# 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

- string brandName;
  int price;
  bool hdmiPort;

- I will only buy if the brand is apple, price is less than one thousand dollars

- I will buy a windows surface computer, price should be less than 700

  dollars

# Using Logical Operators

- bool homeWork;
  string thingsToDo;
  bool isWeekEnd;
- I will go to sleep early if I have homework and its weekdays
- I will go shopping if I do not have homework and its a weekend
- I will watch a movie if its the weekend and have no homework

# 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
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- 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";
}
```

# 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

# Equality of Characters and Strings

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- 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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- thus, `'a'` $<$ `'b'` is true
- and `'a'` $>$ `'A'` is true — this one is not intuitive
- and `'a'` $>$ `'9'` is true — also not intuitive

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- thus, `'a' < 'b'` is true
- and `'a' > 'A'` is true — this one is not intuitive
- and `'a' > '9'` is true — also not intuitive

- but you should know its general structure
  - the ASCII value for 'A' is 65 (so for 'B' it is 66, ...)
  - the ASCII value for 'a' is 97 (so for 'b' it is 98, ...)
  - the ASCII value for '0' is 48 (so for '1' it is 49, ...)
  - the ASCII value for space character is 32

# 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

- you can compare two C++ strings using relops
- you can compare a C++ string and string literals by using the relops

- but you should not compare two string literals by using the relops

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- assuming `string first = "Bill";`
  and `string last = "Monroe";`
  - legal: `first == last`
  - legal: `first >= "Bill"`
  - illegal and may not work: `"Monroe" > "Bill"`

# The Conditional Operator

- a very common programming construct has this structure:
- this construct will definitely give y a value
- the value of y will be either the opposite of x or double x, depending on the value of x
- 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:

```
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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- 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

**Scope**

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

- 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

- Let us try to determine the output of the following program

```
1  #include <iostream>
2  using namespace std;
3
4  int main()
5  {
6      int value = 10;
7
8      int foo = 13;
9
10     if(foo>12)
11     {
12         int value = 20;
13         cout<<" " << value;
14     }
15
16     cout<<" " << value;
17 }
```

# 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