Functions

Functions

- So far, all the programs we've been writing in the course have been written inside of `main()`.
- That hasn't been a problem yet, but it could be if our programs start to become unwieldy.
- C and nearly all languages developed since allow us to write **functions**, sometimes also known as **procedures**, **methods**, or **subroutines**.
- Let's see what functions are all about.

Functions

- What is a function?
  - A *black box* with a set of 0+ inputs and 1 output.

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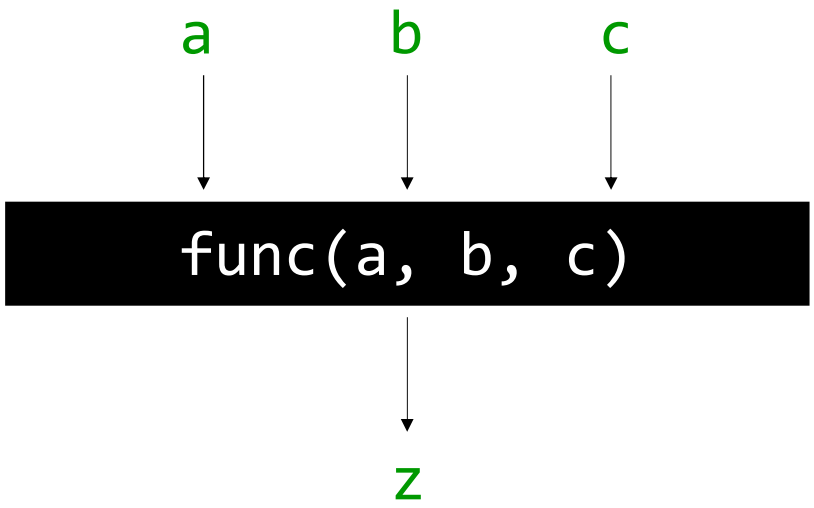

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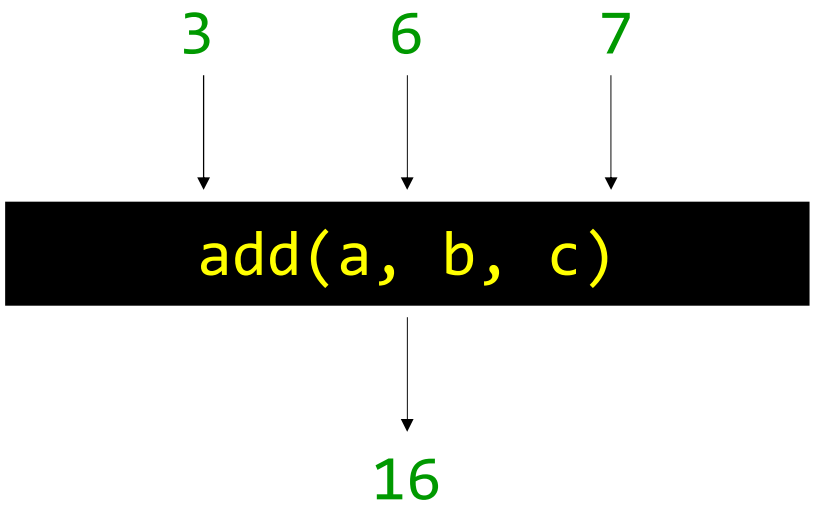

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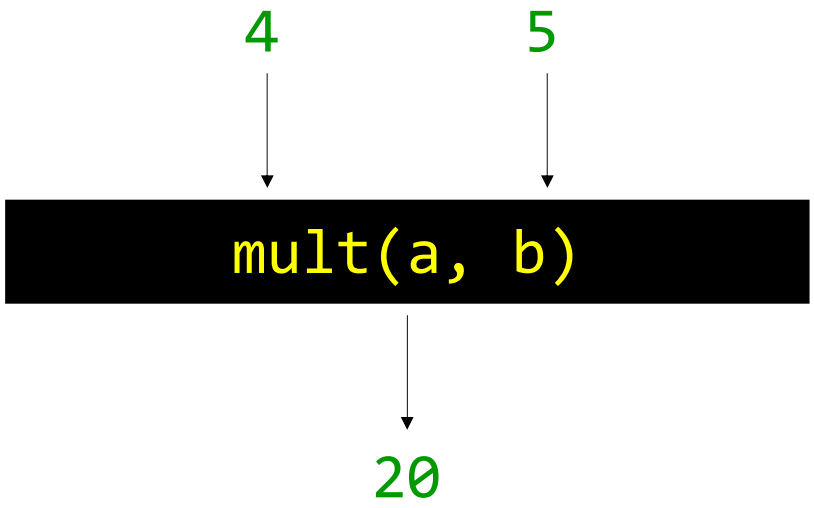

Functions

- Why call it a *black box*?
  - If we aren't writing the functions ourselves, we don't need to know the underlying implementation.

```
mult(a, b):
    output a * b
```

Functions

- Why call it a *black box*?
  - If we aren't writing the functions ourselves, we don't need to know the underlying implementation.

```
mult(a, b):
    set counter to 0
    repeat b times
        add a to counter
    output counter
```

Functions

- Why call it a *black box*?
  - If we aren't writing the functions ourselves, we don't need to know the underlying implementation.
  - That's part of the contract of using functions. The behavior is typically predictable based on that name. That's why most functions have clear, obvious(ish) names, and are well-documented.

Functions

- Why use functions?
  - Organization
    - Functions help break up a complicated problem into more manageable subparts.
  - Simplification
    - Smaller components tend to be easier to design, implement, and debug.
  - Reusability
    - Functions can be recycled; you only need to write them once, but can use them as often as you need!

Functions

- Function Declarations
  - The first step to creating a function is to declare it. This gives the compiler a heads-up that a user-written function appears in the code.
  - Function declarations should always go atop your code, before you begin writing `main()`.
  - There is a standard form that every function declaration follows.

Functions

- Function Declarations

```
return-type name(argument-list);
```

  - The `return-type` is what kind of variable the function will output.
  - The `name` is what you want to call your function.
  - The `argument-list` is the comma-separated set of inputs to your function, each of which has a type and a name.

Functions

- A function to add two integers.

```
int add_two_ints(int a, int b);
```

  - The sum of two integers is going to be an integer as well.
  - Given what this function does, make sure to give it an appropriate name.
  - There are two inputs to this function, and we need to give a name to each of them for purposes of the function. There's nothing important about these inputs as far as we know, so giving them simple names is okay.

Functions

- A function to multiply two floating point numbers.

Functions

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```
float mult_two_reals(float x, float y);
```

  - The product of two floating point numbers is also a floating point number.
  - Let's be sure to give this a relevant name.
  - Again, the names of these particular inputs don't seem to be important, so we can call them anything simple.

Functions

- A function to multiply two floating point numbers.

```
double mult_two_reals(double x, double y);
```

  - The product of two floating point numbers is also a floating point number.
  - Let's be sure to give this a relevant name.
  - Again, the names of these particular inputs don't seem to be important, so we can call them anything simple.

Functions

- Function Definitions
  - The second step to creating a function is to define it. This allows for predictable behavior when the function is called with inputs.
  - Let's try to define `mult_two_reals()`, from a moment ago.

Functions

- A function definition looks **almost** identical to a function declaration, with a small change.

```
float mult_two_reals(float x, float y);
```

```
float mult_two_reals(float x, float y)
{
    float product = x * y;
    return product;
}
```

- How would you fill in this black box?

Functions

- A function definition looks **almost** identical to a function declaration, with a small change.

```
float mult_two_reals(float x, float y);
```

```
float mult_two_reals(float x, float y)
{
    return x * y;
}
```

- How would you fill in this black box?

Functions

- Now, take a moment and try to define `add_two_ints()`, from a moment ago.

```
int add_two_ints(int a, int b);

int add_two_ints(int a, int b)
{




}
```

Functions

- Now, take a moment and try to define `add_two_ints()`, from a moment ago.

```
int add_two_ints(int a, int b);

int add_two_ints(int a, int b)
{
    int sum;        // declare variable
    sum = a + b;    // calculate the sum
    return sum;     // give result back

}
```

Functions

- Now, take a moment and try to define `add_two_ints()`, from a moment ago.

```
int add_two_ints(int a, int b);

int add_two_ints(int a, int b)
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    int sum = a + b;  // calc variable
    return sum;       // give result back


}
```

Functions

- Now, take a moment and try to define `add_two_ints()`, from a moment ago.

```
int add_two_ints(int a, int b);

int add_two_ints(int a, int b)
{
    int sum = 0;
    if(a > 0)
       for(int i = 0; i < a; sum++, i++);
    else
       for(int i = a; i < 0; sum--, i++);
    if(b > 0)
       for(int i = 0; i < b; sum++, i++);
    else
       for(int i = b; i < 0; sum--, i++);
    return sum;
}
```

Functions

- Function Calls
  - Now that you've created a function, time to use it!
  - To call a function, simply pass it appropriate arguments and assign its return value to something of the correct type.
  - To illustrate this, let's have a look at `adder-1.c`

Functions

- Function Miscellany
  - Recall from our discussion of data types that functions can sometimes take no inputs. In that case, we declare the function as having a `void` argument list.
  - Recall also that functions sometimes do not have an output. In that case, we declare the function as having a `void` return type.

Functions

- Practice Problem
  - Declare a write a function called `valid_triangle` that takes three real numbers representing the lengths of the three sides of a triangle as its arguments, and outputs either `true` or `false`, depending on whether those three lengths are capable of making a triangle.

  - Note the following rules about triangles:
    - A triangle may only have sides with positive length.
    - The sum of the lengths of any two sides of the triangle must be greater than the length of the third side.

Functions

```
bool valid_triangle(float x, float y, float z);

bool valid_triangle(float x, float y, float z)
{
    // check for all positive sides
    if (x <= 0 || y <= 0 || z <= 0)
    {
        return false;
    }

    // check that sum of any two sides greater than third
    if ((x + y <= z) || (x + z <= y) || (y + z <= x))
    {
        return false;
    }

    // if we passed both tests, we're good!
    return true;
}
```