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.

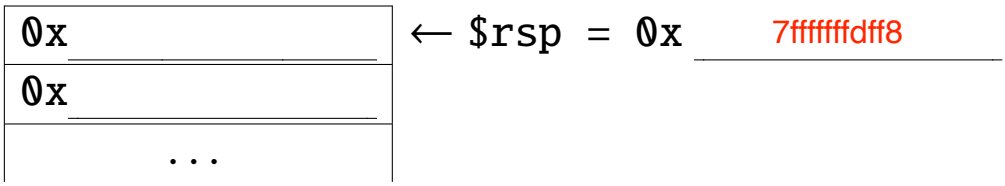
1 Activity 1: Calls

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?

Return is omitted as it is right after the function call.
In either case, the control is going to return to the caller
after the 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?

Format string which has the type of const char *.
x/s prints the string at the memory location

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

On the stack. Not enough registers

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

On the stack.
Pass the top of the stack (beginning of the array) using a normal register (%rdi)

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.)

%r12,%r13 and %rbx
%rax

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

Compute factorial

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	