

CSCI 2021: Practice Final Exam

Spring 2023

University of Minnesota

Exam period: 20 minutes

Points available: 40

Background: Nearby are several C files along with two attempts to compile them on the left. Study these and answer the questions that follow.

```

1 > gcc vf_weak_var.c vf_strong_func.c vf_main.c # COMPILE 1
2 /usr/bin/ld: warning: size of symbol 'foo' changed from 4 to 14
3 /usr/bin/ld: warning: type of symbol 'foo' changed from 1 to 2
4 > file a.out
5 a.out: ELF 64-bit LSB pie executable, x86-64, version
6 > ./a.out
7 -573193927
8 4
9 > rm a.out
10
11 > gcc vf_strong_var.c vf_strong_func.c vf_main.c # COMPILE 2
12 /usr/bin/ld: multiple definition of 'foo';
13 collect2: error: ld returned 1 exit status
14 > file a.out
15 a.out: cannot open 'a.out' (No such file or directory)

```

```

1 // FILE: vf_main.c
2 #include <stdio.h>
3 int foo(int x);
4 int main(){
5     printf("%d\n",foo);
6     printf("%d\n",foo(2));
7     return 0;
8 }
9
10 // FILE: vf_strong_func.c
11 int foo(int x){
12     return 2*x;
13 }
14
15 // FILE: vf_strong_var.c
16 int foo = 0;
17
18 // FILE: vf_weak_var.c
19 int foo;

```

Problem 1 (10 pts): Why does COMPILE 1 succeed while COMPILE 2 fails? Mention pertinent properties of ELF files in your answer.

Problem 2 (10 pts): Nearby is the output of `pmap` showing page table virtual memory mapping information for a running program called `memory_parts`. Answer the following questions about this output.

(A) The mapped memory references something called `libc-2.26.so`. Describe this entity and what kind of information you would expect to find at the mapped locations.

```

> pmap 7986
7986: ./memory_parts
00005579a4abd000      4K r-x-- memory_parts
00005579a4cbd000      4K r---- memory_parts
00005579a4cbe000      4K rw--- memory_parts
00005579a4cbf000      4K rw--- [ anon ]
00005579a53aa000     132K rw--- [ heap ]
00007f441f2e1000    1720K r-x-- libc-2.26.so
00007f441f48f000    2044K ----- libc-2.26.so
00007f441f68e000     16K r---- libc-2.26.so
00007f441f692000     8K rw--- libc-2.26.so
00007f441f694000     16K rw--- [ anon ]
00007f441f698000    148K r-x-- ld-2.26.so
00007f441f88f000     8K rw--- [ anon ]
00007f441f8bb000     4K r---- gettysburg.txt
00007f441f8bc000     4K r---- ld-2.26.so
00007f441f8bd000     4K rw--- ld-2.26.so
00007f441f8be000     4K rw--- [ anon ]
00007fff96ae1000    132K rw--- [ stack ]
00007fff96b48000     12K r---- [ anon ]
00007fff96b4b000     8K r-x-- [ anon ]
total                4276K

```

(B) Why does `pmap` only show a limited number of virtual addresses? What would happen if the program attempted to access an address not listed in the output? Example: address `0x00` is not in the listing.

