Weaver
Spring 2022

CS 161
Computer Security

Discussion 1

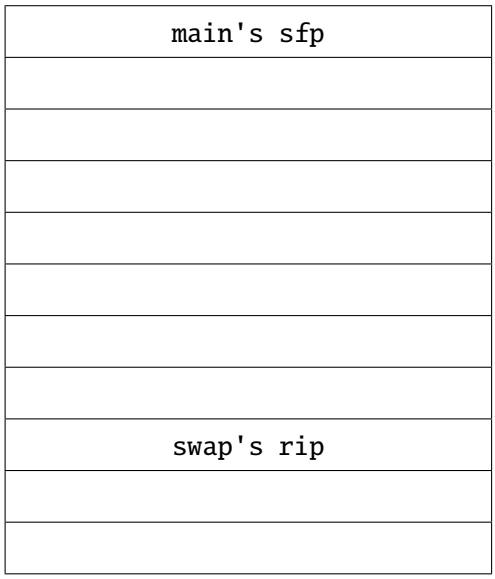
For a handy guide on x86 and GDB, check out this GDB Cheatsheet.

Question 1 ***Stack Diagram Practice*** ()

Consider the following function.

```
1  void swap(int* num1, int* num2, int arr_local[]) {
2      int temp = *num1;
3      *num1 = *num2;
4      arr_local[0] = *num1;
5      *num2 = temp;
6      arr_local[1] = *num2;
7  }
8
9  int main(void) {
10     int x = 61;
11     int y = 1;
12     int arr[2];
13     swap(&x, &y, arr);
14 }
```

1. Complete the diagram of the stack if the code were executed until a breakpoint set on line 3. Assume normal (non-malicious) program execution. You do not need to write the values on the stack, only the names. There are no extraneous boxes, and each box represents 4 bytes in memory. The bottom of the page represents the lower addresses.



2. Now, draw arrows on the stack diagram denoting where the ESP and EBP would point if the code were executed until a breakpoint set on line 3.

Question 2 ***Software Vulnerabilities*** ()

For the following code, assume an attacker can control the value of `basket`, `n`, and `owner_name` passed into `search_basket`.

This code contains several security vulnerabilities. **Circle *three* such vulnerabilities** in the code and briefly explain each of the three on the next page.

```
1  struct cat {
2      char name[64];
3      char owner[64];
4      int age;
5  };
6
7  /* Searches through a BASKET of cats of length N (N should be less
       than 32). Adopts all cats with age less than 12 (kittens).
       Adopted kittens have their owner name overwritten with OWNER_NAME
       . Returns the number of kittens adopted. */
8  size_t search_basket(struct cat *basket, int n, char *owner_name) {
9      struct cat kittens[32];
10     size_t num_kittens = 0;
11     if (n > 32) return -1;
12     for (size_t i = 0; i <= n; i++) {
13         if (basket[i].age < 12) {
14             /* Reassign the owner name. */
15             strcpy(basket[i].owner, owner_name);
16             /* Copy the kitten from the basket. */
17             kittens[num_kittens] = basket[i];
18             num_kittens++;
19             /* Print helpful message. */
20             printf("Adopting kitten: ");
21             printf(basket[i].name);
22             printf("\n");
23         }
24     }
25     /* Adopt kittens. */
26     adopt_kittens(kittens, num_kittens); // Implementation not shown
           .
27     return num_kittens;
28 }
```

1. Explanation:

2. Explanation:

3. Explanation:

Describe how an attacker could exploit these vulnerabilities to obtain a shell:

Question 3 ***Remus*** **()**

This problem is Question 1 of Project 1 converted to a discussion question, with the intention of providing a foundation for completing Project 1. The question will also consist of a live GDB walkthrough, conducted by your TA. A video version of this walkthrough is available on https://cs161.org/.

Consider the following vulnerable code.

```
1  #include <stdio.h>
2
3  void orbit()
4  {
5   char buf[8];
6   gets(buf);
7  }
8
9  int main()
10 {
11  orbit();
12  return 0;
13 }
```

1. Which line of code contains the memory safety vulnerability? Briefly explain this vulnerability.

2. Complete the stack diagram if the code were executed until a breakpoint set on line 6. Assume normal (non-malicious) program execution. You do not need to write the values on the stack, only the names. There are no extraneous boxes, and each box represents 4 bytes in memory. The bottom of the page represents the lower addresses.

orbit's RIP

3. Construct an input to `buf` that would result in a successful buffer overflow attack. Assume that orbit's `RIP` is stored at `0xffffff8e0` and that you have a `SHELLCODE` script that you would like to execute. In addition, assume that there are 8 bytes of compiler padding.