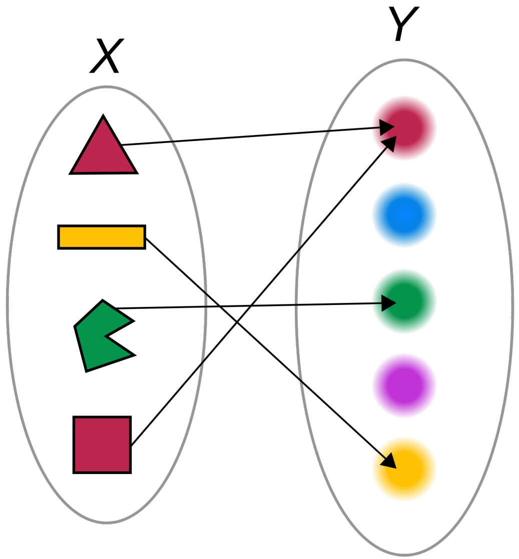
Functions

Functions

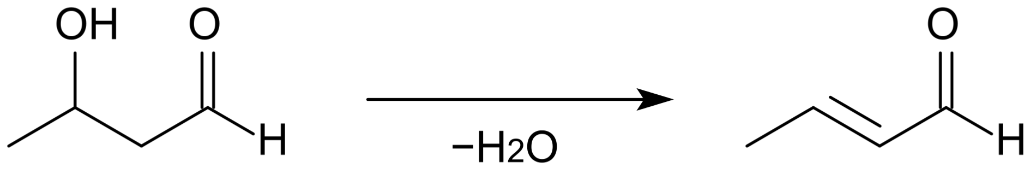
- Allow a program to be broken down into component parts

- Algorithms are not commonly treated as single entities in computer science - they are usually broken down into sub-algorithms



Functions

- **Functional Decomposition**
    - Consists of breaking down large-scale problems into manageable “bits”, then allowing those “bits” to be solved by individual programmers (or small teams)



Functional Decomposition

Example: Home design / building

Functional Decomposition

- This decomposition can work, as long as everyone involved agrees on *interfaces*
  - Interface: standard method of sharing information between two different functions

Function interfaces: Programming

- A function (in programming) has three parts:

  1) A name

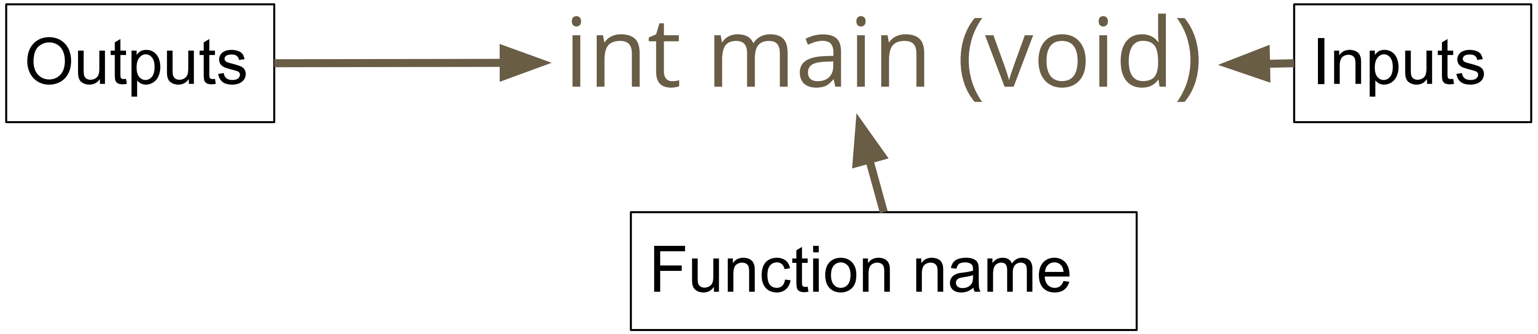
  2) Inputs → also known as *parameters* or *arguments*

  3) Outputs → also known as *return values*

     In C, a function may have 1 or 0 outputs - NO MORE

Functions interfaces

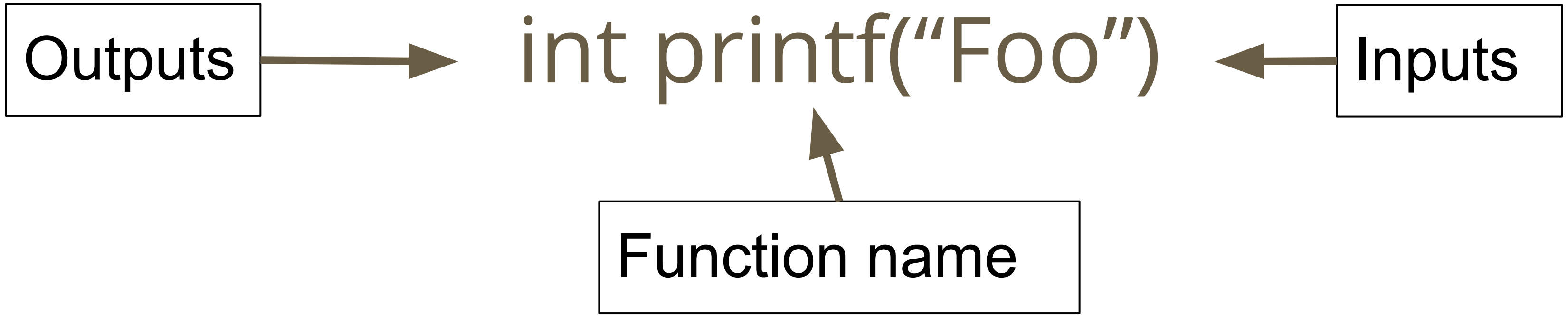
- We’ve seen this before…



```
int main (void)
```

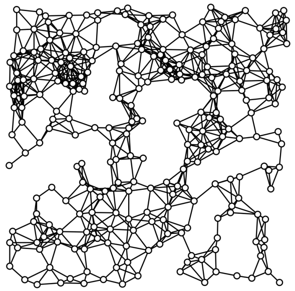
Functions interfaces

- And again...



```
int printf("Foo")
```

Built-in functions



- C libraries (stdio.h, math.h, stdlib.h, etc...) all have pre-defined functions
  - All have defined names, inputs, and outputs
  - What does scanf() take as input? How about output?
  - What does rand() take as input? What does it output?

Function names

- Can be anything
- Follow the same rules as variable names
  - No whitespace, etc...

Function inputs

- Must be specified: this allows the interface to be consistent across code

- If there are NO inputs…
    - Write “void”
- If there ARE inputs…
    - Have to specify type + name

Function inputs

```
int main(void);

int rand(int num1);
```

- Each built-in function has a specific input
  - main() / rand() have no inputs (therefore *void*)

Function outputs

- Must be specified: this allows the interface to be consistent across code

- If there are NO outputs
  - Write “void”
- If there IS an output
  - Have to specify type

Function outputs

```
int main(void);

int rand(void);
```

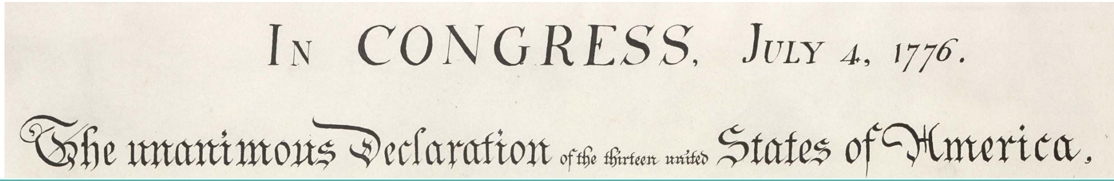
- Both main() and rand() return a value → specifically, both return an integer
- Therefore can be assigned to a value...

```
int num1 = rand();
```

Function Declarations

- In order to be used within a C program, a function must be declared above main()
  - Main() is the only exception to this rule

```
#include <stdio.h>
void do_stuff(void);
int main(void) {
    /*Code goes here*/
    return 0;
}
```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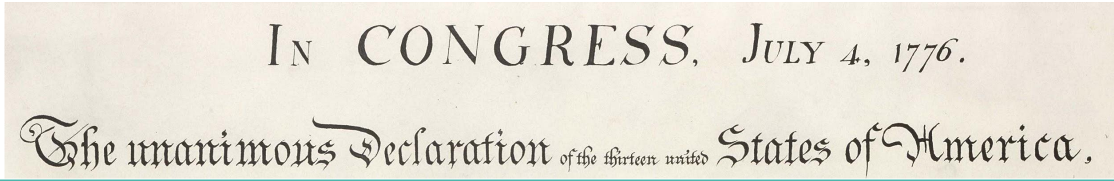
Function Declarations

- The *#include* statement declares pre-built functions
- The *do_stuff()* function is declared as well (will be using it as an example)

```
#include <stdio.h>
void do_stuff(void);
int main(void) {
    /*Code goes here*/
    return 0;
}
```



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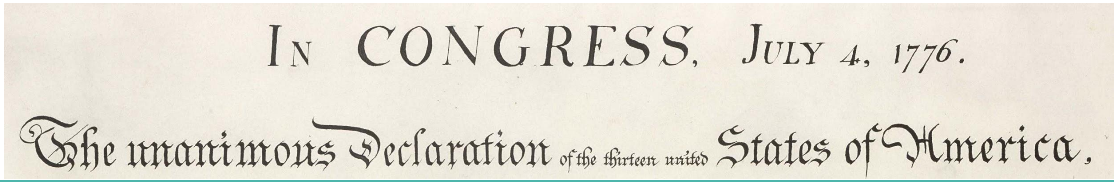
Function Declarations

- These declarations are called *function prototypes*
  - Are necessary to using / creating functions in C

```
#include <stdio.h>
void do_stuff(void);
int main(void) {
    /*Code goes here*/
    return 0;
}
```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Function invocation

- The function *invocation* “runs” the function
- Has 3 parts:

  1) Function name

  2) Parentheses (directly after name)

  3) Zero or more arguments (must be comma separated)

Function invocation

- The function *invocation* "runs" the function

```
void do_stuff(void);
int main(void) {
    do_stuff();
    return 0;
}
```

Function Definition

- 3rd (and most important) part of creating a function
- Definition of a function goes BELOW main()

```
#include <stdio.h>
void do_stuff(void);
int main(void) {
	do_stuff();
	return 0;
}
void do_stuff(void) {
	printf("I'm a function!\n");
}
```

Function Definition

- Begins with a repetition of the function declaration
  - Has to be the same → otherwise, the compiler will give an error

```
#include <stdio.h>
void do_stuff(void);
int main(void) {
      do_stuff();
      return 0;
}
void do_stuff(void) {
      printf("I'm a function!\n");
}
```

Function Definition

- Includes curly braces {}
  - Similar to if statements or loops

```
#include <stdio.h>
void do_stuff(void);
int main(void) {
    do_stuff();
    return 0;
}
void do_stuff(void) {
    printf("I'm a function!\n");
}
```

Function Definition

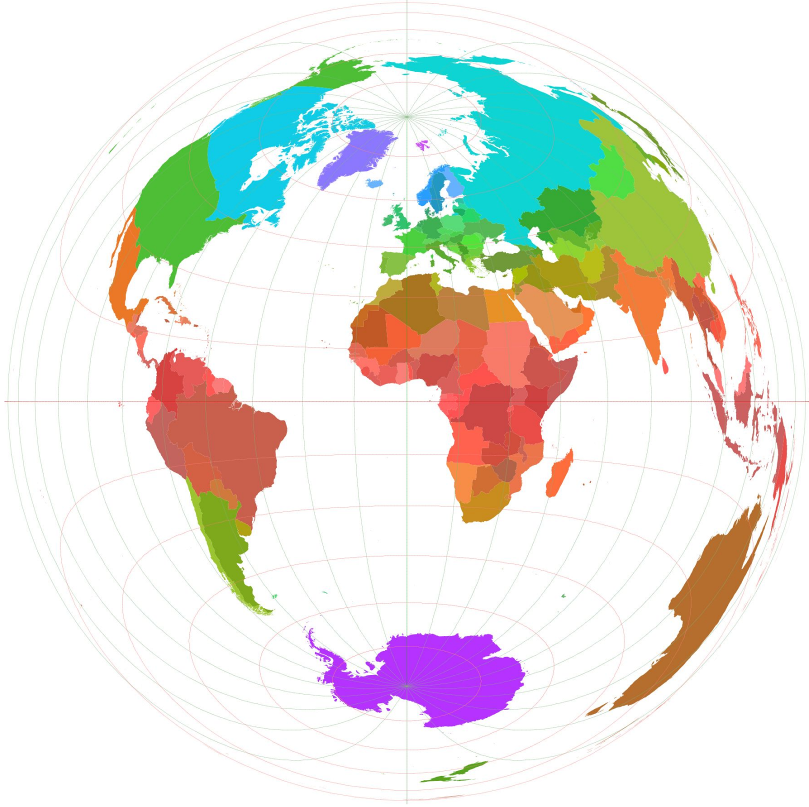
- All code for the function goes inside the braces
    - Is executed WHENEVER the function is invoked

```
#include <stdio.h>
void do_stuff(void);
int main(void) {
	do_stuff();
	return 0;
}
void do_stuff(void) {
	printf("I'm a function!\n");
}
```

Function task 1

- Write the “Hello World” program
  - The line *printf(“Hello World\n”);* has to be in its own function

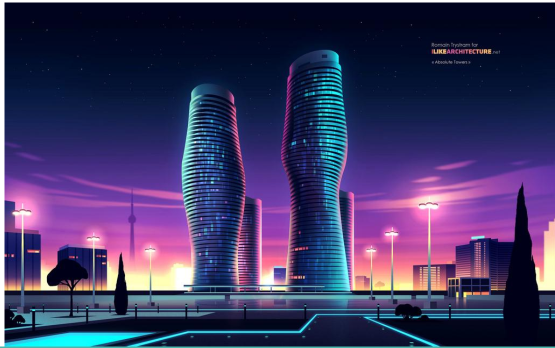
- *Hint: Use the function declaration* ***void hello(void);***



Function Inputs

- Functions can take inputs when they are invoked

- Ex: *abs(int num)* function
  - Finds the absolute value of a number
  - Found in the math.h header file



Function Inputs

- Abs() function in action

```
#include <math.h>
#include <stdio.h>
#include <stdlib.h>
int main(void) {
      int num1;
      scanf("%d", &num1);
      int abs_num1 = abs(num1);
      printf("OG: %d\nAbs: %d\n", num1, abs_num1);
}
```

Function Outputs

- Functions can also RETURN a value
- Can be stored into variables back in main (or other functions...)

- Use abs() as an example again
  - Is declared as *int abs(int num1);*

Function Outputs

- Abs() function in action

```
#include <math.h>
#include <stdio.h>
int main(void) {
	int num1;
	scanf("%d", &num1);
	int abs_num1 = abs(num1);
	printf("OG: %d\nAbs: %d\n", num1, abs_num1);
}
```

Function Task 2: Outputs

- Write a program that takes a number as input, adds 42 to that number, then returns the sum
  - Scan in the number, and print out this sum, in **main**
  - Add 42 within a function declared as *int add(int num1);*

Function Comments

- Large programs have many functions, and therefore many inputs and outputs
- Software engineers HAVE to keep track of these through *function comments*

Function Comments

- Each function comment has three parts:

  1) Description

  2) Inputs with description (if void, write void)

  3) Outputs with description (if void, write void)

Function Comments

- Example (from add)

```
/**
* Adds 42 to a number
* Input: num, an integer
* Output: num, an integer (42 more than input)
**/
int add_42(int num) {
    num += 42;
    return num;
}
```

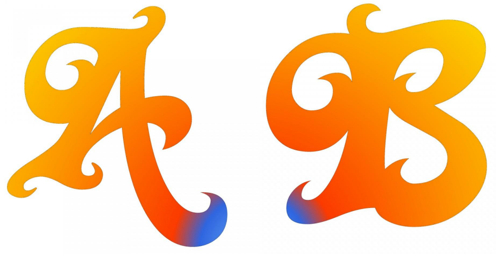
Function Inputs (continued)

- Functions can have as many inputs as necessary

- Example: Sum.c* will take in two numbers, and add them together

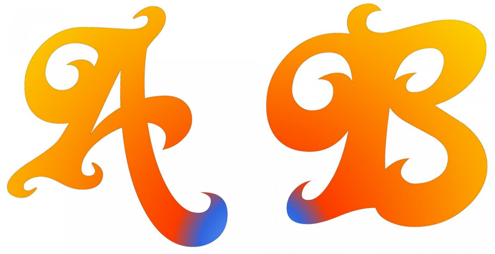
*on Github

Function Task 3: Multiple Inputs



- Task: Scan in two characters, and determine the numerical difference between the two ASCII values
- Requirements: Scan in the chars in main, calculate the difference in a function, and print out the difference in main

Function Task 3: Multiple Inputs



- Grading: 10 points
  - 5 for correct answer
  - 4 for correct software design (functions, etc...)
  - 1 for function comments