Computer Programming 143 – Lecture 4
Structured Program Development I

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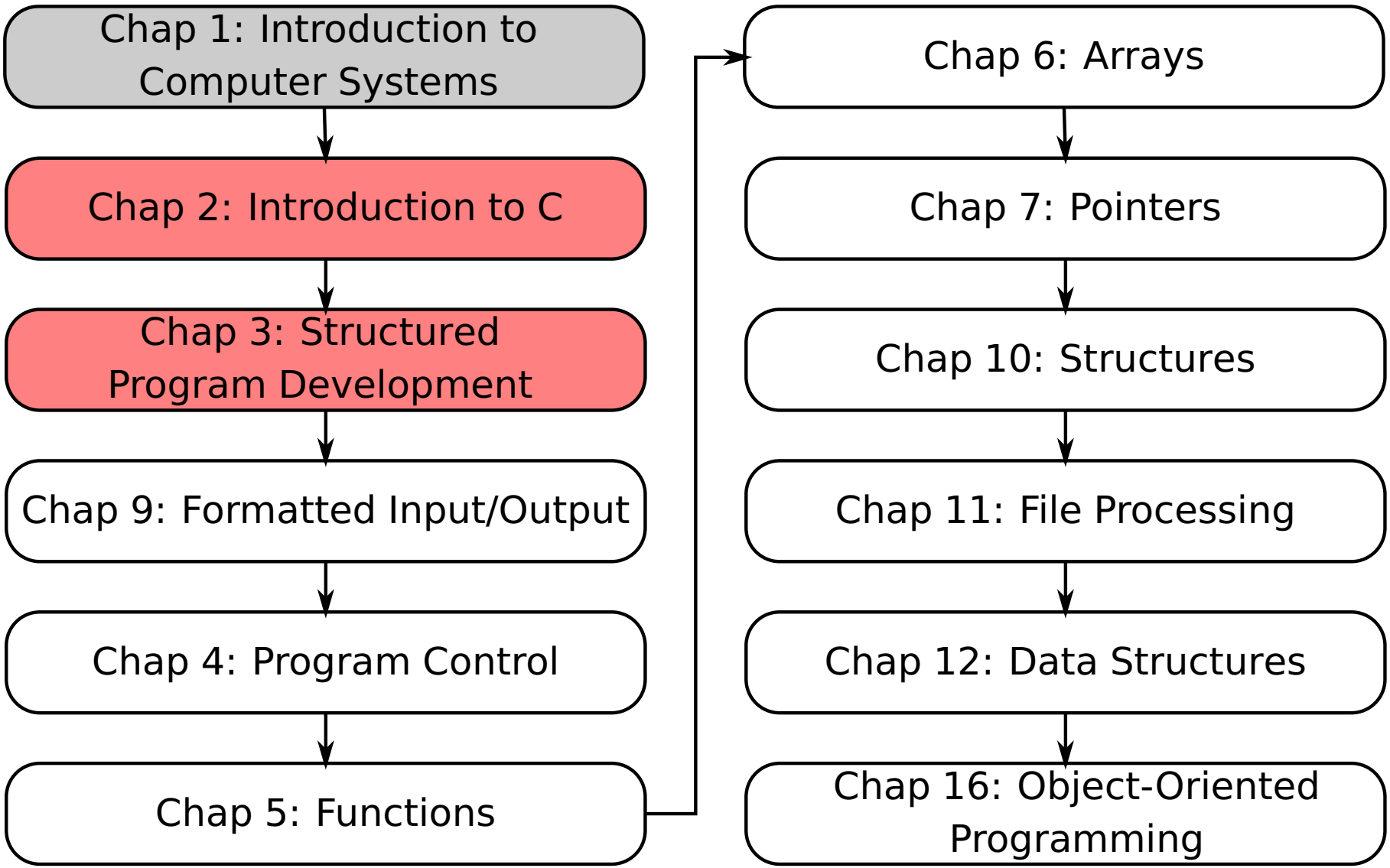
Module Overview



Lecture Overview

1. Introduction to Structured Program Development (3.1-3.4)
2. The ‘if’ Selection Structure (3.5)
3. The ‘if...else’ Selection Structure (3.6)

3.2 Algorithms

Computing problems

- All can be solved by executing a series of actions in a specific order

Algorithm: procedure in terms of

- Actions to be executed
- The order in which these actions are to be executed

Program control

- Specifies the order in which statements are to be executed
- Instead of just executing statements one after the other, we can control the order using *control structures*

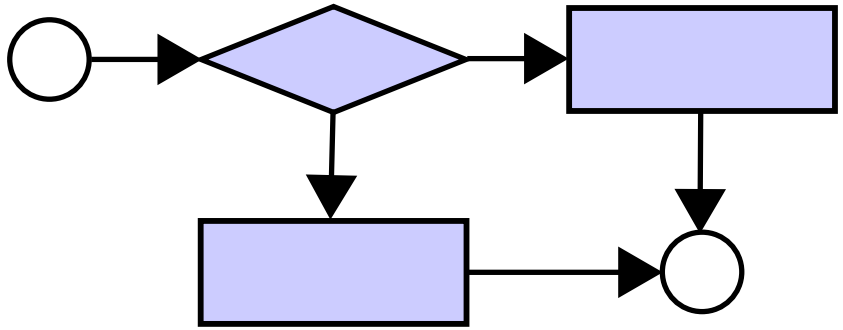
Algorithm description

- Pseudocode
- Flow diagram

3.3 Pseudocode

- Artificial, informal language that helps us develop algorithms
- Similar to everyday English
- Not actually executed on computers
- Helps us “think out” a program before writing it
  - Easy to convert into a corresponding programming language
  - Consists only of executable statements

3.4 Flow diagrams



- Graphical representation of an algorithm
- Drawn using certain special-purpose symbols connected by arrows called flow lines
- Symbols:
  - Rectangle: Indicates any type of action
  - Oval: Indicates the beginning or end of a program or a section of code
  - Diamond: Indicates decision is to be made

3.4 Control Structures I

All programs written in terms of 3 control structures

- **Sequence structures:** Built into C. Programs executed sequentially by default
- **Selection structures:** C has three types: **`if`**, **`if...else`**, and **`switch`**
- **Repetition structures:** C has three types: **`while`**, **`do...while`**, and **`for`**

3.4 Control Structures II

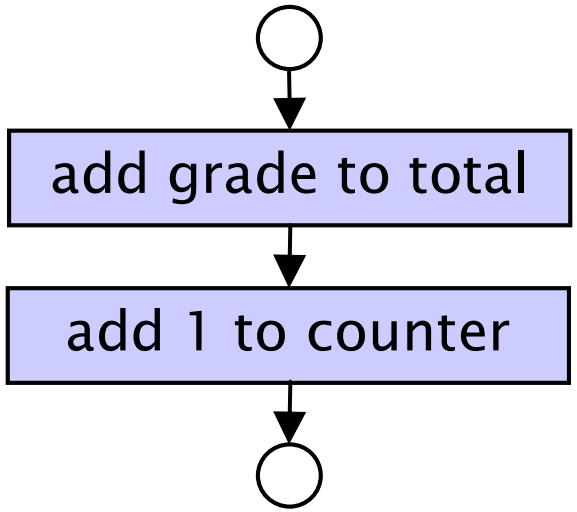
Single-entry/single-exit control structures

- Connect exit point of one control structure to entry point of the next (control-structure stacking)
- Makes programs easy to build

3.4 Control Structures III

Control Structure 1: Sequential execution

- Statements executed one after the other in the order they were written




```
total = total + grade;
counter = counter + 1;
```

3.5 The ‘if’ Selection Statement I

Control structure 2: the ‘if’ statement

- Used to choose among alternative courses of action

Pseudocode:

If student’s grade is greater than or equal to 50
Print “Passed”

- If the condition is `true`:
  - Print statement executed and program goes on to the next statement
- If the condition is `false`:
  - Print statement is ignored and the program goes onto the next statement

3.5 The ‘if’ Selection Statement II

C code:

```
if ( grade >= 50 ) {
  printf( "Passed\n" );
}
```

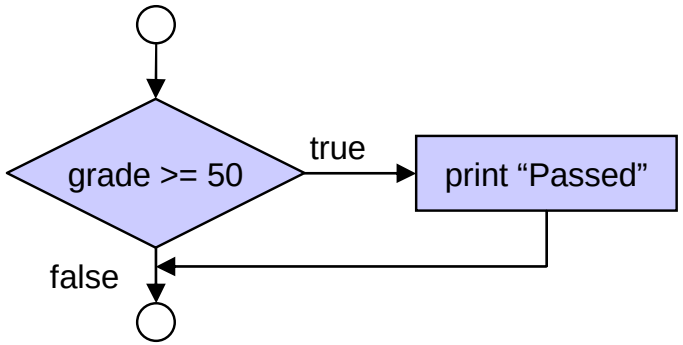
- C code corresponds closely to the pseudocode
- A set of braces may be removed when it contains only one statement

C code:

```
if ( grade >= 50 )
  printf( "Passed\n" );
```

3.5 The ‘if’ Selection Statement III

- **if** statement is a single-entry/single-exit structure



- A decision can be made on any expression.
  - If result is zero: then false
  - If result is nonzero: then true
- Example:
  - a - b is true if a is not equal to b (valid expression but bad programming)
  - a != b is equivalent, but better programming

2.6 Decision Making I

Equality operators

- == Is equal to
- != Is not equal to

Relational operators

- > Greater than
- < Less than
- >= Greater than or equal to
- <= Less than or equal to

2.6 Decision Making II

Examples

```
if ( 2 < 3 ) {
  printf( "2 is less than 3" );
}
if ( 2 != 3 ) {
  printf( "2 is not equal to 3" );
}
```

Example program: Using ’if’ statements, relational and equality operators I

```c
/* description: Making decisions
 * version: 1
 * date: 18/07/2011
 * author: CvD
 */
#include <stdio.h>

/* function main() begins program execution */
int main( void )
{
  int num1; // first number to be read from user
  int num2; // second number to be read from user
```

Example program: Using 'if' statements, relational and equality operators II

(cont'd...)

```
  printf( "Enter two integers and I will tell you\n" );
  printf( "the relationships they satisfy: " );
  scanf( "%d", &num1 ); // read first integer
  scanf( "%d", &num2 ); // read second integer

  if ( num1 == num2 ) {
    printf( "%d is equal to %d\n", num1, num2 );
  }
  if ( num1 < num2 ) {
    printf( "%d is smaller than %d\n", num1, num2 );
  }
  if ( num1 > num2 ) {
    printf( "%d is greater than %d\n", num1, num2 );
  }
  return 0; // program ended successfully
} /* end main */
```

3.6 The ‘if...else’ Statement I

Control structure 3: the ‘if...else’ statement

- Specifies an action to be performed both when the condition is `true` and when it is `false`
- **Pseudocode:**

  If student’s grade is greater than or equal to 50
  Print “Passed”
  else
  Print “Failed”

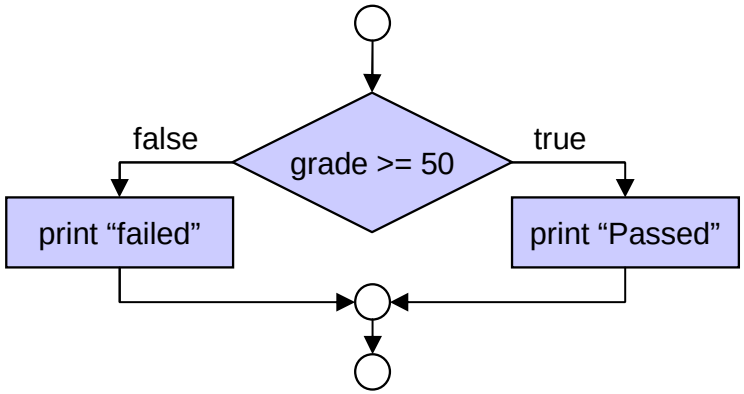
- Note spacing/indentation conventions

C code:

```
if ( grade >= 50 )
  printf( "Passed\n" );
else
  printf( "Failed\n" );
```

3.6 The ‘if...else’ Statement II

Flow diagram of the ‘if...else’ selection statement



Nested ‘if...else’ statements

- Test multiple cases by placing **`if...else`** selection statements inside **`if...else`** selection statement
- Once condition is met, rest of statements skipped

3.6 The ‘if...else’ Statement III

Pseudocode:

```
If grade is greater than or equal to 80
        Print “A”
else
        If grade is greater than or equal to 70
                Print “B”
        else
                If grade is greater than or equal to 60
                        Print “C”
                else
                        If grade is greater than or equal to 50
                                Print “D”
```

3.6 The ‘if...else’ Statement IV

C code

```
if ( grade >= 80 ) {
  printf( "A\n" );
} // end if
else {
  if ( grade >= 70 ) {
    printf( "B\n" );
  } // end if
  else {
    if ( grade >= 60 ) {
      printf( "C\n" );
    } // end if
    else {
      if ( grade >= 50 ) {
        printf( "D\n" );
      } // end if
    } // end else
  } // end else
} // end else
```

3.6 The ‘if...else’ Statement V

Testing multiple conditions

- The following ‘if’ statement is *wrong*:

```
if ( 0 < x < 5 )
  printf( "x lies between 0 and 5" );
```

- Use nested ‘if’ statements (for now):

```
if ( x > 0 )
  if ( x < 5 )
    printf( "x lies between 0 and 5" );
```

Perspective

Today

Structured program development I

- Decision making in C
- Algorithms, pseudocode, flow diagrams and control structures
- 3 structures: sequence, ‘if’ and ‘if...else’ statements

Next lecture

Structured program development II

- ‘while’ repetition structure

Homework

1. Study Sections 2.6 and 3.1-3.6 in Deitel&Deitel
2. Do Self Review Exercises 2.3, 2.6 in Deitel&Deitel
3. Do Exercises 2.7, 3.10(a), 3.14(a)&(b) in Deitel&Deitel