Lecture 3: Programming Python

"Python is an experiment in how much freedom programmers need. Too much freedom and nobody can read another's code; too little and expressiveness is endangered."

- Guido van Rossum
Benevolent Dictator for Life

Anoop M. Namboodiri

IIIT Hyderabad

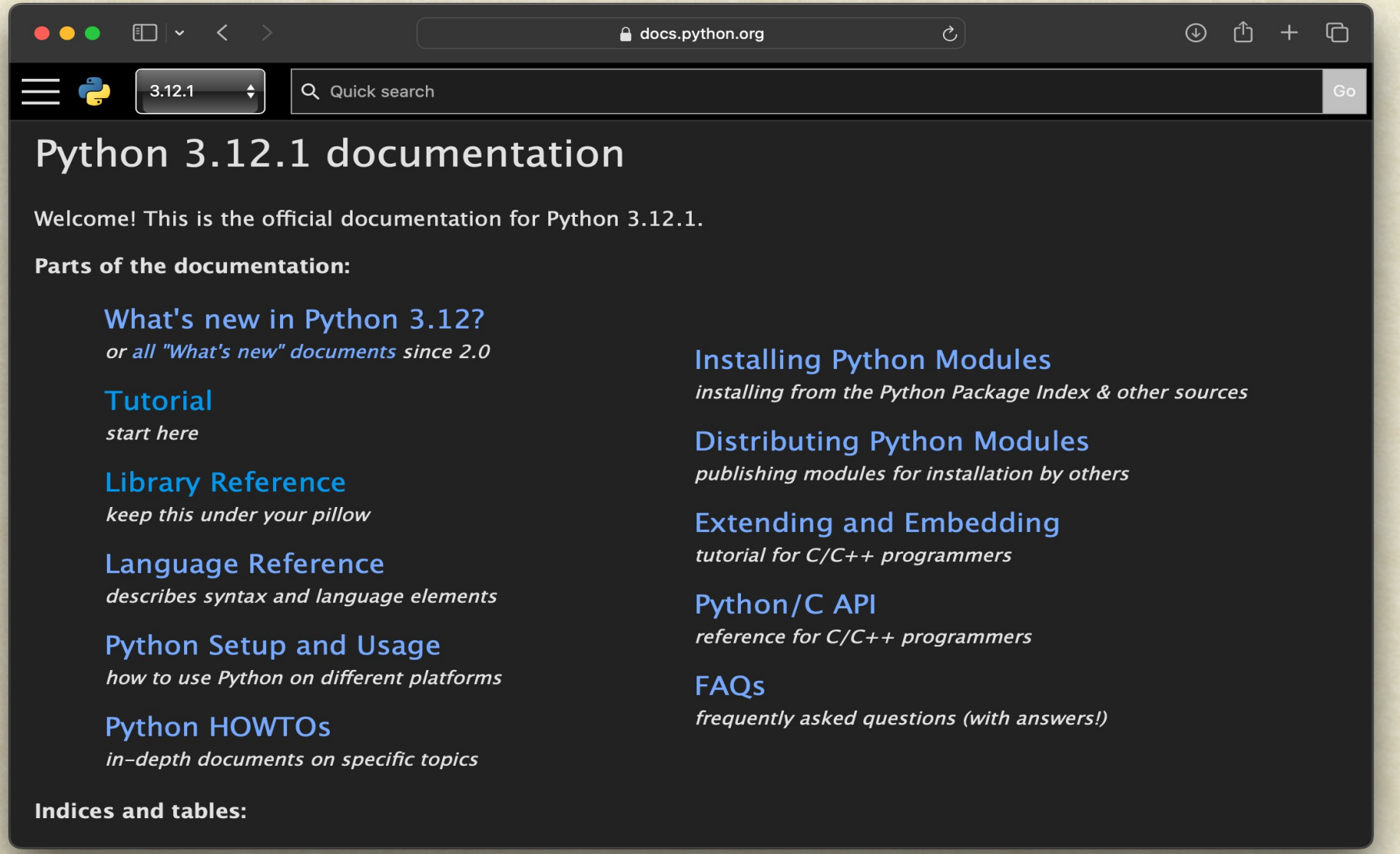
Why Python?

- Scripting Language
- Versatile
- Popular
- Simplicity
- Modules and Frameworks
- Data Visualization, Machine Learning, Cyber Security, Web Servers,
- Extensive Online Documentation
- Community Support

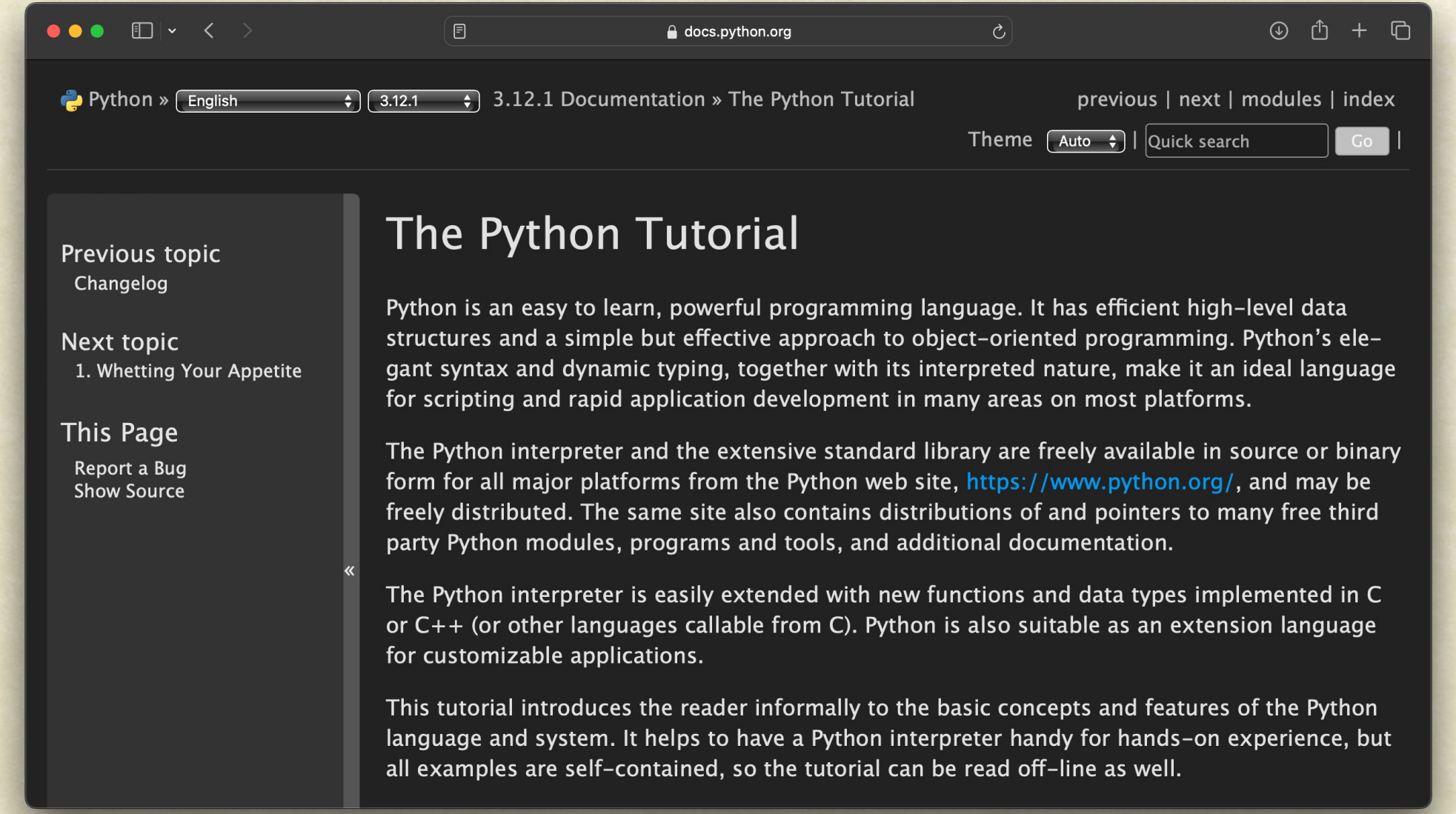
Brief History of Python

- Invented in early 90s by Guido van Rossum
- Named after Monty Python (not the snake)
- Open sourced from the beginning
- A scripting language, but is much more
- Scalable, object oriented and functional from the beginning
- Used by Google from the beginning
- Highly popular

https://docs.python.org/3/



https://docs.python.org/3/tutorial/



Advantages of Python

- Easy to Learn and write error-free code
  - You can start coding today
- Encourages and Insists Coherence (clean/readable code)
  - Limited ways to do a specific task (unlike perl)
  - Forces you to indent
  - Language avoid unnecessary steps (declaration, semicolons)
- Powerful (batteries included)
  - Provides an ever-growing number of powerful modules
- Provides flexibility
  - You can extend the language with additional modules
  - Can make hybrid systems
- Provides Speed
  - Can compile to portable byte code
- Widely used / growing fast

Uses of Python

- Shell tools
  - System admin tools, Command line programs
- Text processing
- Rapid prototyping and development
- Integration of modules from different languages
- Graphical user interfaces
- Database access
- Distributed programming
- Internet scripting

What Gives?

- Slower than C; like any other scripting language
  - Although efficient built-in algorithms and Data structures might offset this
- Delayed error notification
- Lack of profiling tools

Installing Python

- Pre-installed on Unix systems (Linux, Mac OSX).
- Binaries available for Windows
- Latest stable versions are 3.11.7 and 3.12.1
  - We will stick with 3.10 as it works with 3.11 and 3.12
- Several editors and IDEs
  - VIM / Emacs
  - IDLE
  - PyCharm
  - VS Code

Python Interpreter

- Just type python on the command shell (or invoke IDLE)
- Python prompts with a '>>>'

```
>>> 5 + 4 * 3
17
>>> Ctrl+D
```

Running Programs on UNIX

1. Call python program via the python interpreter

```
% python fact.py
```

2. Make a python file directly executable by
   - Adding the appropriate path to your python interpreter as the first line of your script

```
#!/usr/bin/python
```

   - Making the file executable

```
% chmod a+x fact.py
```

   - Invoking file from Unix command line

```
% fact.py
```

Let us Jump Right In

```
#!/usr/bin/python
x = 34 - 23                    # A comment
y = “Hello”                    # Another one
z = 3.45
if z == 3.45 or y == “Hello”:
    x = x + 1
    y = y + “ World”    # String concatenation
print(x)
print(y)
```

Understanding the Code

- Indentation matters to code meaning
  - Block structure indicated by indentation; starts with a **:**
- First assignment to a variable creates it
  - Variable types need not to be declared.
  - Python figures out the object/variable types on its own.
- Assignment is **=** and comparison is **==**
- For numbers, arithmetic operators are as in C
  - Special use of **+** for string
- Logical operators are words (**and**, **or**, **not**) not symbols
- The basic printing command is **print**
- Comments start with a **#**. Rest of the line is ignored

Let's look at it again

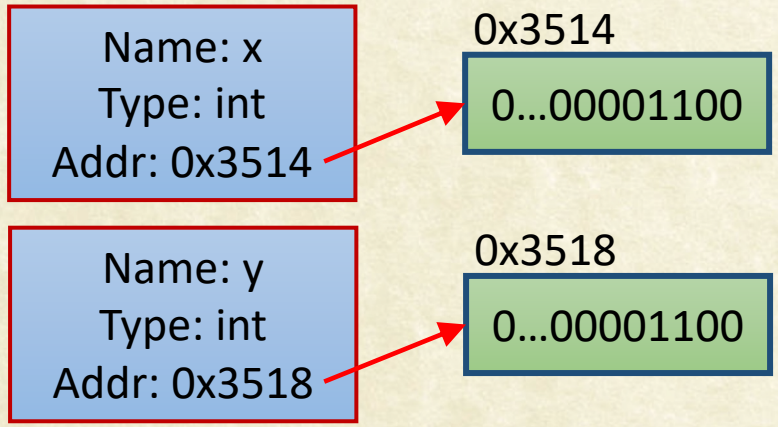
```
#!/usr/bin/python
x = 34 - 23                    # A comment
y = "Hello"                    # Another one
z = 3.45
if z == 3.45 or y == "Hello":
    x = x + 1
    y = y + " World"           # String concatenation
print x
print y
```

Variables in Python

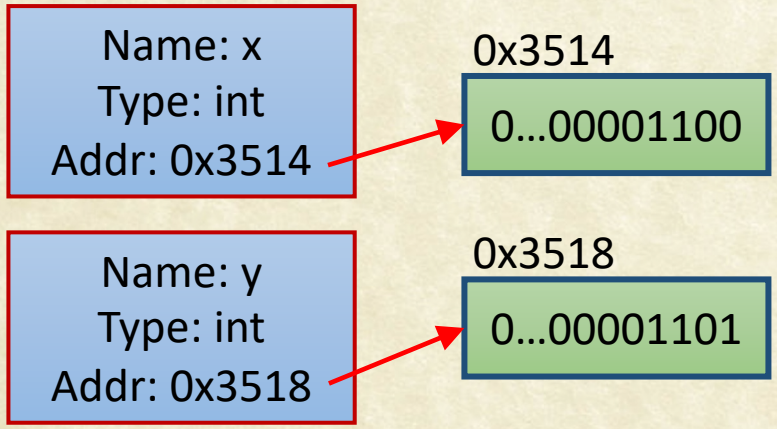
- Variables are not declared; just assigned
- They are created the first time you use it
- Variables are references to objects
- Type info is with the object, not the reference
- Everything in Python is an object (even functions!!)
- The reference may change during execution
- When an object is no-longer referenced, it is deleted automatically (garbage collection)

Variables: C vs. Python

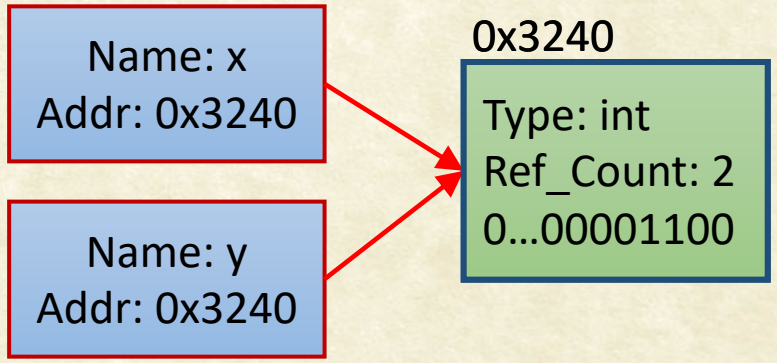
```
int x = y = 12;
```



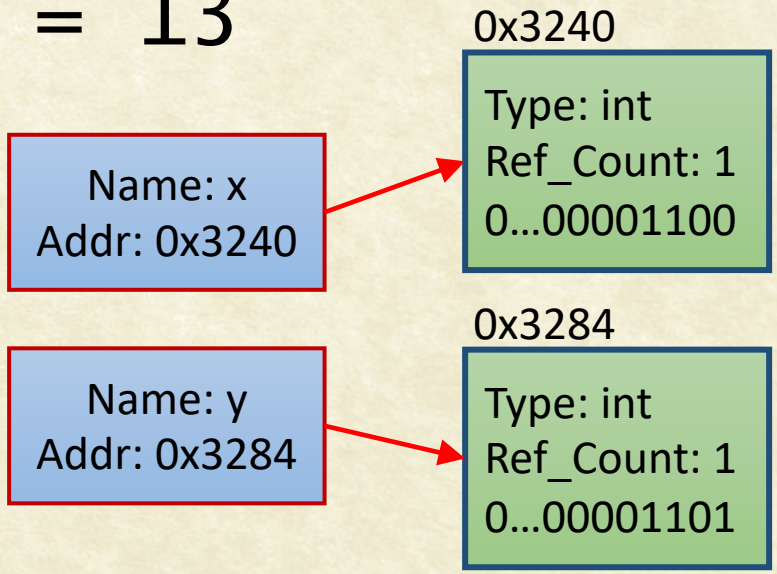

```
y = 13;
```




```
x = y = 12
```




```
y = 13
```



Numbers are Immutable

Code

```
x = 2.5

y = x

y = y+3

print (x, y)
```

What Happens

- x ⟶ 2.5
- y ⟶ 2.5
- x ⟶ 2.5 y ⟶ 5.5

Output: 2.5 5.5

Numbers

- Integer: Equivalent of long in C
- Long Integer: An unbounded integer value
- Float: Equivalent to double precision in C
- Type Convertion
  - int(x) converts x to an integer
  - float(x) converts x to a floating point
- type(var_name) gives the type

```
>>> 132224
132224

>>> 132323 ** 2
17509376329L

>>> 3.1416
3.1416

>> int(2.0)
2
>> float(2)
2.0
```

Arithmetic Operators

- Basic arithmetic operators are the same as in C
  - **+** addition
  - **-** subtraction (and unary negation)
  - ***** multiplication
  - **/** division
  - **%** modulo division
  - **( )** paranthesis
- ****** indicates power operator: **3**2** is **9**
- **//** floored quotient: **5 // 2.3** is **2.0**
- **Brackets -> Exponential -> Mult/Div -> Add/Sub**

Arithmetic Expressions: Practice

• 3 + 2 * 5 - 1	• 12
• 3 + 2 * 5 – 1 / 2	• 12.5
• 3 + 2 * 5 – 1 / 2.	• 12.5
• 3 + 2 * (5 – 1) / 2.0	• 7.0
• 5 + 2 * 5 % 7	• 8
• 3 + 2 * 5 ** 2 % 7	• 4
• 3 + 2 * 5 // 2.8	• 6.0

Boolean Expressions

Things that are False

- The boolean value: False
- The numbers 0 (integer), 0.0 (float) and 0j (complex)
- The empty string ””
- The empty list [], empty dictionary {} and empty set set()

Things that are True

- The boolean value: True
- All non-zero numbers
- Any string containing at least one character
- A non-empty data structure

Boolean Expressions

- Any expression that has a truth value
- Comparison operators
  - Result of a comparison of two objects is a boolean
  - "<" , ">" , "==" , ">=" , "<=” , "!=” have evident meanings
  - "is" ["not”]: true if both operands refer to the same object
  - ["not"] "in”: checks collection membership (more later)
  - Order of evaluation: Left to Right.
  - Comparison operators have lower precedence than Arithmetic
- Logical operators
  - The results of logical operators on boolean is a boolean
  - and, or, not : have evident meanings
  - Order of evaluation: not, and, or
  - Logical operators have lower precedence than comparisons

if: The Conditional Statement

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

- elif stands for else if
- Evaluates the expressions one by one until one is found to be true; then that set of statements (suite) is executed (and no other part of the if statement is executed or evaluated). If all expressions are false, the statements of the else clause, if present, is executed.

if Statement: Examples

```
if num % 10  == 0:
      print("Number is a multiple of 10”)
elif num % 2:
      print("Number is odd”)
else:
      print("Number is even”)

if a <= 5 and c >= 10 or d == “done” and b != 5:
      print(“Right Conditions”)

If  8 <= Time <= 17:
      print(“Working Time”)
```

Let us Code: if

- Write a code that prints if a number is divisible by 11 or not

```
if num % 11:
    print("num is not divisible by 11")
else:
    print("num is divisible by 11")
```

- Write a code that decides if a floating-point number, x, is in the open interval (a,b)

```
if a < x < b:
    print("x is in the open interval ({a},{b})")
else:
    print("x is outside (a,b)")
```

Coding Practice: if

1. Given a circle (center, x and y, and radius r), decide is a given point, (x_1,y_1) is within the circle or not.
2. Write the code that decides if a number is an integer, a complex number or a float
3. Given two integers, write a code that decides if one is a factor of the other or not