Assembly Language – Calling Conventions

- Learning Objectives
  - Define stack frame
  - Explain how the assembler sets up the stack for execution of a function.
  - Locate parameters and local variables on the stack.

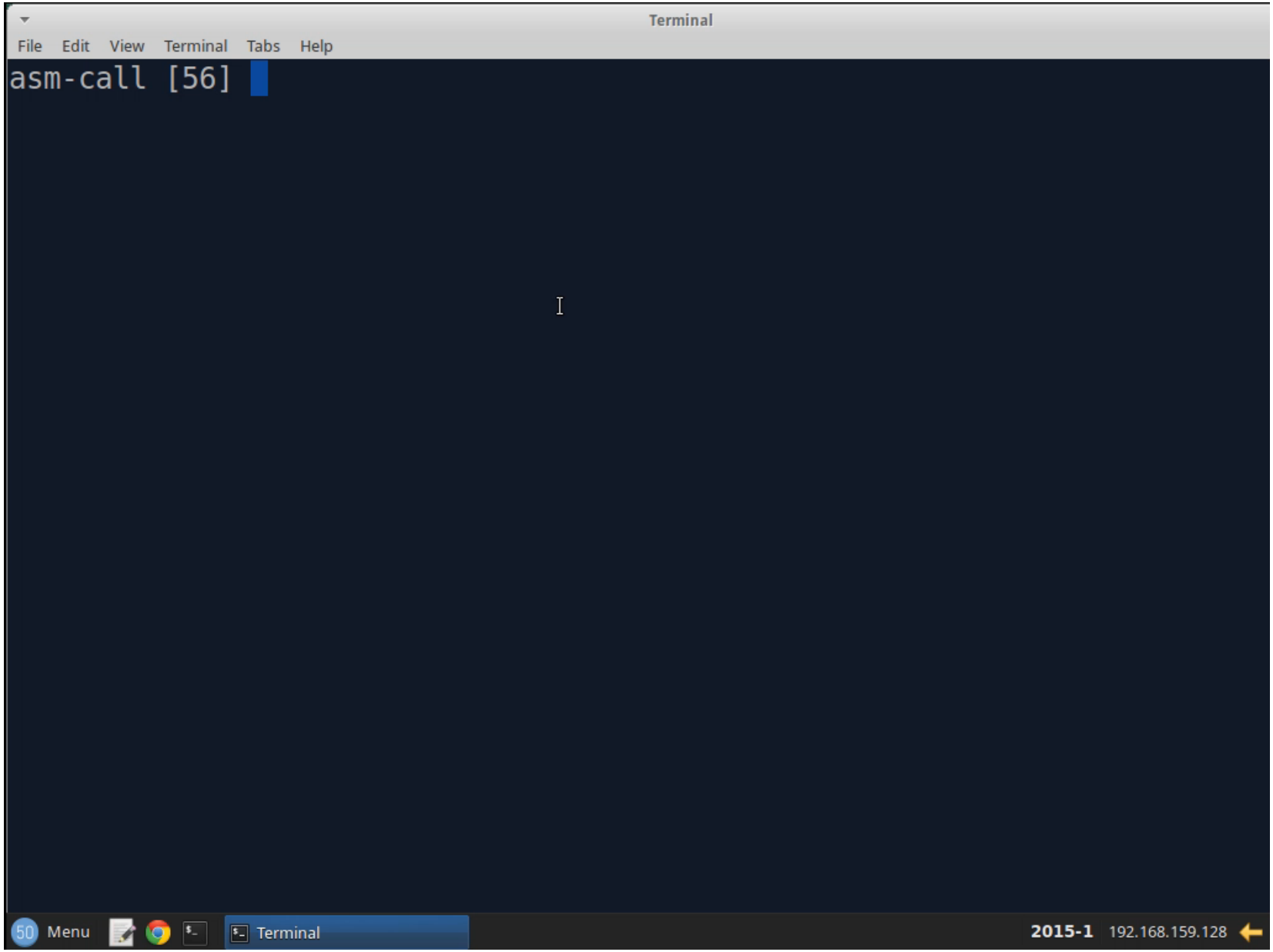
Invoking Functions

- In certain very simple cases, you can just jump to a function address (but this is quite unusual).
- Consider the function:

```
extern void g(void);

void f(void) {
    g();
}
```

- After we execute g, there is nothing left to be done in function `f`; therefore, transferring control to `g` via a simple jump instruction works.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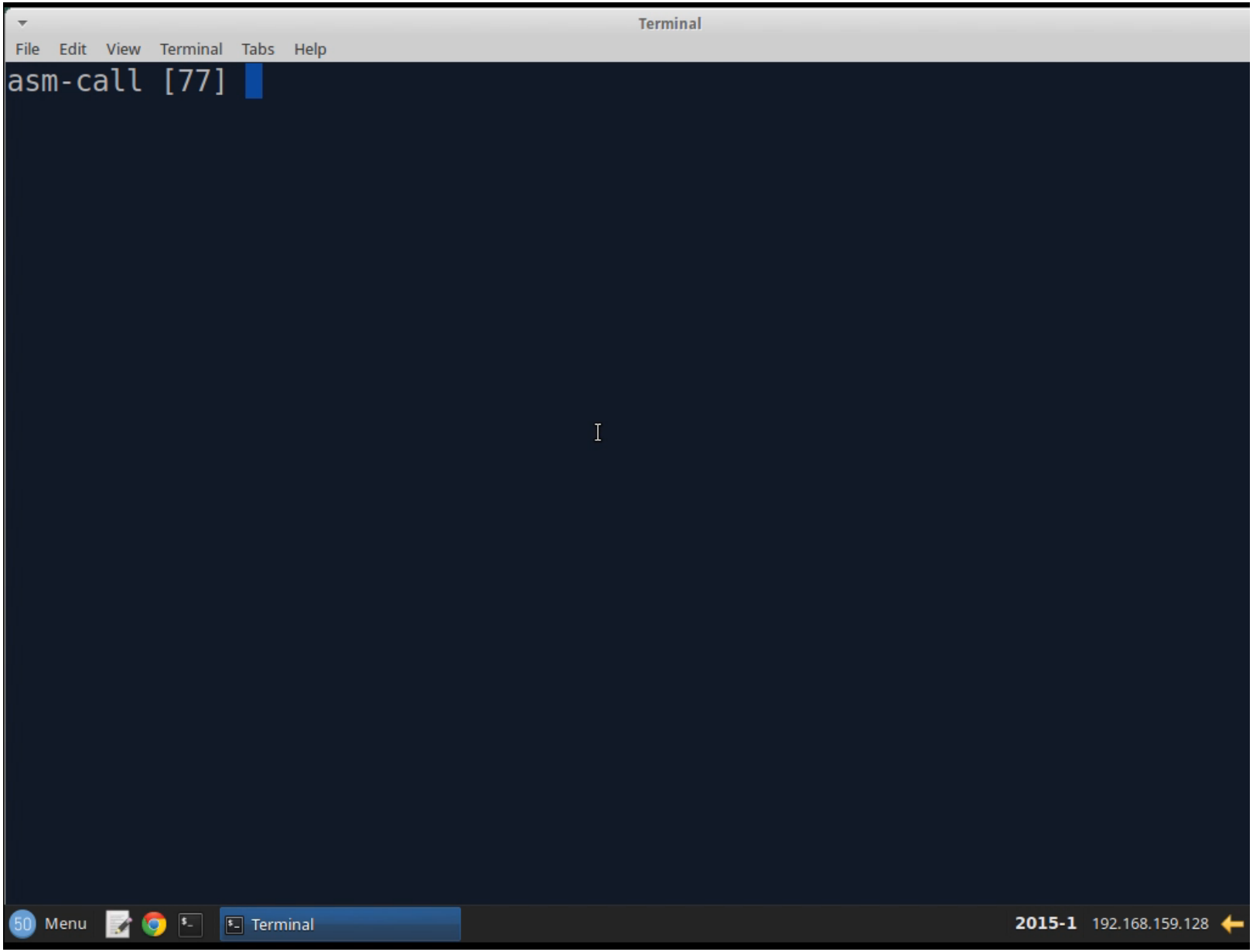
Use of `jmp` function of context

- Note that the ability to use a jmp to invoke a function is a product of the context, not the function being called.

```
extern void g(void);

void f(void) {
    g();
    g();
    g();
}
```

- The first two instances of calls to `g` require that control return to a specific point in function `f`.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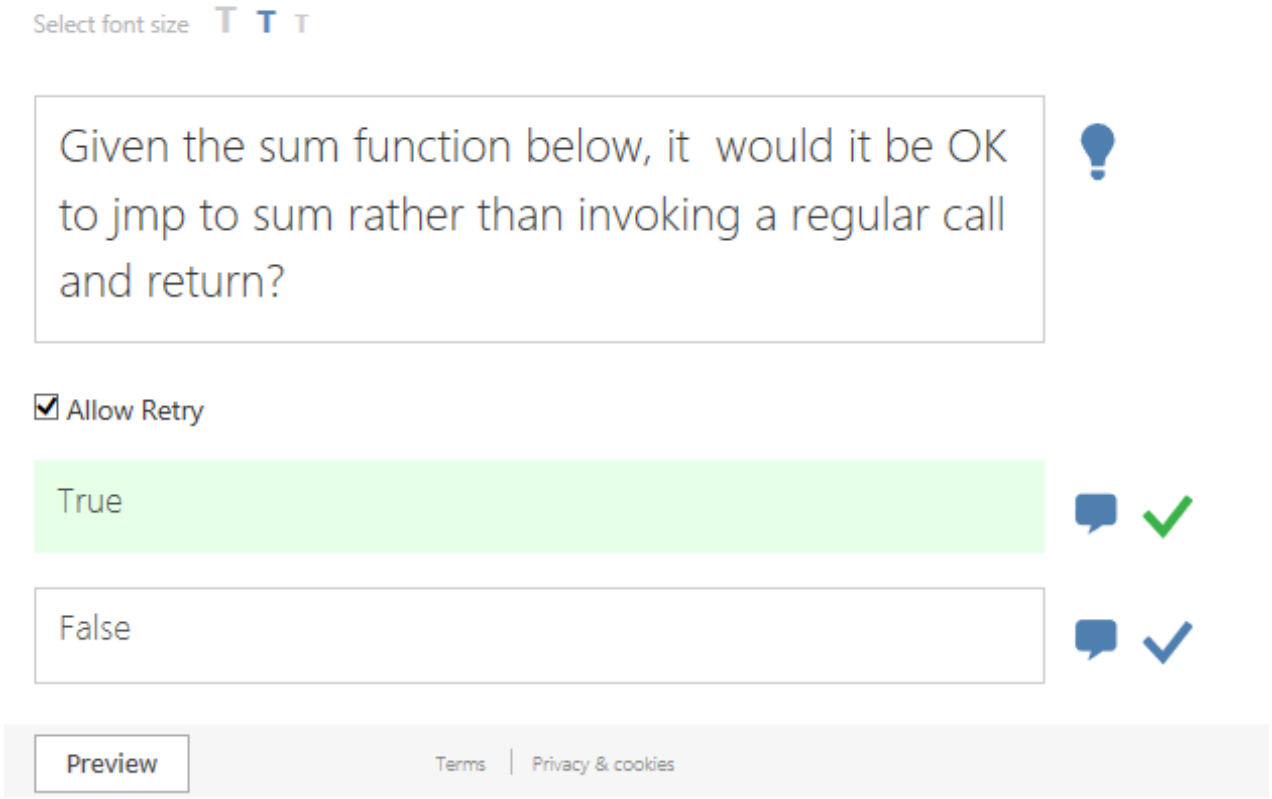
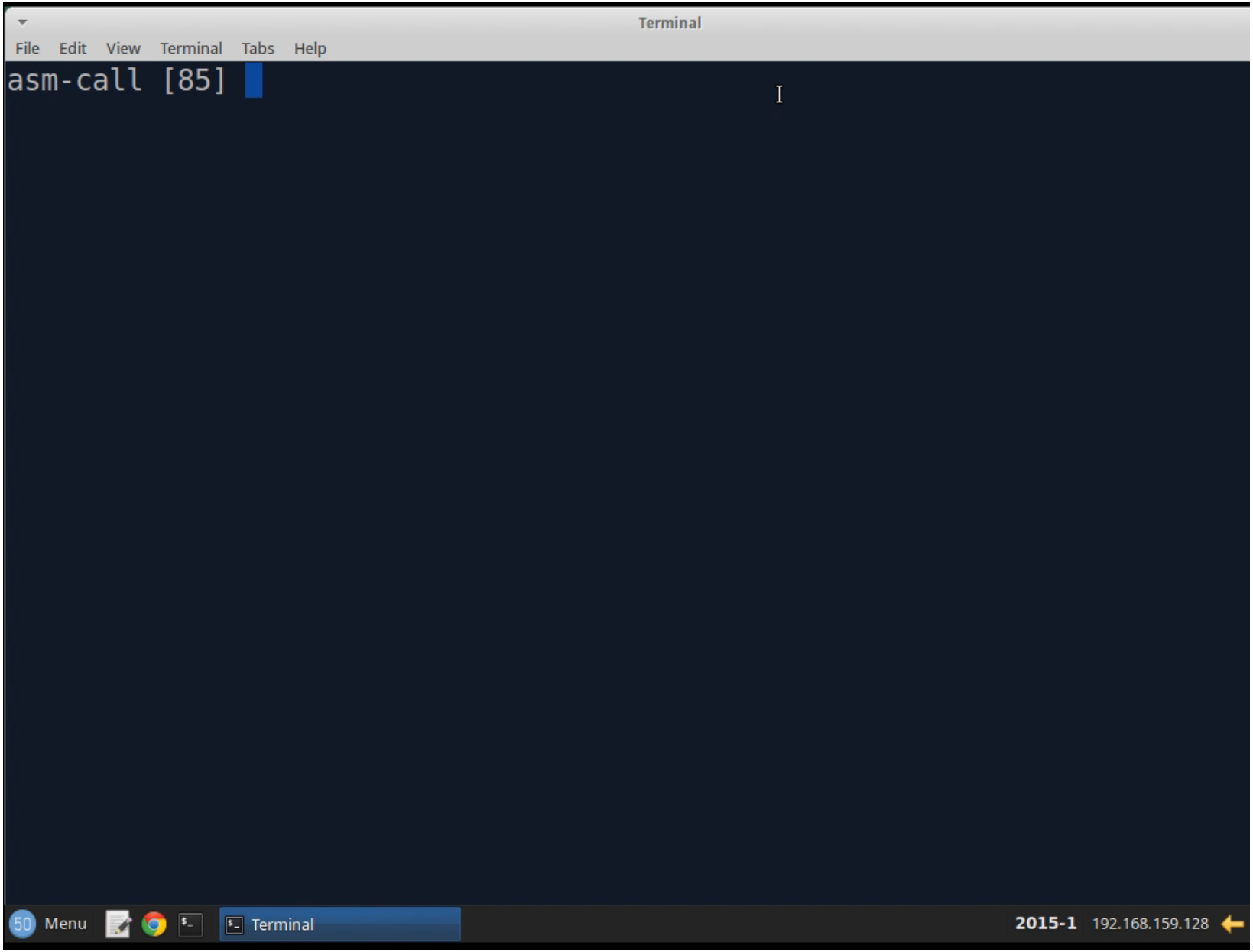



```
extern int sum(int a, int b);

int f(int a, int b) {
    return sum(a, b);
}
```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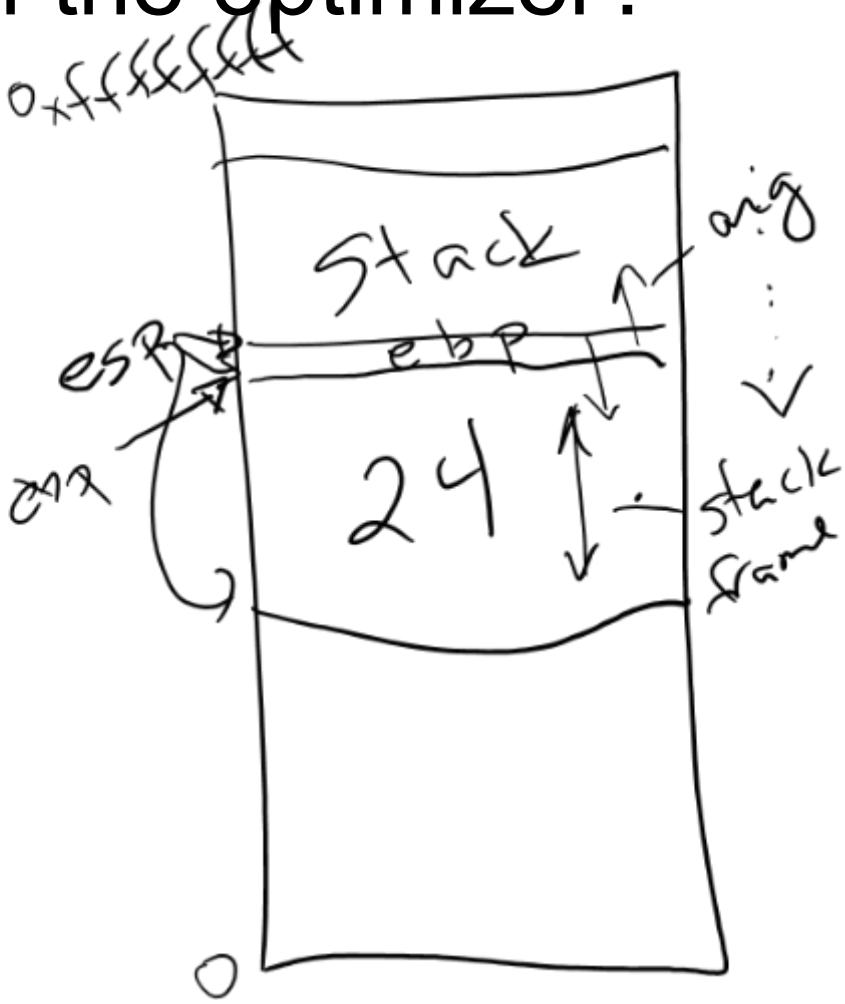
What if we turn off the optimizer?

```
pushl   %ebp
movl    %esp, %ebp
subl    $24, %esp
movl    12(%ebp), %eax
movl    8(%ebp), %ecx
movl    %ecx, -4(%ebp)
movl    %eax, -8(%ebp)
movl    -4(%ebp), %eax
movl    -8(%ebp), %ecx
movl    %eax, (%esp)
movl    %ecx, 4(%esp)
calll   sum
addl    $24, %esp
popl    %ebp
ret
```



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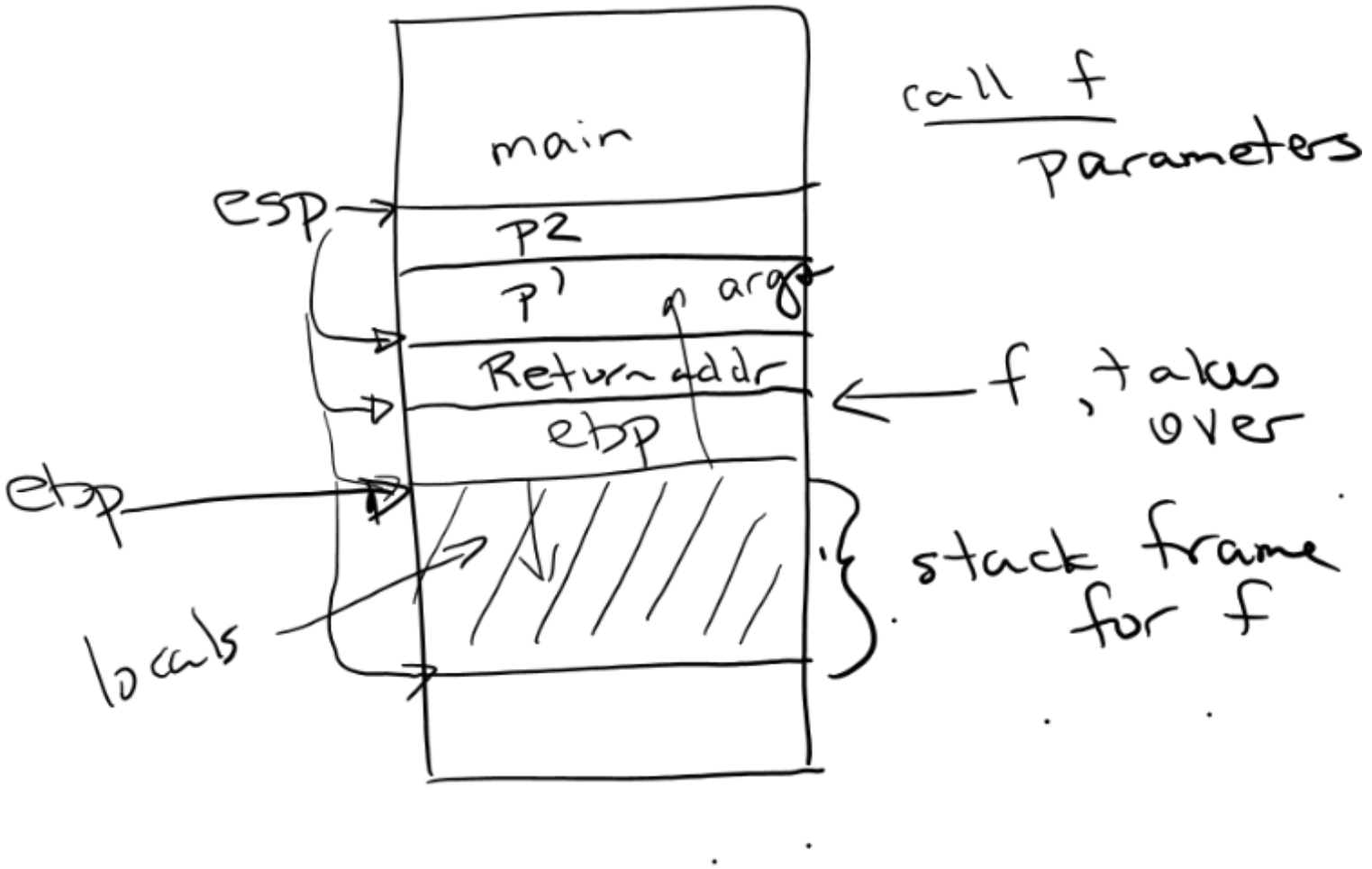
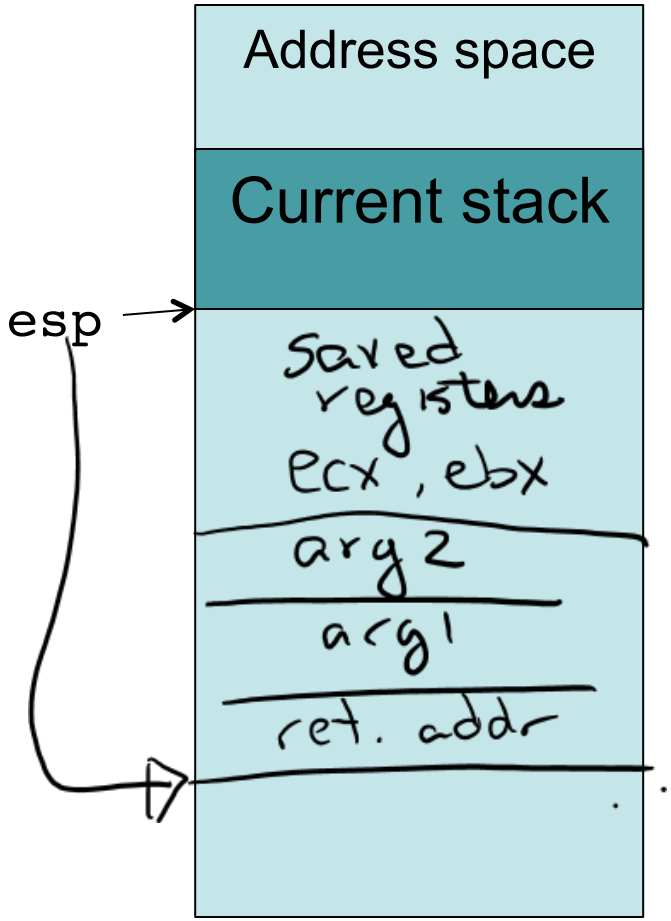

main
esp
p2
p1
arg
Return addr
ebp
ebp
locals
call f
parameters
f, takes over
stack frame for f

Calling Conventions

- The way the compiler has agreed to use the stack, registers and functions to enable functional decomposition (and separate compilation).
- Registers are divided into two sets:
  - Callee saved: the caller assumes that the contents of these registers will be unchanged when the called functions return.
    - Implication: If the callee uses the registers, the callee must save them and restore them.
    - `esp, ebx, ebp, esi, edi`
  - Caller saved: the caller assumes that these registers could be lost in the called function.
    - Implication: The callee can use these registers any way it wants without having to restore them.
    - `eax, ecx, edx`

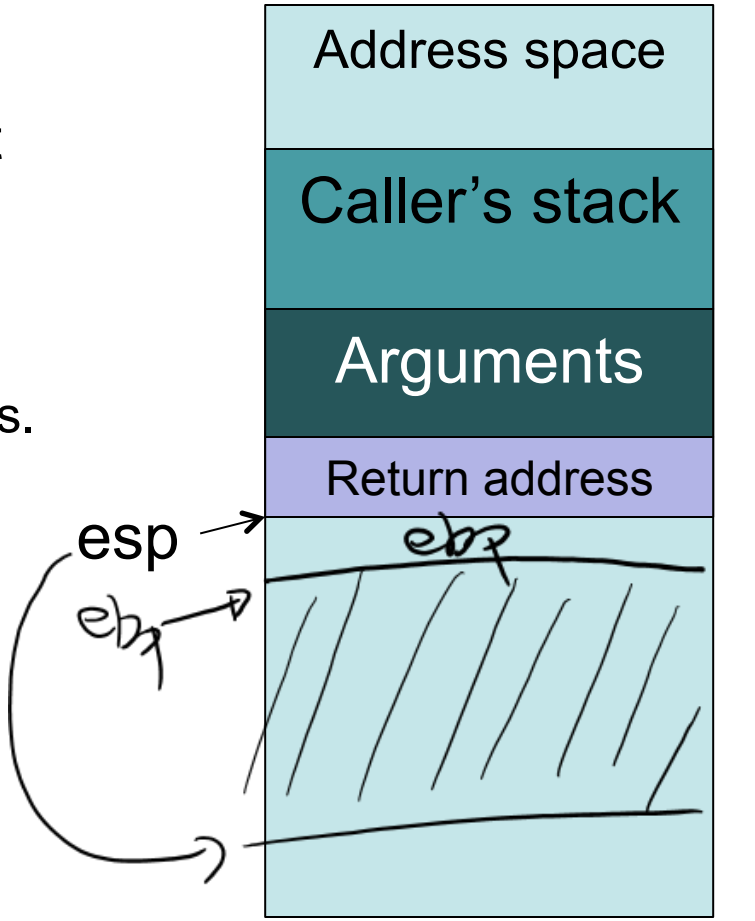
The Caller Side

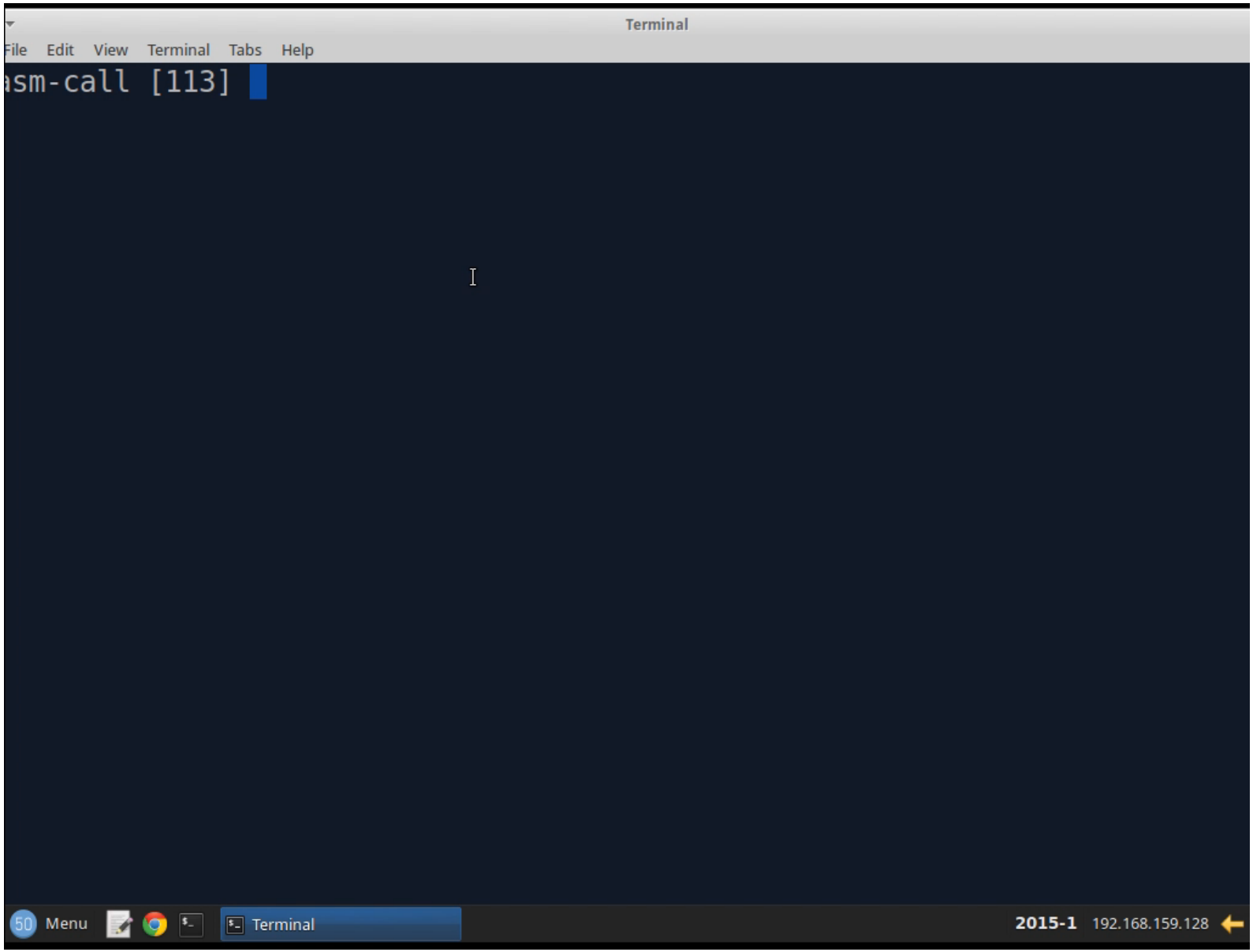
- Save any registers necessary.
- Push arguments on the stack.
- Call the function
  - Push the return address on the stack
  - Jump to the function



The Callee Side

- Save the frame pointer (`ebp`)
- Set the frame pointer to the current top of stack.
- Adjust stack pointer to make space for the stack frame
  - Leave space for all the local variables.
  - Maintain required alignment of stack frames.
- Inside the function:
  - Parameters are positive offsets from `ebp`.
  - Locals are typically negative offsets from the `ebp`.

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Summing Up

- Caller must save caller-saved registers it is using.
- Callee must save callee-saved registers it intends to use.
- Caller pushes arguments and return address.
- Callee creates (aligned) stack frame.
- Arguments are positive offsets from frame pointer.
- Locals are negative offsets from frame pointer.