1.1.After -Og compile and objdump -d test1.exe (from <main>):

```
sub    $0x28,%rsp
call   140001520 <__main>
mov    $0x0,%eax
add    $0x28,%rsp
ret
```

1.2. After -O0 compile and objdump:

```
push   %rbp
mov    %rsp,%rbp
sub    $0x30,%rsp
call   140001530 <__main>
movl   $0x7,-0x4(%rbp)          # int x = 7
movl   $0x2,-0x8(%rbp)          # int y = 2
mov    -0x4(%rbp),%eax
imul   -0x8(%rbp),%eax
mov    %eax,-0xc(%rbp)
mov    $0x0,%eax                # int z
add    $0x30,%rsp               # z = y*x
pop    %rbp
ret
```

1.3. Changing the optimization flag from -Og to -O0 increased the length of our disassembly instructions. -Og is used for faster code while -O0 is used for debugging.

2.1. After -Og compile and objdump -d test2.exe (from <main>):

```
sub    $0x28,%rsp
call   140001520 <__main>
mov    $0x0,%eax
add    $0x28,%rsp
ret
```

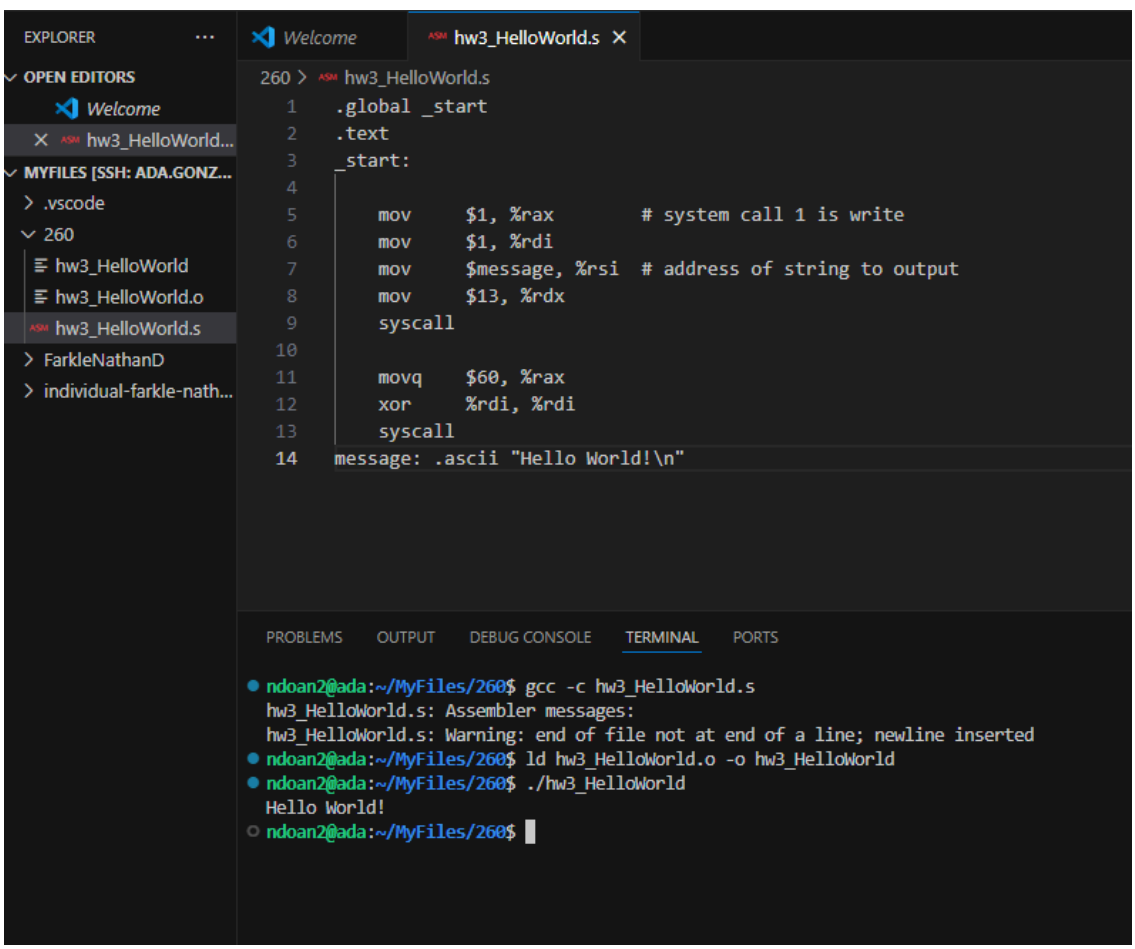
2.2 After -O0 compile and objdump:

```
push   %rbp
mov    %rsp,%rbp
sub    $0x30,%rsp
call   140001540 <__main>
movl   $0x7,-0x4(%rbp)          # int x = 7
movl   $0x0,-0x8(%rbp)          # int y = 0
mov    -0x4(%rbp),%eax
```

```
and    $0x1,%eax
test   %eax,%eax                    # if x % 2
jne    14000147e <main+0x2e>        # if true
movl   $0x2,-0x8(%rbp)              # set y = 2 & return
jmp    140001485 <main+0x35>        # if false
movl   $0x1,-0x8(%rbp)              # set y = 1 & return
mov    $0x0,%eax
add    $0x30,%rsp
pop    %rbp
ret
```

2.3. Like my previous observations, -O0 increases the length of the disassembly instructions. We can confirm this by looking at the outputs. With -O0, no optimization. The compiler will keep all variables and the if-else structure. Even though y isn't used, all steps are kept. With -Og, the compiler removes dead code. Since y is assigned but not used, the entire if-else is eliminated. The assembly would just return 0 without any of the variable assignments or condition checks. -Og helps eliminate any unnecessary operations.

3.1 Assembly code, using Linux ada.gonzaga server (Originally on Windows 11)



3.2 Modifying the original HelloWorld.s file

To print out a larger string, I had to modify the mov $num, %rdx line. The ‘num’ indicates any integer and that will create an empty string based on the size of the integer. For my message to work, 13 characters was not enough so I multiplied it by 10.

Explanation of %rax, %rdi, %rsi, and %rdx

The uses of %rax, %rdi, %rsi, and %rdx are used to call some sort of registry in the computer. I assume these registries allow the computer to access memory or information about the task they’re supposed to perform. I tried changing the %rsi to %rdi on the $message line, and vice versa – however that failed to compile the executable. So, the %rax, %rdi, %rsi, and %rdx does affect the code.