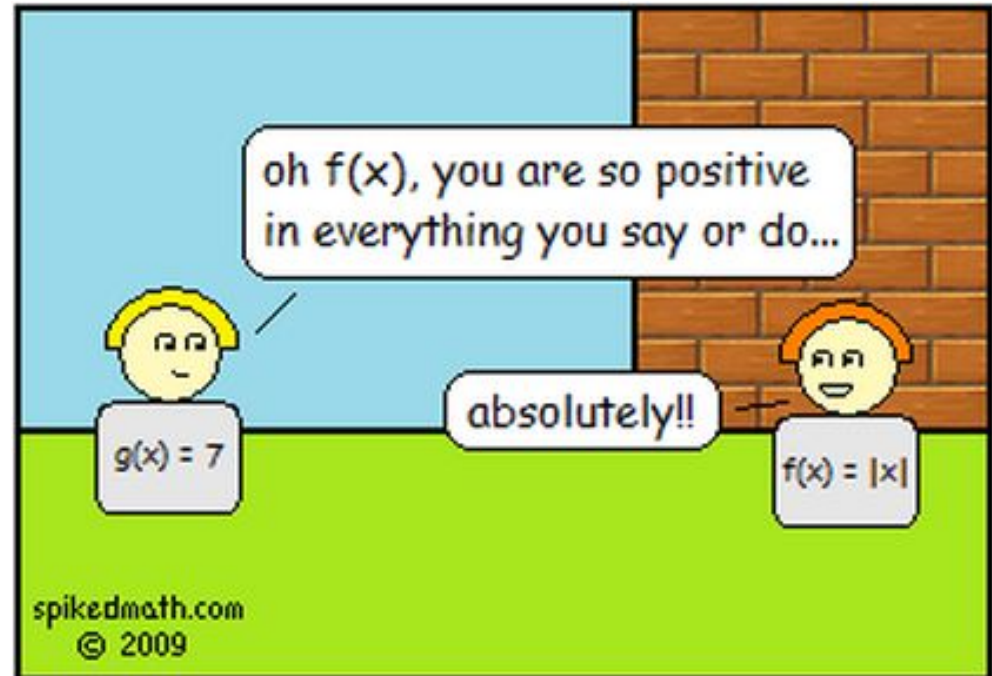




Lecture 6: Functions



Announcements and reminders

Submissions:

- HW 3 (functions) -- due Saturday at 6 PM

Course reading to stay on track:

- 5.1 - 5.4 today
- 5.5 - 5.8 before Wednesday
- 5.9 before Friday

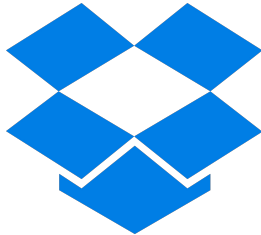
Practicum 1

- 5:30 - 7 PM, Wednesday 20 Feb
- Let us know (Piazza) about conflicts.
Include some verification (covering all our tails)



Back-up your work!

- GitHub (make it a **private** repository)
- Google Drive
- Dropbox
- You might want to revert to an earlier version
- Your computer might crash
- You might need to access your assignment from another computer
- **Use cloud storage - always save your work in more than one place!**



Don't care how. **No extensions** if you find that your assignment is lost to the ether the day before it is due.



Last time on *Starting Computing...*

We saw how **variables** work!

- Variable naming conventions
- Assignments

We saw how to **represent** different types of **numbers**!

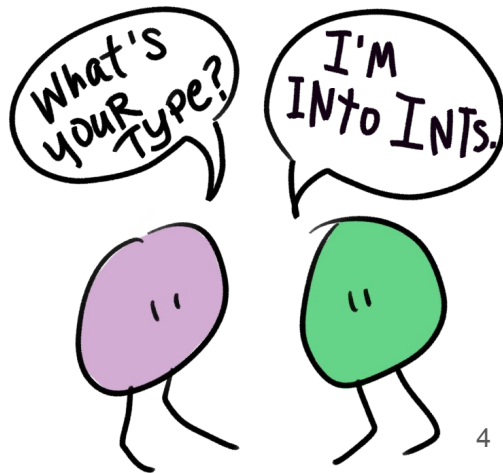
- Floating point (double)
- Integer (int)
- Constants (const)

We saw some **mathematical** functions and **arithmetic**!

- `+` `-` `*` `/` `%` `pow()` `abs()` `sqrt()` etc...
- Need to include the right header files -- Google is your friend!

We saw how to manage **input** from keyboard and **output** to screen!

- `cin >> ... ;`
- `cout << ... ;`
- `fixed << setprecision(##) and setw(##)`



Chapter 5: Functions

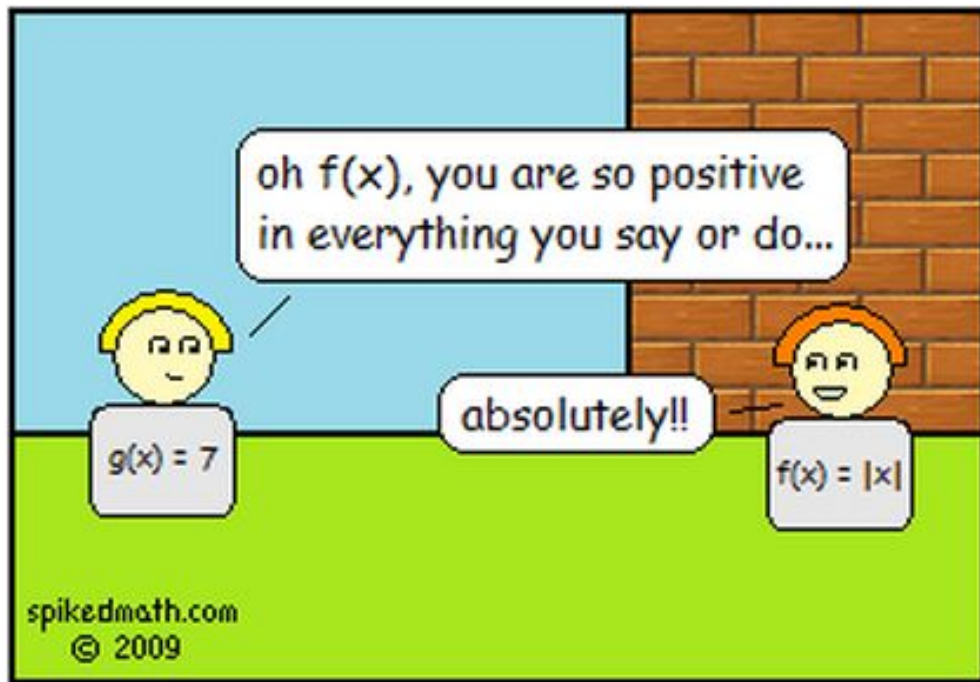
Chapter goals:

- To be able to implement functions
- To become familiar with the concept of parameter passing
- To appreciate the importance of function comments
- To develop strategies for decomposing complex tasks into simpler ones
- To be able to determine the scope of a variable
- To recognize when to use value and reference parameters

Chapter 5: Functions

Chapter topics:

- Functions as black boxes
- Implementing functions
- Parameter passing
- Return values
- Not return values
- Reusable functions
- Stepwise refinement
- Variable scope and globals
- ~~Reference parameters~~
- ~~Recursive functions~~



What is a function? Why is a function? Should I fear it?

Definition: A function...

- is a sequence of instructions with a name
- packages a computation into a form that can be easily understood and reused

What is a function? -- Example, in diagram

Definition: A function...

- is a sequence of instructions with a name
- packages a computation into a form that can be easily understood and reused

```
int main()
{
    double z = pow(2, 3);
    ...
}
```


What is a function? -- Example, in words

Definition: A function...

- is a sequence of instructions with a name
- packages a computation into a form that can be easily understood and reused

```
int main()
{
    double z = pow(2, 3);
    ...
}
```

- main is a function, and so is pow
- main **calls** the pow function, asking it to compute 2^3
- The main function is temporarily suspended while pow does its thing
- The instructions of the pow function execute and compute the result
- The pow function **returns** its result back to main
- main resumes execution

Parameters

```
int main()
{
    double z = pow(2, 3);
    ...
}
```

Definitions:

- When another function calls the pow function, it provides inputs (e.g., the 2 and 3 in the call pow(2, 3))
- In order to avoid confusion with user-provided inputs (cin >>), these values are called parameter values
- The output that the pow functions computes is called the return value (as opposed to output using cout <<)

Parameters

Note: An **output** statement (cout) **does not** return a value and the **return** statement **does not** display output

- output \neq return
- return statement ends the called function and resumes execution of the program that called that function
 - Can also pass a value back to the calling program (e.g., return 0;)
- A cout << statement communicates **only** with the user running the program
 - Just spits things out to the screen. That's it.

The Black Box Concept

You can think of a function as a “black box”

- Know what the box does, but can't see what's inside
- Like a **pressure cooker** -- can't see inside, know what it does

Example: How did the pow function do its job?

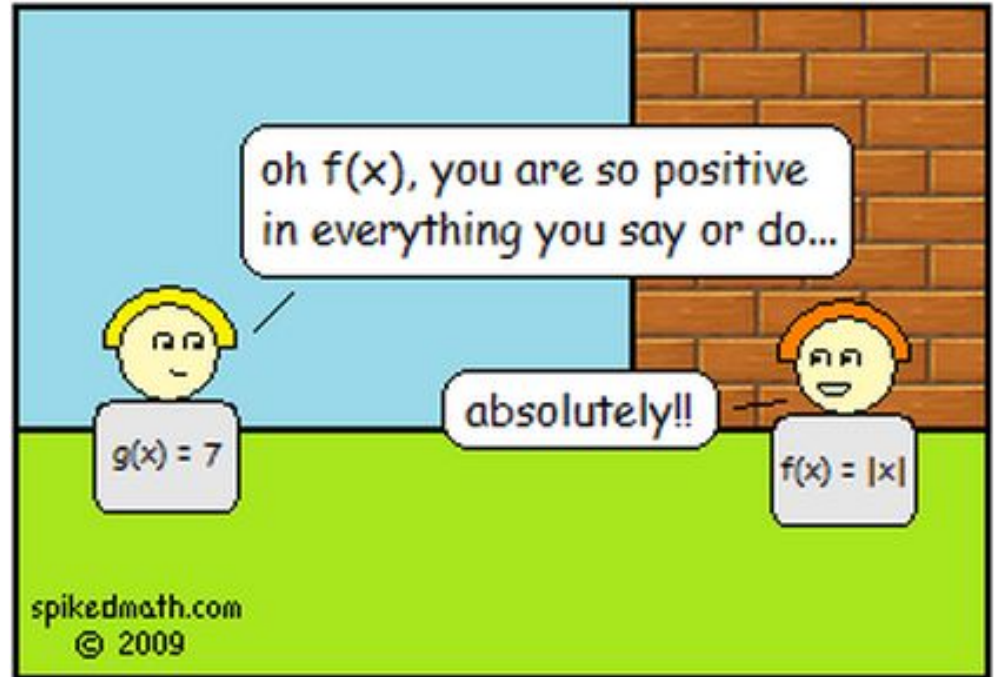
- You didn't need to know in order to use it
- You only need to know its **specification** (inputs/outputs, syntax)



Chapter 5: Functions

Chapter topics:

- Functions as black boxes
- **Implementing functions**
- Parameter passing
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Implementing functions

Example: Calculate the volume of a cube

- 1) Pick a good descriptive name for the function
- 2) Give a type and name for each parameter

There will be one parameter for each piece of information the function needs to do its job

- 3) Specify the type of the return value:

```
double cube_volume(double side_length);
```

- 4) Then write the body of the function, as statements enclosed in curly braces { ... }

Implementing functions

Example: Calculate the volume of a cube

Note: Useful comments at the top: **description, parameters, return, algorithm**

Implementing functions

Example: Calculate the volume of a cube

Note: Useful comments at the top: **description, parameters, return, algorithm**

```
/*  
    Computes the volume of a cube  
    @param side_length -- the side length of the cube  
    @return the volume of the cube  
*/  
double cube_volume(double side_length)  
{  
    double volume = side_length * side_length * side_length;  
    return volume;  
}
```


Implementing functions

Question: How do you know your function works as intended??



Implementing functions

Question: How do you know your function works as intended??

- You should always **test the function**
- Write a **main()** function to do this
- Let's test a couple different `side_lengths` for our `cube_volume` function and see if it outputs the correct volumes



Implementing functions

Question: How do you know your function works as intended??

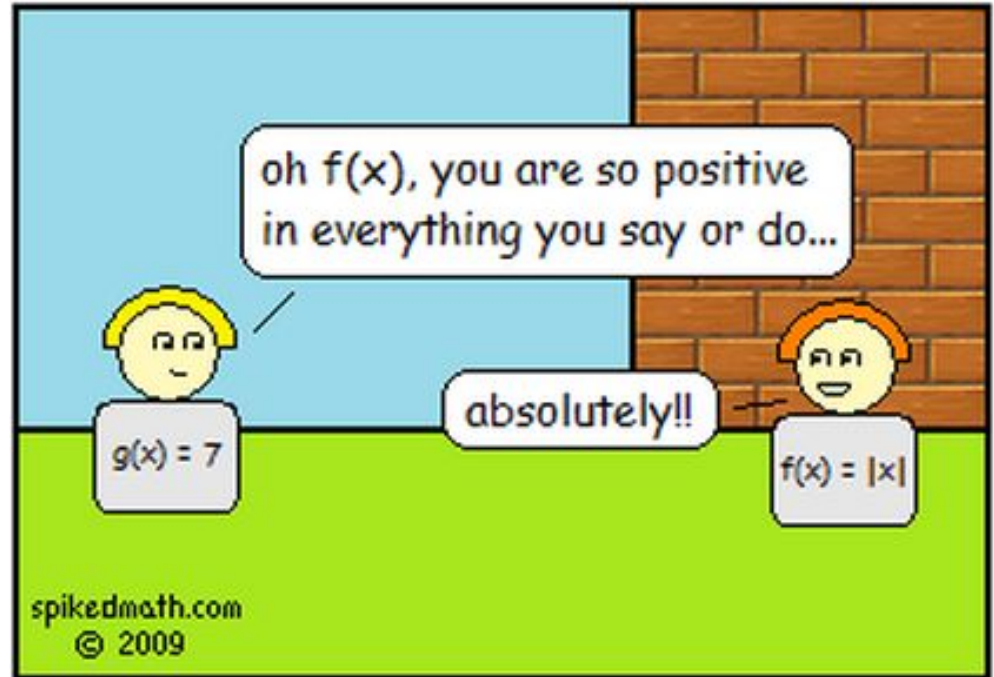
- You should always **test the function**
- Write a **main()** function to do this
- Let's test a couple different `side_lengths` for our `cube_volume` function and see if it outputs the correct volumes

```
int main()
{
    double result1 = cube_volume(2);
    double result2 = cube_volume(10);
    cout << "A cube with side length 2 has volume " << result1 << endl;
    cout << "A cube with side length 10 has volume " << result2 << endl;
    return 0;
}
```

Chapter 5: Functions

Chapter topics:

- Functions as black boxes
- Implementing functions
- **Parameter passing**
- Return values
- Not return values
- Reusable functions
- Stepwise refinement
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Parameter Passing

When a function is called, a **parameter variable** is created for each value passed in.

Each parameter variable is **initialized** with the corresponding parameter value from the call.

```
int hours = read_value_between(1, 12);
```

```
...
```

```
int read_value_between(int low, int high);
```

Parameter Passing

Example: A call to our cube_volume function:

```
double result1 = cube_volume(2);
```

Here is the function definition:

```
double cube_volume(double side_length)
{
    double volume = side_length * side_length * side_length;
    return volume;
}
```

Let's keep track of the variables and their parameters:

```
result1, side_length, volume
```

Parameter Passing -- the play-by-play

First, the function call: `double resultI = cube_volume(2);`

→ `resultI = _____` `side_length = _____`

Second, initializing function parameter variable: `double resultI = cube_volume(2);`

→ `resultI = _____` `side_length = 2`

Third, execute `cube_volume` function:

`double volume = side_length * side_length * side_length;`
`return volume;`

→ `resultI = _____` `side_length = 2` `volume = 8`

Finally, after the function call: `double resultI = cube_volume(2);`

→ `resultI = 8`

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What just happened...?

We learned what a function is!

We learned how to implement a function!

We learned how to pass parameters into a function **and send return values back out!**

We learned a little bit about the **scope** of variables!

- Much more on this later!



