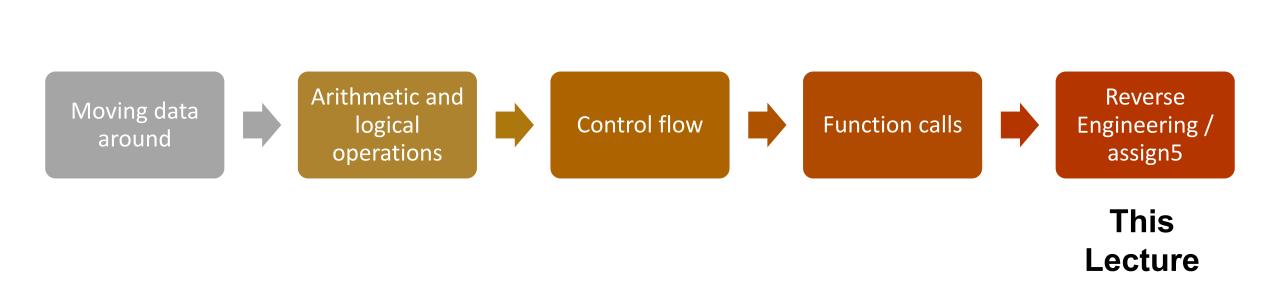
CS107, Lecture 21 Reverse Engineering

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Learning Assembly



Reference Sheet: cs107.stanford.edu/resources/x86-64-reference.pdf See more guides on Resources page of course website!

Learning Goals

- Learn how to approach reverse engineering executables
- Understand the requirements and tasks for assign5

Lecture Plan

- GDB / Function Call Practice: Recursion
- Reverse Engineering Practice: Minivault

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Example: Recursion

- Let's look at an example of recursion at the assembly level.
- We'll use everything we've learned about registers, the stack, function calls, parameters, and assembly instructions!
- We'll also see how helpful GDB can be when tracing through assembly.



factorial.c and factorial

gdb tips



layout split info reg

p \$eax

ni

si

p \$eflags

(ctrl-x a: exit, ctrl-l: resize, refresh: refresh, layout reg/asm, focus next)

View C, assembly, and gdb (lab5) Print all registers

Print register value Print all condition codes currently set

b *0x400546

b *0x400550 if \$eax > 98

Set breakpoint at assembly instruction Set conditional breakpoint

Next assembly instruction

Step into assembly instruction (will step into function calls)

gdb tips



p/x \$rdi p/t \$rsi

x \$rdi x/4bx \$rdi x/4wx \$rdi

x/1gx \$rdi

finish

Print register value in hex Print register value in binary

Examine the byte stored at this address Examine 4 bytes starting at this address

Examine 4 words (4 bytes) starting at this address

Examine 1 giant word (8 bytes) starting at this address

Finish function, return to caller

Lecture Plan

- GDB / Function Call Practice: Recursion
- Reverse Engineering Practice: Minivault

assign5

You are a security researcher hired to explore potential vulnerabilities and issues at Stanford Bank. **3 core parts:**

- 1. Uncovering ATM software vulnerabilities
- 2. Demonstrating how a data leak can lead to data aggregation and uncovering of personal information
- **3. Reverse engineering a secure program** discover 4 passwords needed to gain access to the system

Minivault

The **minivault** program is practice for part 3, SecureVault (it doesn't share code with SecureVault but is similar reverse-engineering practice).

You must provide correct passwords for 2 stages:

./minivault [stage1password] [stage2password]

stage1 and **stage2** are 2 functions in minivault, each passed in the password for that stage. Our goal is to get both to return 1, and not 0.

Reverse Engineering Tips

- **1.** Run the program live in GDB and step through. Reading and diagramming by hand is useful, but quickly becomes infeasible with larger programs.
- 2. Break the assembly into chunks
- 3. Use gdb to verify your hypotheses.
- **4. Document your knowns and unknowns.** Document and re-verify conflicting assumptions.
- 5. Use compiler explorer to see what code looks like in assembly.
- **6. Use library functions to your advantage.** If you spot a call to what looks like a library function, it's the real deal.
- 7. When tracing an unknown function, before dissecting its behavior first learn about the input/output of the function and what role it plays.

Demo: Minivault

Respond on PollEv: pollev.com/cs107 or text CS107 to 22333 once to join.



Recap

- GDB / Function Call Practice: Recursion
- Reverse Engineering Practice: Minivault

Lecture 21 takeaway: Reverse engineering lets us understand the behavior of a program without seeing its source code. Check out slide 12 for some summarized tips!