Chapter 3

Functions

Functions

• Divides a program into manageable units
• Main function contains overall structure of program
  – Details are contained in functions
• Main performs 3 actions
  – Calls a function to perform a task
  – Gives the function any information it needs to perform the task
  – Receives the results returned by the function
Components of a Function

• Must have these 3 parts
  – Function Declaration/Prototype
    • Informs the compiler about the general structure of the function
  – Function Call
    • Instructs the function to execute
  – Function Definition
    • Contains the code that the function executes

Function Prototype

• Placed before any function calls
• Must contain
  – Name of the function
  – Return type
  – Parameter(s) type
• May contain parameter names but this is ignored by the compiler

```cpp
int calculateAge(int, int, int);     // OR
int calculateAge(int day, int month, int year);
```
Function Definition

• Placed after main function (not inside)
  – Never place a function inside of another
• Variables defined in a function are only visible to that function
  – Called local variables
  – Can have the same variable names in different functions
• Return statement sends data back to the calling function
  – Some functions have nothing to return (void)

```c
double calcPay(double hours, double rate, double overRate) {
    double overtimeHrs = 0.0;
    double pay = 0.0;

    if (hours > 40.0) {
        overtimeHrs = hours - 40.0;
        hours -= overtimeHrs;
    }

    pay = (hours * rate) + (overtimeHrs * overRate);
    return pay;
}
```
Function Call

• This is the statement that invokes the function
  – Function can be defined but never called
• Functions can call other functions
• Must pass required data
  – Can pass literals and values in variables
• Use assignment to store return values (if they exist)

```
salary = calcPay(60, 25, 37.5);
```

Void Functions

• Performs a task but does not send any information back
  – Display information on screen
• } causes the function to terminate
  – Use a return statement to terminate prior to the end of the function

```
void printTemp(int temp) {
    cout << "The current temperature is " << temp
        << " and if you're in Houghton it's probably snowing.";
    cout << endl;
}
```
Boolean Functions

• Returns true or false
  – Can be in the form of a boolean expression
  – `return ((rate == 0) || (rate < 10))`

• Return value can directly be used in an if statement or while loop

```cpp
if (isValidDate(month, day, year))
    cout << “Valid Date
”;
else
    cout << “Invalid Date
”;
```

main() - “The Special Function”

• Recall main() is a function

• Special because
  – Only one main function can exist in a program

• Who calls main()?
  – Operating System

• Return type can be int or void
  – Int is preferred
  – 0 means everything went well
  – 1 means there was an error e.g. `exit(1);`
Global Variables

• Declared outside all functions
  – Usually at the top of the file
• Dangerous in large software applications
  – No control over usage
• Commonly used for constants
  – All functions have access to global constants

```cpp
#include <iostream>
using namespace std;

const double TAX_RATE = 0.05;

int main() {
    ...
}
```

Block Scope

• A block is a piece of code enclosed in { }
  – Still a block if the {} are omitted e.g. loop with one statement in the body
• Any variable declared in a block is visible only in that block
  – Called “block scope”

```cpp
for (int i = 1, sum = 0; i < 3; ++i) {
    sum += i;
}
cout << sum << endl;
```
Procedural Abstraction

• Need to know “what” a function does, not “how” it does it
• Think “black box”
  – You know how to use it, not how it's designed
• Implement functions like black boxes
  – User of function only needs declaration
  – Does not need to know function definition
    • Called information hiding
    • Hide details of how function works

Commenting Functions

• Each function definition should be preceded by its
  – Preconditions
    • Things that must be true for the function to work properly
  – Postconditions
    • Effects of calling the function

// double sqrt(double x)
// Precondition   - x is a non-negative number
// Postcondition  - Returns the sqrt of x
double sqrt(double x) {
  ....
Predefined Functions

- Libraries full of functions you can use
- Must "#include" appropriate library

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Random Numbers

- Return "randomly chosen" number
- Commonly used in simulations & games
  - `rand()`
    - Takes no arguments
    - Returns value between 0 & RAND_MAX - 1
  - Scaling
    - Squeezes random number into smaller range
    - `rand() % 6`
      - Returns random value between 0 & 5
  - Shifting
    - `(rand() % 6) + 1`
    - Shifts range between 1 & 6 (e.g., die roll)
Random Number Seeds

- Pseudo random numbers
  - Calls to rand() produce given "sequence" of random numbers

- Use "seed" to alter sequence
  - srand(seed_value);
    - void function
    - Receives one int argument, the "seed"
    - Can use any seed value, including system time:
      srand(time(0));
    - time(0) returns system time as numeric value
    - Library <ctime> contains time() functions

Parameter vs. Argument

- Terms often used interchangeably
- For our purposes:
  - Parameters
    - Types specified in function prototype
    - Variables declared in function definition's header
  - Argument
    - Data passed in function call
- Parameter is “formal” piece
- Argument is “actual” piece