Getting Started

To obtain a copy of today's activity, log into a shark machine and do the following:

```
$ wget http://www.cs.cmu.edu/~213/activities/machine-procedures.tar
$ tar xf machine-procedures.tar
$ cd machine-procedures
```

Record your answers to the discussion questions below. You may wish to refer back to the activity from September 8 (https://www.cs.cmu.edu/~213/activities/gdb-and-assembly.pdf) which contains a list of relevant GDB commands.

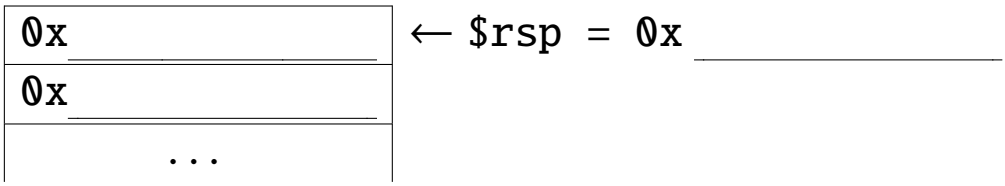
1 Activity 1: Calls

In the `machine-procedures` directory that you created, run the `calls` binary from within GDB, like this:

```
$ gdb --args ./calls
(gdb) r
```

The program will instruct you as you progress through the activity. These questions accompany the program; when it prompts you to answer a problem, discuss with your partner and write your answer here.

Problem 1. Fill in the contents of the stack:



Problem 2. What was the meaning of the second number on the stack?

Problem 3. What does the `ret` instruction do?

Problem 4. Given your answer to Problem 3, what must it be that `call` does?

Problem 5. What special optimization of calls has been applied to `returnOneOpt`? Why does this optimization work for `returnOneOpt`? Can it be used for any call?

2 Activity 2: Arguments and Local Variables

In the `machine-procedures` directory that you created, run the `locals` binary from within GDB, like this:

```
$ gdb --args ./locals
(gdb) r
```

The program will instruct you as you progress through the activity. These questions accompany the program; when it prompts you to answer a problem, discuss with your partner and write your answer here.

Problem 6. What is the type of the data `seeArgs` passes as the first argument to `printf`? (You should be able to answer this question based solely on what you already know about `printf`.) Given this, and what you saw when you followed the instructions up to this point, what does the GDB command `x/s` do?

Problem 7. When `seeMoreArgs` calls `printf`, where did the compiler place arguments 7 and 8? Why do you think this happened?

Problem 8. Where does the function `getV` allocate its array? How does it pass this location to `getValue`?

Problem 9. Which registers are treated as call-preserved by `mult4`? Which register does `mult4` expect to contain a return value? (It may help to disassemble `mult2` as well.)

Problem 10. What does the function `mrec` do?

3 Activity 3 (Optional, Time Permitting): Endianness Preview

Rerun `gdb -args ./calls` and continue to the point where you printed the stack before.

Problem 11. The first eight bytes of the stack contain the number `0x15213`. What do you expect the first *two* bytes of the stack to contain?

Problem 12. Check your hypothesis by running `x/2xb $rsp`. What did the first two bytes of the stack contain? What can you deduce about the order in which each integer's bytes are stored?

Appendix: x86-64 ELF Calling Convention Summary

The following table lists all of the x86-64 integer registers, indicates whether each is call-preserved or call-clobbered, and gives the conventional function of each.

Register	Call Treatment	Function
`%rax`	Clobbered	Return value
`%rbx`	Preserved	
`%rcx`	Clobbered	Argument #4
`%rdx`	Clobbered	Argument #3
`%rbp`	Preserved	
`%rsp`	Preserved	Stack pointer
`%rsi`	Clobbered	Argument #2
`%rdi`	Clobbered	Argument #1
`%r8`	Clobbered	Argument #5
`%r9`	Clobbered	Argument #6
`%r10`	Clobbered	
`%r11`	Clobbered	
`%r12`	Preserved	
`%r13`	Preserved	
`%r14`	Preserved	
`%r15`	Preserved	