CSE 351

GDB + Lab 2

Lab 2

- Already out!
- Due Friday, February 3, 2017 at 5:00pm

- Reading and understanding x86_64 assembly
- Debugging and disassembling programs

- Today:
  - General debugging for C with GDB

GDB

- GNU Debugger
- GDB is your best friend
  - start, stop, peek in, poke at your program
- Today we will be going over many of the features that will make GDB a great resource for you this quarter
- **Useful in future classes!**
  - CSE 333, CSE 451, CSE 484 etc.

Breakpoints

- In order to step through code, we need to be able to pause execution.

- GDB allows you to set breakpoints, just like when you debugged Java programs in Eclipse or jGRASP.

- **`break`** (**`b`** for short) command creates breakpoints.
- **`info break`** shows your breakpoints

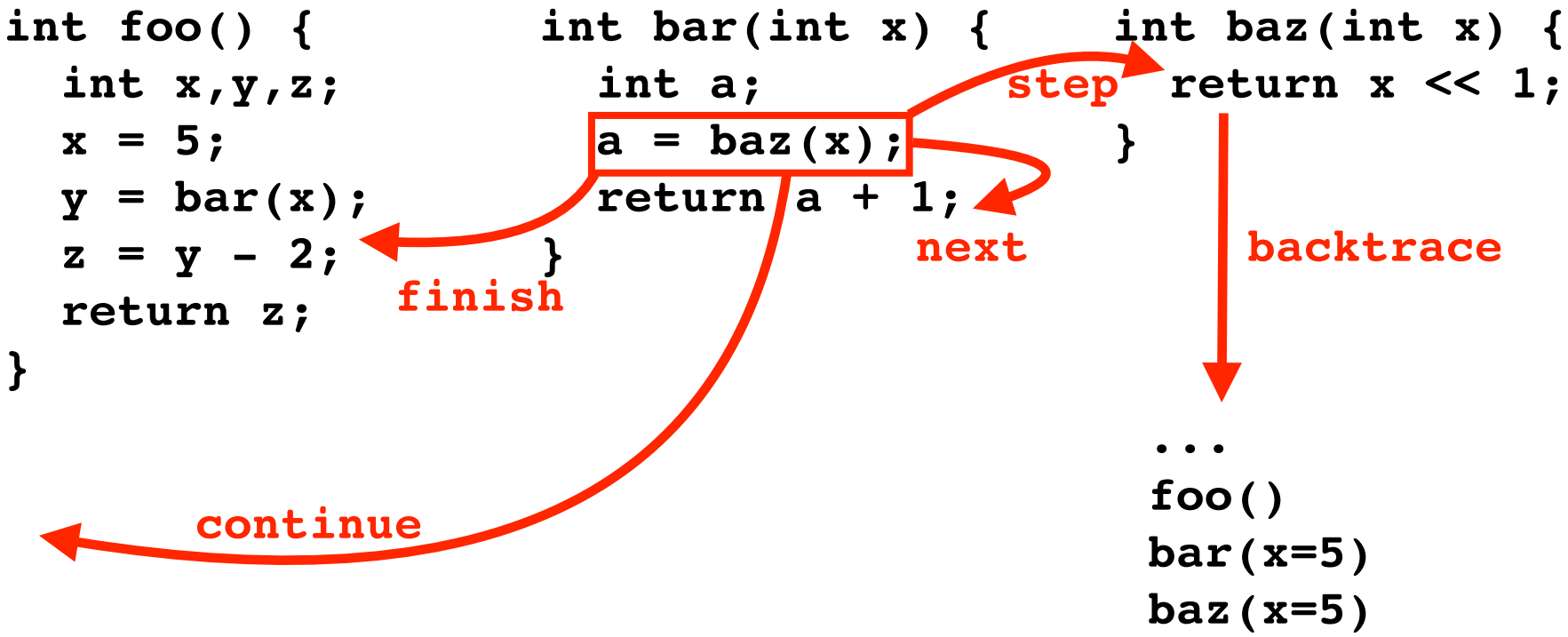
Stepping Through Code

```
int foo() {
  int x,y,z;
  x = 5;
  y = bar(x);
  z = y - 2;
  return z;
}
```

```
int bar(int x) {
  int a;
  a = baz(x);
  return a + 1;
}
```

```
int baz(int x) {
  return x << 1;
}
```

Stepping Through Code



Printing

- **`print`** to look at values
- **`x`** to examine memory
- **`help x`** to see how to use it
  - **`help`** anything else!

Printing

How can I display something persistently?

`display /i $pc` (current instruction)

`display /x $rax` (contents of `%rax` in hex)

`display /16bd $rdi` (16 bytes of memory pointed to by `%rdi` as integers in decimal)

Debugging

- GDB will stop you when you get an error
  - null-dereference, **`1/0`**
- **`backtrace`** (**`bt`**) shows how you got there
  - Viewing a backtrace can be very helpful in debugging.
- **`list`** shows you C code
- **`disas`** shows you assembly
  - **`objdump`** as well

Register Conventions

- Parameters: `%rdi, %rsi, %rdx, %rcx, %r8, %r9`
- Return value: `%rax`
- We'll see how this is used in `phase_1` of the lab

Register Conventions

- Let's say one of your functions looks like

```
foo(){
    int bar = some + complex + calculation;
    int bar2 = complex_subroutine();
    return bar * bar2;
}
```

- What happens to 'bar' if it was in a register?
- Some registers are caller-saved, others callee-saved
- Why have a calling convention? Linked libraries, …

The x86 Calling Convention

Caller-Saved Registers

`%rax`	Return Value
`%rdi`	Arguments 1-6
`%rsi`	
`%rdx`	
`%rcx`	
`%r8`	
`%r9`	
`%r10`	Temporaries
`%r11`	

Callee-Saved Registers

`%rbx`	Temporaries
`%r12`	
`%r13`	
`%r14`	
`%rbp`	Base Pointer
`%rsp`	Stack Pointer

Control Flow

- 1-bit condition code registers [CF, SF, ZF, OF]
- Set as side effect by arithmetic instructions or by `cmp`, `test`
- CF – Carry Flag
  - Set if addition causes a carry out of the most significant (leftmost) bit.
- SF – Sign Flag
  - Set if the result had its most significant bit set (negative in two's complement)
- ZF – Zero Flag
  - Set if the result was zero
- OF – Overflow Flag
  - If the addition with the sign bits off yields a result number with the sign bit on or vice versa

Lab 2

- Requires you to defuse “bombs” by entering a series of passcodes
  - Not real bombs/viruses/etc!
- Each passcode is validated by some function
  - You only have access to the assembly code
- It’s your job to determine what passcodes will prevent the program from ever calling the `explode_bomb()` function
- Each student has a different bomb

Lab 2 Files

- `bomb`
  - The executable bomb program
- `bomb.c`
  - This is the entry point for the bomb program, not including the phase_* functions
- `defuser.txt`
  - Place your passcodes here once you solve each phase, separated by newline
  - Can be passed as an argument to prevent you from entering the passcodes manually each time
  - `run defuser.txt` from within GDB

Lab 2 Notes

- The bomb uses sscanf, which parses a string into values
- Example:

```
int a, b;
sscanf(“123, 456”, “%d, %d”, &a, &b);
```

- The first argument is parsed according to the format string
- Specifiers like printf

Lab 2 Tips

- Print out the disassembled phases
  - `objdump -d bomb > bomb.s`
  - You can then print out `bomb.s`
  - Mark the printouts up with notes
- Try to work backwards from the “success” case of each phase
- Remember that some addresses are pointing to strings located elsewhere in memory
  - Print them out in GDB

Lab 2 Phase 1