```cpp
#include <iostream>

void functions_in_c_plus_plus() {
    using namespace std;
    cout << "Welcome to the lesson on functions!" << endl;
}

int main() {
    functions_in_c_plus_plus();
}
```

Functions

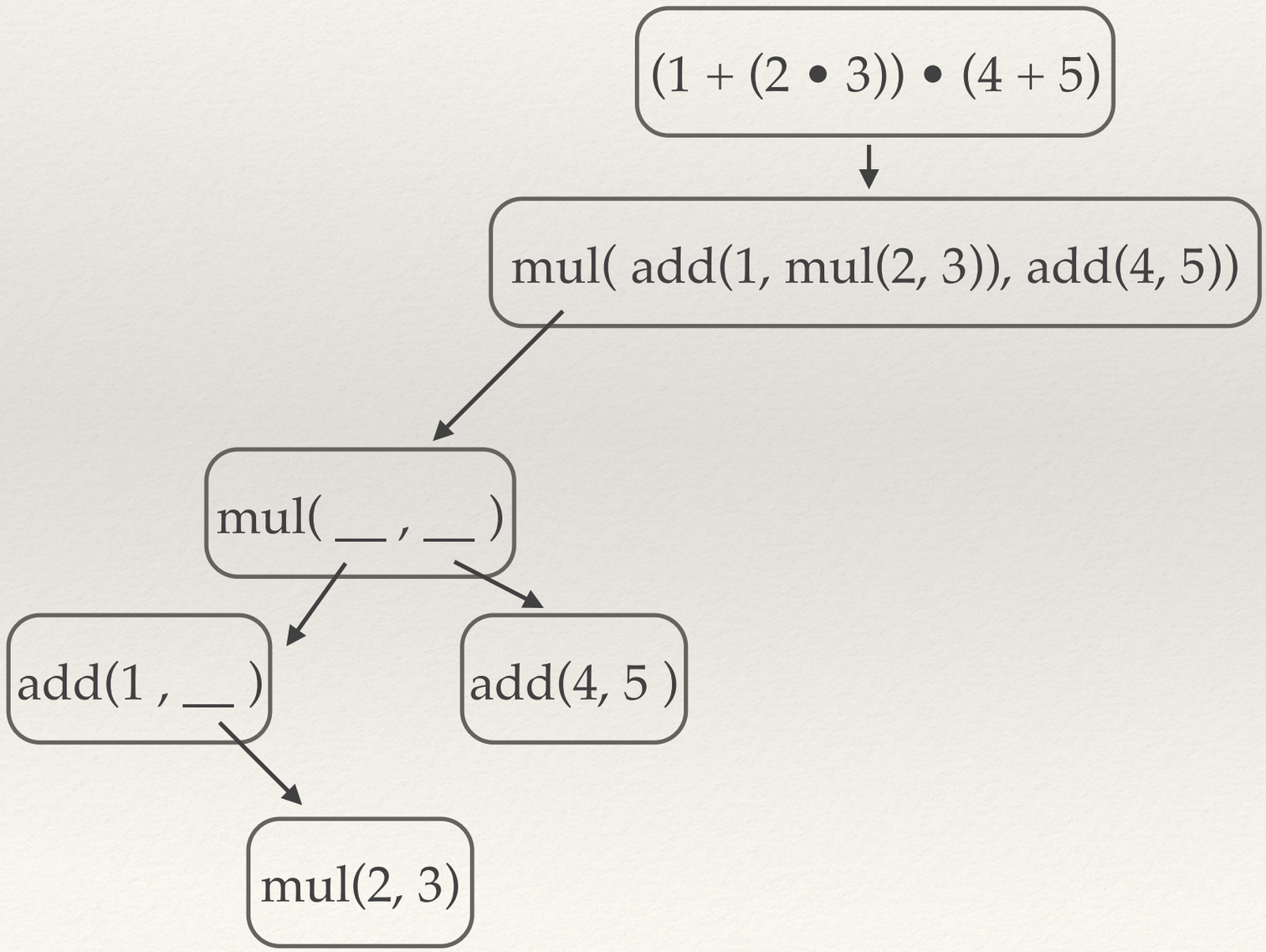
Matthew Mussomele

Expressions

- Expressions are computable statements
  - 3 + 10
  - √(169)
  - |-13|
  - f(x)

Evaluating Expressions

When evaluating expressions, any sub-expressions within them must be evaluated first.



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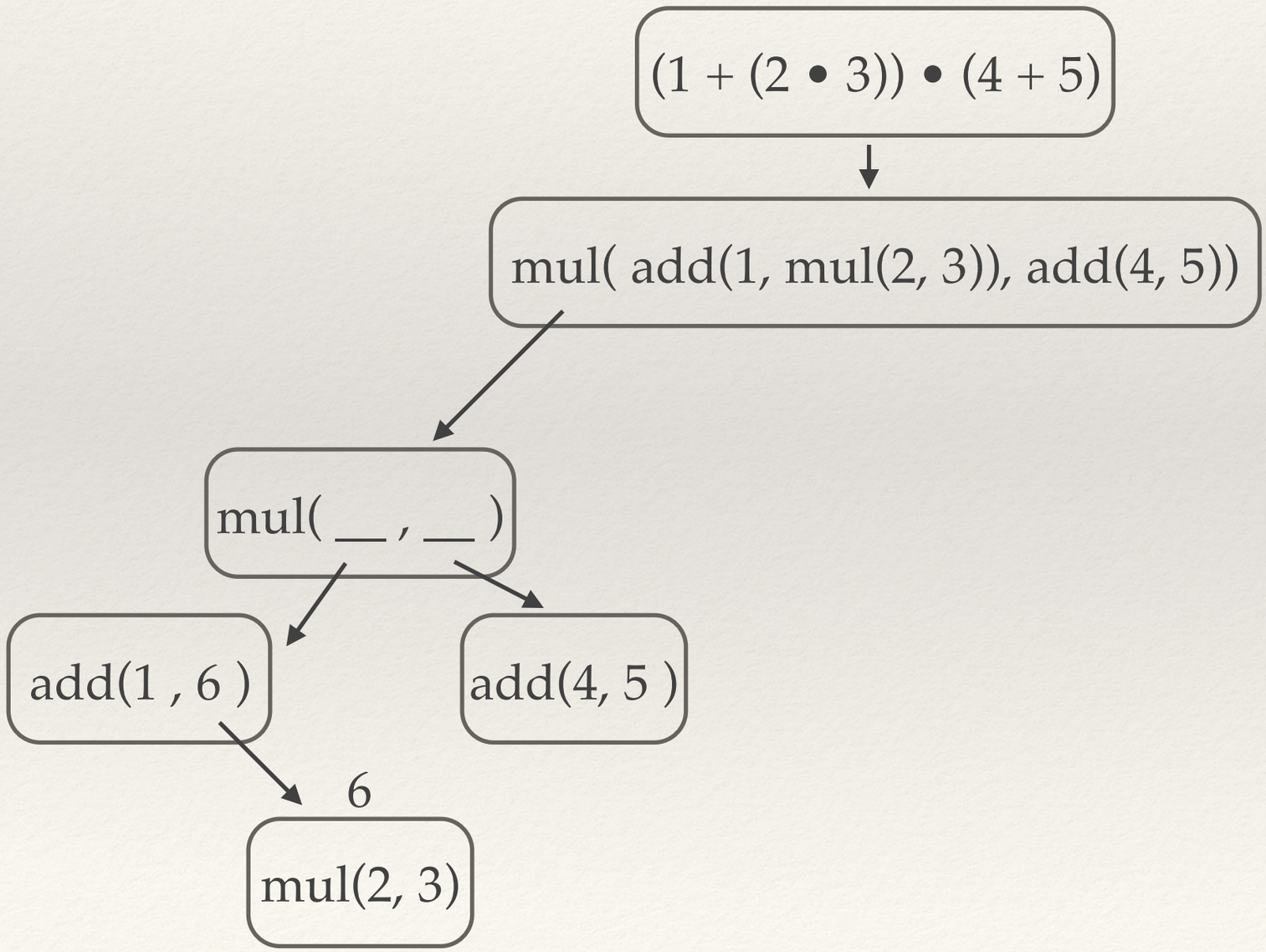

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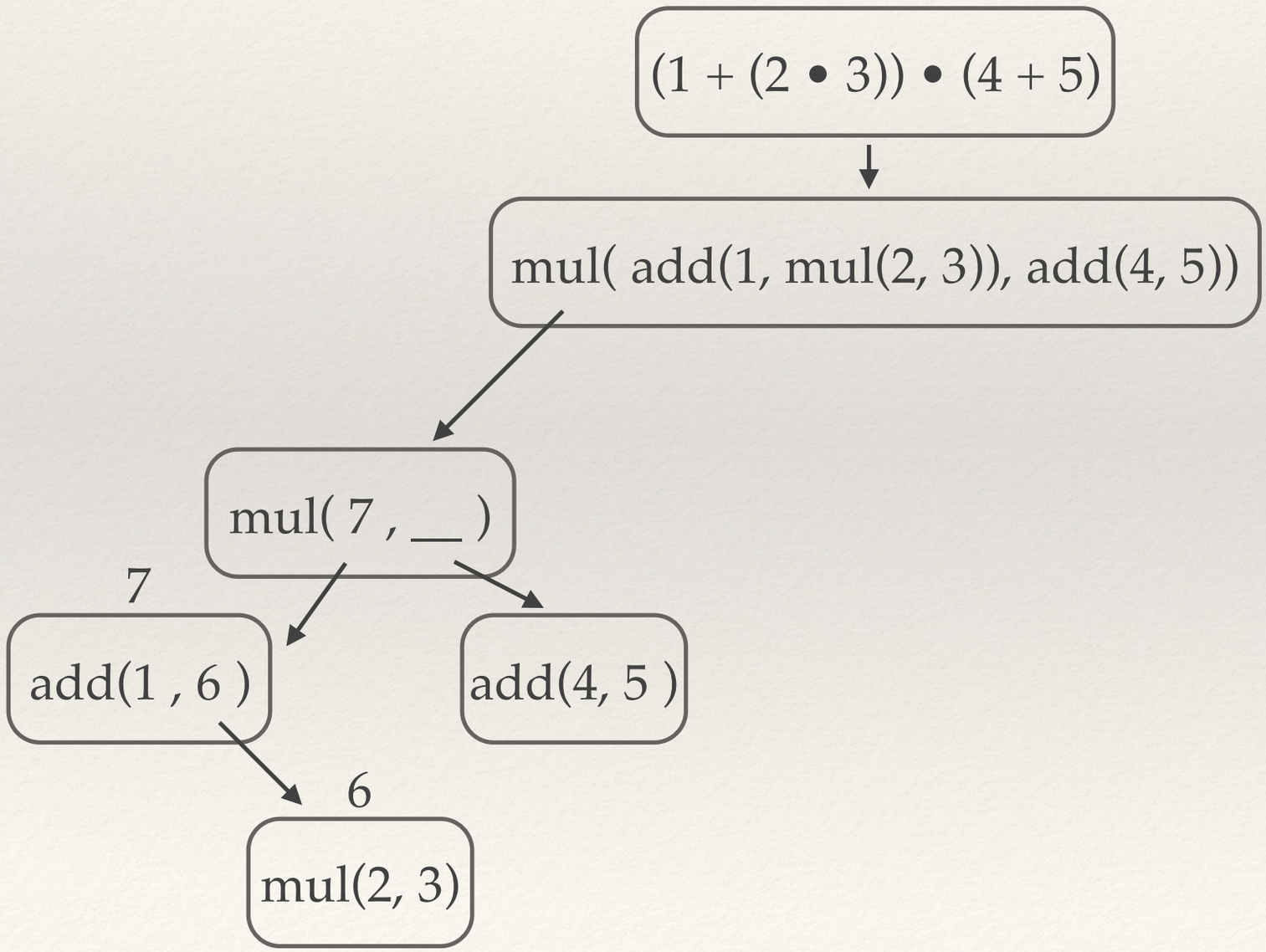

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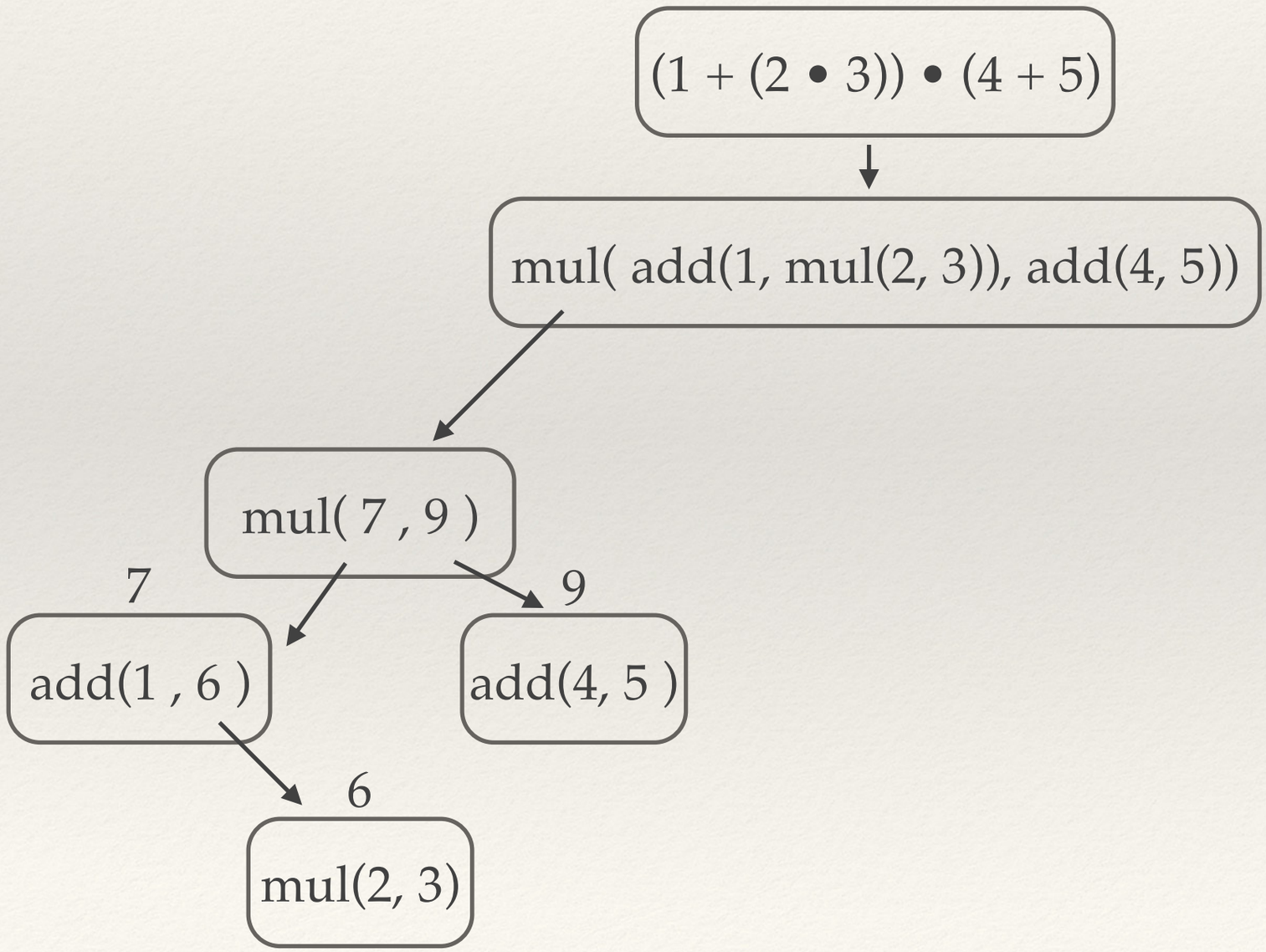

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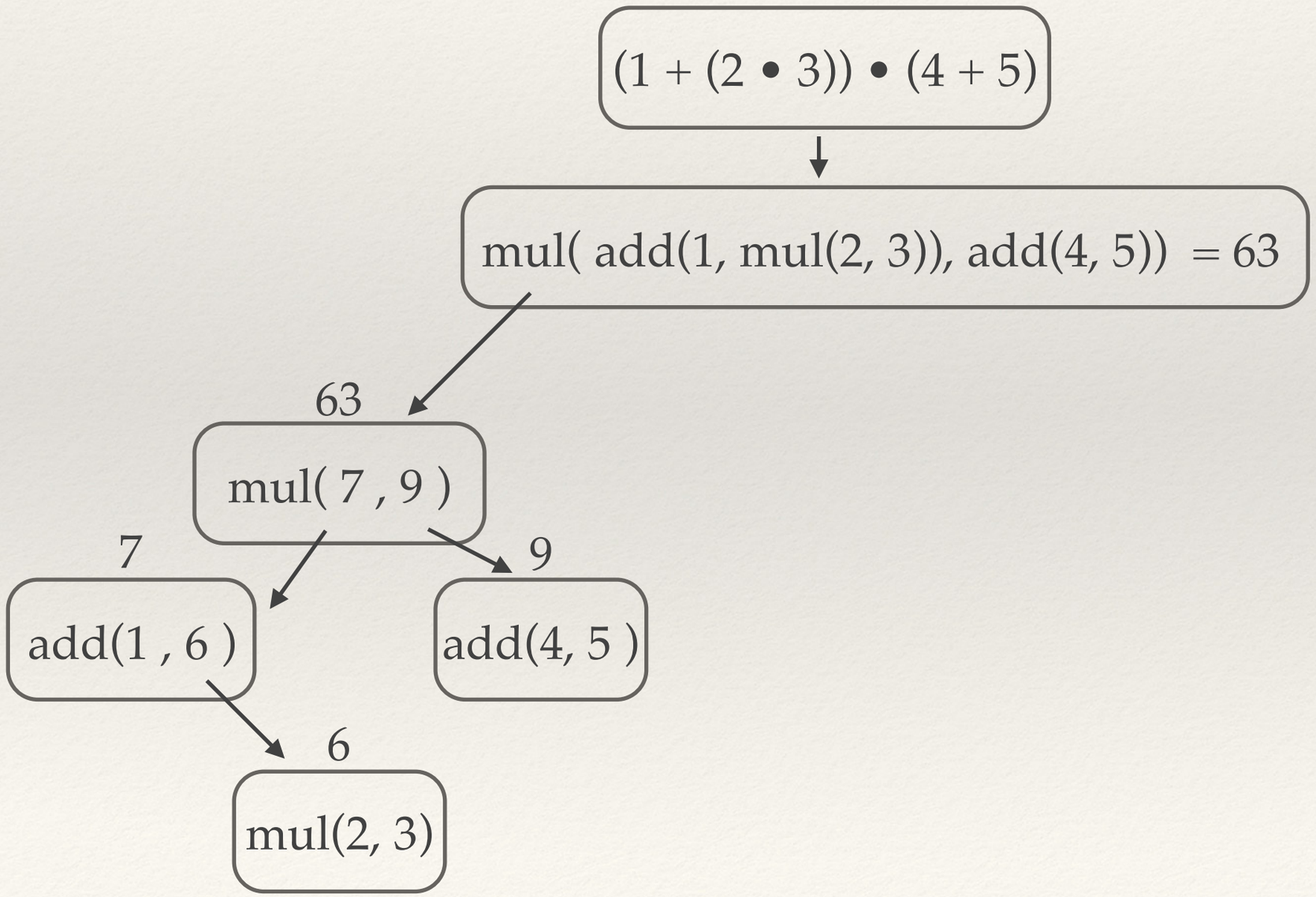
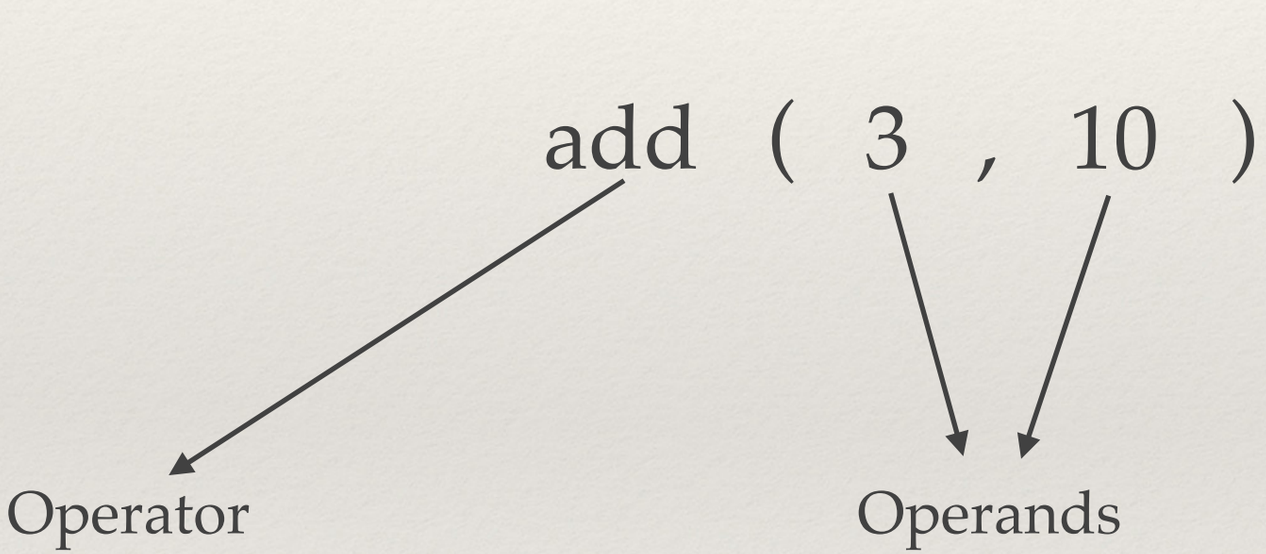


Functions

- Function calls are types of expressions

This is a function call:

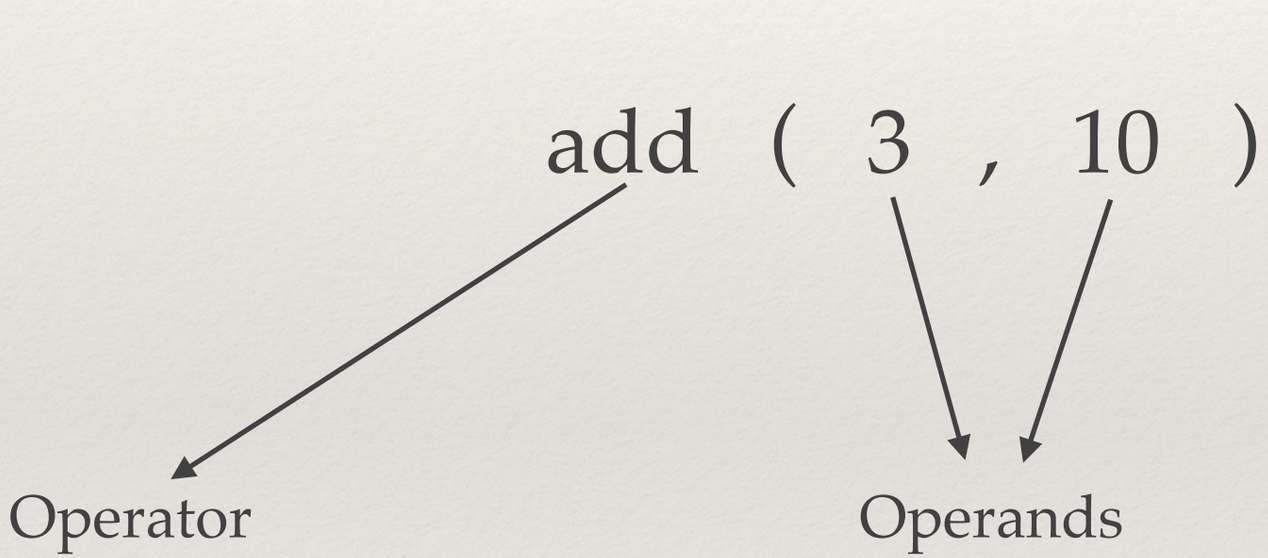


Operators and Operands are expressions themselves and evaluate to values.

Functions

- Function calls are types of expressions

This is a function call:



Order of Operations:

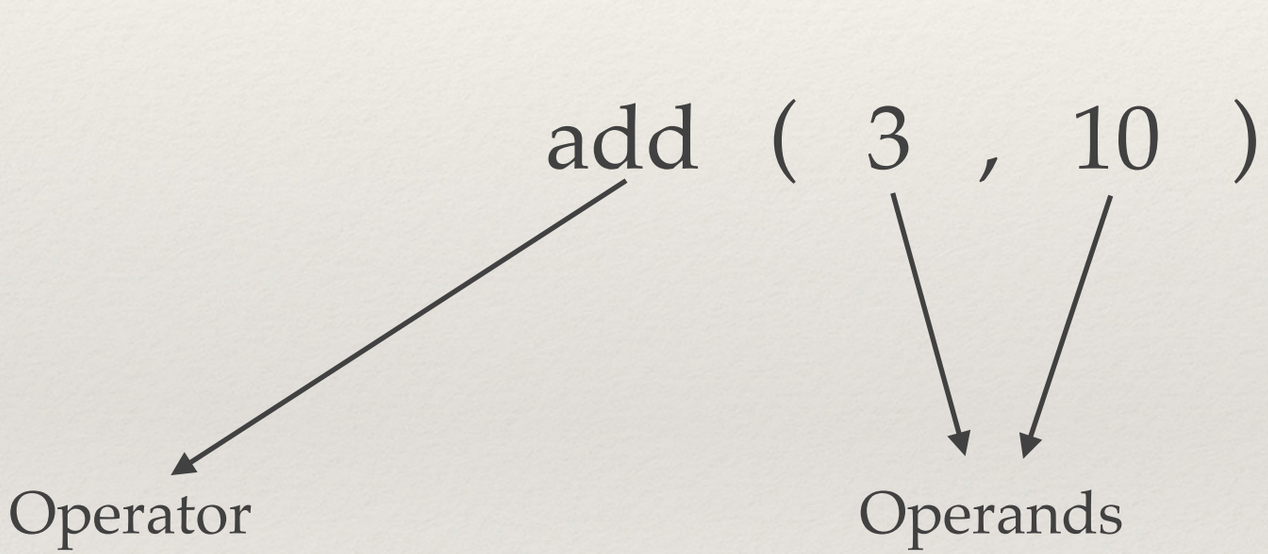
1. Evaluate the Operator and the Operands*

*The order of evaluation for operands is undefined.

Functions

- Function calls are types of expressions

This is a function call:



Order of Operations:

2. Pass the evaluated components to the function.

Defining Your Own Functions

In C++, all functions match a general form.

```
<return type> <name>(<formal paramters>) {
        <body>
}
```

- Return Type - The type of expression that the function will evaluate to
- Name - The name used to call and refer to the function
- Formal Parameters - The arguments that are to be passed to the function
- Body - An expression (1+ lines) that is to be evaluated when the function is called

Return Type

The return type of a function is the type it should evaluate to.

For example, a function that adds two integers should return an integer.

Example Return Types:

- Integer - `int`
- Double - `double`
- Boolean - `bool`
- Nothing - `void`

Name

You can name your functions whatever you like as long as they follow the following rules:

1. Only alphanumeric and underscore characters may be used.
2. Names cannot start with a number.
3. C++ keywords cannot be used (more on this later)

Names are also case sensitive. For example, `myvariable` is a different variable than `myVariable`.

Formal Parameters

Formal parameters are the arguments your function takes in to do things with.

These parameters consist of a type and a name (or identifier).

For example, a function with the header,

```
void printNum(int a)
```

would take a single integer parameter that could be referred to as ‘a’ inside the function.

Functions can have many formal parameters, but having more than 3 makes things messy.

Body

The body of a function is where all the processing and calculation happens.

Function bodies can have 1 or more lines and expressions.

If a function has a return type, then its body must contain a return statement.

Valid Function Body

```
int add_one(int a) {
    return a + 1;
}
```

Invalid Function Body

```
int add_one(int a) {
    int x = a + 1;
}
```

Main

You may have noticed that all the work you have done so far has looked something like the following:

```
int main() {
    <body>
}
```

Main is a function itself, and it has two common versions it comes in.

One is the version you see above, and another has two formal parameters, argc and argv.

These allow input from the command line to the main function.

Main

Main is a function just like any other.

The only difference is that it is automatically called when your program is ran.

This leads to some consequences.

You cannot have more than one main in a compiled program.

If you forget a main, your program will fail to compile and/or run at all.

Scope

In a function, any variables that are used as parameters or declared in the body have local scope.

This means that they cannot be accessed outside of the function.

Observe the following example:

```cpp
#include <iostream>

int x = 5;

void print_x() {
    int x = 10;
    std::cout << x << std::endl;
}

int main() {
    std::cout << x << std::endl;    //prints 5
    print_x();                      //prints 10
}

```

Scope

In fact, all basic code blocks that can use curly braces have their own local scope, meaning any variables declared inside them cannot be used outside of them.

Functions, if-else statements, while loops, for loops, switch-case blocks and try-catch blocks are all examples of this.

While new variables made inside these blocks have no effect on the surrounding code, changes to accessible outside variables are possible.

Using Functions

Like stated before, functions are a type of expression, meaning they can be used in more complicated expression and can be called many times.

To call a function, we use the syntax:

```
<name>(<arguments>)
```

Lets use the add_one function from the last slide as an example.

Using Functions

```
int add_one(int a) {
    return a + 1;
}
```

Here are some ways we might use `add_one`:

```
add_one(1); //this works, evaluates to 2
```

```
add_one(-1); //this works, evaluates to 0
```

```
add_one(0.5); //this works, evaluates to 1
```

```
add_one(1, 2); /* this won't compile! The
                  arguments given to the
                  function don't match the
                  formal parameters! */
```

Function Guidelines and Tips

- Every function should have exactly one job.
  - If you can't describe what they do without using 'and', split them up.
- Use functions if you find yourself copying code over and over.
- Make your functions general.
  - Our `add_one(int a)` function was not general.
  - A general version would be just `add(int a, int b)`

Function Documentation

All functions should have a documentation comment above them.

These comments should follow the following format:

```
/**
 * @brief <short description of function>
 * @details <longer description>
 *
 * @param <name> <description>
 * @param  <name> <description>
 *  …
 * @return <description of return value>
 */
```

Citations

- DeNero, John. "Composing Programs." Composing Programs. Chapters 1.2-1.4 Web. 10 June 2015.