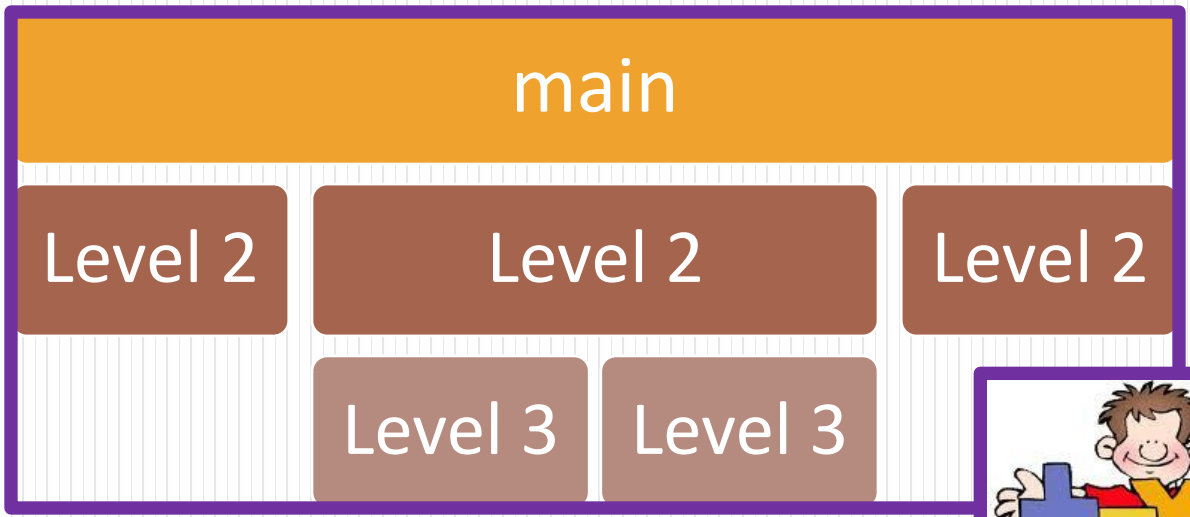
Programming in C

Chapter 8
Programmer-Defined Functions

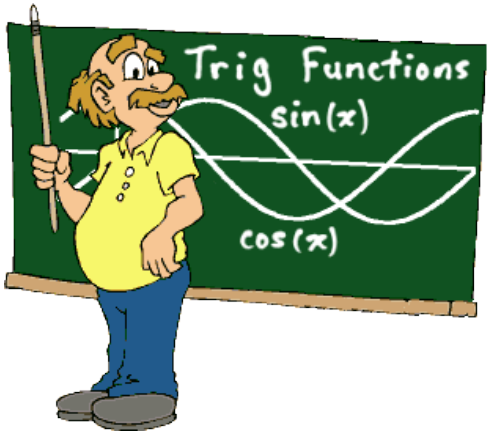


Programmer-Defined Functions

- Modularize with building blocks of programs
  - Divide and Conquer
    - Construct a program from smaller pieces or components
      - Place smaller pieces into functions
    - Pieces are more manageable than one big program
      - Makes other functions smaller
      - Pieces can be independently implemented and tested

Programmer-Defined Functions

- Readability
  - Function name should indicate operations performed
- Reuse
  - Functions may be used multiple times in same program
  - Functions may be used in other programs



Components of Function Use

- Three steps to using functions
  1. Function declaration/prototype
     - If not defined before use
  2. Function definition
  3. Function call
     - Either prototype or definition must come first

- Prototype and/or definitions can go in either
  - Same file as main()
  - Separate file so other programs can also use it
    - #include

Program Function Definition Structure

- main first (preferred)
  - Top down design
  - Some prototypes required
  - Complete prototyping allows function definition in any order
- main is last – lowest level functions first
  - Bottom up design
  - Prototypes not required
- main in the middle
  - Confusing: Do not do!

1. Function Declaration/Prototype

- An 'informational' declaration for compiler
- Tells compiler how to interpret calls
- Syntax:

```
<return_type> FnName(<formal-parameter-list>);
```

- Formal parameter syntax:

```
<data_type> Parameter-Name
```

- Example:

```
char grade(int score);
```

Function Declaration/Prototype

- Placed before any calls
  - Generally above all functions in global space
  - May be placed in declaration space of calling function
- Example

```
#include <stdio.h>

    // Function prototypes
    double total_cost(int quantity, double unit_cost);

int main() {
```

Alternative Function Declaration

- Function declaration is 'information' for compiler, so
  - Compiler only needs to know:
    - Return type
    - Function name
    - Parameter list
      - Formal parameter names not needed but help readability
- Example

```
#include <stdio.h>

   // Function prototypes
   double total_cost(int, double);

int main() {
```

2. Function Definition

- Actual implementation/code for what function does
  - Just like implementing function main()
  - General format – header & basic block:

    <return-type> fn-name (parameter-list)

        basic block

    header

- Example:

```
double total_cost(int quantity, double unit_cost) {
    const double TAXRATE = 0.05;
    double sub_total;
    sub_total = quantity * unit_cost;
    return (sub_total + sub_total * TAXRATE);
}
```

Return Statements

- Syntax: **return return-value-expression**
- Two actions
  - Sets return value
  - Transfers control back to 'calling' function
- Typically the last statement in function definition
  - Good programming practice
  - Course requirement

```
double total_cost(int quantity, double unit_cost) {
    const double TAXRATE = 0.05;
    double sub_total;
    sub_total = quantity * unit_cost;
    return (sub_total + sub_total * TAXRATE);
}
```

3. Function Call

- Using function name transfers control to function
  1. Values are passed through parameters
  2. Statements within function are executed
  3. Control continues after the call
- For value-returning functions, either
  - Store the value for later use

```
bill = total_cost(number, price);
```

  - Use the value returned without storing

```
printf("Cost is %f\n", total_cost(number, price));
```

  - Throw away return value

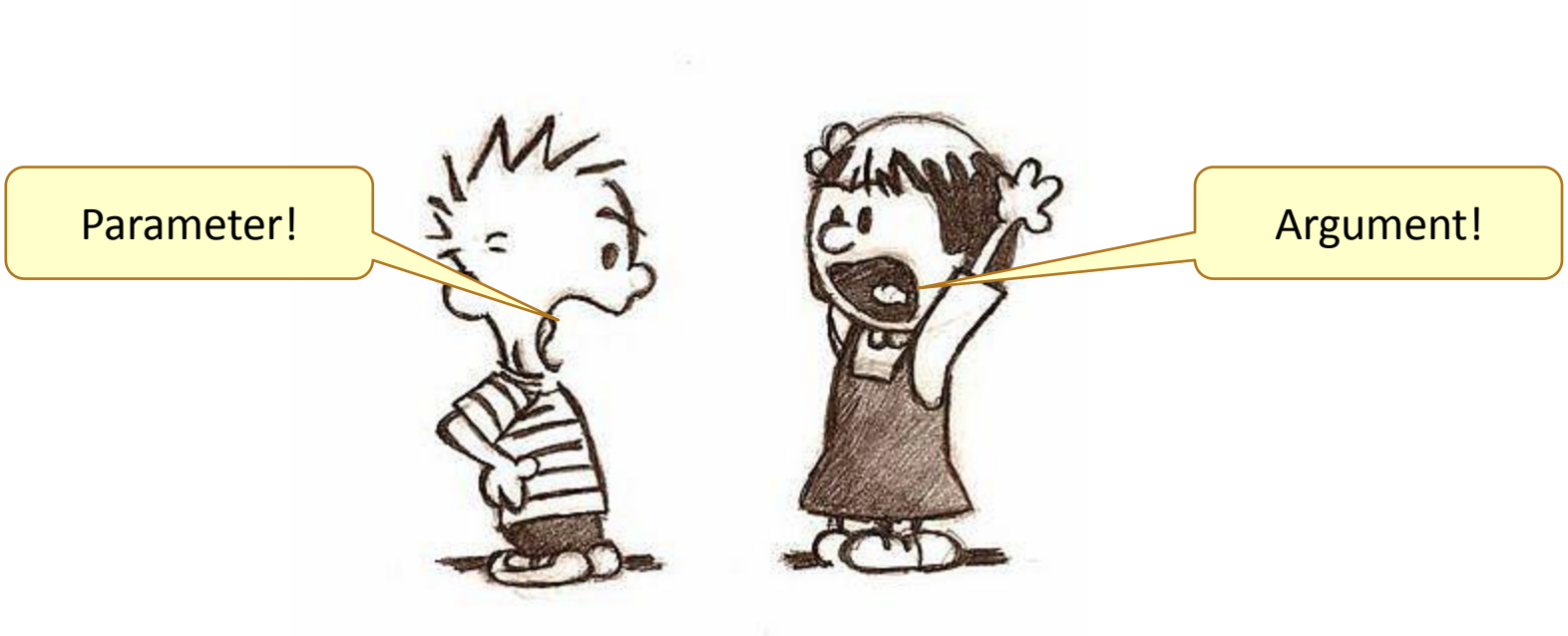
```
total_cost(number, price);
```

Parameters (Arguments)

- Formal parameters/arguments
  - In function declaration
  - In function definition's header
  - 'Placeholders' for data sent in
  - 'Variable name' used to refer to data in definition of function
- Actual parameters/arguments
  - In function call

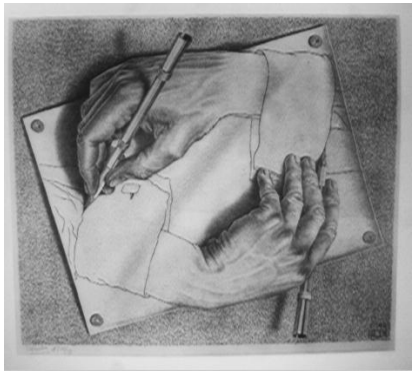
Parameter vs. Argument

- Names used interchangeably
- Technically parameter is 'formal' piece while argument is 'actual' piece



Functions Calling Functions

- We're already doing this!
  - main() IS a function calling printf!
- Only requirement:
  - Function's declaration or definition must appear first
- Common for functions to call many other functions
  - Function can call itself → Recursion



Declaring Void Functions

- Similar to functions returning a value
  - Return type specified as 'void'
- Example prototype:

```
void showResults(double fDegrees, double cDegrees);
```

  - Return-type is 'void'

Declaring Void Functions

- Nothing is returned
  - Void functions cannot have return statement with an expression
    - Will return at end of function
  - Non-void functions must have return statement with an expression
- Example definition:

```
void showResults(double fDegrees, double cDegrees) {
   printf("%.2f degrees fahrenheit equals ", fDegrees);
   printf("%.2f degrees celsius\n", cDegrees);
}
```

Calling Void Functions

- From some other function, like main():

```
showResults(degreesF, degreesC);
showResults(32.5, 0.3);
```

- Cannot be used where a value is required
  - Cannot be assigned to a variable, since no value returned

Function documentation

- Used to aid in program maintenance
- Comments at declaration or definition
  - Purpose of function
  - Preconditions / Parameters
  - Postcondition / Return

```
double interest(double balance, double rate);
// Calculates the interest charge on an account balance
// Precondition:   balance - non-negative account balance
//                 rate - interest rate percentage
// Postcondition:  calculated interest charge
```

```
double interest(double balance, double rate);
// Calculates the interest charge on an account balance
// Parameters:   balance - non-negative account balance
//               rate - interest rate percentage
// Return:       calculated interest charge
```

main(): ‘Special’

- Recall: main() IS a function
- 'Special'
  - It is the first function executed
  - Called by operating system or run-time system
  - Can return value to operating system
    - Value can be tested in command scripts
- Tradition holds it should return an int
  - Zero indicates normal ending of program

Scope of Identifier Names

- Region of a program where identifier is visible
  - Begins at definition within block
  - Ends at end of block
- Local variables
  - Name given to variables defined within function block
  - Can have different local variables with same name declared in different functions
  - Cannot have duplicate local names within a function

Scope Rules

- Local variables preferred
  - Maintain individual control over data
  - Need to know basis (Hidden)
  - Functions should declare whatever local data needed to 'do their job'

Global Scope

- Names declared 'outside' function bodies
  - Global to all functions in that file
- Global declarations typical for constants:
  - Declare globally so all functions have scope, can use

```
#include <stdio.h>

    const double TAX_RATE = 0.05;

int main() {
```

Global Constants and Global Variables

- Global variables?
  - Possible, but SELDOM-USED
  - Better alternative is to use parameters
  - Dangerous: no control over usage!
  - **We do not use global variables in this class!**

Block Scope

- Declare data inside nested blocks
  - Has 'block-scope'
    - Note: All function definitions are blocks!

```
if (amount > 5) {
    int add_in;
    add_in = prior_amount * .05;
    amount += add_in;
}
```

Lifetime

- How long does it last
  - Allocation ⇨ Deallocation
- Normally variables are allocated when defined
- Normally variables are deallocated at the end of block

```
double total_cost(int quantity, double unit_cost) {
    const double TAXRATE = 0.05;  // TAXRATE allocated
    double sub_total;             // sub_total allocated
    sub_total = quantity * unit_cost;
    return (sub_total + sub_total * TAXRATE);
}   // TAXRATE and sub_total deallocated
```

Static Lifetime

- Variable definition modifier keyword: **static**
- Static variables are only allocated once
- Static variables are not deallocated until program ends

```
int keep_count() {
    static int count = 0;
    // count will remain allocated and keep its value
    count++;
    return count;
}
```

Programming in C

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THE END