More Boolean and Relational Topics

Class 14

Overlapping

- consider the bank loan rate, but with slightly different rules
- illustrated by this two-dimensional chart

		Employed	
		No	Yes
Grad	No	good	better
	Yes	better	best

- because the cases overlap, you could use a nested-if structure
- but it's simpler and more natural to use a logical operator

Logical Operators

- C++ has three logical operators
- and
  - && logical-and is a binary operator
  - its operands are both Boolean values
  - its return value is Boolean
- or
  - || logical-or is a binary operator
  - its operands are both Boolean values
  - its return value is Boolean
- not
  - ! logical-not is a unary operator
  - its operand is a Boolean value
  - its return value is Boolean

Truth Tables

- computer scientists use truth tables to explain the behavior of logical operators

a	b	a && b
f	f	f
f	t	f
t	f	f
t	t	t

a	b	a || b
f	f	f
f	t	t
t	f	t
t	t	t

a	!a
f	t
t	f

Using Logical Operators

- for the bank loan, in English
- if the customer is neither employed nor graduated, the rate is good
- if the customer is employed or graduated, but not both, the rate is better
- if the customer is both employed and graduated, the rate is best

Using Logical Operators

- for the bank loan, in English
- if the customer is neither employed nor graduated, the rate is good
- if the customer is employed or graduated, but not both, the rate is better
- if the customer is both employed and graduated, the rate is best

- this can be expressed in C++ in various ways

Loan Version 1

```
if (graduated == 'Y' && employed == 'Y')
{
  rate = "best";
}
else if (graduated == 'Y')
{
  rate = "better";
}
else if (employed == 'Y')
{
  rate = "better";
}
else
{
  rate = "good";
}
```

Loan Version 2

```
if (graduated == 'Y' && employed == 'Y')
{
  rate = "best";
}
else if (graduated == 'Y' || employed == 'Y')
{
  rate = "better";
}
else
{
  rate = "good";
}
```

Loan Version 3

```
if (graduated != 'Y' && employed != 'Y')
{
  rate = "good";
}
else if (graduated != 'Y' || employed != 'Y')
{
  rate = "better";
}
else
{
  rate = "best";
}
```

Or

- in English, or can have two different meanings
  1. do you want fries or onion rings with that burger?
  2. to help as a volunteer, you can carry boxes or set up signs
- in case 1, you can choose fries or onion rings, but not both
- in case 2, you can help by carrying boxes, by setting up signs, or by doing both
- case 1 is called exclusive or
- case 2 is called inclusive or
- the C++ || logical or operator is the inclusive or operator
- C++ does not have a logical exclusive or operator
- (it does have a bitwise exclusive or operator, which you will study later)

Equality of Characters and Strings

- testing the equality of characters is obvious
- one letter is either exactly the same as another, or not
- `'A' == 'A'` is true while `'A' == 'a'` is false

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- two string objects are equal if they have exactly the same characters in exactly the same order, and are the same length
- assuming `string word = "Extra";` has been initialized:
- `word == "Extra"` is true
- `word == "Extravagant"` is false

Order of Characters

- the less-than and greater-than relops apply to characters
- based on the ASCII chart (Gaddis page 1287)
- a character that is listed in the chart is less than one that is listed later, and greater than one that is listed earlier

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- but you should know its general structure
  - a bunch of non-printable characters
  - the space character and then some symbols
  - the digits 0 – 9
  - more symbols
  - the upper case letters
  - more symbols
  - the lower case letters
  - a few more symbols

Comparing Strings

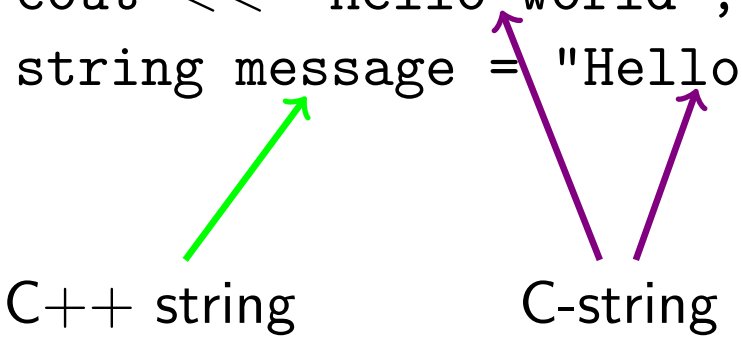
- the less-than and greater-than relops apply to string objects
- strings are compared character-by-character down the length of both strings
- the first character at which they differ determines which string is less-than the other
- if two strings have different lengths and contain exactly the same characters as far as the shorter one, the shorter one is less than the larger

f	o	o	t				
f	o	o	t	b	a	l	l

Comparing Strings Warning

- recall that C++ has two different things called "string"
  1. the old-fashioned C-strings that we wish we could ignore, but can't
  2. the easy-to-use newfangled C++ strings that we always use when we can
- the main place we've seen C-strings so far is as string literals

```
cout << "Hello world";
string message = "Hello world";
```



Comparing Strings Warning

- you can compare two C++ strings using relops
- you can compare a C++ string and a C-string using relops (because the C-string value is converted to a C++ string before comparison)
- but you cannot compare two C-strings using relops
- thus every statement in Gaddis Checkpoint 4.23 on page 200 is illegal!

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- thus every statement in Gaddis Checkpoint 4.23 on page 200 is illegal!

- assuming `string first = "Bill";`
  and `string last = "Monroe";`
  - legal: `first == last`
  - legal: `first >= "Bill"`
  - illegal: `"Fred" < "Bill"`

The Conditional Operator

- a very common programming construct has this structure:
- this construct will definitely give y a value
- the value will be either the opposite of x or double x, depending
- this is so common that there is a shortcut form

```
if (x < 0)
{
  y = x * -1;
}
else
{
  y = 2 * x;
}
```

```
y = x < 0 ? x * -1 : 2 * x;
```

The Conditional Operator

```
y = x < 0 ? x * -1 : 2 * x;
```

- the conditional operator is ternary
  1. first part: a Boolean expression
  2. second part: value if the Boolean expression is true
  3. third part: value if the Boolean expression is false

Flag Variables

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- in a program that calculates sales commissions, we can create the flag variable:

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bool sales_quota_met = sale_amount >= QUOTA;
```

- later in the program we can check the state of the flag:

```
if (sales_quota_met)
{ ...
```

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bool sales_quota_met = sale_amount >= QUOTA;
```

- later in the program we can check the state of the flag:

```
if (sales_quota_met)
{ ...
```

- this is more readable than not using the flag:

```
if (sale_amount >= QUOTA)
{ ...
```

Scope

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A variable's scope is the region of the program in which the variable exists and in which its name can be legally used.

- a variable's scope extends from declaration to the end of the closest containing block
- look at program_4_29_modified.html, which is a modification of Gaddis' Program 4-29 on page 214

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- some scopes:
  1. MIN_INCOME's scope is all of lines 8 – 36
  2. income's scope is lines 12 – 36
  3. years's scope is lines 18 – 30
  4. years_remaining's scope is lines 27 – 29

Variables With the Same Name

- on page 215 Gaddis shows a program that has two variables with the same name in nested scopes
- as he points out, this is legal but a bad idea
- to emphasize the point, never do this!

```
int number;
...
if (...)
{
  int number; // the outer number is no longer visible
  ...
}
// now outer number is again visible
```

Variables With the Same Name

- however, it is fine to have two variables with the same name in parallel scopes
- because only one side of the if statement can run, only one variable named number ever exists
- there is no ambiguity

```
if (...)
{
  int number;
  ...
}
else
{
  int number;
  ...
}
```

Not Included

- note: we will not cover Gaddis Section 4.14 The `switch` Statement at this time