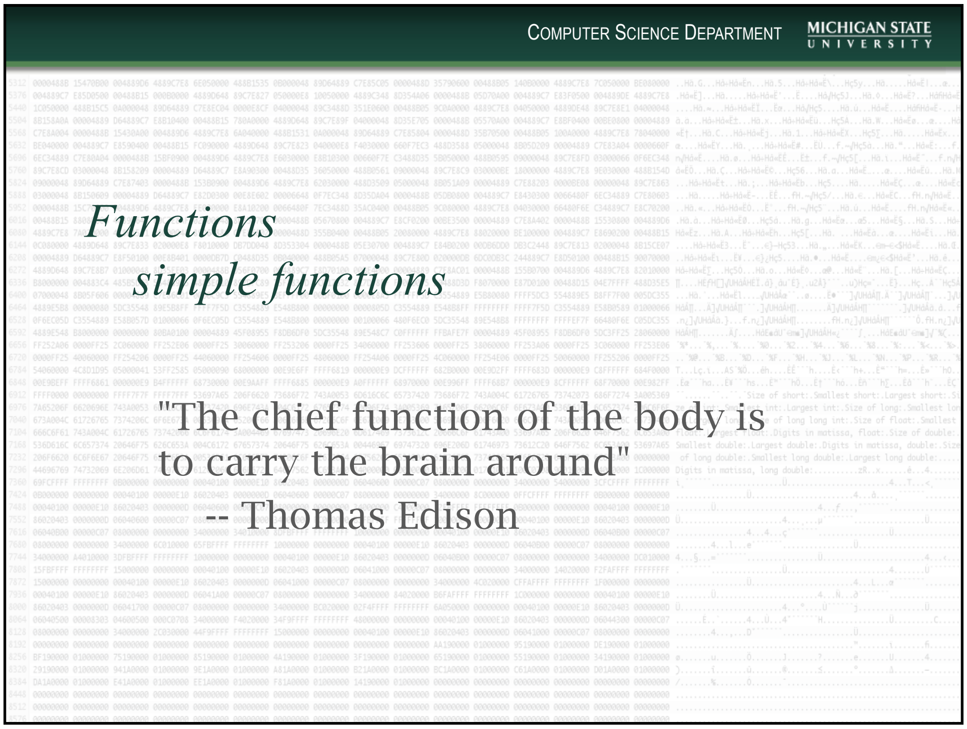

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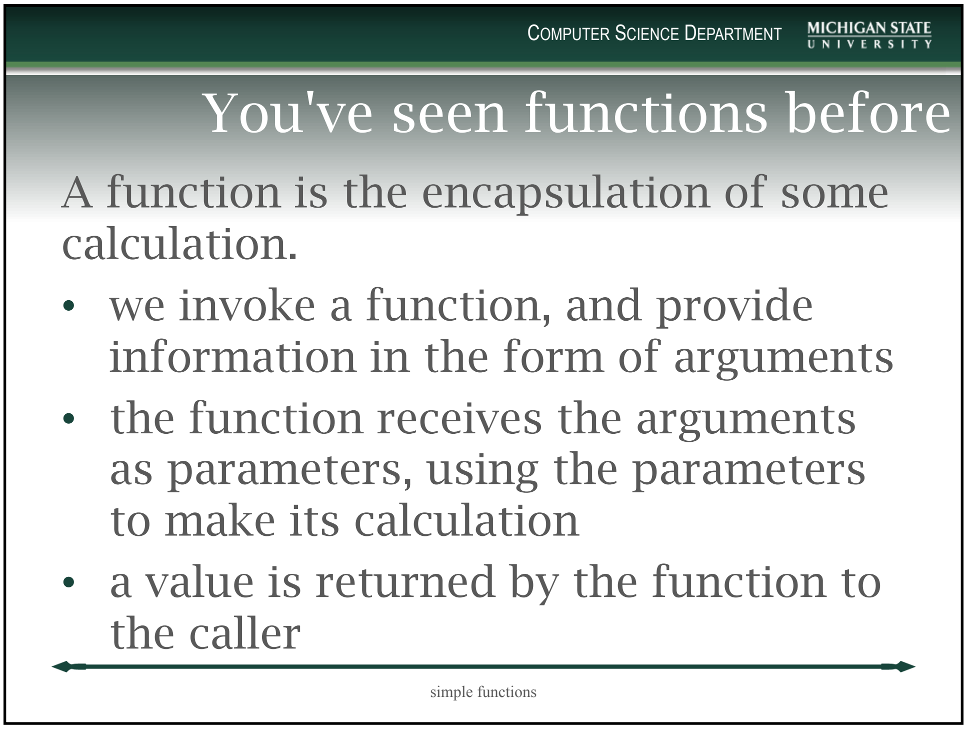
Functions

simple functions

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



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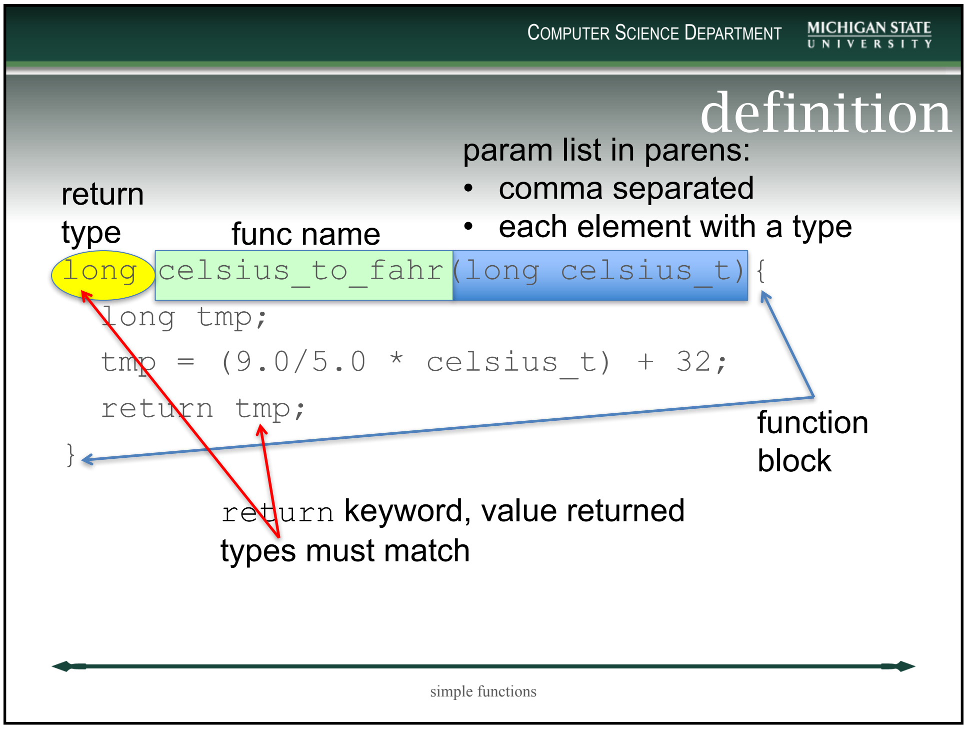
You've seen functions before

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

simple functions



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definition

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

return type

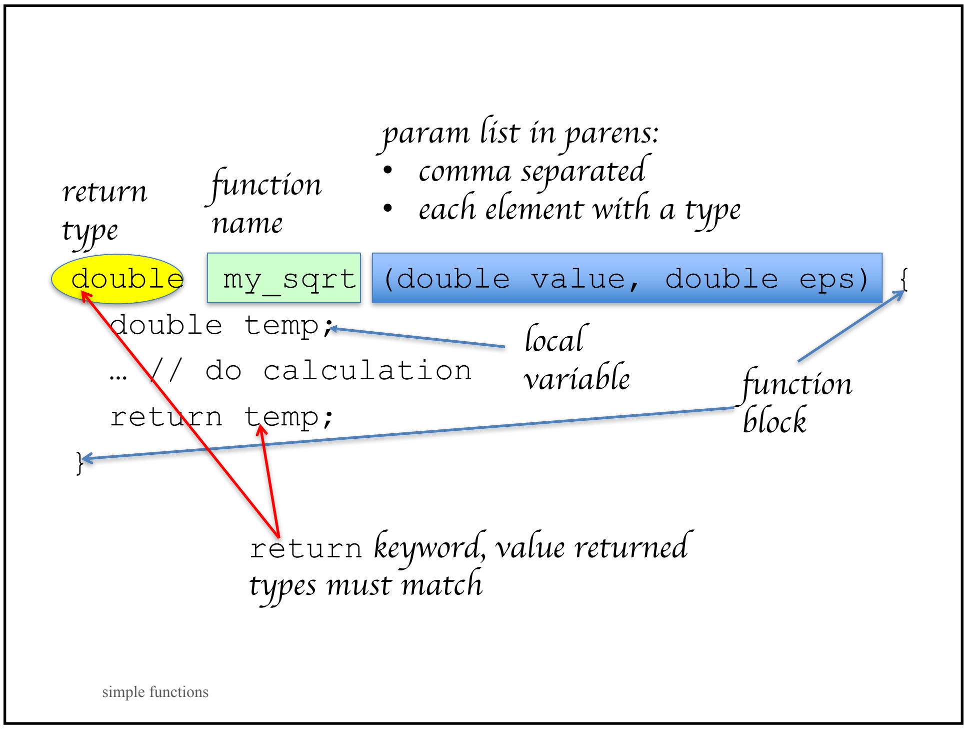
func name

```
long celsius_to_fahr(long celsius_t){
  long tmp;
  tmp = (9.0/5.0 * celsius_t) + 32;
  return tmp;
}
```

function block

`return` keyword, value returned types must match

simple functions



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

return type

function name

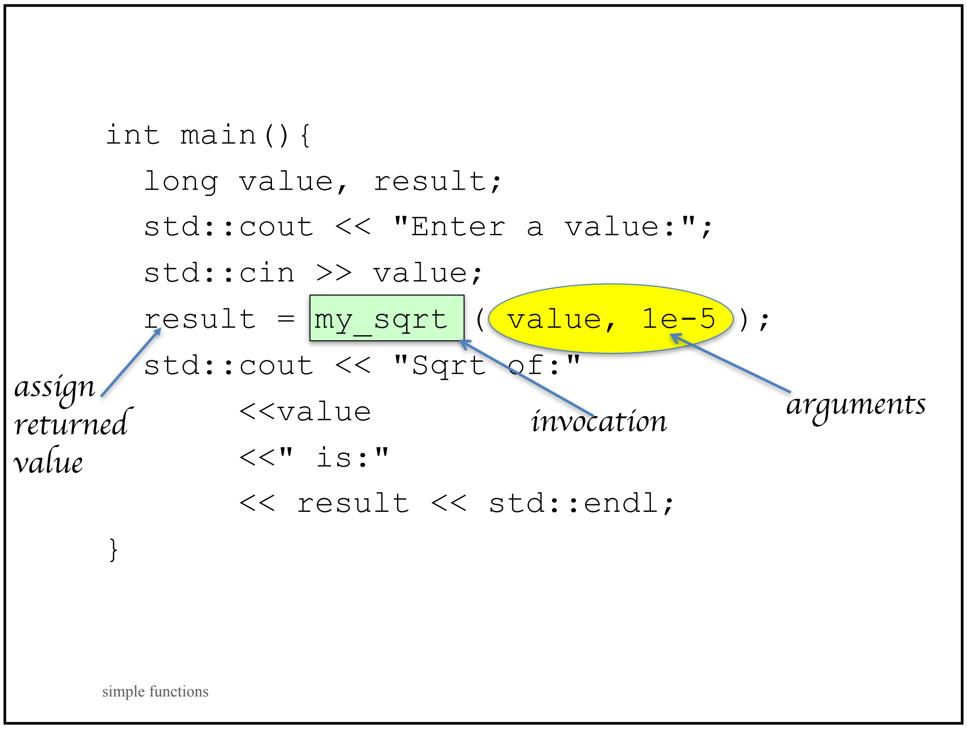
```
double  my_sqrt  (double value, double eps) {
  double temp;
  … // do calculation
  return temp;
}
```

local variable

function block

`return` *keyword, value returned types must match*

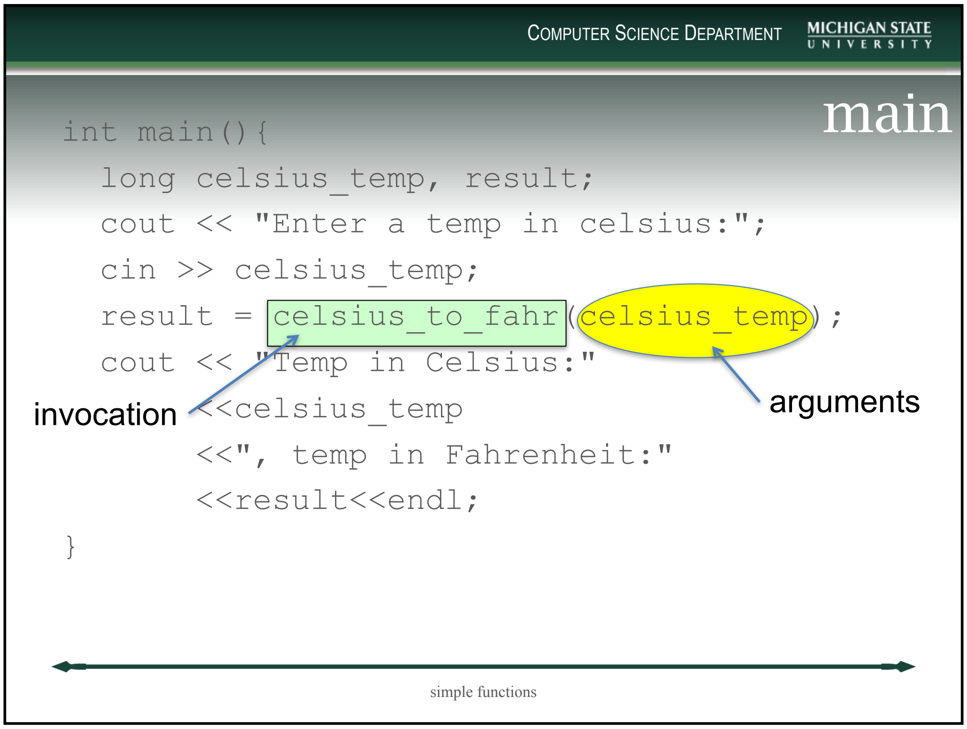
simple functions



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

assign returned value
invocation
arguments

simple functions



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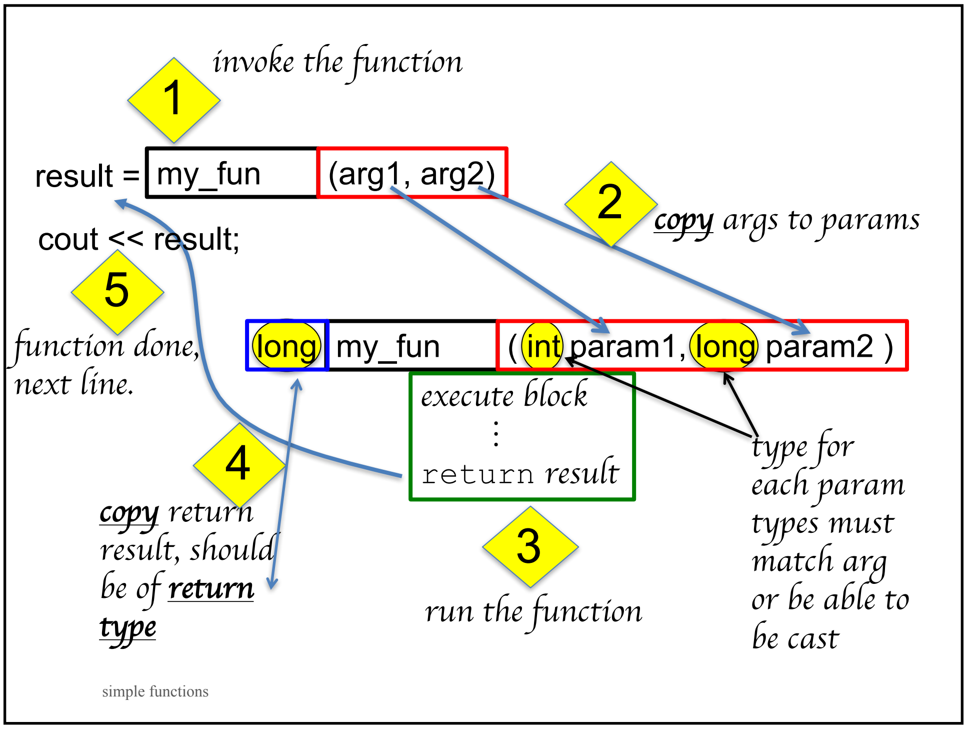
main

```
int main(){
  long celsius_temp, result;
  cout << "Enter a temp in celsius:";
  cin >> celsius_temp;
  result = celsius_to_fahr(celsius_temp);
  cout << "Temp in Celsius:"
       <<celsius_temp
       <<", temp in Fahrenheit:"
       <<result<<endl;
}
```

invocation
arguments

simple functions



1 invoke the function

result = my_fun (arg1, arg2)

cout << result;

2 *copy* args to params

long my_fun (int param1, long param2)

execute block
⋮
return result

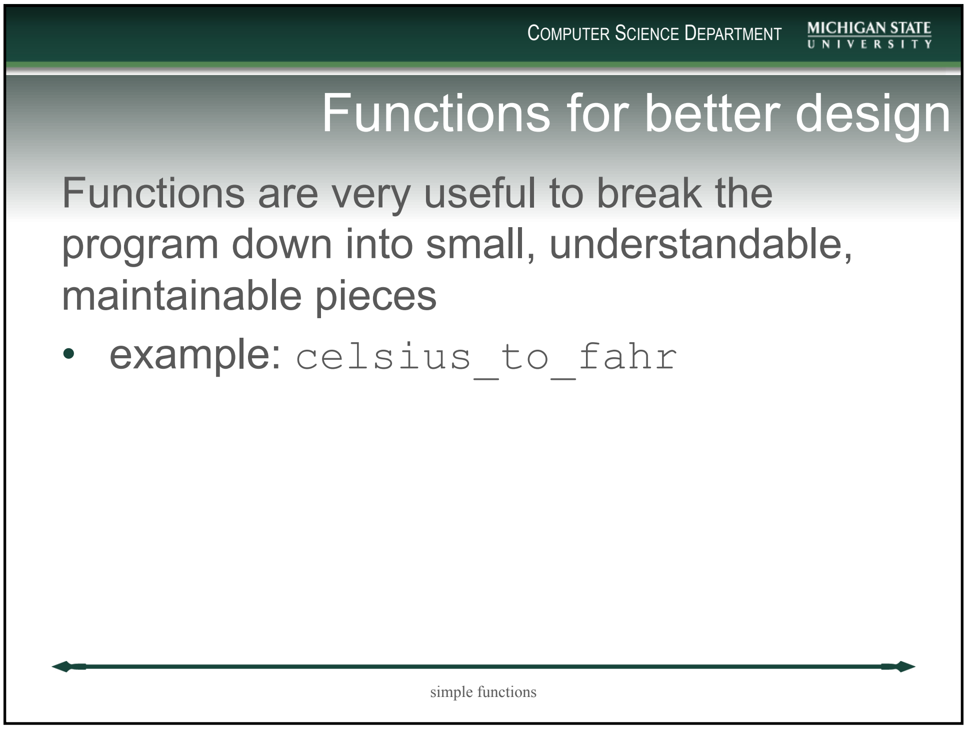
3 run the function

4 *copy* return result, should be of **return type**

5 function done, next line.

type for each param types must match arg or be able to be cast

simple functions



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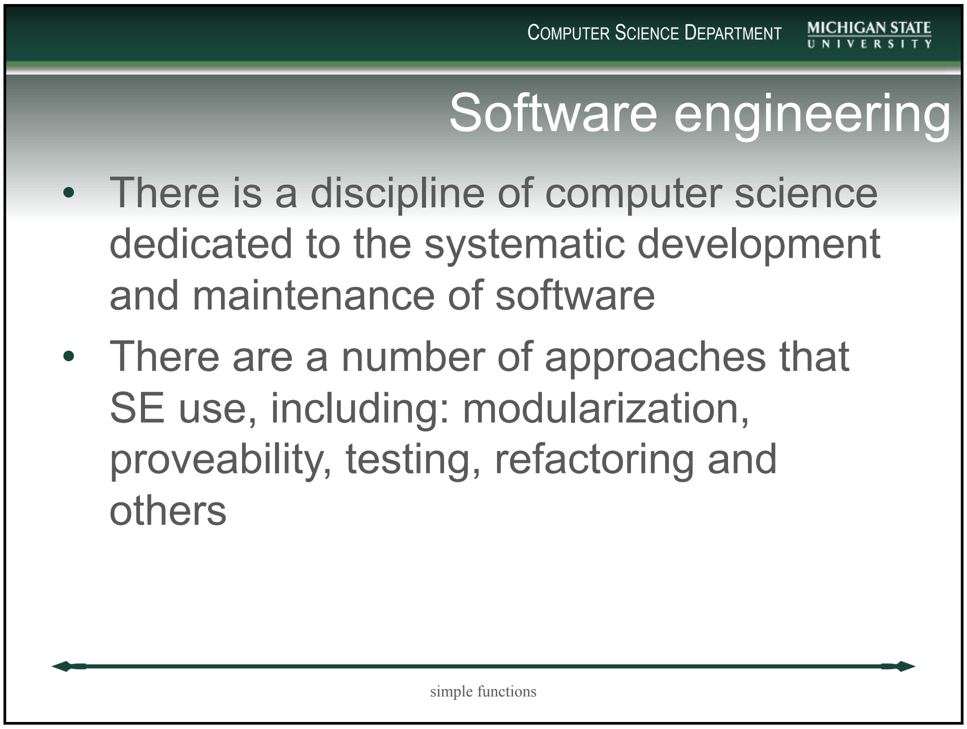
Functions for better design

Functions are very useful to break the program down into small, understandable, maintainable pieces

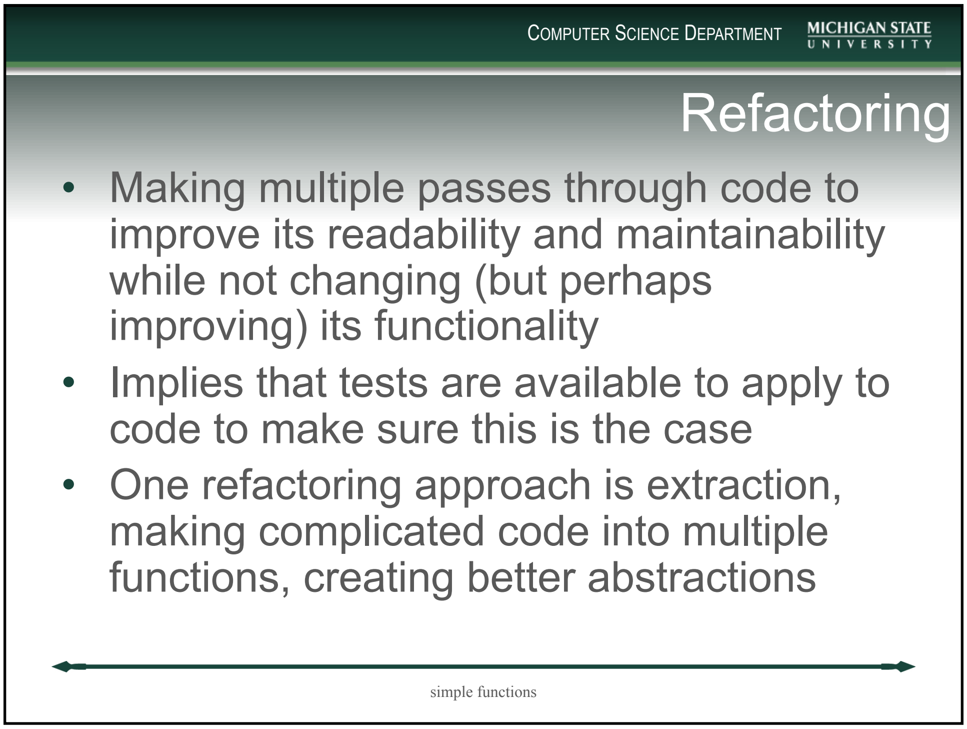
- example: `celsius_to_fahr`

simple functions



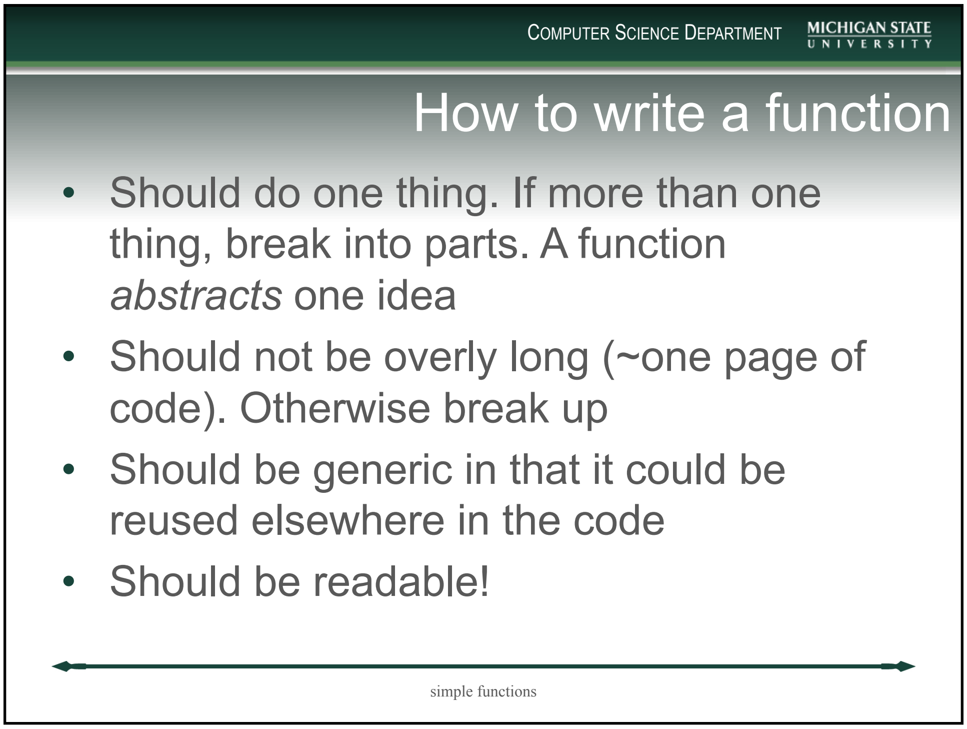
Software engineering

- 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



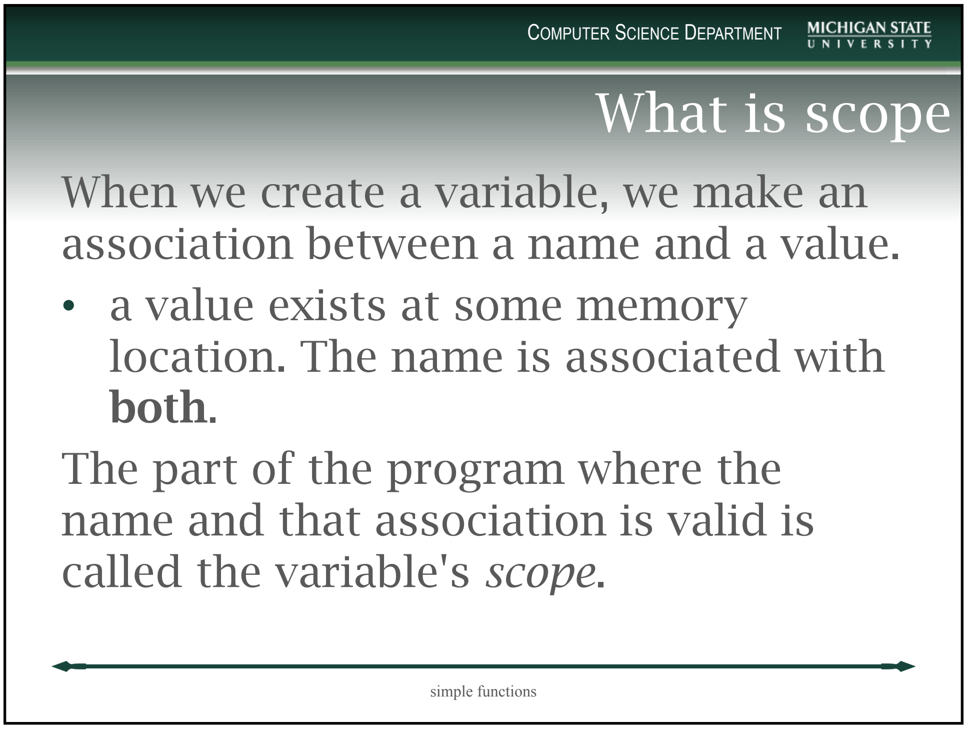
How to write a function

- 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

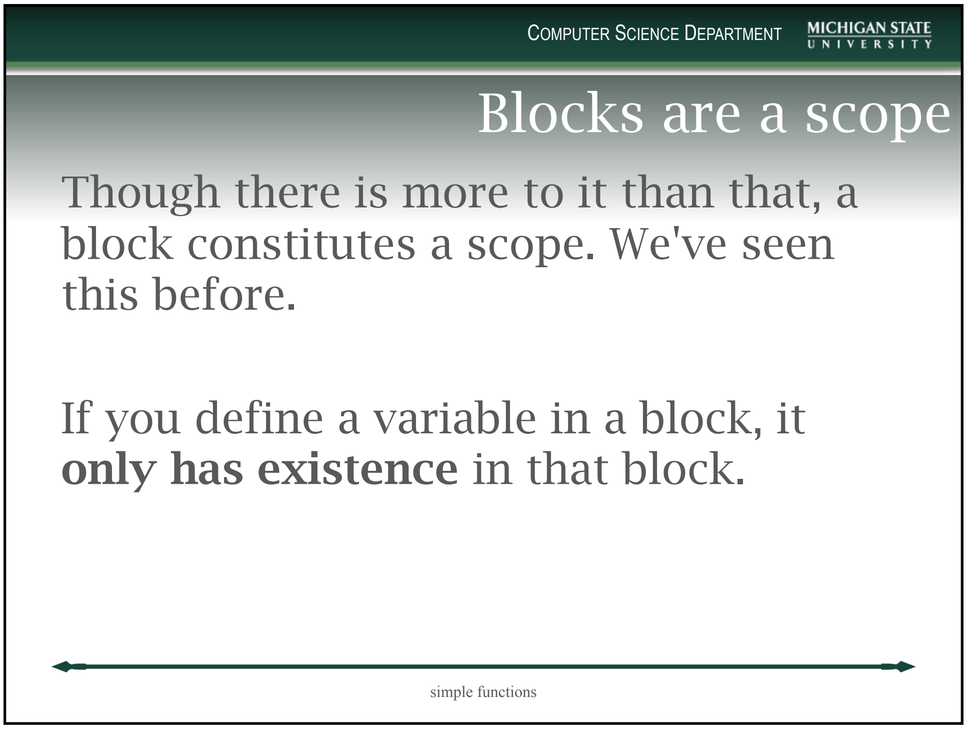


What is scope

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**.

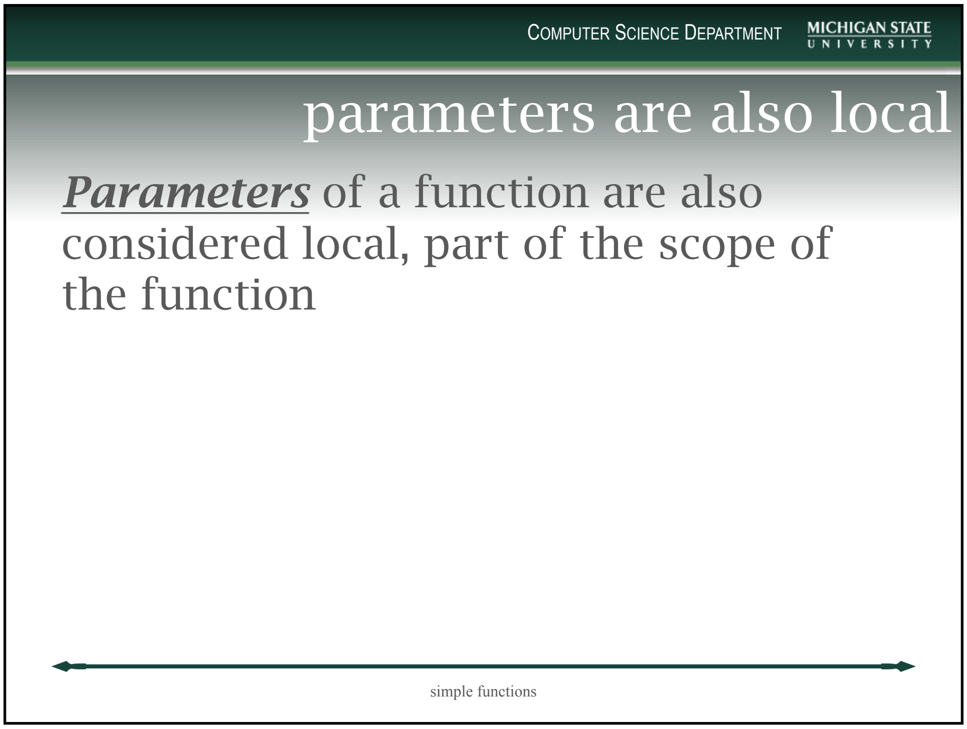
The part of the program where the name and that association is valid is called the variable's *scope*.



Blocks are a scope

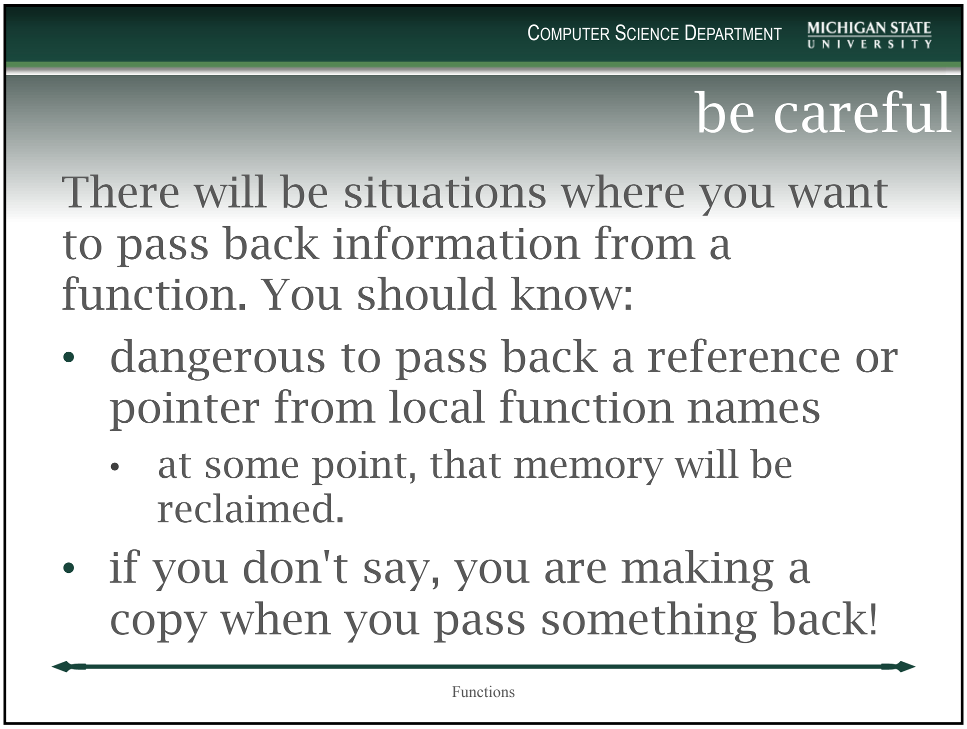
Though there is more to it than that, a block constitutes a scope. We've seen this before.

If you define a variable in a block, it **only has existence** in that block.



parameters are also local

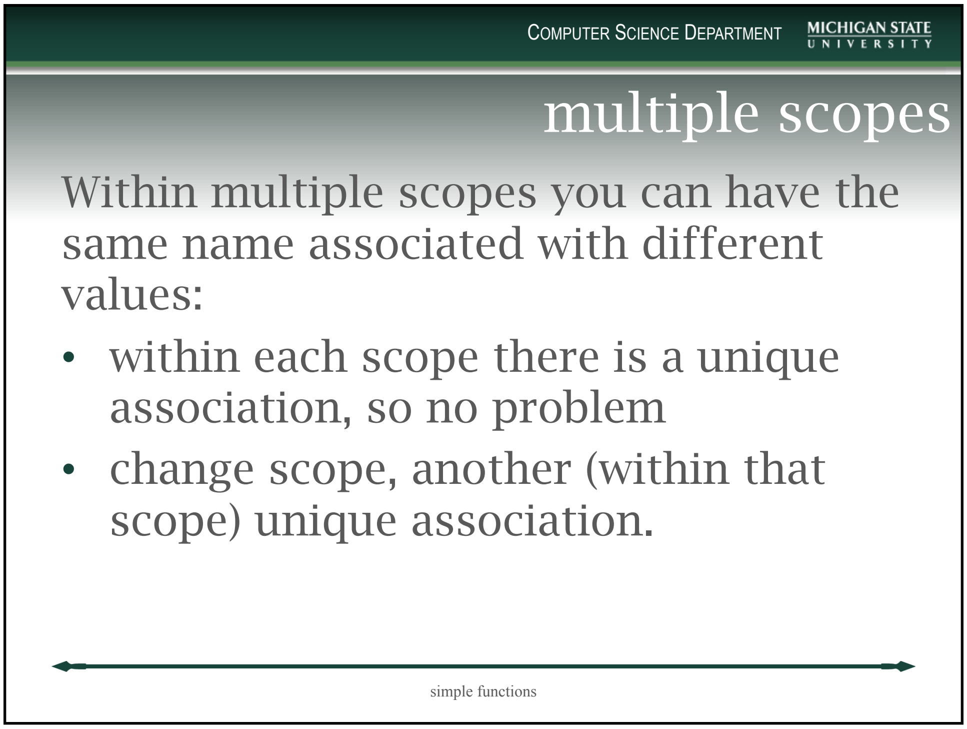
Parameters of a function are also considered local, part of the scope of the function



be careful

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

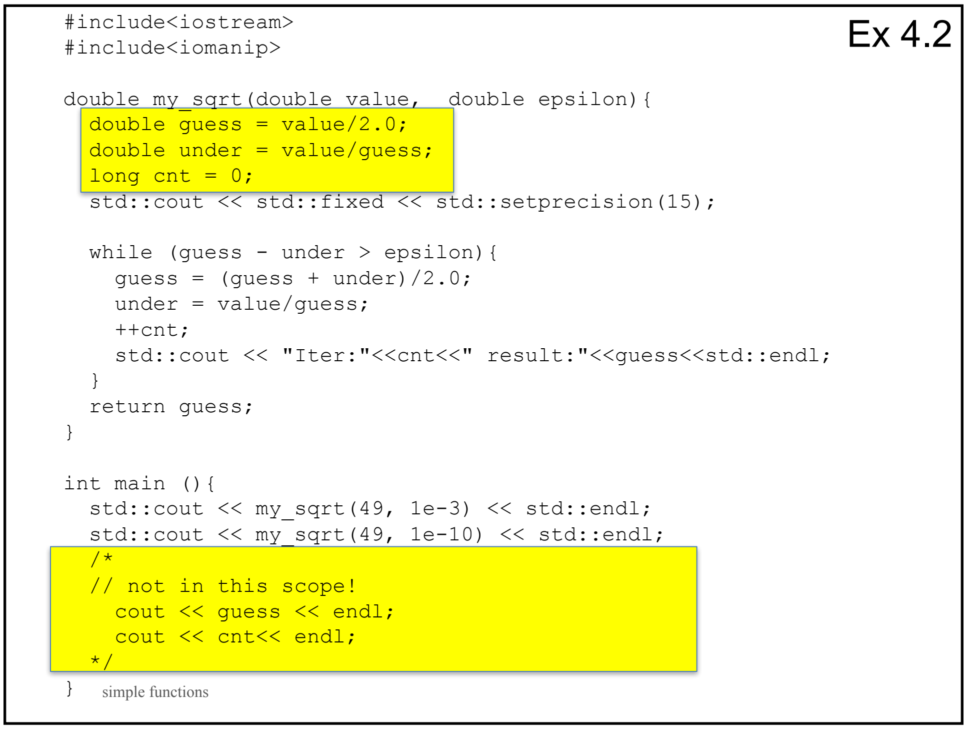
- dangerous to pass back a reference or pointer from local function names
  - at some point, that memory will be reclaimed.
- if you don't say, you are making a copy when you pass something back!



multiple scopes

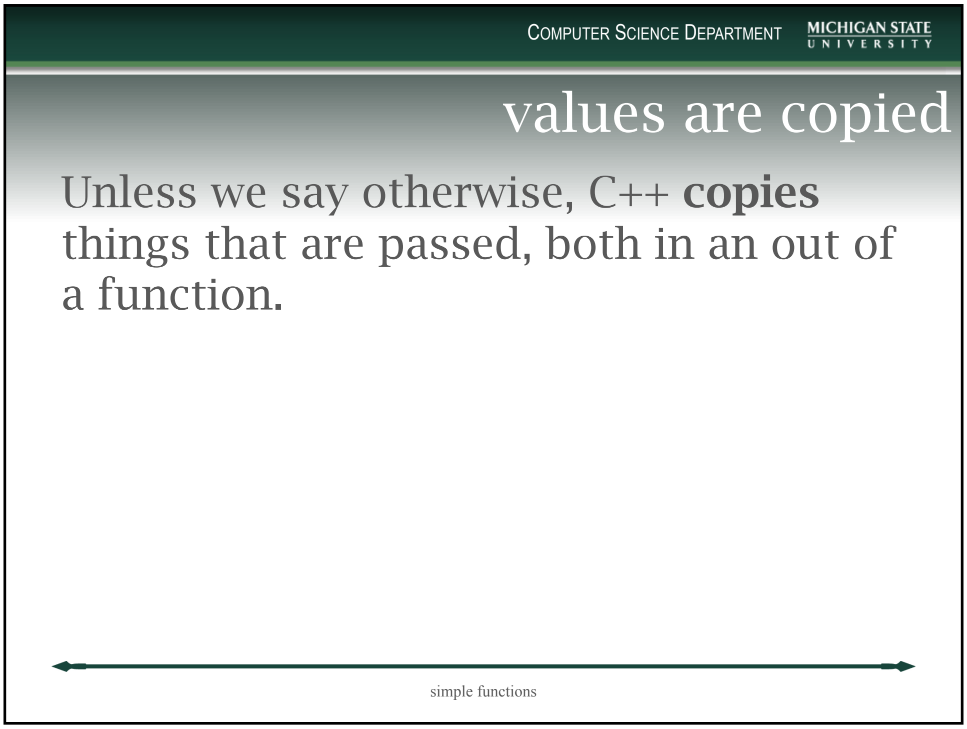
Within multiple scopes you can have the same name associated with different values:

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



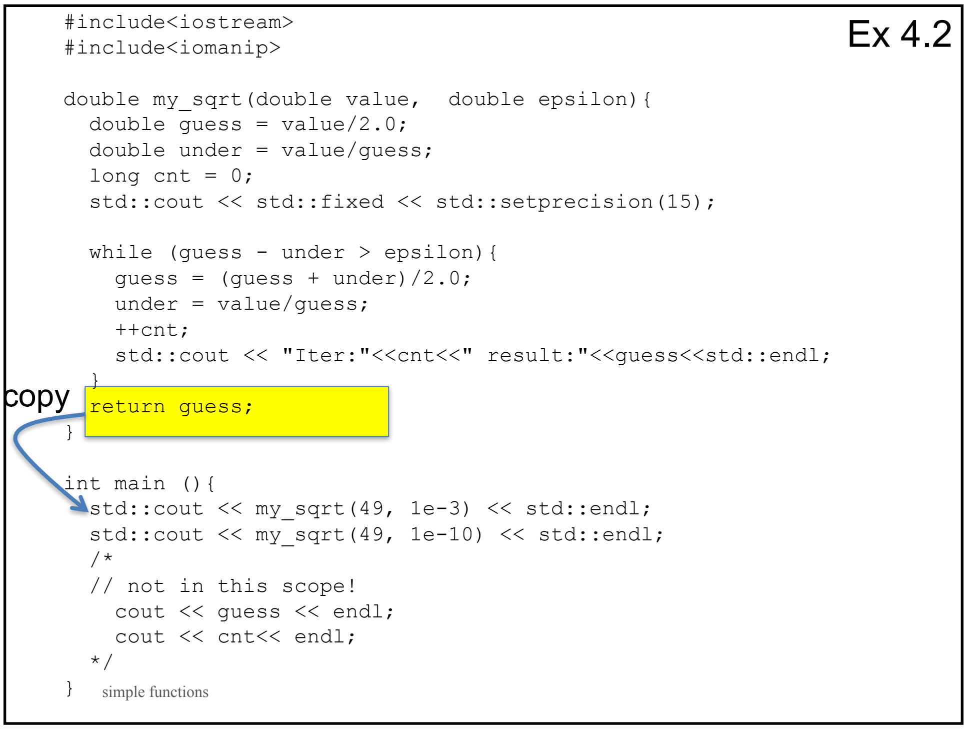
Ex 4.2

```
#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;
  */
}
```



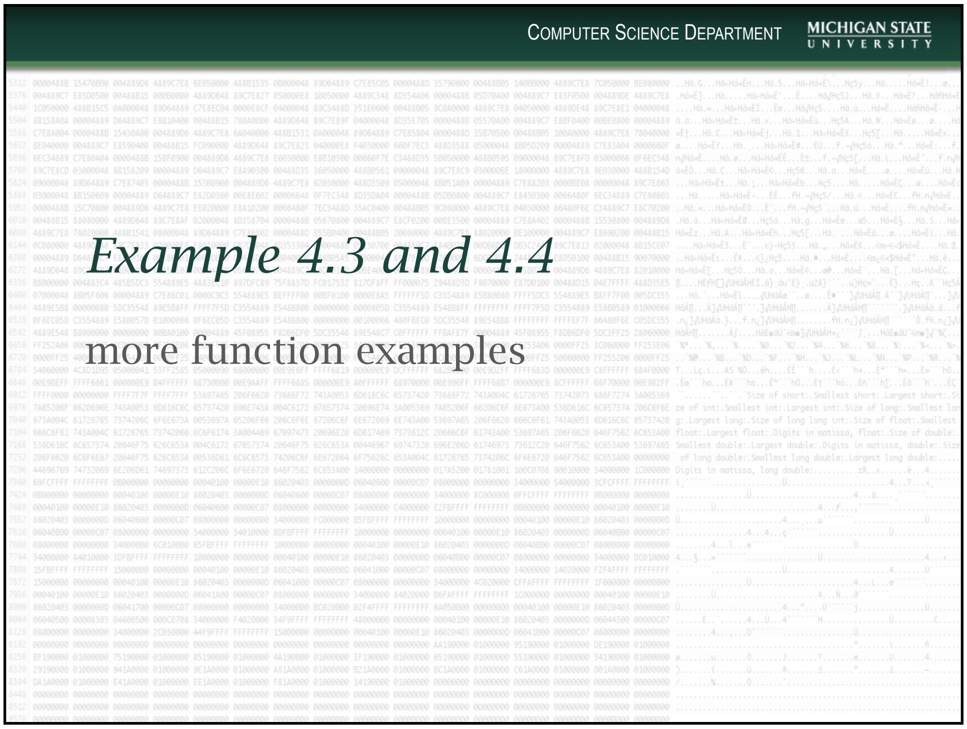
values are copied

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



Ex 4.2

```
#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;
  */
}
```



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Example 4.3 and 4.4

more function examples