clones>
=> 0x555555555169 <main>:       endbr64
   0x55555555516d <main+4>:     push   rbp
   0x55555555516e <main+5>:     mov    rbp,rsp
   0x555555555171 <main+8>:     sub    rsp,0x20
   0x555555555175 <main+12>:    mov    DWORD PTR [rbp-0x14],edi
[------------------------------------stack-------------------------------------]
0000| 0x7fffffffe2b8 --> 0x7ffff7de60b3 (<__libc_start_main+243>:       mov    edi,eax)
0008| 0x7fffffffe2c0 --> 0x31 ('1')
0016| 0x7fffffffe2c8 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
0024| 0x7fffffffe2d0 --> 0x1f7fa7618
0032| 0x7fffffffe2d8 --> 0x555555555169 (<main>:        endbr64)
0040| 0x7fffffffe2e0 --> 0x555555555200 (<__libc_csu_init>:     endbr64)
0048| 0x7fffffffe2e8 --> 0x162930ca88b779dc
0056| 0x7fffffffe2f0 --> 0x555555555080 (<_start>:      endbr64)
[------------------------------------------------------------------------------]
Legend: code, data, rodata, value

Breakpoint 1, main (argc=0x5555, argv=0x0) at time_conversion.c:4
4       int main(int argc, char *argv[]) {
gdb-peda$ |
[Lab2] 0:gdb*                                                                        "molly" 03:34 18-Nov-21
```

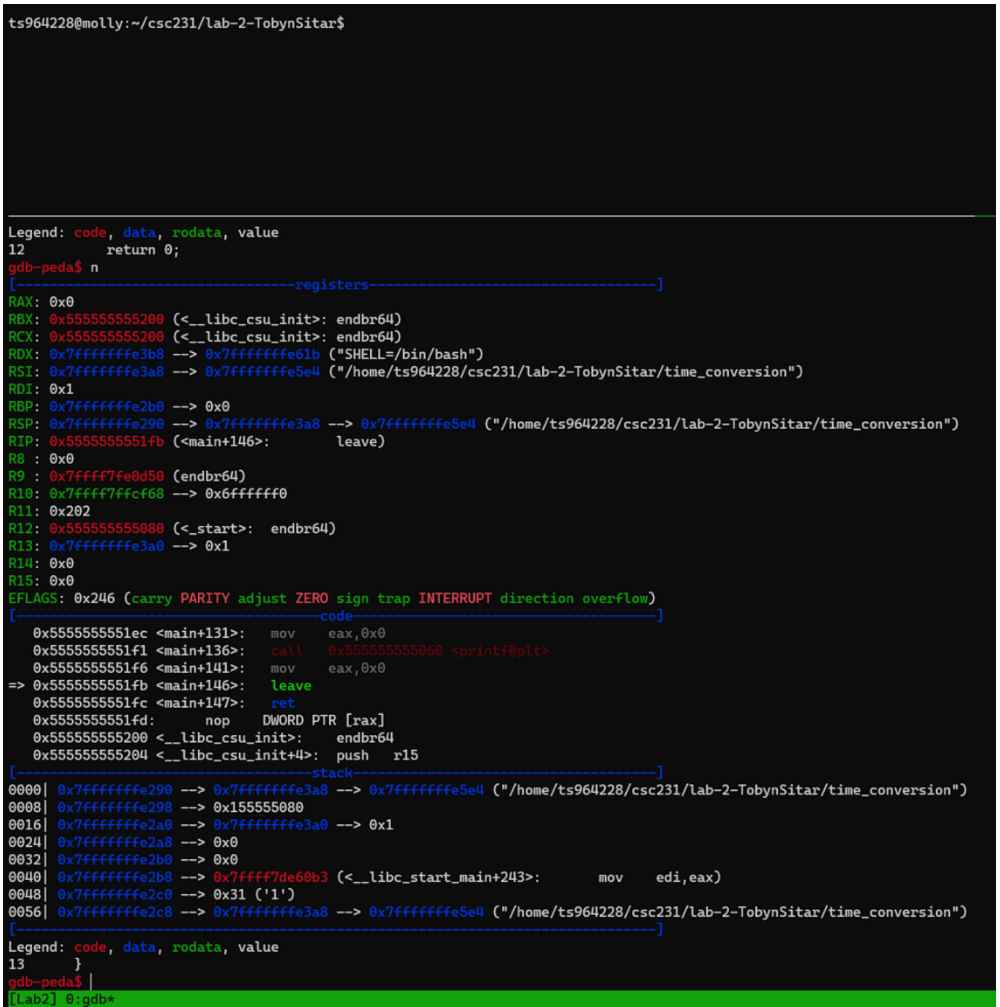
- Using n, step through all the remaining instructions in main, taking a screenshot of each step. Once again, your screenshot should clearly show the gdb contents of registers, code, stack, and the instruction to be executed next.



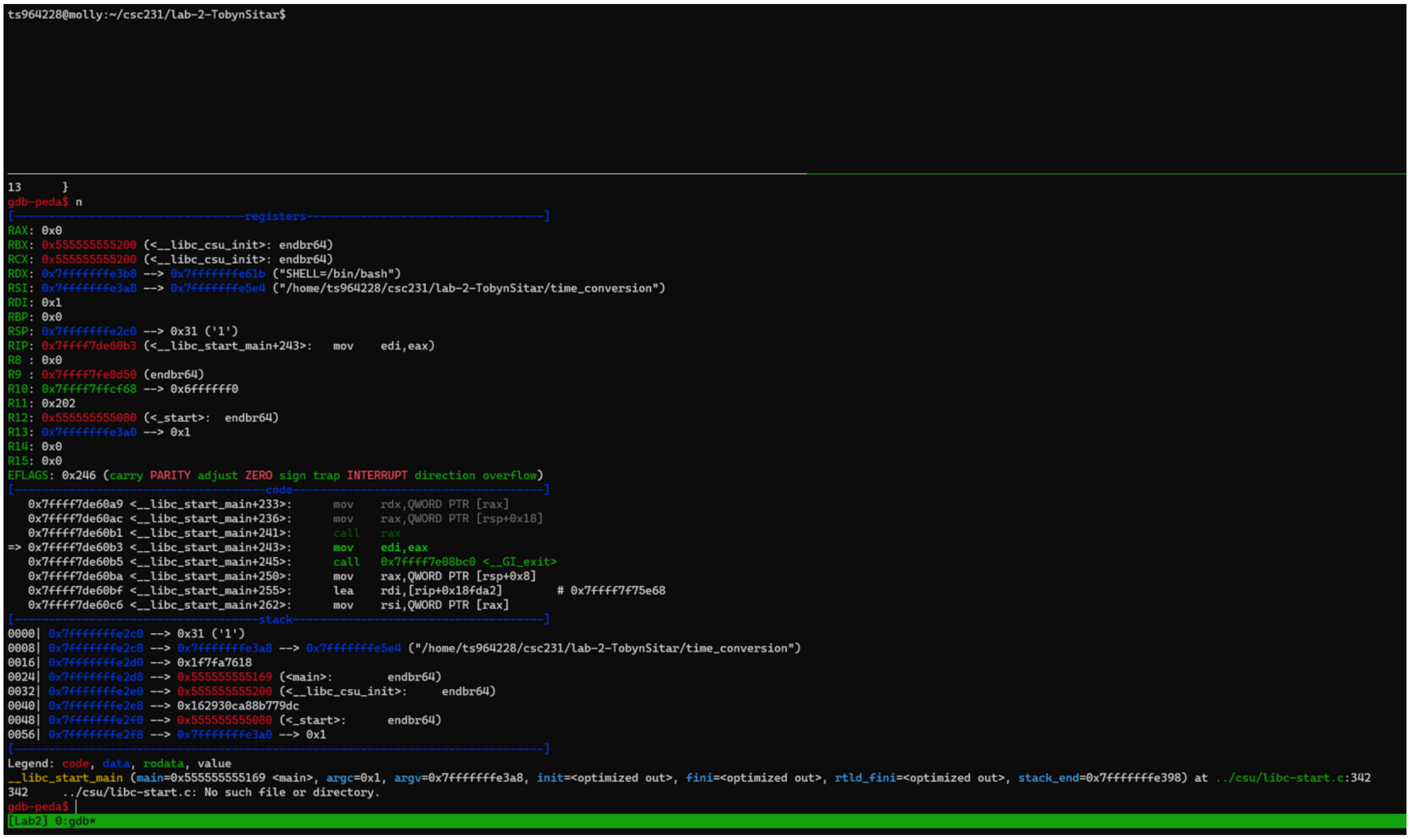
```
ts964228@molly:~/csc231/lab-2-TobynSitar$



Breakpoint 1, main (argc=0x5555, argv=0x0) at time_conversion.c:4
4       int main(int argc, char *argv[]) {
gdb-peda$ n
[----------------------------------registers-----------------------------------]
RAX: 0x555555555169 (<main>:    endbr64)
RBX: 0x555555555200 (<__libc_csu_init>: endbr64)
RCX: 0x555555555200 (<__libc_csu_init>: endbr64)
RDX: 0x7fffffffe3b8 --> 0x7fffffffe61b ("SHELL=/bin/bash")
RSI: 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
RDI: 0x1
RBP: 0x7fffffffe2b0 --> 0x0
RSP: 0x7fffffffe290 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
RIP: 0x55555555517c (<main+19>: cmp    DWORD PTR [rbp-0x14],0x1)
R8 : 0x0
R9 : 0x7ffff7fe0d50 (endbr64)
R10: 0x7ffff7ffcf68 --> 0x6ffffff0
R11: 0x202
R12: 0x555555555080 (<_start>:  endbr64)
R13: 0x7fffffffe3a0 --> 0x1
R14: 0x0
R15: 0x0
EFLAGS: 0x206 (carry PARITY adjust zero sign trap INTERRUPT direction overflow)
[-------------------------------------code-------------------------------------]
   0x555555555171 <main+8>:     sub    rsp,0x20
   0x555555555175 <main+12>:    mov    DWORD PTR [rbp-0x14],edi
   0x555555555178 <main+15>:    mov    QWORD PTR [rbp-0x20],rsi
=> 0x55555555517c <main+19>:    cmp    DWORD PTR [rbp-0x14],0x1
   0x555555555180 <main+23>:    jle    0x5555555551f6 <main+141>
   0x555555555182 <main+25>:    mov    rax,QWORD PTR [rbp-0x20]
   0x555555555186 <main+29>:    add    rax,0x8
   0x55555555518a <main+33>:    mov    rax,QWORD PTR [rax]
[------------------------------------stack-------------------------------------]
0000| 0x7fffffffe290 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
0008| 0x7fffffffe298 --> 0x155555080
0016| 0x7fffffffe2a0 --> 0x7fffffffe3a0 --> 0x1
0024| 0x7fffffffe2a8 --> 0x0
0032| 0x7fffffffe2b0 --> 0x0
0040| 0x7fffffffe2b8 --> 0x7ffff7de60b3 (<__libc_start_main+243>:       mov    edi,eax)
0048| 0x7fffffffe2c0 --> 0x31 ('1')
0056| 0x7fffffffe2c8 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
[------------------------------------------------------------------------------]
Legend: code, data, rodata, value
5           if (argc > 1) {
gdb-peda$ |
[Lab2] 0:gdb*
```



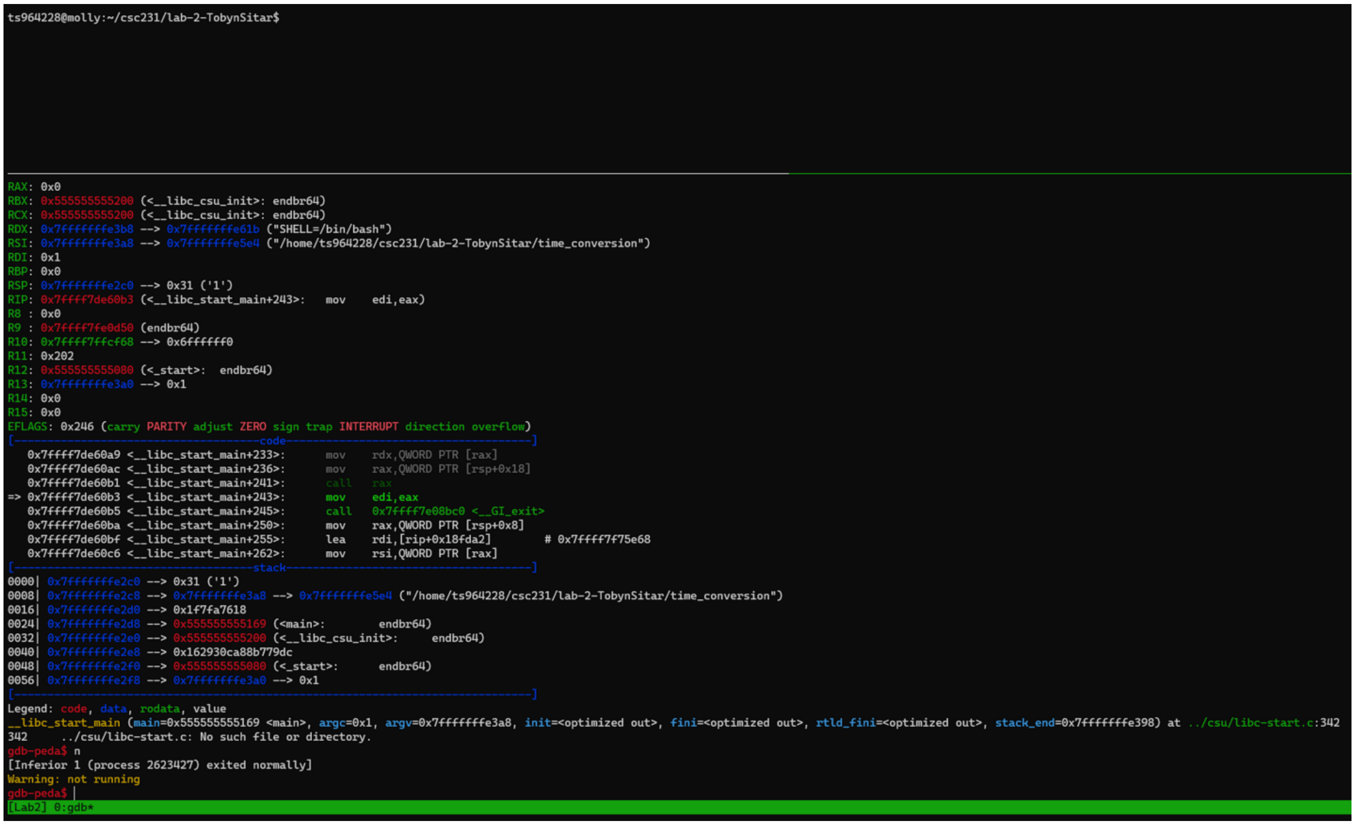
```
s964228@molly:~/csc231/lab-2-TobynSitar$








egend: code, data, rodata, value
          if (argc > 1) {
db-peda$ n
---------------------------------registers-----------------------------------]
AX: 0x555555555169 (<main>:    endbr64)
BX: 0x555555555200 (<__libc_csu_init>: endbr64)
CX: 0x555555555200 (<__libc_csu_init>: endbr64)
DX: 0x7fffffffe3b8 --> 0x7fffffffe61b ("SHELL=/bin/bash")
SI: 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
DI: 0x1
BP: 0x7fffffffe2b0 --> 0x0
SP: 0x7fffffffe290 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
IP: 0x5555555551f6 (<main+141>:        mov    eax,0x0)
8 : 0x0
9 : 0x7ffff7fe0d50 (endbr64)
10: 0x7ffff7ffcf68 --> 0x6ffffff0
11: 0x202
12: 0x555555555080 (<_start>:  endbr64)
13: 0x7fffffffe3a0 --> 0x1
14: 0x0
15: 0x0
FLAGS: 0x246 (carry PARITY adjust ZERO sign trap INTERRUPT direction overflow)
------------------------------------code-------------------------------------]
  0x5555555551e5 <main+124>:   lea    rdi,[rip+0xe18]        # 0x555555556004
  0x5555555551ec <main+131>:   mov    eax,0x0
  0x5555555551f1 <main+136>:   call   0x555555555060 <printf@plt>
> 0x5555555551f6 <main+141>:   mov    eax,0x0
  0x5555555551fb <main+146>:   leave
  0x5555555551fc <main+147>:   ret
  0x5555555551fd:      nop    DWORD PTR [rax]
  0x555555555200 <__libc_csu_init>:    endbr64
-----------------------------------stack-------------------------------------]
000| 0x7fffffffe290 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
008| 0x7fffffffe298 --> 0x155555080
016| 0x7fffffffe2a0 --> 0x7fffffffe3a0 --> 0x1
024| 0x7fffffffe2a8 --> 0x0
032| 0x7fffffffe2b0 --> 0x0
040| 0x7fffffffe2b8 --> 0x7ffff7de60b3 (<__libc_start_main+243>:       mov    edi,eax)
048| 0x7fffffffe2c0 --> 0x31 ('1')
056| 0x7fffffffe2c8 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
-----------------------------------------------------------------------------]
egend: code, data, rodata, value
2          return 0;
db-peda$ |
Lab2] 0:gdb*
```



```
ts964228@molly:~/csc231/lab-2-TobynSitar$








Legend: code, data, rodata, value
12          return 0;
gdb-peda$ n
[----------------------------------registers-----------------------------------]
RAX: 0x0
RBX: 0x555555555200 (<__libc_csu_init>: endbr64)
RCX: 0x555555555200 (<__libc_csu_init>: endbr64)
RDX: 0x7fffffffe3b8 --> 0x7fffffffe61b ("SHELL=/bin/bash")
RSI: 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
RDI: 0x1
RBP: 0x7fffffffe2b0 --> 0x0
RSP: 0x7fffffffe290 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
RIP: 0x5555555551fb (<main+146>:        leave)
R8 : 0x0
R9 : 0x7ffff7fe0d50 (endbr64)
R10: 0x7ffff7ffcf68 --> 0x6ffffff0
R11: 0x202
R12: 0x555555555080 (<_start>:  endbr64)
R13: 0x7fffffffe3a0 --> 0x1
R14: 0x0
R15: 0x0
EFLAGS: 0x246 (carry PARITY adjust ZERO sign trap INTERRUPT direction overflow)
[-------------------------------------code-------------------------------------]
   0x5555555551ec <main+131>:   mov    eax,0x0
   0x5555555551f1 <main+136>:   call   0x555555555060 <printf@plt>
   0x5555555551f6 <main+141>:   mov    eax,0x0
=> 0x5555555551fb <main+146>:   leave
   0x5555555551fc <main+147>:   ret
   0x5555555551fd:      nop    DWORD PTR [rax]
   0x555555555200 <__libc_csu_init>:    endbr64
   0x555555555204 <__libc_csu_init+4>:  push   r15
[------------------------------------stack-------------------------------------]
0000| 0x7fffffffe290 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
0008| 0x7fffffffe298 --> 0x155555080
0016| 0x7fffffffe2a0 --> 0x7fffffffe3a0 --> 0x1
0024| 0x7fffffffe2a8 --> 0x0
0032| 0x7fffffffe2b0 --> 0x0
0040| 0x7fffffffe2b8 --> 0x7ffff7de60b3 (<__libc_start_main+243>:       mov    edi,eax)
0048| 0x7fffffffe2c0 --> 0x31 ('1')
0056| 0x7fffffffe2c8 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
[------------------------------------------------------------------------------]
Legend: code, data, rodata, value
13      }
gdb-peda$ |
[Lab2] 0:gdb*
```



```
ts964228@molly:~/csc231/lab-2-TobynSitar$

13      }
gdb-peda$ n
[----------------------------------registers-----------------------------------]
RAX: 0x0
RBX: 0x555555555200 (<__libc_csu_init>: endbr64)
RCX: 0x555555555200 (<__libc_csu_init>: endbr64)
RDX: 0x7fffffffe3b8 --> 0x7fffffffe61b ("SHELL=/bin/bash")
RSI: 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
RDI: 0x1
RBP: 0x0
RSP: 0x7fffffffe2c0 --> 0x31 ('1')
RIP: 0x7ffff7de60b3 (<__libc_start_main+243>:   mov    edi,eax)
R8 : 0x0
R9 : 0x7ffff7fe0d50 (endbr64)
R10: 0x7ffff7ffcf68 --> 0x6ffffff0
R11: 0x202
R12: 0x555555555080 (<_start>:  endbr64)
R13: 0x7fffffffe3a0 --> 0x1
R14: 0x0
R15: 0x0
EFLAGS: 0x246 (carry PARITY adjust ZERO sign trap INTERRUPT direction overflow)
[-------------------------------------code-------------------------------------]
   0x7ffff7de60a9 <__libc_start_main+233>:      mov    rdx,QWORD PTR [rax]
   0x7ffff7de60ac <__libc_start_main+236>:      mov    rax,QWORD PTR [rsp+0x18]
   0x7ffff7de60b1 <__libc_start_main+241>:      call   rax
=> 0x7ffff7de60b3 <__libc_start_main+243>:      mov    edi,eax
   0x7ffff7de60b5 <__libc_start_main+245>:      call   0x7ffff7e08bc0 <__GI_exit>
   0x7ffff7de60ba <__libc_start_main+250>:      mov    rax,QWORD PTR [rsp+0x8]
   0x7ffff7de60bf <__libc_start_main+255>:      lea    rdi,[rip+0x18fda2]        # 0x7ffff7f75e68
   0x7ffff7de60c6 <__libc_start_main+262>:      mov    rsi,QWORD PTR [rax]
[------------------------------------stack-------------------------------------]
0000| 0x7fffffffe2c0 --> 0x31 ('1')
0008| 0x7fffffffe2c8 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
0016| 0x7fffffffe2d0 --> 0x1f7fa7618
0024| 0x7fffffffe2d8 --> 0x555555555169 (<main>:        endbr64)
0032| 0x7fffffffe2e0 --> 0x555555555200 (<__libc_csu_init>:     endbr64)
0040| 0x7fffffffe2e8 --> 0x162930ca88b779dc
0048| 0x7fffffffe2f0 --> 0x555555555080 (<_start>:      endbr64)
0056| 0x7fffffffe2f8 --> 0x7fffffffe3a0 --> 0x1
[------------------------------------------------------------------------------]
Legend: code, data, rodata, value
__libc_start_main (main=0x555555555169 <main>, argc=0x1, argv=0x7fffffffe3a8, init=<optimized out>, fini=<optimized out>, rtld_fini=<optimized out>, stack_end=0x7fffffffe398) at ../csu/libc-start.c:342
342     ../csu/libc-start.c: No such file or directory.
gdb-peda$ |
[Lab2] 0:gdb*
```



```
ts964228@molly:~/csc231/lab-2-TobynSitar$

RAX: 0x0
RBX: 0x555555555200 (<__libc_csu_init>: endbr64)
RCX: 0x555555555200 (<__libc_csu_init>: endbr64)
RDX: 0x7fffffffe3b8 --> 0x7fffffffe61b ("SHELL=/bin/bash")
RSI: 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
RDI: 0x1
RBP: 0x0
RSP: 0x7fffffffe2c0 --> 0x31 ('1')
RIP: 0x7ffff7de60b3 (<__libc_start_main+243>:   mov    edi,eax)
R8 : 0x0
R9 : 0x7ffff7fe0d50 (endbr64)
R10: 0x7ffff7ffcf68 --> 0x6ffffff0
R11: 0x202
R12: 0x555555555080 (<_start>:  endbr64)
R13: 0x7fffffffe3a0 --> 0x1
R14: 0x0
R15: 0x0
EFLAGS: 0x246 (carry PARITY adjust ZERO sign trap INTERRUPT direction overflow)
[-------------------------------------code-------------------------------------]
   0x7ffff7de60a9 <__libc_start_main+233>:      mov    rdx,QWORD PTR [rax]
   0x7ffff7de60ac <__libc_start_main+236>:      mov    rax,QWORD PTR [rsp+0x18]
   0x7ffff7de60b1 <__libc_start_main+241>:      call   rax
=> 0x7ffff7de60b3 <__libc_start_main+243>:      mov    edi,eax
   0x7ffff7de60b5 <__libc_start_main+245>:      call   0x7ffff7e08bc0 <__GI_exit>
   0x7ffff7de60ba <__libc_start_main+250>:      mov    rax,QWORD PTR [rsp+0x8]
   0x7ffff7de60bf <__libc_start_main+255>:      lea    rdi,[rip+0x18fda2]        # 0x7ffff7f75e68
   0x7ffff7de60c6 <__libc_start_main+262>:      mov    rsi,QWORD PTR [rax]
[------------------------------------stack-------------------------------------]
0000| 0x7fffffffe2c0 --> 0x31 ('1')
0008| 0x7fffffffe2c8 --> 0x7fffffffe3a8 --> 0x7fffffffe5e4 ("/home/ts964228/csc231/lab-2-TobynSitar/time_conversion")
0016| 0x7fffffffe2d0 --> 0x1f7fa7618
0024| 0x7fffffffe2d8 --> 0x555555555169 (<main>:        endbr64)
0032| 0x7fffffffe2e0 --> 0x555555555200 (<__libc_csu_init>:     endbr64)
0040| 0x7fffffffe2e8 --> 0x162930ca88b779dc
0048| 0x7fffffffe2f0 --> 0x555555555080 (<_start>:      endbr64)
0056| 0x7fffffffe2f8 --> 0x7fffffffe3a0 --> 0x1
[------------------------------------------------------------------------------]
Legend: code, data, rodata, value
__libc_start_main (main=0x555555555169 <main>, argc=0x1, argv=0x7fffffffe3a8, init=<optimized out>, fini=<optimized out>, rtld_fini=<optimized out>, stack_end=0x7fffffffe398) at ../csu/libc-start.c:342
342     ../csu/libc-start.c: No such file or directory.
gdb-peda$ n
[Inferior 1 (process 2623427) exited normally]
Warning: not running
gdb-peda$ |
[Lab2] 0:gdb*
```