Week 2 - Wednesday

COMP 1800

Last time

- What did we talk about last time?
- π
- **`math`** library
- Archimedes' approximation
- Leibniz's approximation

Questions?

Back to π

Problem solving

- The famous mathematics educator George Pólya outlined a series of steps for solving problems:
  1. Understand the problem
  2. Make a plan
  3. Execute the plan
  4. Look back and reflect

John Wallis

- John Wallis was a 17th century British mathematician who is believed to have come up with the ∞ symbol for infinity
- Of course, he also found an approximation for π
  - $\frac{\pi}{2} = \frac{2}{1} \cdot \frac{2}{3} \cdot \frac{4}{3} \cdot \frac{4}{5} \cdot \frac{6}{5} \cdot \frac{6}{7} \cdot \frac{8}{7} \ldots$

Wallis approximation

- $\frac{\pi}{2} = \frac{2}{1} \cdot \frac{2}{3} \cdot \frac{4}{3} \cdot \frac{4}{5} \cdot \frac{6}{5} \cdot \frac{6}{7} \cdot \frac{8}{7} \ldots$

- As with Leibniz, we will use the Accumulator Pattern
- Although the Accumulator Pattern often adds things up, we'll be multiplying stuff as we go
  - When summing, we start with 0
  - When multiplying, we start with 1
- Note that both the numerator and the denominator are used twice in a row before increasing by two
  - But they change on opposite turns!
- How can we apply Pólya's problem solving approach?

Selection Statements

Behold!

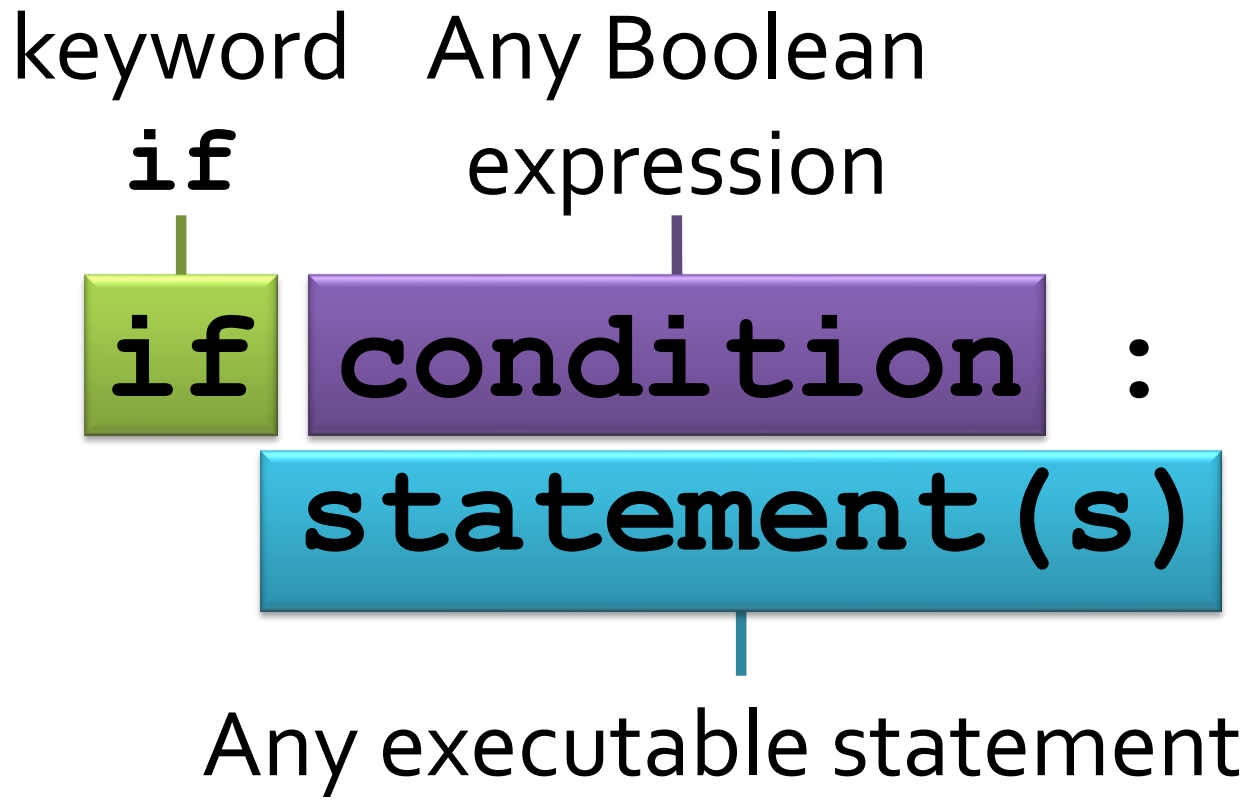
- To make choices in our program, we can use an **`if`**-statement:

```
x = 4

if x < 5:
  print('x is small!')
```

- **`x is small`** will only print out if **`x`** is less than 5
- In this case, we know that it is, but **`x`** could come from user input or a file or elsewhere

Anatomy of an `if`



Note: The colon after the condition and the indentation before the statement are **required**

Conditions in the `if`

- Any statement that evaluates to a Boolean is legal
- Examples:
  - `x <= y`
  - `True`
  - `s == 'Help me!' and z < 4`

- In actual fact, almost anything can be used for the condition
  - Integers and floating-point values are considered `True` as long as they aren't zero
  - Most strings (except the empty string `''`) are considered `True`
  - Avoid using things that aren't Booleans, since it's confusing

Comparison

- The most common condition you will find is a comparison between two things
- In Python, that comparison can be:
  - **==** equals
  - **!=** does not equal
  - **<** less than
  - **<=** less than or equal to
  - **>** greater than
  - **>=** greater than or equal to
- These are called **relational** operators

Equals

- You can use the `==` operator to compare any two things of the same type
- Different numerical types can be compared as well (`3 == 3.0`)
- Be careful with floating-point types, `0.33333333` is not equal to `0.33333332`

```
x = 3
if x == 4:
  print('This doesn't print')
```

Not Equals

- Any place you could have used the **==** operator, you can use the **!=** operator
- If **==** gives **True**, the **!=** operator will always give **False**, and vice versa
- If you want to negate a condition, you can always use the **not** operator

```
if x != 4:
```

is the same as

```
if not(x == 4):
```

= != ==

- Remember, a single equal sign (**=**) is the **assignment** operator (think of a left-pointing arrow)
- A double equals (**==**) is a **comparison** operator
- Assigning variables in **`if`** statements is not allowed

```
y = 10
if y = 6:           # syntax error
  print('Oh, no!')
```

```
b = False
if b = False:       # syntax error
 print('Not this?')
```

Less Than (or Equal To)

- Inequality is very important in programming
- You may want to take an action as long as a value is below a certain threshold
- For example, you might want to keep bidding at an auction until the price is greater than what you can afford

```
if x <= 4:
  print('x is less than 5')
```

- Watch for strict inequality (**<**) vs. non-strict inequality (**<=**)

Greater Than (or Equal To)

- Just like less than or equal to, except the opposite
- Note that (because of the All-Powerful Math Gods) the opposite of **<=** is **>** and the opposite of **>=** is **<**
- Thus,
  - **`not( x <= y )`** is equivalent to **`( x > y )`**
  - **`not( x >= y )`** is equivalent to **`( x < y )`**

and and or

- You can also have multiple Boolean conditions in an **`if`** statement
- You can join them together with:
  - **`and`** (which results in a **`True`** value only if both the conditions it joins are **`True`**)
  - **`or`** (which result in a **`True`** value if either of the conditions it joins are **`True`**)

```
if attempts < 5 and password == 'open sesame':
  print('You know the secret!')
```

Another useful library

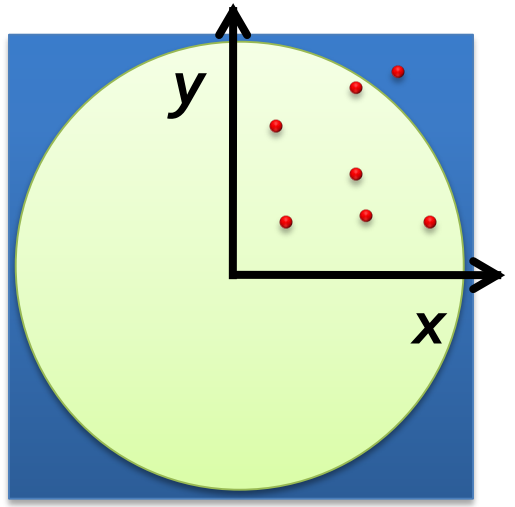
- The **`random`** library lets us produce random numbers
- It has two functions that will be useful to us:
  - **`randint(a, b)`**: Returns a random integer **`n`** where **`a`** ≤ **`n`** ≤ **`b`**
  - **`random()`**: Returns a random floating-point value from [0, 1)
- To use them, import **`random`** and then call the functions qualified by **`random`** followed by a period:

```
import random

dice = random.randint(1, 6)
percentage = random.random()
```

Monte Carlo approximation of π

- We can do something called a Monte Carlo approximation of π
- We "throw" darts at a 1 x 1 square in the upper right corner of a circle with radius 1
- We count the ones that fall inside the circle and divide by the total darts thrown
- That fraction is an estimation of the area of one fourth of the circle
- By multiplying by 4, we approximate π



Monte Carlo approximation function

- Here is a function that performs the Monte Carlo approximation:

```
import random

def monteCarlo(darts):
    hits = 0
    for i in range(darts):
        x = random.random()
        y = random.random()
        if x*x + y*y <= 1.0: # see if dart is in circle
            hits += 1
    return 4.0 * hits / darts
```

Quiz

Upcoming

Next time…

- More on selection statements
- Visualization of Monte Carlo simulation
- We'll mostly have work time for assignments
  - Assignment 1 is due Friday by midnight
  - Assignment 2 will be available to work on as well

- 20 employers in the fields of Engineering and Computer Science
- 20 alumni members attending
- Free professional LinkedIn headshots
- Plenty of food and great conversations
- Build new connections on LinkedIn
- Door prizes
- Network with people in your field
- Learn about possible internships
- Gain new insights about your major
- Required event for all sophomores

ENGINEERING PROFESSIONAL DEVELOPMENT

SEPTEMBER 7, 5PM-7.30PM, @ THE POINT

CAREER JUMPSTART:

ENGINEERING & COMPUTER SCIENCE

Come and network with engineering and computer science alumni and business partners and learn how to be successful in your strategic job and internship search

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Reminders

- Review Chapter 2 of the textbook
- Emergency elections for CS Club
  - Do you want to have a voice in CS Club?
  - Come vote at 4 p.m. this Wednesday, August 30 in Point 113!