Top-Down Design with Functions
Chapter 3

Problem Solving & Program Design in C

Eighth Edition

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Chapter Objectives

- To learn about functions and how to use them to write programs with separate modules
- To understand the capabilities of some standard functions in C
- To understand how control flows between function main and other functions
- To learn how to pass information to functions using input arguments
- To learn how to return a value from a function

Top-Down Design

- top-down design
  - a problem solving method
  - first, break a problem up into its major subproblems
  - solve the subproblems to derive the solution to the original problem

Figure 3.9
House and Stick Figure

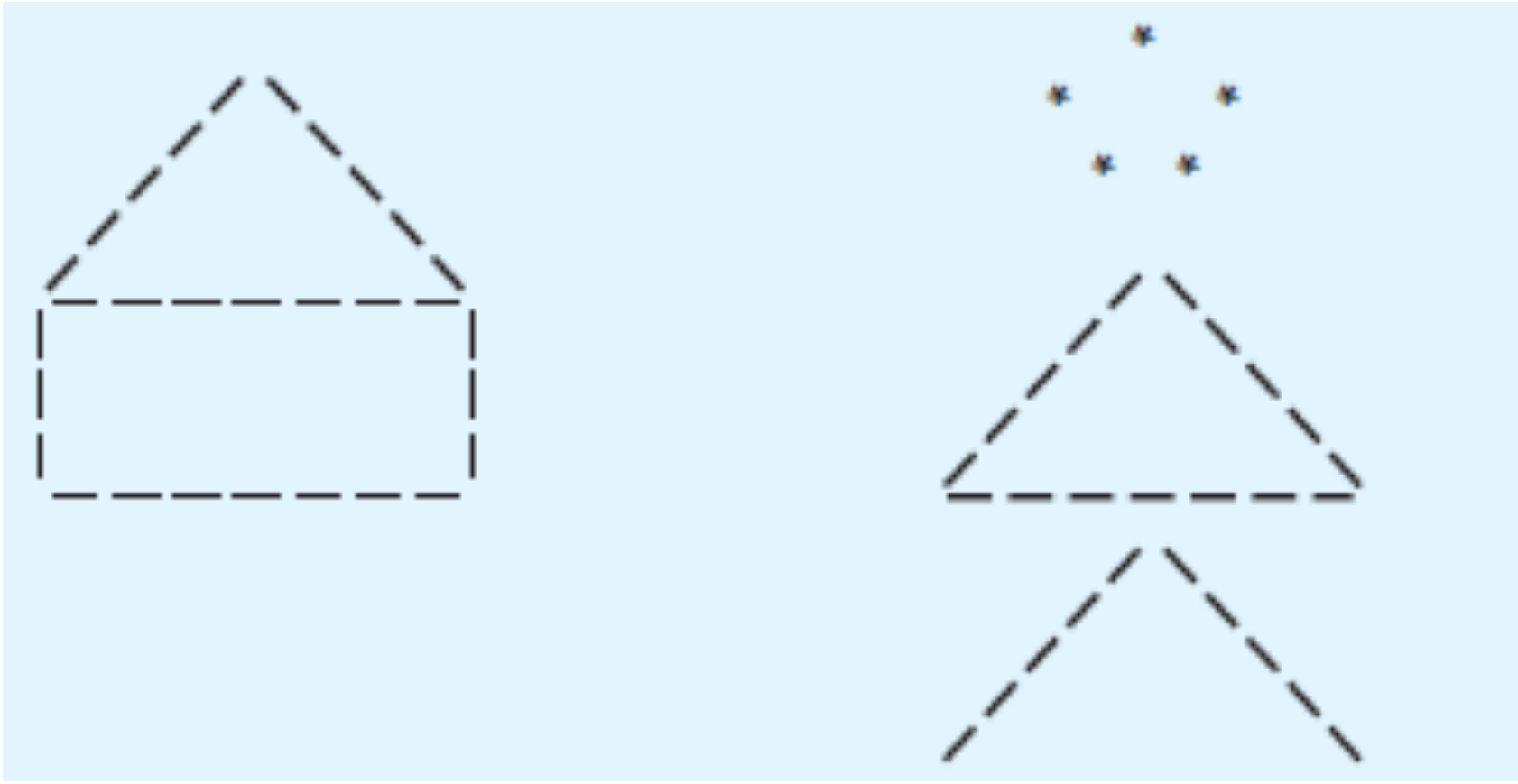
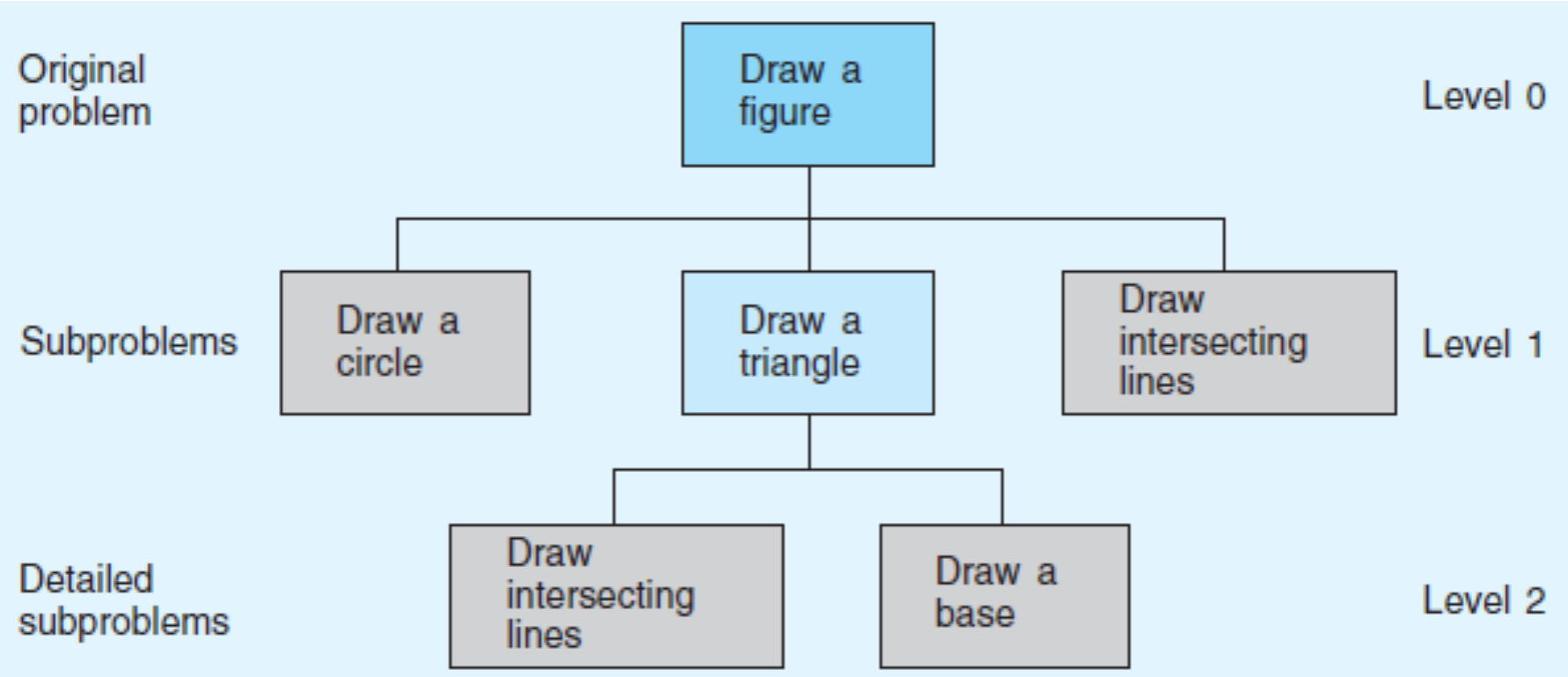


Figure 3.10
Structure Chart for Drawing a Stick Figure



Functions Call Statement
(Function Without Arguments)

- Syntax

  fname();

- Example:

  draw_circle();

- Interpretation
  - the function fname is called
  - after fname has finished execution, the program statement that follows the function call will be executed

Figure 3.11 Function Prototypes and Main Function for Stick Figure

```
1.  /*
2.   * Draws a stick figure
3.   */
4.
5.  #include <stdio.h>            /* printf definition */
6.
7.  /* function prototypes */
8.
9.  void draw_circle(void);       /* Draws a circle               */
10.
11. void draw_intersect(void);    /* Draws intersecting lines     */
12.
13. void draw_base(void);         /* Draws a base line            */
14.
15. void draw_triangle(void);     /* Draws a triangle             */
16.
17. int
18. main(void)
19. {
20.       /* Draw a circle. */
21.       draw_circle();
22.
23.       /* Draw a triangle. */
24.       draw_triangle();
25.
26.       /* Draw intersecting lines. */
27.       draw_intersect();
28.
29.       return (0);
30. }
```

Function Prototype
(Function Without Arguments)

- Syntax

  ftype fname(void);

- Example:

  void draw_circle(void);

- Interpretation
  - the identifier fname is declared to be the name of a function
  - the identifier ftype specifies the data type of the function result

Figure 3.12
Function draw_circle

```
1.  /*
2.   * Draws a circle
3.   */
4.  void
5.  draw_circle(void)
6.  {
7.        printf("   *  \n");
8.        printf(" *   *\n");
9.        printf("  * * \n");
10. }
```

Function Definitions
(Function Without Arguments)

- Syntax

```
ftype
fname(void)
{
        local declarations
        executable statements
}
```

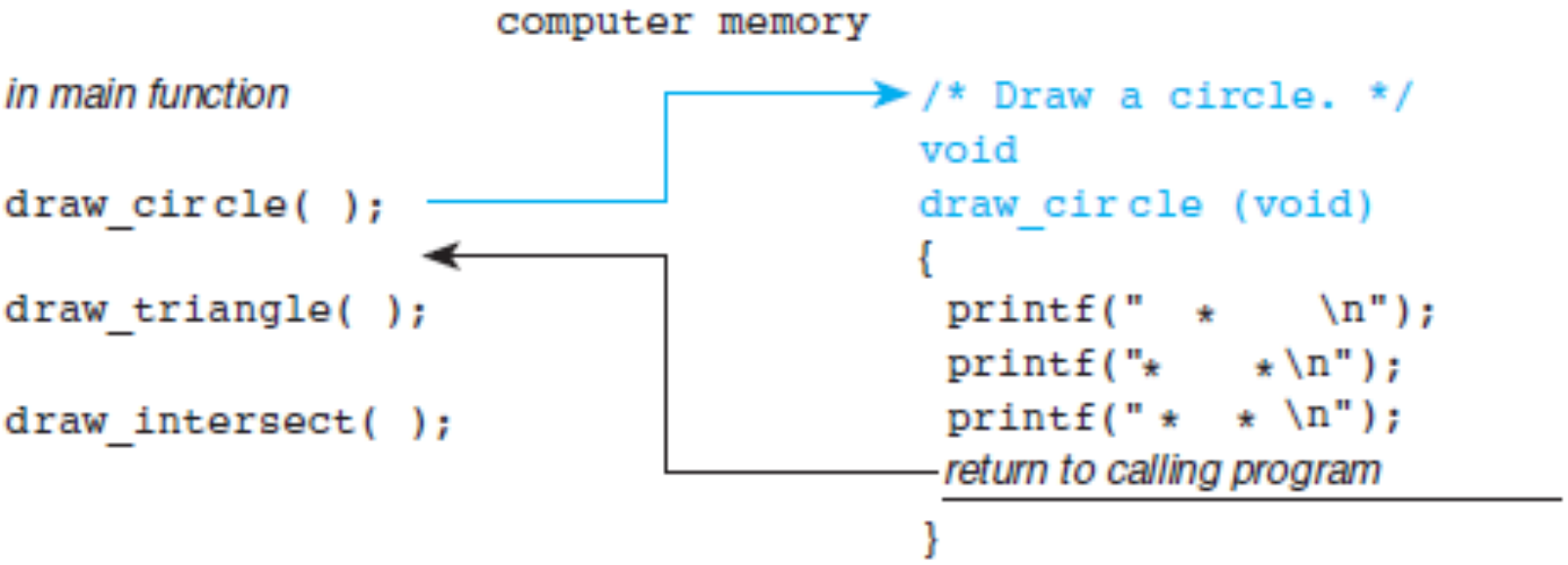
Figure 3.13
Function draw_triangle

```
1. /*
2.  * Draws a triangle
3.  */
4. void
5. draw_triangle(void)
6. {
7.       draw_intersect();
8.       draw_base();
9. }
```

Advantages of Using Function Subprograms

- procedural abstraction
  - a programming technique in which a main function consists of function calls and each function is implemented separately
- reuse of function subprograms
  - functions can be executed more than once in a program

Figure 3.15
Flow of Control Between the main Function and a Function Subprogram

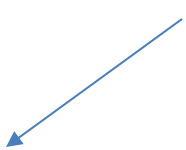


Library Functions

- code reuse
  - reusing program fragments that have already been written and tested
- C standard libraries
  - many predefined functions can be found here

stdio.h

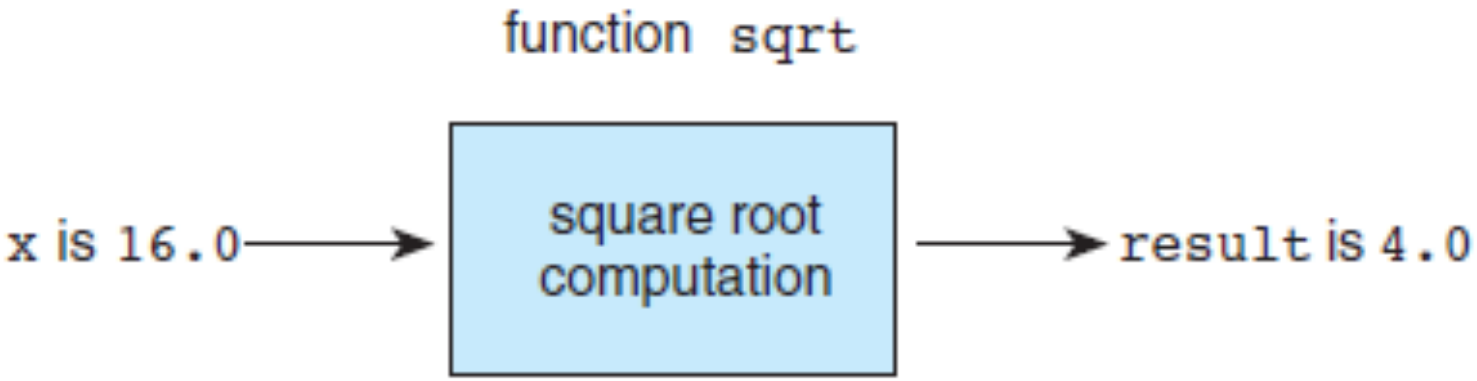
math.h



Note: must use –lm flag to compile when using math library
For example, gcc –o exe –Wall my_c_program.c -lm

Figure 3.6

Function sqrt as a "Black Box"



C Math Library Functions

- Examples
  - abs(x)
  - ceil(x)
  - log(x)
  - sin(x)
  - sqrt(x)

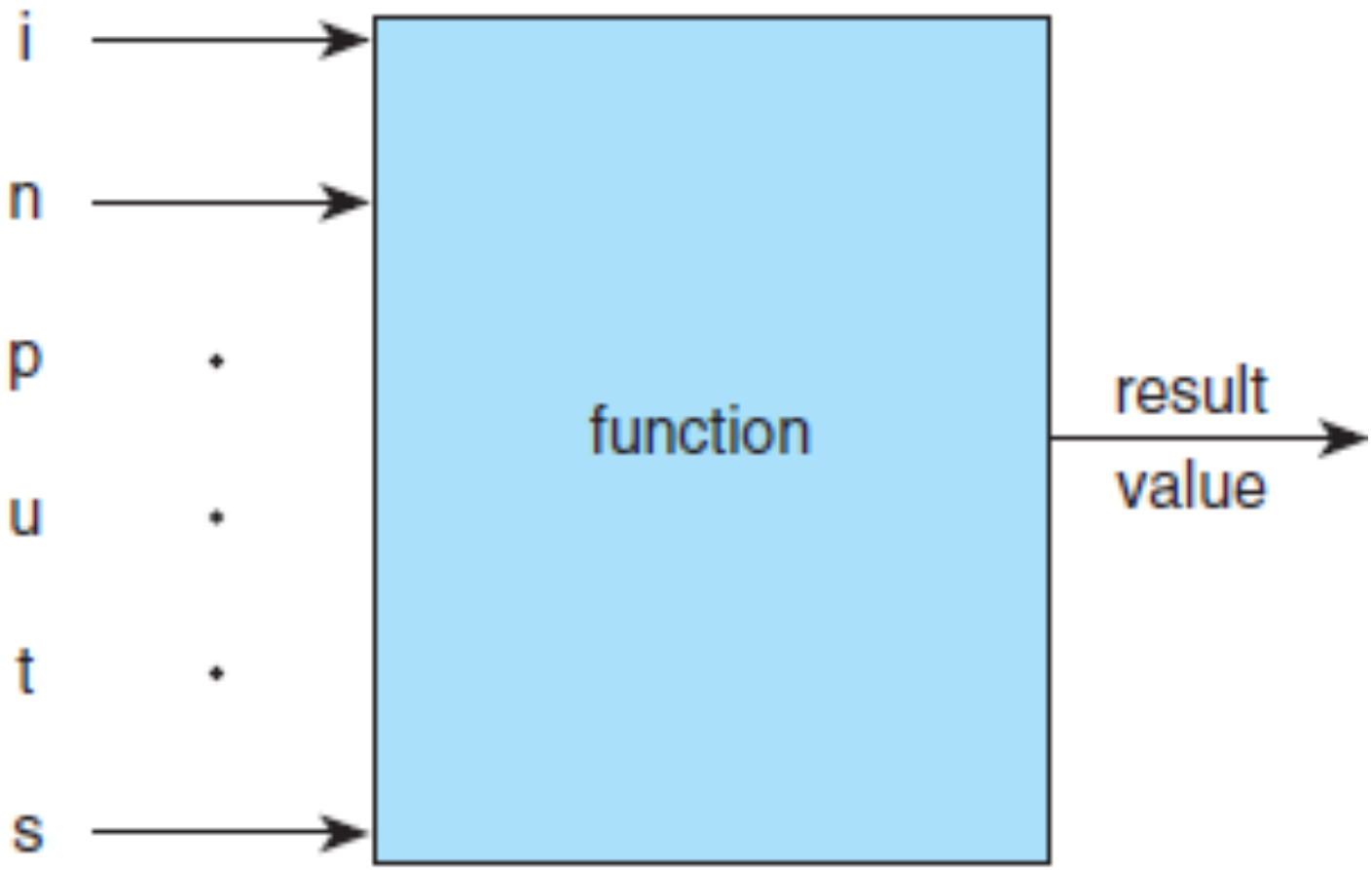
Functions with Input Arguments

- input argument
  - arguments used to pass information into a function subprogram

- output argument
  - arguments used to return results to the calling function

Figure 3.18

Function with Input Arguments and One Result



Functions with Multiple Arguments

Argument List Correspondence

- The number of actual arguments used in a call to a function must be the same as the number of formal parameters listed in the function prototype.

- Each actual argument must be of a data type that can be assigned to the corresponding format parameter with no unexpected loss of information.

Functions with Multiple Arguments
Argument List Correspondence

- The order of arguments in the lists determines correspondence.
  - The first actual argument corresponds to the first formal parameter.
  - The second actual argument corresponds to the second form parameter.
  - And so on…

Figure 3.23
Function scale

```
1.  /*
2.   * Multiplies its first argument by the power of 10 specified
3.   * by its second argument.
4.   * Pre : x and n are defined and math.h is included.
5.   */
6.  double
7.  scale(double x, int n)
8.  {
9.       double scale_factor;      /* local variable */
10.      scale_factor = pow(10, n);
11.
12.      return (x * scale_factor);
13. }
```

Wrap Up

- Code reuse is good.
- When possible, develop your solution from existing information.
- Use C's library functions to simplify mathematical computations.
- You can write functions with none, one, or multiple input arguments.
- Functions can only return one value.