"The chief function of the body is to carry the brain around" -- Thomas Edison

A function is the encapsulation of some calculation.
- we invoke a function, and provide information in the form of arguments
- the function receives the arguments as parameters, using the parameters to make its calculation
- a value is returned by the function to the caller
long celsius_to_fahr(long celsius_t)
{
    long tmp;
    tmp = (9.0/5.0 * celsius_t) + 32;
    return tmp;
}

return keyword, value returned

types must match

return type

func name

do something

return keyword, value returned

types must match

return type

function name

param list in parens:
• comma separated
• each element with a type

function block

param list in parens:
• comma separated
• each element with a type

function block

local variable

return keyword, value returned

types must match

return type

function name

param list in parens:
• comma separated
• each element with a type

function block

local variable

return keyword, value returned

types must match

return type

function name

return keyword, value returned

types must match
int main()
{
    long value, result;
    std::cout << "Enter a value:";
    std::cin >> value;
    result = my_sqrt(value, 1e-5);
    std::cout << "Sqrt of:";
    std::cout << value << " is:";
    std::cout << result << std::endl;
}

int main()
{
    long celsius_temp, result;
    std::cout << "Enter a temp in celsius:";
    std::cin >> celsius_temp;
    result = celsius_to_fahr(celsius_temp);
    std::cout << "Temp in Celsius:";
    std::cout << celsius_temp << ", temp in Fahrenheit:";
    std::cout << result << std::endl;
}
Functions are very useful to break the program down into small, understandable, maintainable pieces

- example: celsius_to_fahr
Software engineering

• There is a discipline of computer science dedicated to the systematic development and maintenance of software
• There are a number of approaches that SE use, including: modularization, proveability, testing, refactoring and others

Refactoring

• Making multiple passes through code to improve its readability and maintainability while not changing (but perhaps improving) its functionality
• Implies that tests are available to apply to code to make sure this is the case
• One refactoring approach is extraction, making complicated code into multiple functions, creating better abstractions
How to write a function

- Should do one thing. If more than one thing, break into parts. A function *abstracts* one idea
- Should not be overly long (~one page of code). Otherwise break up
- Should be generic in that it could be reused elsewhere in the code
- Should be readable!

Scope

“Still this planet's soil for noble deeds grants scope abounding.”

-- Goethe
What is scope

When we create a variable, we make an association between a name and a value.

- a value exists at some memory location. The name is associated with both.

The part of the program where the name and that association is valid is called the variable's scope.

Blocks are a scope

Though there is more to it than that, a block constitutes a scope. We've seen this before.

If you define a variable in a block, it only has existence in that block.
parameters are also local

*Parameters* of a function are also considered local, part of the scope of the function

be careful

There will be situations where you want to pass back information from a function. You should know:

- dangerous to pass back a reference or pointer from local function names
  - at some point, that memory will be reclaimed.
- if you don't say, you are making a copy when you pass something back!
Within multiple scopes you can have the same name associated with different values:

- within each scope there is a unique association, so no problem
- change scope, another (within that scope) unique association.

```cpp
#include<iostream>
#include<iomanip>

double my_sqrt(double value, double epsilon)
{
    double guess = value/2.0;
    double under = value/guess;
    long cnt = 0;
    std::cout << std::fixed << std::setprecision(15);

    while (guess - under > epsilon)
    {
        guess = (guess + under)/2.0;
        under = value/guess;
        ++cnt;
        std::cout << "Iter:"<<cnt<<" result:"<<guess<<std::endl;
    }
    return guess;
}

int main()
{
    std::cout << my_sqrt(49, 1e-3) << std::endl;
    std::cout << my_sqrt(49, 1e-10) << std::endl;
    /*
    // not in this scope!
    cout << guess << endl;
    cout << cnt<< endl;
    */
    return 0;
}
```
values are copied

Unless we say otherwise, C++ copies things that are passed, both in an out of a function.

```cpp
#include<iostream>
#include<iomanip>

double my_sqrt(double value, double epsilon)
{
    double guess = value/2.0;
    double under = value/guess;
    long cnt = 0;
    std::cout << std::fixed << std::setprecision(15);

    while (guess - under > epsilon){
        guess = (guess + under)/2.0;
        under = value/guess;
        ++cnt;
        std::cout << "Iter:"<<cnt<<" result:"<<guess<<std::endl;
    }
    return guess;
}

int main (){
    std::cout << my_sqrt(49, 1e-3) << std::endl;
    std::cout << my_sqrt(49, 1e-10) << std::endl;
    /*
    // not in this scope!
    cout << guess << endl;
    cout << cnt<< endl;
    */
}  
```
Example 4.3 and 4.4

more function examples