

Welcome!

We'll get started shortly. Please take the Zoom poll in the meanwhile!

CS 49 Week 5

Surajit A. Bose

Agenda

- Logistics
- Boolean expressions
 - Comparison operators
 - Logical operators
- Conditionals: **if**, **if-else**, **if-elif-else**
 - Worked example: [Check for leap year](#)
- **while** loops
- **for** loops
 - Worked example: [First 20 even numbers](#)
- Section problem: [High-Low](#)

Logistics

Reminders

- General expectation during section is that cameras stay on
- Complete [Mid-Course Survey](#) this week
- Check Pronto for section communications
 - Launch Pronto from the left hand navigation bar of the course Canvas page
 - Open Pronto into a full browser window
 - If the list of groups for the course is not showing, click on the course title
 - Click on the "CS49 Section — Surajit" group
 - Typically, three announcements weekly
 - Toward beginning of week: what's coming up in section
 - A few minutes before section: a reminder to join
 - Shortly after section: recap
 - DM me via Pronto for help with course material or assignments

How to get hold of me / get help from other resources

- Surajit's office hours
 - Fridays 12 noon–1p, directly after section
 - By appointment on [Zoom](#)
 - Pronto DM for a quick response (usually within a couple hours)
 - Email boesesurajit@fhda.edu or Canvas inbox, 24 hr turnaround
 - The [github repo](#) has section materials, starter code, and solutions
-

- Pronto DM or Canvas inbox for Lane
- [Lane's office hours](#)
- [Online](#) or [in-person](#) tutoring at the STEM center (Room 4213)

Boolean expressions

Boolean expressions

- Reminder: an expression is a statement that can be evaluated
- A boolean expression evaluates to one of two values: **True** or **False**
- Like arithmetic expressions:
 - Boolean expressions are built using operators
 - The result is typically stored in a variable
 - For example, given a whole number greater than 1, we could set a variable **is_prime** to the value **True** or **False** for that number
- Boolean operators are of two types:
 - Comparison
 - Logical

Comparison operators (Slide 1 of 3)

- The boolean comparators are similar to the ones in math
- Given **x = 3** and **y = 4**, what is the value of these boolean expressions?
 - **x == y - 1** *# x equals y minus 1*
 - **x + 1 != y** *# x plus 1 not equal to y*
 - **x < y** *# x less than y*
 - **x <= y** *# x less than or equal to y*
 - **x > y** *# x greater than y*
 - **x >= y** *# x greater than or equal to y*

Comparison operators (Slide 2 of 3)

- The boolean comparators are similar to the ones in math
- Given **x = 3** and **y = 4**, what is the value of these boolean expressions?
 - **x == y - 1** *# x equals y minus 1* **True**
 - **x + 1 != y** *# x plus 1 not equal to y* **False**
 - **x < y** *# x less than y* **True**
 - **x <= y** *# x less than or equal to y* **True**
 - **x > y** *# x greater than y* **False**
 - **x >= y** *# x greater than or equal to y* **False**

Comparison operators (Slide 3 of 3)

- Note that `==` and `=` are very different beasts!
 - `x == y - 1` is not the same as `x = y - 1`
 - One is an expression: it checks whether the operands on the left and right sides of the operator are equal
 - The other is an assignment: it evaluates the expression on the RHS and stores the resulting value into the variable on the LHS
- Comparison operators can be chained:
 - `x < y` and `y < z` can be expressed as `x < y < z`, to check whether the value of `y` is between the values of `x` and `z`

Logical operators (Slide 1 of 2)

- The logical operators are **not**, **and**, and **or**
- **not** simply reverses the truth value of its operand:
 - **3 > 4** is **False**, so **not (3 > 4)** is **True**
 - if **x < y** is **True**, then **not (x < y)** is **False**
 - if **x < y** is **True**, then **not (x >= y)** is **True**
- Note the opposites:
 - The opposite of **==** is **!=**
 - The opposite of **<** is **>=**
 - The opposite of **>** is **<=**
- So if **x < 5** is **False**, then **not (x < 5)** is **True** and **x >= 5** is **True**

Logical operators (Slide 2 of 2)

- The logical operators are **not**, **and**, and **or**
- **and** is **True** only when both of its operands are **True**:
 - $3 < 5$ and $5 \geq 4$ are both **True**, so $(3 < 5)$ **and** $(5 \geq 4)$ is **True**
 - $3 < 5$ is **True** but $5 < 4$ is **False**, so $(3 < 5)$ **and** $(5 < 4)$ is **False**
- **or** is **True** when at least one of the operands is **True**:
 - $3 < 5$ and $5 \geq 4$ are both **True**, so $(3 < 5)$ **or** $(5 \geq 4)$ is **True**
 - $3 < 5$ is **True** and $5 < 4$ is **False**, but $(3 < 5)$ **or** $(5 < 4)$ is **True**
 - $3 > 5$ is **False** and $5 < 4$ is **False**, so $(3 > 5)$ **or** $(5 < 4)$ is **False**
- Short circuiting evaluation: operands are evaluated from left to right, so
 - for **and**, if the left operand is **False**, the right operand is never evaluated
 - for **or**, if the left operand is **True**, the right operand is never evaluated

Operator Precedence

From highest to lowest:

- Parentheses
- Arithmetic operators:
 - Exponentiation
 - Unary negation
 - Multiplication, division, integer division, modulus
 - Addition, subtraction
- Comparison operators: equals, less than, etc, all identical in precedence
- Logical **not**
- Logical **and**
- Logical **or**

Conditionals

Conditionals: **if** and **if-else**

- **if** statement:
 - When the associated boolean expression is **True**, the indented block below the **if** clause runs once
 - When the boolean is **False**, the indented block does not run
- **if-else** statement
 - When the associated boolean expression is **True**, the indented block below the **if** clause runs once
 - When the boolean is **False**, the indented block below the **else** clause runs once

Conditionals: **if-elif-else**

- **if-elif-else** is used when multiple conditions need to be checked
- Each condition is checked one after another until:
 - One of them evaluates to **True**, in which case only the block of code indented below that **if** or **elif** clause is executed, and only once
 - All of them have evaluated to **False**, in which case only the block of code below the **else** clause is executed, and only once
- The **else** clause is not required: could have just **if** and **elif** clauses
- Example: [checking for leap years](#)
 - If a given year is not evenly divisible by 4, it is not a leap year: 2024 was a leap year, 2025 is not
 - If a given year is evenly divisible by 100, it is not a leap year unless it is also divisible by 400: 2000 was a leap year, 1900 was not

A conditional puzzle (Slide 1 of 2)

What is wrong with this code?

```
x = 5
y = 12
if x = y:
    print("They're equal.")
elif x < y:
    print("x is smaller!")
else:
    print("y is smaller!")
```

A conditional puzzle (Slide 2 of 2)

The correct code:

```
x = 5
y = 12
if x == y:
    print("They're equal.")
elif x < y:
    print("x is smaller!")
else:
    print("y is smaller!")
```

Loops

The **while** loop (Slide 1 of 2)

- The **while** loop is governed by a boolean expression
- If the expression evaluates to **False**, the loop is never entered and any code inside the loop is ignored
- If the expression evaluates to **True**, the loop is entered and the block of code inside it is executed
- At the end of the code block, the boolean is re-evaluated. If the expression is still **True**, then the loop is re-entered.
- This continues until the boolean evaluates to **False**.
- This loop is also called an *indefinite loop* because it will run until the associated condition becomes **False**.

The **while** loop (Slide 2 of 2)

- **while** loops can be used to check user input, for example to control game play:

```
keep_going = True
```

```
while keep_going:
```

```
    # All the game commands
```

```
    # At the end of the round:
```

```
    wants_more = input("Play another round? y/n: ")
```

```
    if wants_more == "n":
```

```
        keep_going = False
```

- Here, "n" is called a **sentinel value** as it guards against the loop running forever.

The **for** loop (Slide 1 of 2)

- The **for** loop performs its block of code a specified number of times
- It is called a *definite loop* as the number of times it runs is predictable
- It is controlled by a loop variable, often **i** (for index)
- **i** is typically specified as a **range**
- Syntax: **for i in range(start, stop, step)**
 - Default **start** is 0
 - A specified **stop** is always required
 - Default **step** is 1; if a different **step** is needed, **start** must also be specified
- **i** enters the **for** loop with value 0 or the specified start, increments by 1 or the specified step, and terminates the loop when **i == stop**
- Note that the loop does not execute when **i** has the value of **stop**

The **for** loop (Slide 2 of 2)

- Example: First 20 even numbers

```
for i in range(20):  
    print(i * 2)
```

- Example: First 10 odd numbers

```
for i in range(1, 20, 2):  
    print(i)
```

- Example: Lost marbles

```
for i in range(10, 1, -1):  
    print(f"I have {i} marbles left. Oops, there goes another!")  
print("I'm down to my last marble!")
```


Section Problem: High-Low

High-Low: Overview

- Two numbers are generated from 1 to 100 (inclusive on both ends): one for you and one for the computer, who will be your opponent
- You get to see your number, but not the computer's
- You make a guess, saying your number is either higher than or lower than the computer's number
- If your guess matches the truth (e.g. you guess your number is higher, and then your number is actually higher than the computer's), you get a point
- Design the game following the milestones in the assignment description!
- Note: if you do Extension 2, the autograder will mark your code wrong. This is a known issue.

That's all, folks!

Next up: Graphics

Bonus Slides

More about **while** loops, booleans, precedence

More about **while** loops

Infinite loops (Slide 1 of 2)

- Beware of infinite loops, where the boolean will never be **False**!
- Something inside the loop body must eventually alter the loop condition.
- The following code fragment is intended to allow employee lookups based on employee ID numbers. The user enters employee ID numbers one after another, entering **-1** as a sentinel when all lookups are done:

```
employee_id = input("Enter employee ID number or -1 to end: ")
while int(employee_id) != -1 :
    # Some code here to process employee in some way
    next_id = input("Enter employee ID number: ")
```

Infinite loops (Slide 2 of 2)

- Beware of infinite loops, where the boolean will never be **False**!
- Something inside the loop body must eventually alter the loop condition.
- The following code fragment is intended to allow employee lookups based on employee ID numbers. The user enters employee ID numbers one after another, entering **-1** as a sentinel when all lookups are done:

```
employee_id = input("Enter employee ID number or -1 to end: ")
while int(employee_id) != -1 :
    # Some code here to process employee in some way
    employee_id = input("Enter employee ID number: ")
```

More about **True** and **False**

Truthy and falsy values

- Some Python values are automatically considered **False**, e.g.
 - Zero, whether as **int 0** or **float 0.0**
 - Empty strings **""**
 - Other empty sequences like empty lists or dictionaries (we'll cover lists and dictionaries in the last week)
 - **False** itself
- Conversely, their opposites are considered **True**, e.g.
 - Any nonzero number
 - Any non-empty string or sequence
 - **True** itself

Using zero and nonzero

- Instead of

```
if year % 4 != 0:
```

can write

```
if year % 4:
```

- Instead of

```
if year % 100 == 0:
```

can write

```
if not year % 100:
```

Short-circuiting and strings (Slide 1 of 2)

- Given short-circuit evaluation of **and** and **or** and the truthiness of non-empty strings, what will the following code print?

```
def main():  
  
    print(True or "Hello")  
    print(False or "Hello")  
    print(True and "Hello")  
    print(False and "Hello")  
  
if __name__ == '__main__':  
    main()
```

Short-circuiting and strings (Slide 2 of 2)

- Given short-circuit evaluation of **and** and **or** and the truthiness of non-empty strings, what will the following code print?

```
def main():
```

```
    print(True or "Hello")           # True
```

```
    print(False or "Hello")          # Hello
```

```
    print(True and "Hello")           # Hello
```

```
    print(False and "Hello")          # False
```

```
if __name__ == '__main__':  
    main()
```

More about operator precedence

Operator Precedence (Slide 1 of 2)

- Use parentheses rather than relying on implicit precedence
 - Even though they are equivalent, $x + (y / z)$ is clearer than $x + y / z$
- Watch out for the higher precedence of logical **not**!
- If **x** and **y** are both **False**, what is the value of:
 - **not** **x** **and** **y**
 - **not** (**x** **and** **y**)
 - **not** **x** **or** **y**
 - **not** (**x** **or** **y**)

Operator Precedence (Slide 2 of 2)

- Use parentheses rather than relying on implicit precedence
 - Even though they are equivalent, $x + (y / z)$ is clearer than $x + y / z$
- Watch out for the higher precedence of logical **not**!
- If **x** and **y** are both **False**, what is the value of:
 - **not** **x** **and** **y** # *(not False) and False* **False**
 - **not** (**x** **and** **y**) # *not (False and False)* **True**
 - **not** **x** **or** **y** # *(not False) or False* **True**
 - **not** (**x** **or** **y**) # *not (False or False)* **True**

Bonus Slides

Advanced Topics

Advanced topic: **match case**

match case

- A possible alternative to **if-elif-else** is **match case**
- Note: **match case** does not work in the Code in Place IDE
- Example: song [If it's Tuesday, this must be Belgium](#)

```
if day == "Tuesday":  
    place = "Belgium"  
elif day == "Wednesday":  
    place = "Rome"  
elif day == "Thursday":  
    place = "Montreux"  
  
print (f"If it's {day} it must be {place}")
```

match case

- A possible alternative to **if-elif-else** is **match case**
- Python tries to match the value to a specific case to see what commands to run
- Example: song [If it's Tuesday, this must be Belgium](#)

```
if day == "Tuesday":  
    place = "Belgium"  
elif day == "Wednesday":  
    place = "Rome"  
elif day == "Thursday":  
    place = "Montreux"
```

```
match day:  
    case "Tuesday":  
        place = "Belgium"  
    case "Wednesday":  
        place = "Rome"  
    case "Thursday":  
        place = "Montreux"
```

```
print (f"If it's {day} it must be {place}")
```

Advanced topic: bitwise operators

Bitwise operators (Slide 1 of 4)

- In addition to the logical operators **and** and **or**, Python also has three bitwise operands:
 - bitwise not **~**
 - bitwise and **&**
 - bitwise or **|**
- These operate on the binary representations of the operand values
- A binary representation is a representation in base 2
- An explanation of base 2 representation is in [this Khan Academy video](#)
- The bitwise operators work in ways analogous to when the logical **not**, **and**, and **or** return **True** or **False**

Bitwise operators (Slide 2 of 4)

- bitwise `~` evaluates to `0` if the operand bit is `1`, `1` if the operand bit is `0`
`~1` *# result: 0* `~0` *# result: 1*
- bitwise `&` evaluates to `1` if both operand bits are `1`, and `0` if either operand bit is `0`
`1 & 1` *# result: 1* `0 & 1` *# result: 0*
`1 & 0` *# result: 0* `0 & 0` *# result: 0*
- bitwise `|` evaluates to `0` if both operand bits are `0`, and `1` if either operand bit is `1`
`1 | 1` *# result: 1* `1 | 0` *# result: 1*
`0 | 1` *# result: 1* `0 | 0` *# result: 0*

Bitwise operators (Slide 3 of 4)

```
def bitwise_operations():  
    a = 3          # decimal 3: binary    011  
    b = 6          # decimal 6: binary    110  
    c = a & b      # result: ?  
    d = a | b      # result: ?  
  
    print(f"Result of bitwise and, 3 & 6 : {c}")  
    print(f"Result of bitwise or,  3 | 6 : {d}")  
  
if __name__ == "__main__":  
    bitwise_operations()
```

Bitwise operators (Slide 4 of 4)

```
def bitwise_operations():  
    a = 3          # decimal 3: binary    011  
    b = 6          # decimal 6: binary    110  
    c = a & b      # result:                &   010    decimal 2  
    d = a | b      # result:                |   111    decimal 7  
  
    print(f"Result of bitwise and, 3 & 6 : {c}")  
    print(f"Result of bitwise or,  3 | 6 : {d}")  
  
if __name__ == "__main__":  
    bitwise_operations()
```