If/else & switch

Unit 3
Sections 4.1-6, 4.8-12, 4.14-15

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Straight-line code
(or IPO: Input-Process-Output)

• So far all of our programs have followed this basic format:
  ‣ Input some values
  ‣ Do some computations
  ‣ Output the results

• The statements are executed in a sequence, first to last.

Decisions

• Sometimes we want to be able to decide which of two statements to execute:

  ![Decision Diagram]

  - N
  - monthly sales > $3,000
  - Y

  - fee is 2.9%
  - fee is 2.5%

Relational Expressions

• Making decisions require being able to ask “Yes” or “No” questions.

• Relational expressions allow us to do this.

• Relational expressions evaluate to true or false.

• Also called:
  ‣ logical expressions
  ‣ conditional expressions
  ‣ boolean expressions
Relational Expressions

- Boolean literals:
  - true
  - false
  
  true evaluates to true  false evaluates to false

- Boolean variables

  ```
  bool isPositive = true;
  bool found = false;
  ```
  
  isPositive evaluates to true  found evaluates to false

4.1 Relational Operators

- Binary operators used to compare expressions:
  - <  Less than
  - <= Less than or equal to
  - >  Greater than
  - >= Greater than or equal to
  - == Equals  (note: do not use =) !!
  - != Not Equals

Relational Expressions

- Examples:

  ```
  int x = 6;
  int y = 10;
  ```

  a. x == 5  evaluates to false
  b. 7 <= x + 2  evaluates to false
  c. y - 3 > x  evaluates to false
  d. x != y  evaluates to true
  d. true  evaluates to true

- Can assign relational expressions to variables:

  ```
  bool isPositive;
  int x;
  cin >> x;
  isPositive = x > 0;
  ```

  isPositive stores the value false

Relational Operator Precedence

- Relational operators are LOWER than arithmetic operators:

  ```
  int x, y;
  ```

  ... x < y -10 ...  // minus happens first
  ... x * 5 >= y + 10 ... // mult, then plus, then >=

- Relational operators are HIGHER than assignment:

  ```
  int x, y;
  ```

  ... bool t1 = x > 7;  // > then =
  bool t2 = x * 5 >= y + 10;  // *, +, >=, =
4.2 The if statement

- The if statement can be used to execute a statement only under certain conditions:

```java
if (expression) 
    statement
```

- expression is evaluated
  - If it is true, then statement is executed.
  - If it is false, then statement is skipped

4.3 The block statement

- a block (or a compound statement) is a set of statements inside braces:

```java
{ 
    int x;
    cout << "Enter a value for x: " << endl;
    cin >> x;
    cout << "Thank you." << endl;
}
```

- This groups several statements into a single statement.
- This allows us to use multiple statements when by rule only one is allowed.

if statement example

- Example: An employee gets a $100 bonus if their hours are over 40.

```java
double rate = 14.50;
double hours, pay;
cout << "Enter the hours you worked: ";
cin >> hours;
pay = hours * rate;
if (hours > 40) 
    pay = pay + 100;
cout << "Your pay is: $" << pay << endl;
```

if with a block

- We can use a block to conditionally execute more than just one statement:

```java
double rate = 14.50;
double hours, pay;
cout << "Enter the hours you worked: ";
cin >> hours;
pay = hours * rate;
if (hours > 40) {
    pay = pay + 100;
    cout << "Your pay includes a bonus." << endl;
}
cout << "Your pay is: $" << pay << endl;
```
4.4 The if/else statement

- if/else statement is used to decide which of two statements to execute:
  
  ```
  if (expression)
  statement1 (or block)
  else
  statement2 (or block)
  ```

- expression is evaluated
  - If it is true, then statement1 is executed. (statement2 is skipped).
  - If it is false, then statement2 is executed (statement1 is skipped).

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

4.5 Nested if statements

- if-else is a statement. It can occur as a branch of another if-else statement.

Notice:

- relational expression is in parentheses
- NO semi-colon after expression, nor the else
- Good style: indent the statements in each branch!!

```
if (monthlySales > 3000)
  rate = .025;
else
  rate = .029;
```
Nested if statements

- if-else is a statement. It can occur as a branch of another if-else statement.

```cpp
char bornInUSA;
int age;
cout << "Were you born in the USA (Y/N)?: " ;
cin >> bornInUSA;
cout << "Please enter your age: ";
cin >> age;
if (bornInUSA == 'Y')
  if (age >= 35)
    cout << "You qualify to run for President\n";
  else
    cout << "You are too young to run for President\n";
else
  cout << "You must have been born in the US in order " << "to run for President" << endl;
```

Testing a series of conditions

- Decision structure to determine a grade

```
if (testScore >= 90)
  grade = 'A';
else {
  if (testScore >= 80)
    grade = 'B';
  else {
    if (testScore >= 70)
      grade = 'C';
    else {
      if (testScore >= 60)
        grade = 'D';
      else
        grade = 'F';
    }
  }
}
```

Common nested if pattern

- Determine letter grade from test pattern:

```
if (testScore >= 90)
  grade = 'A';
else {
  if (testScore >= 80)
    grade = 'B';
  else {
    if (testScore >= 70)
      grade = 'C';
    else {
      if (testScore >= 60)
        grade = 'D';
      else
        grade = 'F';
    }
  }
}
```

- Note the braces are actually optional here!
4.6 The if/else if Statement

- Not really a different statement, just a different way of indenting the nested if statement from the previous slide:

```java
if (testScore >= 90)
    grade = 'A';
else if (testScore >= 80)
    grade = 'B';
else if (testScore >= 70)
    grade = 'C';
else if (testScore >= 60)
    grade = 'D';
else
    grade = 'F';
```

- removed braces, put “if (…)” on previous line
- eliminated nested indentation.

4.8 Logical Operators

- Used to create relational expressions from other relational expressions:
  - `&&` AND (binary operator)
    - `a && b` is true only when both `a` and `b` are true
  - `||` OR (binary operator)
    - `a || b` is true whenever either `a` or `b` is true
  - `!` NOT (unary operator)
    - `!a` is true when `a` is false

Logical Operators

- Examples
  ```java
  int x=6;
  int y=10;
  a. x == 5 && y <= 3  false && false is false
  b. x > 0 && x < 10   true && true is true
  c. x == 10 || y == 10 false || true is true
  d. x == 10 || x == 11 true || true is true
  e. !(x > 0)        !true is true
  f. !(x > 6 || y == 10) ! (false || true) is false
  ```

  bool flag;
  flag = (x > 0 && x < 25);
  g. !flag
  h. flag || x < 100

Logical Operator Precedence

- `!` is higher than most operators, so use parentheses:

  ```java
  int x;
  ... !(x < 0 && x > -10) ... // <, >, &&, !
  ```

- `&&` is higher than `||`

  ```java
  int x, y;
  bool flag;
  ... flag || x * 5 >= y + 10 && x == 5
  // which op is first? second? etc?
  ```

- `&&` and `||` are lower than arithmetic+relational operators: parens not usually needed
4.9 Checking Numeric Ranges

- We want to know if x is in the range from 1 to 10 (inclusive)
  a. if (1 <= x <= 10) //as in math class
      cout << "YES" << endl;
     //THIS DOES NOT WORK IN C++:
     // (1<=x) <=10) (assume x is -5)
     // => ( false <= 10)
     // => ( 0<=10 ) is true, but should be false
  b. if (1 <= x && x <= 10)
      cout << "YES" << endl;
     -check: x=0? (1<=0 && 0<=10) => false && true
     -check: x=5? (1<=5 && 5<=10) => true && true
     -check: x=100? (1<=100 && 100<=10) => ??

4.10 Menus

- Menu-driven program: program controlled by user selecting from a list of actions
- Menu: list of choices on the screen
- Display list of numbered/lettered choices
- Prompt user to make a selection
- Test the selection in nested if/else or switch
  - Match found: execute corresponding code
  - Else: error message (invalid selection).

Sample menu code:

```cpp
int choice;
double charges;
int months = 12;

// Display the menu and get a choice.
cout << "Health Club Membership Menu\n";
cout << "1. Standard Adult Membership\n";
cout << "2. Child Membership\n";
cout << "3. Senior Citizen Membership\n";
cout << "Enter your choice: ";
cin >> choice;

// Respond to the user's menu selection.
if (choice==1) {
    charges = months * 40.0;
cout << "The total charges are \\
    \$" << charges << endl;
} else if (choice==2) {
    charges = months * 20.0;
cout << "The total charges are \\
    $" << charges << endl;
} else if (choice==3) {
    charges = months * 30.0;
cout << "The total charges are \\
    $" << charges << endl;
} else {
    cout << "ERROR: The valid choices are 1 through 3.\n    " << endl;
}
```

4.11 Validating User Input

- Input validation: inspecting input data to determine whether it is acceptable
- Invalid input is an error that should be treated as an exceptional case.
  - The program can ask the user to re-enter the data
  - The program can exit with an error message

```cpp
cout << "Enter a positive number: ";
cin >> x;
if (x > 0) {
    //do something with x here
    cout << "You entered a negative number or 0.\n    " << endl;
    cout << "The program is ending.\n    " << endl;
} else {
    cout << "The program is ending.\n    " << endl;
    }```
4.12 Comparing Characters and Strings

- Characters are compared using their ASCII values
  - 'A' < 'B'
    - This is true. ASCII value of 'A' (65) is less than the ASCII value of 'B' (66)
  - '1' < '2'
    - This is true. ASCII value of '1' (49) is less than the ASCII value of '2' (50)
- Lowercase letters have higher ASCII codes than uppercase letters, so 'a' > 'Z'

Comparing string objects

- Like characters, strings are compared using their ASCII values

```
string name1 = "Mary";
string name2 = "Mark";
name1 > name2    // true
name1 <= name2   // false
name1 != name2   // true
name1 < "Mary Jane" // true
```

4.14 The switch statement

- Like a nested if/else, used to select one of multiple alternative code sections.
- tests one integer/char expression against multiple constant integer/char values:

```
switch (expression) {
    case const1: statements
    ...
    case constn: statements
    default: statements
}
```

switch statement behavior

- expression is evaluated to an int/char value
- execution starts at the case labeled with that int/char value
- execution starts at default if the int/char value matches none of the case labels
switch statement syntax

```cpp
switch (expression) {
    case const1: statements
    ...
    case constn: statements
    default: statements
}
```

- expression must have int/char type
- const1, constn must be constants! a literal or named constant
- statements is one or more statements (braces not needed and not recommended!)
- default: is optional

The break Statement

- The break statement causes an immediate exit from the switch statement.
- Without a break statement, execution continues on to the next set of statements (the next case).
- Sometimes this is useful: the textbook has some nice examples.

switch statement example

```cpp
Example:
```
```cpp
int quarter;
...
switch (quarter) {
    case 1: cout << "First"; break;
    case 2: cout << "Second"; break;
    case 3: cout << "Third"; break;
    case 4: cout << "Fourth"; break;
    default: cout << "Invalid choice";
}
```

Multiple labels

- if ch is 'a', it falls through to output “Option A” (then it breaks)

```cpp
char ch;
...
switch (ch) {
    case 'a':
        case 'A': cout << "Option A"; break;
        case 'b':
        case 'B': cout << "Option B"; break;
        case 'c':
        case 'C': cout << "Option C"; break;
    default: cout << "Invalid choice";
}
```
4.15 More about blocks and scope

- The scope of a variable is the part of the program where the variable may be used.
- The scope of a variable is the innermost block in which it is defined, from the point of definition to the end of that block.
- Note: the body of the main function is just one big block.

Variables with the same name

- In an inner block, a variable is allowed to have the same name as a variable in the outer block.
- When in the inner block, the outer variable is not available (it is hidden).
- Not good style: difficult to trace code and find bugs
- See example next slide

Scope of variables in blocks

```cpp
int main()
{
    double income; //scope of income is red + blue
    cin >> income;
    if (income >= 35000) {
        int years; //scope of years is blue;
        cin >> years;
        if (years > 5)
            cout << "You qualify.\n"
        else
            cout << "You do not qualify.\n";
    } else
        cout << "You do not qualify.\n";
    return 0;
}
```

Variables with the same name

```cpp
int main()
{
    int number;
    cout << "Enter a number greater than 0: ";
    cin >> number;
    if (number > 0) {
        int number; // another variable named number
        cout << "Now enter another number ";
        cin >> number;
        cout << "The second number you entered was ";
        cout << number << endl;
    }
    cout << "Your first number was " << number << endl;
}
```

Enter a number greater than 0: 88
Now enter another number 2
The second number you entered was 2
Your first number was 88