CS 1112: Introduction To Programming

Booleans and Conditionals

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Friendly Reminders

- Your ***safety*** and ***comfort*** is important!
  - If you choose to wear a mask you are welcome to do so
  - *We will interpret wearing a mask as being considerate and caring of others in the classroom (not that you are sick), and realize that some may choose to mask to remain distanced*
- Be an ***active*** participant in your learning!
  You're welcome and ***encouraged*** to ask questions during class!
- If you feel ***unwell***, or think you are, please stay home
  - *We will work with you!*
  - Get some rest ☺
  - View the recorded lectures – *please allow 24-48 hours to post*
  - *Contact us!*

Announcements

- **PA00** graded!
  - You can view your score on Canvas and Gradescope

- **Quiz 2** is due by 11:00pm on Monday (***tonight***)!
  - No late quizzes accepted
  - No make-up quizzes allowed
  - If you believe your computer is glitching, it's a good idea to copy down your answers to each of the questions in a word document. In the event something happens, you can send me your solutions
  - **Take quiz on:** Sherlock.cs.virginia.edu

- **Programming Assignment 01 (PA01)** is due by 11:00pm on Wednesday (*2/7*)!

Booleans

The Boolean Data Type

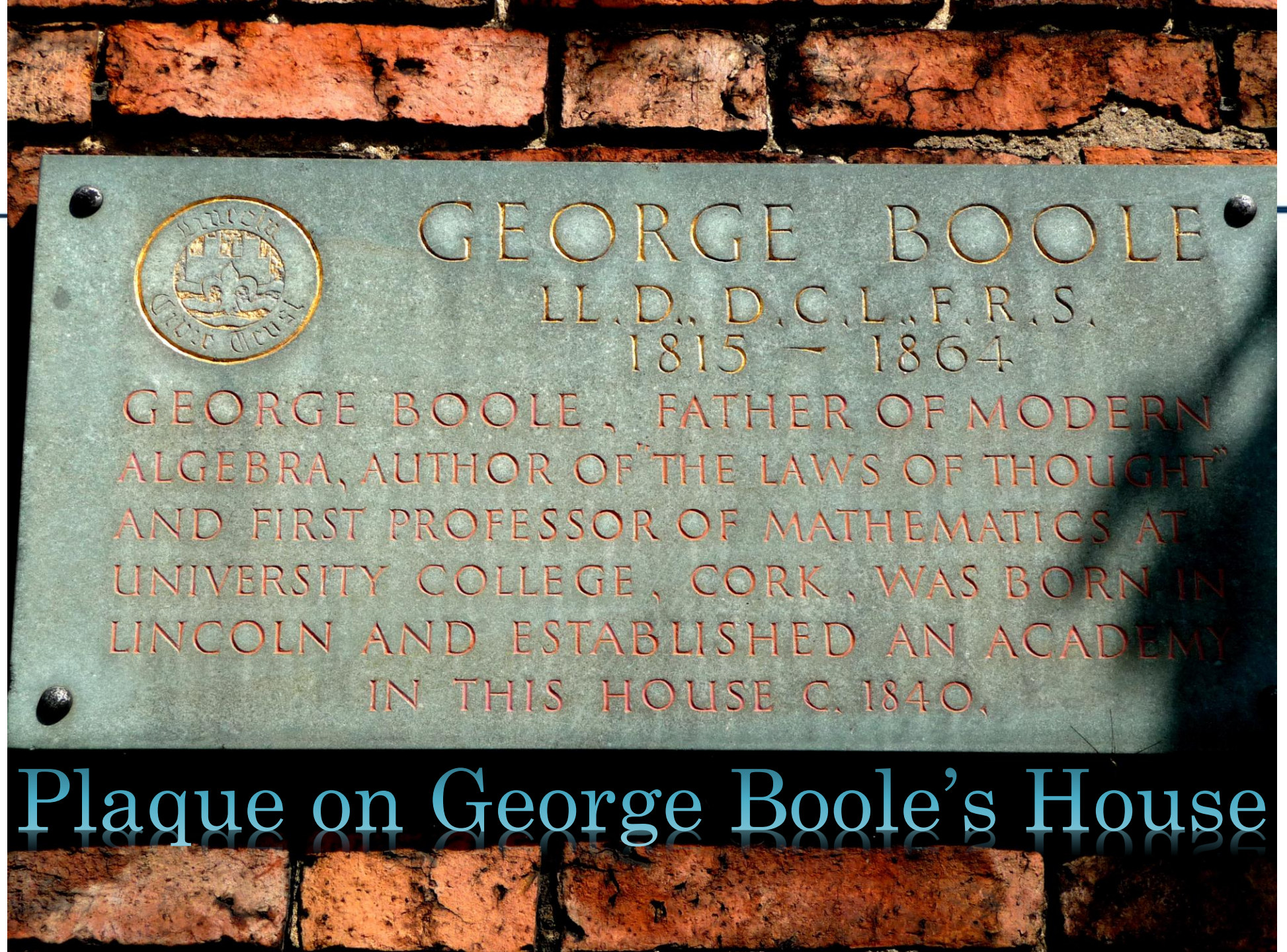
- A Boolean type ("**bool**" in Python) is used to denote "**truth**" and only has two possible values:
  - **True**
  - **False**

TYPE	Values	Operators	Inventor
`bool` *Boolean*	True, False	not, and, or	George Boole

- The words ***True*** and ***False*** are special **keywords** in Python. Do not confuse them for strings!

George Boole: A brief history

- George Boole (Nov. 1815 – Dec. 1864)
- English Mathematician, Philosopher, and Logician
- Most of his career was a professor of mathematics at Queens's College, Cork in Ireland
- Inventor of:
  - Boolean Logic ~ logical theory centered around three simple Boolean Operators:
    - "Or", "And", and "Not"
  - Symbolic Logic ~ known as Boolean Algebra
    - Which is a branch in algebra where values are either true for false, usually denoted by 1 and 0
- Boolean Logic is credited with laying the foundations for the Information Age!



Plaque on George Boole's House

The Boolean Data Type

- When using the **comparison operators** (`<` `>` `<=` `>=` `==` `!=`), a **bool** value is produced.
  - Note, we use `>=` instead of ≥
  - Given this statement: `if a < b:`
    Python will evaluate `a < b` to be either **True** or **False**
- Let's look at the following example:

```
a = 5
b = 10
c = a < b
d = a == b
```

```
print(type(c), c)   # prints: <class 'bool'> True
print(type(d), d)   # prints: <class 'bool'> False
```

Boolean Operators (also called Logical Operators)

- **`and`**
  - Used between 2 Boolean expressions (*binary* operator): `<bool> and <bool>`
  - Example: `x < 2 and x > 0`
  - **True** when **all** of the things are true
- **`or`**
  - Used between 2 Boolean expressions (*binary* operator): `<bool> or <bool>`
  - Example: `x < 2 or x > 0`
  - **True** when **any** of the things are true
- **`not`**
  - Precedes 1 Boolean expression (*unary* operator): `not <bool>`
  - Example: `not x`
  - **True** when **x** is false

Note: you should only use Boolean operators with values of type bool

Boolean Operators

- int and float operations like +, -, *, etc
- Booleans similarly have **3 operations:**
  - **and** `a and b` is **True** if ***both*** `a` and `b` are **True**, **False** otherwise
  - **or** `a or b` is **True** if ***at least one of*** `a` or `b` are **True**, **False** otherwise
  - **not** `not a` is ***the opposite of*** `a`

Truth Tables

A	B	A and B
True	True	True
True	False	False
False	True	False
False	False	False

A	B	A or B
True	True	True
True	False	True
False	True	True
False	False	False

A	not A
True	False
False	True

P	Q	$\neg P$	$P \wedge Q$	$P \vee Q$
T	T	F	T	T
T	F	F	F	T
F	T	T	F	T
F	F	T	F	F

Practice: A Closer Look at Using Booleans

- `x = 7` *# Anywhere you see 'x', assume the value is 7*

- `a = (x == 7)` *# Evaluate the condition "is x equal to 7", result is True*
- `b = (x != 7)`
- `c = not (x != 7)` *# Evaluate the condition: "what is the opposite of 'is x not equal to 7'", result is not (False), which is True*

Practice: A Closer Look at Using Booleans

- `d = (x < 7)`
- `e = (x <= (3 + 4))`
- `f = (x < 0 or x > 10)`
- `g = (x > 0 or x < 100)`

Practice: A Closer Look at Using Booleans

- `h = (x > 0 or x > 10)`
- `i = (x > 0 and x > 10)`
- `j = (x > 0 and x < 100)`
- `k = (x > 0 and not (x < 100))`

Practice: A Closer Look at Using Booleans

```
l = 8 < x < 10      # x is > 8 and x < 10
m = 0 < x < 10      # x is > 0 and x < 10
```

```
n = (x == 5 or 6)
o = (x == 3 or 7)
```

Don't do this, please!

```
n = (x == 5 or x == 6)
o = (x == 3 or x == 7)
```

Operands for the logical operators (**and**, **or**, **not**) must be Booleans.
This way is better.

Small Boolean Example (1)

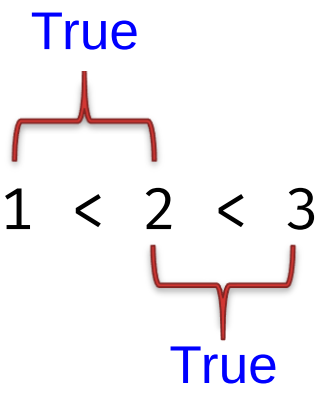
```
rain = True
wind = True

if rain and not wind:
        print(“Bring an umbrella!")
elif wind and not rain:
        print(“Wear a jacket!")
```

Small Boolean Example (2)

```
# trying to turn right
green_light = False
red_light = True
turn_on_red = True
if green_light :
    print(“Car may turn”)
elif red_light and not turn_on_red :
    print(“Car may not turn, no turn on red allowed”)
elif red_light and turn_on_red :
    print(“Car may turn, turn on red allowed”)
```

Comparators Can Be Chained As A Shortcut

- When this happens, the **and** operator is implied



- `1 < 2 < 3` # a shortcut that is equivalent to writing `1 < 2 and 2 < 3`
- `a < b < c < d < e` # this is also legal and acceptable practice
- `1 < 3 > 2 < 400 == 400 < 401` # this is legal in Python, but confusing, so don't do this! ☺

Quick & Fun Survey Questions

Get to know your peers! ☺

Chocolate or Vanilla or Strawberry?

Python Demonstration

Let's jump on PyCharm!

Boolean examples

Conditionals

Conditional Decision Statement

- Boolean operators are used to form Boolean expressions
- **Conditional Decision Statement**
  - Defines code that is only sometimes executed
  - There are multiple configurations for **if statements**

Conditional Decision Statement Example

```
age = int(input('Enter your age: '))

if age < 2:
    print("infant")
elif age < 18:
    print("youth")
elif age < 65:
    print("adult")
else:
    print("senior")
```

1 of these

0 or more of these

0 or 1 of these

Different Versions of Decision Statements

```
if boolean expression:
    statements
```

```
if boolean expression:
    statements
else:
    statements
```

```
if boolean expression:
    statements
elif boolean expression:
    statements
```

1 or more

```
if boolean expression:
    statements
elif boolean expression:
    statements
else:
    statements
```

1 or more

Remember…
An "expression" is a portion of a statement describing a value.

Python Demonstration

Let's jump on PyCharm!

Conditional examples

In-Class "lab" Activity!

Activity on Conditionals

- In pairs or groups up to three work on the following questions
- **turtle_conditionals_ica.py**
- *Use conditionals to determine what your turtle will draw.*

Remember to check-in with a TA before leaving class today!

Notes/Reminders…

Reminder: CS Laptop Loaner Program

- This course requires students to have a **laptop**
- I realize that not everybody might have one (nor necessarily need one for their desired major / path…)
- If you do not have a laptop for any reason… ***not to worry!***
- The CS department's Systems staff has a notebook / laptop loaner program and will be able to loan you a notebook / laptop computer for the duration of the semester if you don't have one or if you cannot afford one.
  - Also available if your laptop is broken and under repair, we can arrange for you to receive a loaner laptop for a week or two until your own laptop is fixed

Interested? Link: https://www.cs.virginia.edu/wiki/doku.php?id=cs_laptop_loaner

I am happy to be your sponsor. Please let me know.

Tools: Piazza

- We will use **Piazza** in the following way:
  - Website: https://piazza.com/ [Linked through Canvas]
  - Piazza is a great tool for asking questions about **course content**, **policies**, or getting help on **homework** assignments
  - While you are waiting for an answer, see if there's an answer you can provide to someone else's question. We're all in this together! CS is a team sport! ☺
  - TAs will monitor and answer questions throughout the semester
  - Not a means to help you debug your code! (See more below)

It is very important to remember the following:

- **Do not post** complete or partial code solutions (for Homework) on Piazza when seeking answers to your question unless it is in a **PRIVATE** post
- **Do not post** complete or partial quiz solutions (code or short-answer) when seeking answers to your question unless it is in a **PRIVATE** post

Tools: Gradescope

- We will use **Gradescope** in the following way:
  - Website: https://www.gradescope.com/
  - Linked through Canvas
  - Homework assignments will be **submitted**
    - Most programming assignments are autograded
    - Some aspects of programming assignments may be manually graded