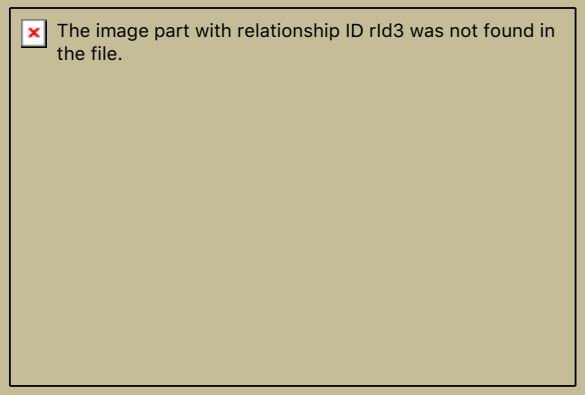
COMPUTER SCIENCE 1: STARTING COMPUTING
CSCI 1300



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Lecture 9

University of Colorado Boulder

Agenda

- This week
  - Conditional Statements – if-else, cont.
  - While, Do While loops
  - Strings

Announcements

- Rec 4 due on 2/10
- Hmwk 3 due 2/11
- Practicum 1 has been scheduled:
  - February 21st, 2018
  - In lecture. 50 minutes. Bring a laptop!
  - Review: in lecture on 2/19
  - Visible in *Tentative Schedule* on Moodle

Control Flow: Learning Objectives

- Boolean Expressions
  - Building, Evaluating & Precedence Rules
- Branching Mechanisms
  - if-else
  - switch
  - Nesting if-else
- Loops
  - While, do-while, for
  - Nesting loops

Boolean Expressions

- Data type bool
  - Returns true or false
  - true, false are predefined library consts

Boolean Expressions: Comparison Operators

1. Comparison Operators: ==, <, >, !=, <=, >=
2. Logical Operators
   - Logical AND (&&)
   - Logical OR (||)

Display 2.1 Comparison Operators

MATH SYMBOL	ENGLISH	C++ NOTATION	C++ SAMPLE	MATH EQUIVALENT
=	Equal to	==	x + 7 == 2*y	x + 7 = 2y
≠	Not equal to	!=	ans != 'n'	*ans* ≠ *'n'*
<	Less than	<	count < m + 3	*count* < m + 3
≤	Less than or equal to	<=	time <= limit	*time* ≤ *limit*
>	Greater than	>	time > limit	*time* > *limit*
≥	Greater than or equal to	>=	age >= 21	*age* ≥ 21

Evaluating Boolean Expressions: Truth Tables

Display 2.2 Truth Tables

AND

Exp_1	*Exp_2*	*Exp_1* && *Exp_2*
true	true	true
true	false	false
false	true	false
false	false	false

OR

Exp_1	*Exp_2*	*Exp_1* || *Exp_2*
true	true	true
true	false	true
false	true	true
false	false	false

NOT

Exp	!(*Exp*)
true	false
false	true

Precedence Examples

- Arithmetic before logical
  - x + 1 > 2 || x + 1 < -3 means:
    - (x + 1) > 2 || (x + 1) < -3
- Short-circuit evaluation
  - (x >= 0) && (y > 1)
  - Be careful with increment operators!
    - (x > 1) && (y++) // don't do it!
- Integers as boolean values
  - All non-zero values → true
  - Zero value → false

Branching Mechanisms

- if-else statements
  - Choice of two alternate statements based on condition expression
  - Example:

```
if (temp > 60)
    cout << "It's warm outside" << endl;
else
    cout << "It's cold outside" << endl;
```

if-else Statement Syntax

- Formal syntax:

```
if (<boolean_expression>)
     <yes_statement>
else
     <no_statement>
```

- Note: in example above, each alternative is only ONE statement!

Compound/Block Statement

- Only "get" one statement per branch
- Must use compound statement { }
  for multiples
  - Also called a "block" statement
- Each block should have block statement
  - Even if just one statement
  - Enhances readability

Compound Statement in Action

- Note indenting in this example:

```
if (myScore > yourScore)
{
    cout << "I win!\n";
    wager = wager + 100;
}
else
{
    cout << "I wish these were golf scores.\n";
    wager = 0;
}
```

Common Pitfalls

- Operator "=" vs. operator "=="
- One means "assignment" (=)
- One means "equality" (==)

```
if (x = 12)   ←Note operator used!
      Do_Something
else
      Do_Something_Else
```

Let's go to C9 and see what happens!

The Optional else

- else clause is optional
  - If, in the false branch (else), you want "nothing" to happen, leave it out
  - Example:

```
if (sales >= minimum)
      salary = salary + bonus;
cout << "Salary = " << salary;
```

  - Note: nothing to do for false condition, so there is no else clause!
  - Execution continues with cout statement

Boolean Return-Type Functions

- Function return-type can be any valid type
  - Given function declaration/prototype:
    ```
    bool appropriate(int rate);
    ```
  - And function's definition:
    ```
    bool appropriate (int rate)
    {
        return (((rate>=10)&&(rate<20))||(rate==0);
    }
    ```
  - Returns "true" or "false"
  - Function call, from some other function:
    ```
    if (appropriate(entered_rate))
         cout << "Rate is valid\n";
    ```

Nested Statements

- if-else statements contain smaller statements
  - Compound or simple statements (we've seen)
  - Can also contain any statement at all, including another if-else statement!
  - Example:

```
if (speed > 55)
      if (speed > 80)
            cout << "You're really speeding!";
      else
            cout << "You're speeding.";
```

    - Note proper indenting!

Multiway if-else

- Not new, just different indenting
- Avoids "excessive" indenting
  - Syntax:

Multiway if-else Statement

SYNTAX

```
if (Boolean_Expression_1)
    Statement_1
else if (Boolean_Expression_2)
    Statement_2
          .
          .
          .
else if (Boolean_Expression_n)
    Statement_n
else
    Statement_For_All_Other_Possibilities
```

Multiway if-else Example

EXAMPLE

```
if ((temperature < -10) && (day == SUNDAY))
    cout << "Stay home.";
else if (temperature < -10) //and day != SUNDAY
    cout << "Stay home, but call work.";
else if (temperature <= 0) //and temperature >= -10
    cout << "Dress warm.";
else //temperature > 0
    cout << "Work hard and play hard.";
```

The Boolean expressions are checked in order until the first `true` Boolean expression is encountered, and then the corresponding statement is executed. If none of the Boolean expressions is *true*, then the *Statement_For_All_Other_Possibilities* is executed.

The switch Statement

- A statement for controlling multiple branches
- Can do the same thing with if statements but sometimes switch is more convenient
- Uses controlling expression which returns bool data type (true or false)
- Syntax:
  - Next slide

switch Statement Syntax

switch Statement

SYNTAX

```
switch (Controlling_Expression)
{
    case Constant_1:
        Statement_Sequence_1
        break;
    case Constant_2:
        Statement_Sequence_2
        break;
                    .
                    .
                    .
    case Constant_n:
        Statement_Sequence_n
        break;
    default:
        Default_Statement_Sequence
}
```

You need not place a `break` *statement in each case. If you omit a* `break`*, that case continues until a* `break` *(or the end of the* `switch` *statement) is reached.*

The controlling expression must be integral! This includes char.

The switch Statement in Action

EXAMPLE

```
int vehicleClass;
double toll;
cout << "Enter vehicle class: ";
cin >> vehicleClass;

switch (vehicleClass)
{
    case 1:
        cout << "Passenger car.";
        toll = 0.50;
        break;
    case 2:
        cout << "Bus.";
        toll = 1.50;
        break;
    case 3:
        cout << "Truck.";
        toll = 2.00;
        break;
    default:
        cout << "Unknown vehicle class!";
 }
```

If you forget this **break**, *then passenger cars will pay $1.50.*

The switch: multiple case labels

- Execution "falls thru" until break
  - switch provides a "point of entry"
  - Example:

```
case 'A':
case 'a':
     cout << "Excellent: you got an "A"!\n";
     break;
case 'B':
case 'b':
     cout << "Good: you got a "B"!\n";
     break;
```

  - Note multiple labels provide same "entry"

switch Pitfalls/Tip

- Forgetting the break;
  - No compiler error
  - Execution simply "falls thru" other cases until break;
- Biggest use: MENUs
  - Provides clearer "big-picture" view
  - Shows menu structure effectively
  - Each branch is one menu choice

!!! No “menu” built-in function exists in C++

switch Menu Example

- Switch statement "perfect" for menus:

```
switch (response)
{
 case 1:
    // Execute menu option 1
    break;
 case 2:
    // Execute menu option 2
    break;
 case 3:
    // Execute menu option 3
    break;
 default:
    cout << "Please enter valid response.";
}
```

Conditional Operator

- Also called "ternary operator"
  - Allows embedded conditional in expression
  - Essentially "shorthand if-else" operator
  - Example:

```
if (n1 > n2)
      max = n1;
else
      max = n2;
```

  - Can be written:

```
max = (n1 > n2) ? n1 : n2;
```

    - "?" and ":" form the "ternary" operator

Loops

- 3 Types of loops in C++
  - while
    - Most flexible
    - No "restrictions"
  - do-while
    - Least flexible
    - Always executes loop body at least once
  - for
    - Natural "counting" loop

while Loops Syntax

Syntax for `while` and `do-while` Statements

A `while` STATEMENT WITH A SINGLE STATEMENT BODY

```
while (Boolean_Expression)
     Statement
```

A `while` STATEMENT WITH A MULTISTATEMENT BODY

```
while (Boolean_Expression)
{
     Statement_1
     Statement_2
        .
        .
        .
     Statement_Last
}
```

while Loop Example

- Consider:

```
count = 0;   // Initialization
while (count < 3)// Loop Condition
{
    cout << "Hi ";// Loop Body
    count++;   // Update expression
}
```

  – Loop body executes how many times?

do-while Loop Syntax

A do-while STATEMENT WITH A SINGLE-STATEMENT BODY

```
do
    Statement
while (Boolean_Expression);
```

A do-while STATEMENT WITH A MULTISTATEMENT BODY

```
do
{
    Statement_1
    Statement_2
      .
      .
      .
    Statement_Last
} while (Boolean_Expression);
```

Do not forget the final semicolon.

do-while Loop Example

```
count = 0;   // Initialization
do
{
   cout << "Hi "; // Loop Body
   count++;      // Update expression
} while (count < 3);// Loop Condition
```

- Loop body executes how many times?
- do-while loops always execute body at least once!

while vs. do-while

- Very similar, but…
  - One important difference
    - Issue is "WHEN" boolean expression is checked
    - while: checks BEFORE body is executed
    - do-while: checked AFTER body is executed
- After this difference, they're essentially identical!
- while is more common, due to it's ultimate "flexibility"