# CSCI 1300

Spring 2022 - Starting Computing

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## Decisions

- Recitation 2
- Homework 2
    - Write solutions in VSCode and paste in Autograder, Homework 2 CodeRunner.
    - Zip your .cpp files and submit on canvas Homework 2. Check the due date! No late submissions!!
- Extra-credit: coderunner (start early bonus (3 points)) + coderunner (extra credit (3 points))
- Start going through the textbook readings and watch the videos
    - Take Quiz 3.
    - Check the due date! No late submissions!!
- Practice Set 2
- Week 3: 3-2-1

## Today

- Boolean variables
- Relational operators
- The if statement

## 3-2-1 Q&As

## What is the difference between double and float? Why is it called double?

| **float** | **double** |
|---|---|
| 32 bits | 64 bits |
| 6-7 digits | 15 - 16 digits |
| single precision | double precision |
| less memory | more accurate |

## Is Pseudo code something we would use for a job?

## Boolean variables and operators

- Sometimes you need to evaluate a logical condition in one part of a program and use it elsewhere.
- To store a condition that can be **true** or **false**, you use a Boolean variable
- Variables of type **bool** can hold exactly two values, **false** or **true**.
  - *not* strings.
  - *not* integers; they are special values, just for Boolean variables.
- **BUT actually zero is false, and any non-zero value is treated as true.**

## Relational Operators

| C++ | Math Notation | Description |
|---|---|---|
| > | > | Greater than |
| >= | ≥ | Greater than or equal |
| < | < | Less than |
| <= | ≤ | Less than or equal |
| == | = | Equal |
| != | ≠ | Not equal |

## Boolean Variables

- Here is a declaration of a Boolean variable, initialized to false:

```
bool failed = false;
```

- Here's another example:

```
// If the value of x is negative, set the boolean variable to True
bool isNegative = x < 0;
```

## Boolean Variables - cout

- Boolean variables that hold the value True, print the value 1 when displayed to the console via cout
- Boolean variables that hold the value False, print the value 0 when displayed to the console via cout
- Here's an example:

```
int x = -3;
bool isNegative = (x < 0);
bool isPositive = (x > 0);
cout << isNegative << “ “ << isPositive << endl;
```

**Output:** `1 0`

| Expression | Value | Comment |
|---|---|---|
| 3 <= 4 | true | 3 is less than 4; <= tests for “less than or equal. |
| 3 =< 4 | Error | The “less than or equal” operator is <=, not =<. The “less than” symbol comes first. |
| 3 > 4 | false | > is the opposite of <=. |
| 4 < 4 | false | The left-hand side of < must be strictly smaller than the right-hand side. |
| 4 <= 4 | true | Both sides are equal; <= tests for “less than or equal”. |

## Relational Operators – Some Notes

- The == operator is initially confusing to beginners.
- In C++, = already has a meaning, namely assignment
- The == operator denotes equality testing:

```
floor = 13; // Assign the value 13 to floor
// Test whether value of floor equals 13
if (floor == 13)
```

- You can compare strings as well:

```
if (input == "Quit") ...
```

## Confusing = and ==

- In C++, assignments have values.
- The value of the assignment expression floor = 13 is 13.
- These two features conspire to make a horrible pitfall:

```
    if (floor = 13) …
```

- is legal C++.
- The code sets floor to 13, and since that value is not zero, the condition of the if statement is always true.

**SO... Use only == inside tests/conditions.**
**Use = outside tests/conditions.**

## Logical Operators

- **Example:** you need to write a program to process temperature values, and tests whether a given temperature corresponds to liquid water or to solid ice.
- At sea level, water freezes at 0 degrees Celsius and boils at 100 degrees Celsius.
- Water is liquid IF the temperature is greater than 0 AND less than 100

## Logical Operators: And &&

- **Example:** you need to write a program to process temperature values, and tests whether a given temperature corresponds to liquid water or to solid ice.
- At sea level, water freezes at 0 degrees Celsius and boils at 100 degrees Celsius.
- Water is liquid IF the temperature is greater than 0 AND less than 100
- In C++, the && operator (called “and”) yields true only when both conditions that it joins are true

```
if (temp > 0 && temp < 100)
{
    cout << “Liquid” << endl;
}
if (temp > 0 && temp < 100)
{
    cout << “Liquid” << endl;
}
else
{
    cout < “Not liquid” << endl;
}
```

- If temp is within the 0 to 100 range, then both the left-hand side and right-hand side are true, so the whole expression in parentheses ( ) has value = true
- In all other cases, the whole expression’s value is false

## Logical Operators: Or ||

- The || operator (called or) yields the result true if at least one of the conditions connected by it is true
- Written as two adjacent vertical bar symbols (above the Enter key)

```
if (temp <= 0 || temp >= 100)
{
    cout < “Not liquid” << endl;
}
```

- If either of the left-hand or right-hand side expressions is true, then the whole expression has value true
- **Question:** What is the only case in which “Not liquid” would appear?

## Logical Operators: Not!

- Sometimes, you need to invert a condition with the logical not operator:!
- The ! operator takes a single condition and evaluates to true if the condition is false, and to false if the condition is true

```
if (!frozen)
{
    cout < “Not frozen” << endl;
}
```

- “Not frozen” will be written only when frozen contains the value false
- **Question:** What is the value of !false?

## Truth Tables

- **Definition:** A truth table displays the value of a Boolean operator expression for all possible combinations of its constituent expressions.
- (You'll look at truth tables a lot more in CSCI 2824 (Discrete))
- So if A and B denote bool variables or Boolean expressions, we have:

## AND &&

| A | B | A && B |
|---|---|---|
| true | true | true |
| true | false | false |
| false | true | false |
| false | false | false |

## OR ||

| A | B | A \|\| B |
|---|---|---|
| true | true | true |
| true | false | true |
| false | true | true |
| false | false | false |

## Not !

| A | !A |
|---|---|
| true | false |
| false | true |

## Examples

- 0 < 200 && 200 < 100
- 0 < 200 || 200 < 100
- 0 < 200 || 100 < 200
- 0 < 200 < 100
- !(0 < 200)
- -10 && 10 > 0
- 0 < x && x < 100 || x == - 1
- (!0 < x && x < 100) || x == - 1

## The if Statement

- The **if** statement is used to implement a decision
  - When a condition is fulfilled,
    one set of statements is executed
  - Otherwise,
    another set of statements is executed
- Like a fork in the road

## Syntax of the if() Statement

```
if (condition)// **never put a semicolon after the parentheses!!**
{
  statement1; // **executed if condition is true**
}
else // **the else part is optional**
{
  statement2; // **executed if condition false**
} // **braces are optional but recommended**
```

## Common Error – The Do-nothing Statement

- This is *not* a compiler error.
- The compiler does not complain.
- It interprets this **if** statement as follows:
    - If floor is greater than 13, execute the do nothing statement (semicolon by itself is the do-nothing statement)
    - Then execute the code enclosed in the braces.

```
if (floor > 13); // ERROR?
{
  floor--;
}
```

- Any statements enclosed in the braces are no longer a part of the if statement.

## The if Statement: Elevator Example

We must write the code to control the elevator.

How can we skip the 13th floor?

## if() Elevator Example Code

- If the user inputs 20, the program must set the actual floor to 19.
- Otherwise, we simply use the supplied floor number.

We need to decrement the input only under a certain condition:

```
int floor;
cout << “Enter the desired floor: “;
cin >> floor;
int actual_floor;
if (floor > 13) **//never put a semicolon after the parentheses!!**
{
    actual_floor = floor – 1; //
}
else
{
    actual_floor = floor;
}
```

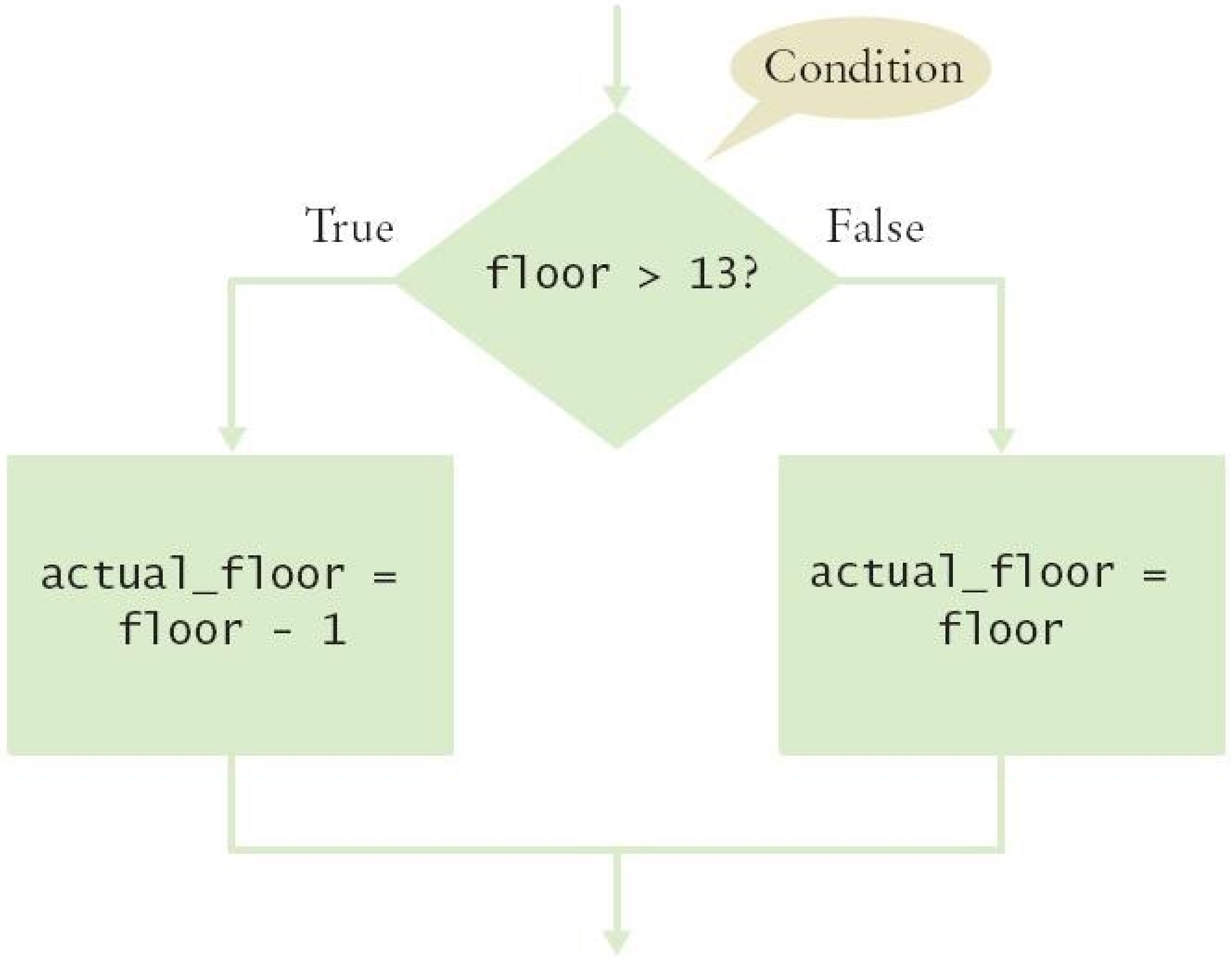
## if() Elevator Example without else

- Here is another way to write this code:
- We only need to decrement when the floor is greater than 13.
- We can set **actual_floor** before testing:

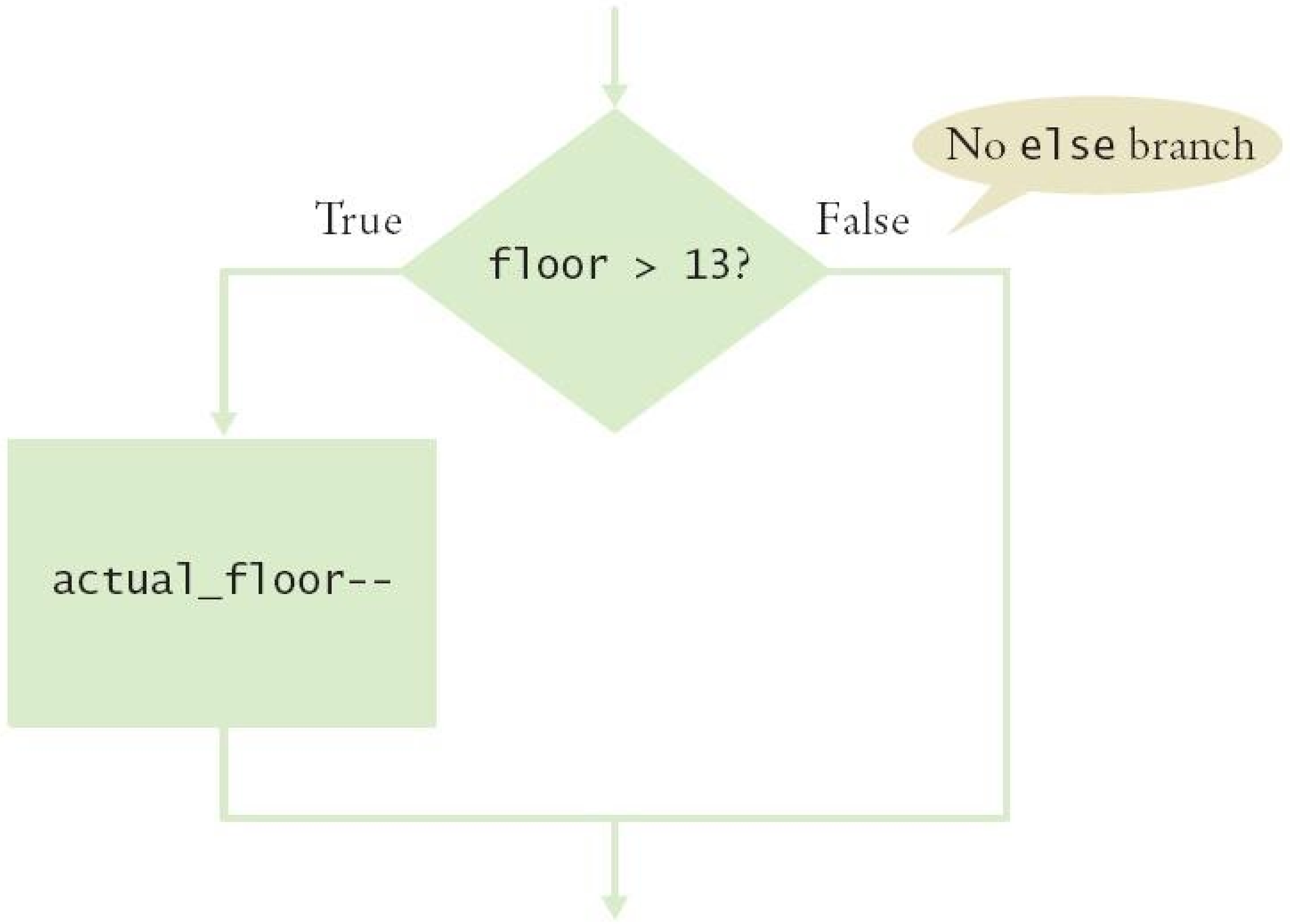
```
int actual_floor = floor;
if (floor > 13)
{
  actual_floor--;
} // No else needed
```

## The if Statement Flowcharts

## With else


Condition
True
False
floor > 13?
actual_floor = floor - 1
actual_floor = floor

## Without else



## The if Statement – Brace Layout

- Making your code easy to read is good practice.
- Lining up braces vertically helps.

```
if (floor > 13)
{
  floor--;
}
```

## The if Statement – Always use Braces

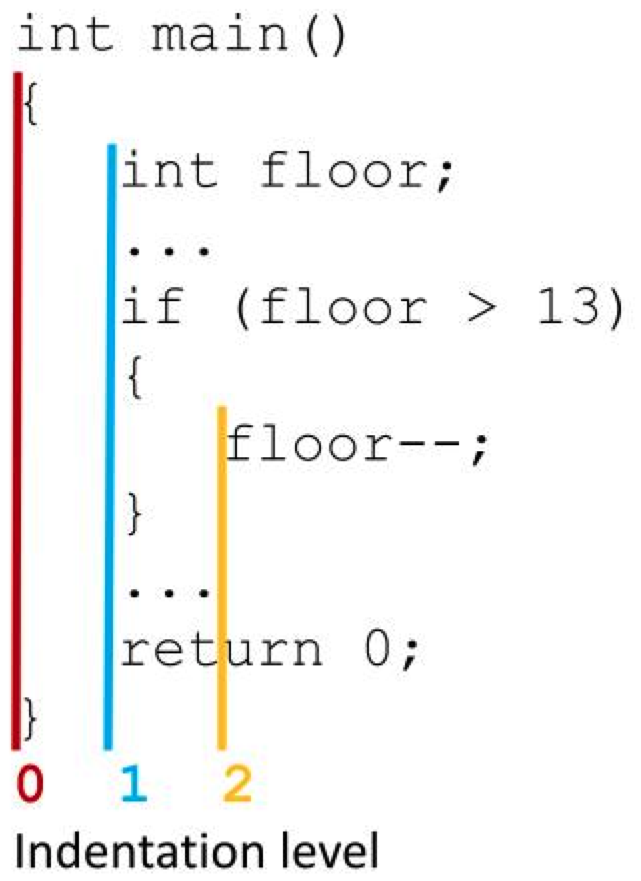
- When the body of an **if** statement consists of a single statement, you need not use braces:

```
if (floor > 13)
floor--;
```

- However, it is a good idea to always include the braces:
    - the braces makes your code easier to read, and
    - you are less likely to make errors such as ...

## The if Statement – Indent when Nesting

Block-structured code has the property that *nested* statements are indented by one or more levels.



```
int main()
{
    int floor;
    ...
    if (floor > 13)
    {
        floor--;
    }
    ...
    return 0;
}
```

## The if Statement – Removing Duplication

```
if (floor > 13)
{
  actual_floor = floor - 1;
  cout << "Actual floor: " << actual_floor << endl;
}
else
{
  actual_floor = floor;
  cout << "Actual floor: " << actual_floor << endl;
}
```

- Do you find anything redundant in this code?

```
if (floor > 13)
{
  actual_floor = floor - 1;
}
else
{
  actual_floor = floor;
}
cout << "Actual floor: " << actual_floor << endl;
```

You can remove the duplication by moving the two identical `cout` statements outside of and after the braces, and of course deleting one of the two.