Programming Fundamentals
Lecture 4

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Relational Operators

- Relational operators:
  - Allow comparisons
  - Require two operands (binary)
  - Return `1` if expression is `true`, `0` otherwise
- Comparing values of different data types may produce unpredictable results
  - For example, `8 < '5'` should not be done
- Any nonzero value is treated as `true`

TABLE 4-1 Relational Operators in C++

Operator	Description
==	equal to
!=	not equal to
<	less than
<=	less than or equal to
>	greater than
>=	greater than or equal to

Logical (Boolean) Operators

- Logical (Boolean) operators enable you to combine logical expressions
- Three logical (Boolean) operators:

  `!` - not

  `&&` – and

  `||` - or

- Logical operators take logical values as operands and yield logical values as results
- `!` is unary; `&&` and `||` are binary operators
- Putting `!` in front of a logical expression reverses its value

TABLE 4-5 Logical (Boolean) Operators in C++

Operator	Description
`!`	`not`
`&&`	`and`
`||`	`or`

TABLE 4-6 The ! (Not) Operator

Expression	!(Expression)
`true` (nonzero)	`false` (0)
`false` (0)	`true` (1)

EXAMPLE 4-2

Expression	Value	Explanation
`!('A' > 'B')`	`true`	Because `'A' > 'B'` is `false`, `!('A' > 'B')` is `true`.
`!(6 <= 7)`	`false`	Because `6 <= 7` is `true`, `!(6 <= 7)` is `false`.

TABLE 4-7 The && (And) Operator

Expression1	Expression2	Expression1 && Expression2
true (nonzero)	true (nonzero)	true (1)
true (nonzero)	false (0)	false (0)
false (0)	true (nonzero)	false (0)
false (0)	false (0)	false (0)

EXAMPLE 4-3

Expression	Value	Explanation
`(14 >= 5) && ('A' < 'B')`	true	Because (14 >= 5) is true, ('A' < 'B') is true, and true && true is true, the expression evaluates to true.
`(24 >= 35) && ('A' < 'B')`	false	Because (24 >= 35) is false, ('A' < 'B') is true, and false && true is false, the expression evaluates to false.

TABLE 4-8 The || (Or) Operator

Expression1	Expression2	Expression1 || Expression2
true (nonzero)	true (nonzero)	true (1)
true (nonzero)	false (0)	true (1)
false (0)	true (nonzero)	true (1)
false (0)	false (0)	false (0)

EXAMPLE 4-4

Expression	Value	Explanation
`(14 >= 5) || ('A' > 'B')`	true	Because (14 >= 5) is true, ('A' > 'B') is false, and true || false is true, the expression evaluates to true.
`(24 >= 35) || ('A' > 'B')`	false	Because (24 >= 35) is false, ('A' > 'B') is false, and false || false is false, the expression evaluates to false.
`('A' <= 'a') || (7 != 7)`	true	Because ('A' <= 'a') is true, (7 != 7) is false, and true || false is true, the expression evaluates to true.

Control Structures

- A computer can proceed:
  - In sequence
  - Selectively (branch) - making a choice
  - Repetitively (iteratively) - looping
- Some statements are executed only if certain conditions are met
- A condition is represented by a logical (Boolean) expression that can be true or false
- A condition is met if it evaluates to true

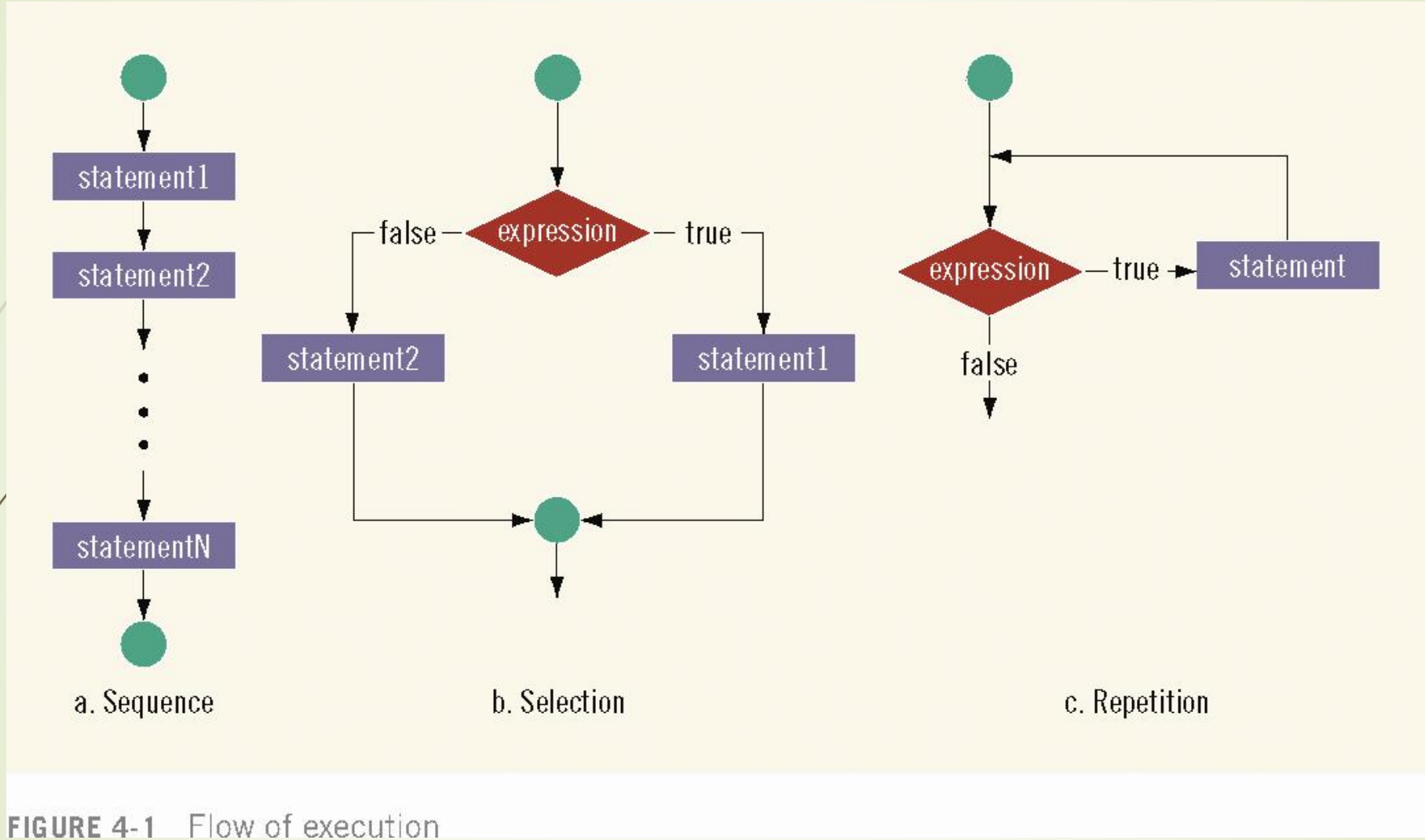


FIGURE 4-1 Flow of execution

Larger of two Numbers

- Write the code to print larger of two numbers.
- **DISPLAY** "Enter the Number1 "
- **READ** Number1
- **DISPLAY** "Enter the Number2 "
- **READ** Number2
- **IF** (Number1 >= Number2)
  - **DISPLAY** "Number1"
- **ELSE**
  - **DISPLAY** "Number2"

Even/odd Number?

- **DISPLAY** "Enter the Number "
- **READ** Number
- **IF**(Number MOD 2 == 0)
  - **DISPLAY** "Number is Even"
- **ELSE**
  - **DISPLAY** "Number is Odd"

Compare two integer values

- **DISPLAY** "Enter two integers: “
- **READ** number1
- **READ** number2
- **if** (number1 == number2)
  - **DISPLAY** “two numbers are equal”
- **else if** (number1 > number2)
  - **DISPLAY** ”number1 is greater than number2”
- **else**
  - **DISPLAY** “number1 is less than number2”

Grade

- You have been selected as grader at FAST NUCES; you find it quite tiring to calculate the grade of each student manually.
- You know conditional statements (if/if-else) and decided to automate the system.
- You have to write a pseudocode that will help the programmer to automate the grading system

Grading Criteria

- Students will be assigned with A grade if average marks of student is greater than 80; B grade for students having marks greater than 70; C for marks greater than 60; D for marks greater and equal to 50 otherwise student will be awarded with grade “F”.

- Display” Enter average marks”
- Read marks
- Display “ Your Grade is "
- if (marks > 80)
  - Display "A"
- else if (marks > 70)
  - Display "B"
- else if (marks > 60)
  - Display "C"
- else if (marks > 50)
  - Display "D"
- else
  - Display "F“

Question

- **What Will be the Output? If (marks==80)**

- Display” Enter average marks”
- Read marks
- Display “ Your Grade is "
- if (marks >= 80)
  - Display "A"
- else if (marks >=70)
  - Display "B"
- else if (marks >=60)
  - Display "C"
- else if (marks >=50)
  - Display "D"
- else
  - Display "F“

- Display” Enter average marks”
- Read marks
- Display “ Your Grade is "
- if (marks > 80)
  - Display "A"
- else if (marks > 70 AND marks <=80)
  - Display "B"
- else if (marks > 60 AND marks <=70)
  - Display "C"
- else if (marks > 50 AND marks <=80)
  - Display "D"
- else
  - Display "F“

Exercise 1

- *Int X= 0;*
- Int Z = 1;
- *Cin >>X;*
- Cout << Z;

What is output of above program if input is
a) X is 3
b) X is 4
c) X is 2

Exercise 1

- *Int X= 0;*
- Int Z = 1;
- *Cin >>X;*
- if (X <4)
  - Z = 2;
- Cout << Z;

What is output of above program if input is
a) X is 3
b) X is 4
c) X is 2

Exercise 2

- *Int X= 0;*
- Int Z = 1;
- *Cin >> X;*
- if (X < 4)
  - Z = 2;
- else
  - Z = 4;
- Cout << Z;

What is output of above program if input is
a) X is 1
b) X is 5
c) X is 4

Exercise 3

- *Int X= 0;*
- Int Z = 1;
- *Cin >> X;*

- if (X <4)
  - Z = 1;
- If (X == 3)
  - Z = 2;

- Cout << Z;

What is output of above program if input is
a) X is 3
b) X is 4
c) X is 1

One-Way (`if`) Selection

- The syntax of one-way selection is:

```
if (expression)
  statement
```

- Statement is executed if the value of the expression is `true`
- Statement is bypassed if the value is `false`; program goes to the next statement

EXAMPLE 4-9

```
if (score >= 90)
    grade = 'A';
```

In this code, if the expression (`score >= 90`) evaluates to `true`, the assignment statement, `grade = 'A';`, executes. If the expression evaluates to `false`, the statements (if any) following the `if` structure execute. For example, if the value of `score` is `95`, the value assigned to the variable `grade` is `'A'`.

EXAMPLE 4-10

The following C++ program finds the absolute value of an integer:

```
//Program: Absolute value of an integer

#include <iostream>

using namespace std;

int main()
{
    int number, temp;

    cout << "Line 1: Please enter an integer: ";  //Line 1
    cin >> number;                                //Line 2
    cout << endl;                                 //Line 3

    temp = number;                                //Line 4

    if (number < 0)                               //Line 5
        number = -number;                         //Line 6

    cout << "Line 7: The absolute value of "
         << temp << " is " << number << endl;     //Line 7

    return 0;
}
```

Sample Run: In this sample run, the user input is shaded.

```
Line 1: Please enter an integer: -6734
Line 7: The absolute value of -6734 is 6734
```

Two-Way (if…else) Selection

- Two-way selection takes the form:

```
if (expression)
  statement1
else
  statement2
```

- If expression is `true`, statement1 is executed otherwise statement2 is executed
- statement1 and statement2 are any C++ statements
- `else` is a reserved word

EXAMPLE 4-13

Consider the following statements:

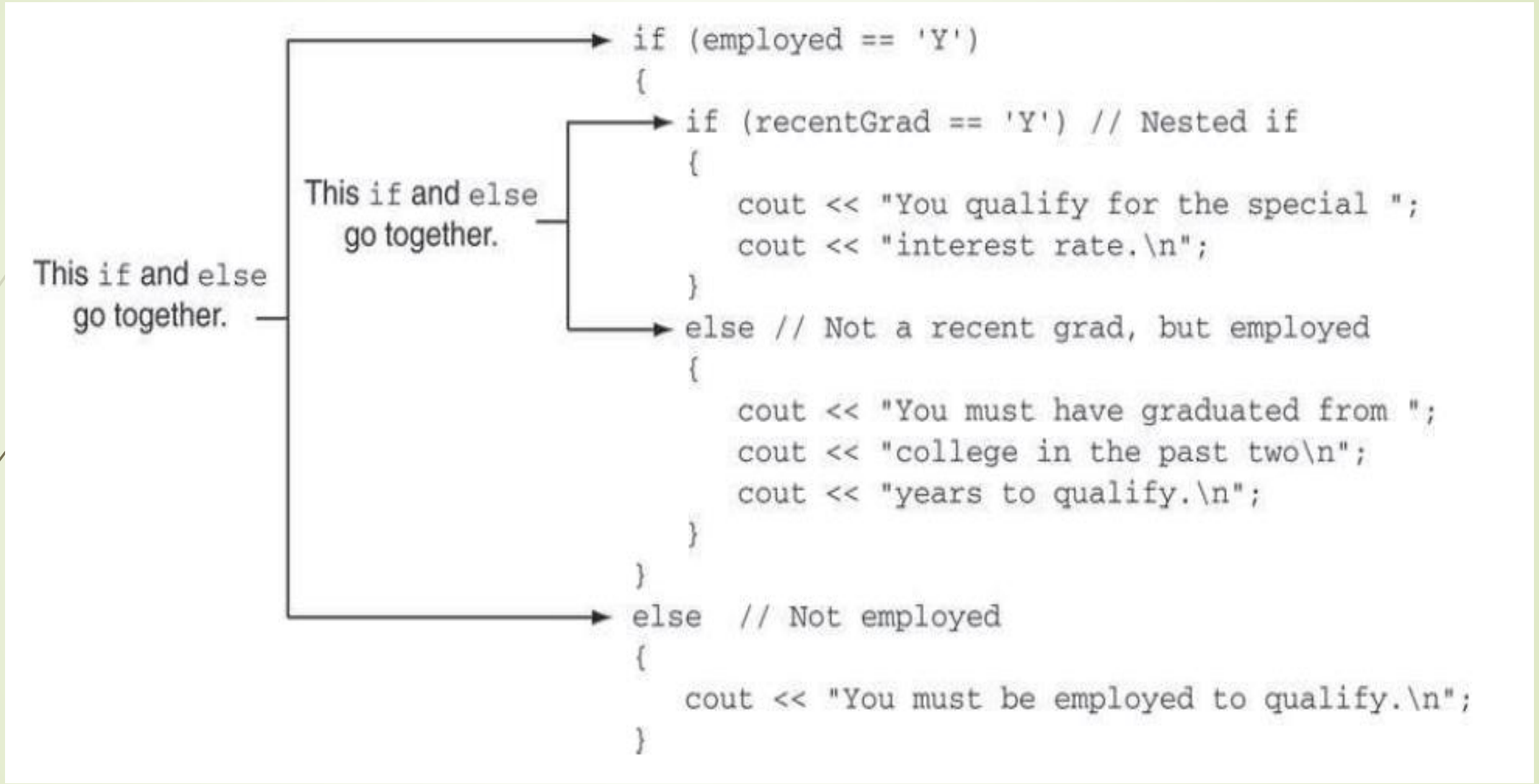
```
if (hours > 40.0)                                    //Line 1
    wages = 40.0 * rate +
            1.5 * rate * (hours - 40.0);             //Line 2
else                                                 //Line 3
    wages = hours * rate;                            //Line 4
```

if the value of the variable `hours` is greater than `40.0`, then the `wages` include overtime payment. Suppose that `hours` is `50`. The expression in the **`if`** statement, in Line 1, evaluates to **`true`**, so the statement in Line 2 executes. On the other hand, if `hours` is `30`, or any number less than or equal to `40`, the expression in the **`if`** statement, in Line 1, evaluates to **`false`**. In this case, the program skips the statement in Line 2 and executes the statement in Line 4—that is, the statement following the reserved word **`else`** executes.

Indentation

```
if (employed == 'Y')
{
if (recentGrad == 'Y') // Nested if
{
cout << "You qualify for the special ";
cout << "interest rate.\n";
}
else // Not a recent grad, but employed
{
cout << "You must have graduated from ";
cout << "college in the past two\n";
cout << "years to qualify.\n";
}
}
else // Not employed
{
cout << "You must be employed to qualify.\n";
}
```

Don't write code like this!




```
if (employed == 'Y')
{
   if (recentGrad == 'Y') // Nested if
   {
      cout << "You qualify for the special ";
      cout << "interest rate.\n";
   }
   else // Not a recent grad, but employed
   {
      cout << "You must have graduated from ";
      cout << "college in the past two\n";
      cout << "years to qualify.\n";
   }
}
else  // Not employed
{
   cout << "You must be employed to qualify.\n";
}
```

References

1. C++ Programming: From Problem Analysis to Program Design, Third Edition
2. https://www.just.edu.jo/~yahya-t/cs115/