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# Python For Engineers I



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# Why Python?

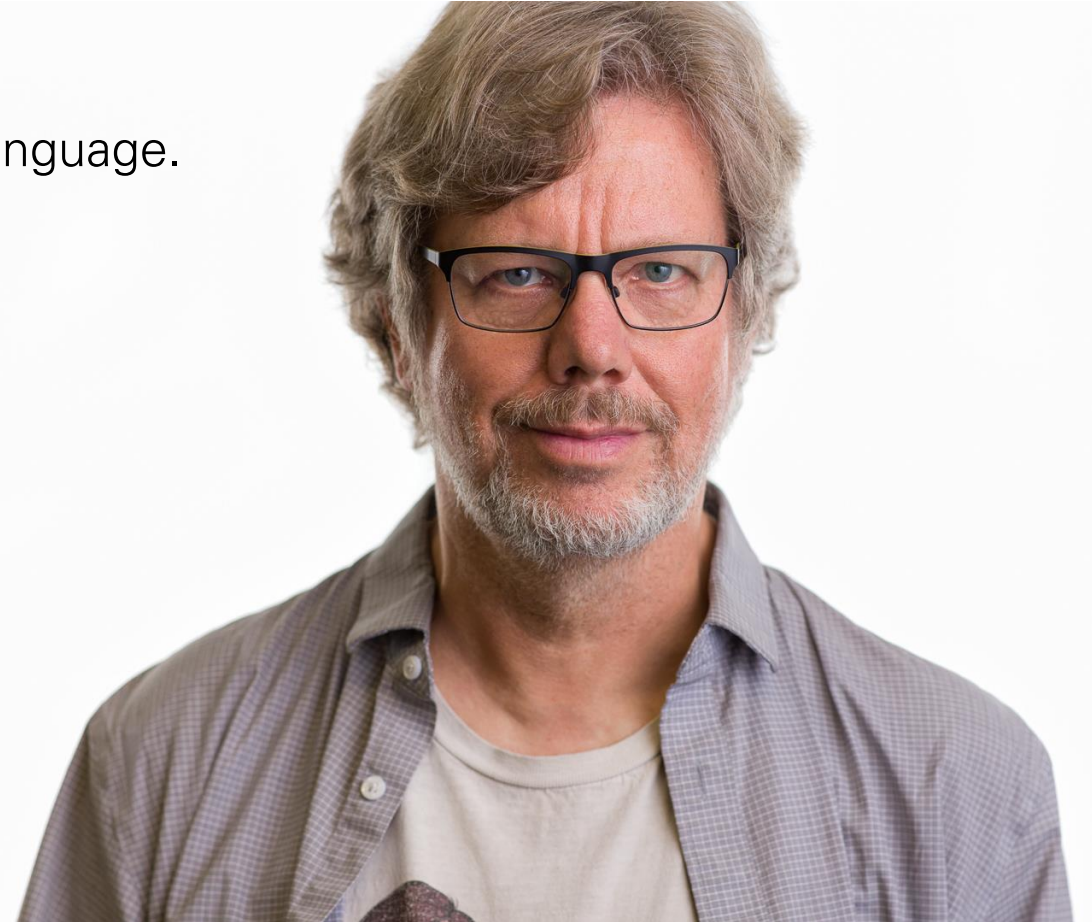
- Used in every software industry.
    - From web development to even embedded devices & Raspberry Pi's.
  - Easy-to-pick-up language that only gets as complex as one requires.
  - Writing Python code feels like Pseudocode.
  - Great language to prototype/test out software concepts and ideas.
  - Nicer to use than Java and MATLAB.
  - Complete Python environment can be embedded into a C(++) program.
    - Allows for faster development time.
    - Wider audience reach to make plugins for an application.
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# Little bit of History

- Brainchild of **Guido Van Rossum** in the Netherlands.
- Conceived in the **late 1980s**.
- Created as a successor of the ABC Programming Language.
- **Python version 1.0 came out January 26, 1994**
  - Python is technically older than Java!
  - Java version 1.0 was released January 23, 1996
- Boomed in popularity in 2003+
- *Core Philosophy*:
  - Beautiful is better than ugly.
  - Explicit is better than implicit.
  - Simple is better than complex.
  - Complex is better than complicated.
  - Readability counts.



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## Our first Python program

```
print('hello world')
```

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# Starting a Python program

- Starting Python programs are extremely simple.
  - Open up a Python IDE on [replit.com](https://replit.com) or [onlinegdb.com](https://onlinegdb.com)
  - Python programs are segmented into individual files, containing Python code, called *scripts*.
  - Python scripts always (and should) end with a **.py** file extension.
  - As Python is mostly a scripting language, Python programs work from a starter script which either contains all the code required or kicks off code that's organized in other Python scripts.
  - All code in Python is sequential\* and flows from top to bottom as the order of execution/interpretation.
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# Basic Data Types of Python

```
# this is a comment
''' single-quote documentation comment '''
""" double-quote documentation comment """
i = 1 # int
b = True # bool
f = 3.33333 # float
s = 'text' # str | string
l = [i, b, f, s] # list
t = (i, b, f, s) # tuple
d = { 'l': l, 't': t } # dict | dictionary
```

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# Creating Variables

- Creating variables is as easy as using a name and then giving it a value directly.
- Everything in Python is an object, including variables!

**# structure**

```
<var name> = <expression>
```

```
<comma separated names> = <comma separated expressions>
```

**# example**

```
a = 1
```

```
a, b, c = 1, 2, 3
```

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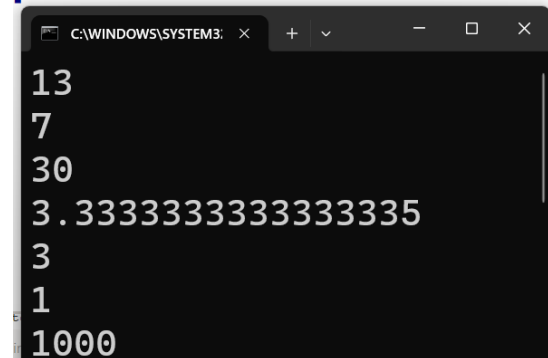
# Type of Numbers

- Integers:
    - Python's integers has no maximum limit!
      - Be aware, the larger your integer values, the more memory required to represent the value.
  - Floats:
    - Has a limit of 64-bits.
  - Complex:
    - Can be made as a value by using the 'j' suffix like: `1j`.
      - Real and Imaginary parts can be retrieved:
        - `1j.real`
        - `1j.imag`
    - You can convert other numbers to complex.
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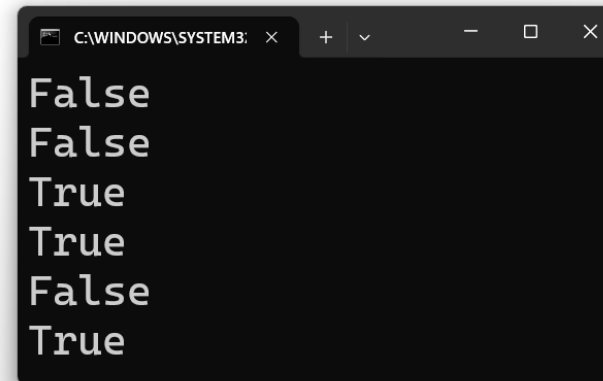
# Numbers and Expressions

```
print(10 + 3)
print(10 - 3)
print(10 * 3)
print(10 / 3)
print(10 // 3) # '/' means integer division.
print(10 % 3)  # '%' is modulo.
print(10 ** 3) # '**' means power!
```



A screenshot of a Windows command prompt window titled 'C:\WINDOWS\SYSTEM32'. It displays the output of the first set of Python code: 13, 7, 30, 3.3333333333333335, 3, 1, and 1000, each on a new line.

```
print(10 < 3)      # 10 less than 3
print(10 <= 3)     # 10 less than-equal to 3
print(10 > 3)      # 10 greater than 3
print(10 >= 3)     # 10 greater than-equal 3
print(10 == 3)     # 10 equal to 3
print(10 != 3)     # 10 not equal to 3
```



A screenshot of a Windows command prompt window titled 'C:\WINDOWS\SYSTEM32'. It displays the output of the second set of Python code: False, False, True, True, False, and True, each on a new line.

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# Other Operators

# logical operators

a, b = True, False

print(a and b) # False

print(a or b) # True

print(not a) # False

print(not b and (a or b)) # True

# bitwise operators

# only works for int objects.

# AND operator - &

print(1 & 3) # prints 1

# OR operator - |

print(1 | 4) # prints 5

# XOR operator - ^

print(1 ^ 3) # prints 2

# NOT operator - ~

print(~1) # prints -2

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# Compound Assignment Operators

# compound assignment structure.

`<var> <op> = <expression>`

# same as doing:

`<var1> = <var1> <op> <expression>`

# compound assignment.

`a = 10`

`a += 1` # add - 'a' is now 11

`a -= 4` # sub - 'a' is now 7

`a *= 3` # mul - 'a' is now 21

`a /= 2` # div - 'a' is now 10

`a %= 4` # mod - 'a' is now 2

`a **= 5` # pow - 'a' is now 32

`a |= 1` # OR - 'a' is now 33

`a &= 1` # AND - 'a' is now 1

`a ^= 1` # XOR - 'a' is now 0

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# Identity Operators

```
# identity operators
# 'is' checks if same object!
x = 'a'
x += 'bc'
y = 'abc'
print(x == y)      # True - Same Value
print(x is y)      # False - NOT same object!
print(x is not y)  # True
```

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# Strings - Basics

- Can be created using single or double quotes!

```
my_name = "peter"  
print(my_name[3])    # prints 2nd 'e'.
```

```
# strings can be added together.
```

```
my_name += 'griffin'  
print(my_name)    # prints 'peter griffin'.
```

```
# multiplying a string by a number repeats it.
```

- Strings can also be indexed like an array.

```
my_name *= 3  
print(my_name)
```

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## Data Conversion

# structure

<type\_name>(<expression>)

# example, convert str, float, & bool to int.

a, b, c = int('1'), int(1.5), int(True)

print(a, b, c)      # 1, 1, 1

# some data can't be converted properly

# ValueError here.

x = int('1.5')

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# Control Flow – If Statements

```
if <expression> :  
    → <statements>
```

```
if <expression> :  
    → <statements>  
else:  
    → <statements>
```

```
if <expression> :  
    → <statements>  
elif <expression> :  
    → <statements>  
else:  
    → <statements>
```

```
a, b = 100, 10 * 5  
if a < b:  
    → print('a is less than b')  
elif a > b:  
    → print('a is greater than b')  
else:  
    → print('a is equal to b')
```

```
a = 100  
if (a & 1) == 0:  
    → print('a is odd')  
else:  
    → print('a is even')
```

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# Control Flow – While Loops

```
while <expression> :  
    →<statements>
```

```
while <expression> :  
    →<statements>
```

```
else:  
    →<statements>
```

```
a = int(input('enter a: '))  
b = int(input('enter b: '))  
while a < b:  
    →print(b - a)  
    →a += 1  
else:  
    →print("loop is done.")
```

- Best to use for data that has an unknown end.

- Example with  $3n+1$  is called the Collatz Conjecture.

- The 'else' part runs after the loop finishes.

```
n = int(input('enter a number: '))  
while n != 1:  
    →print(n)  
    →if n % 2 == 0:  
        →→n //= 2  
    →else:  
        →→n = 3 * n + 1
```

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# Control Flow – For Loops

```
for <var> in <expression> :  
    → <statements>
```

# when loop ends, the 'else' part executes!

```
for <var> in <expression> :  
    → <statements>  
else:  
    → <statements>
```

```
# loop 'a' from 0 to 99 or [0, 100)  
for a in range(100):  
    → print(a)
```

```
# loop 'b' starting at 80 | [80, 100)  
for b in range(80, 100):  
    → print(b)
```

```
# loop 'c' starting at 72 | [72, 100)  
# increment 'c' by 3 instead of 1  
for c in range(72, 100, 3):  
    → print(c)
```

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# Control Flow – Loop Controls

# 'continue' – skips current iteration of loop

# 'break' – stops the loop entirely.

# they can be used in ANY type of loop.

```
for i in range(30):
```

```
    > # skip printing multiples of 5
```

```
    > # and move onto the next iteration.
```

```
    > if i % 5 == 0:
```

```
        > continue
```

```
    > print(i)
```

- **break** and **continue**.

- Can ONLY be used in a loop, any kind of loop.

```
# break stops the 'else' part from executing.
```

```
n, factorial = 5, 1
```

```
for i in range(1, n + 1):
```

```
    > factorial *= i
```

```
    > if factorial > 50:
```

```
        > print("Factorial exceeds 50!")
```

```
        > break
```

```
else:
```

```
    > print("Factorial:", factorial)
```

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# Functions I

```
def <name here> (<parameters here>) :  
    ><statements here>
```

```
def add_mul1(a, b, c):  
    >return a + b * c
```

# same function with OPTIONAL type annotations.

```
def add_mul2(a: int, b: int, c: int) -> int:  
    >return a + b * c
```

```
def no_params1():  
    >return 1.0
```

```
# this will return 2 + 4 * 6  
print( add_mul2(2, 4, 6) )
```

```
def no_params2():  
    >pass # function has no code!
```

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## Functions II

# Python Functions can

# return multiple objects!

```
def cube_and_root(num):
```

```
    → if num < 0.0:
```

```
        → → return 0.0, 0.0, False
```

```
    → return num**3, num**(1/3), True
```

# ask for a numerical input

```
str_entry = input('enter a positive number: ')
```

# convert the input to a decimal point value.

```
num_entry = float(str_entry)
```

```
print(cube_and_root(num_entry))
```

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## Word Problems Set A

```
a = int(input('enter an int: '))
```

1. Square the value of **a** then print **a**.
  2. if **a** is over 50, add 5 more to it then print **a**.
  3. If **a** is negative, multiply **a** with -1.
  4. While **a** is less than 10, print **a** then increase **a** by 2.
  5. While **a** is less than 20 and **a** is an even number, print **a** and then increase **a** by 4.
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## Word Problems Set B

```
a = int(input('enter an int #1: '))  
b = int(input('enter an int #2: '))
```

1. Print the sum of **a** and **b**.
  2. Print the difference of **a** and **b**.
  3. Print if **a** is greater than **b**.
  4. If **a**, multiplied by 2, is greater than **b**, print that **a** is bigger. Else, print **b** is greater.
  5. Swap the values of **a** and **b**.
  6. Print the multiplication of **a** and **b** if both **a** and **b** are even, print the division of **a** and **b** if they're both odd, print the addition of **a** and **b** if **a** is even but **b** is odd, print the subtraction of **a** and **b** if **a** is odd but **b** is even.
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## Abstract Word Problem #1

- Using `input()`, try to create a small program that doesn't stop running (basic interactive program) unless a user specifically wants to quit.
    - Don't forget you can give `input` a prompt message as a function argument!
    - You don't necessarily need a variable but if it helps, use one.
    - Don't focus on efficiency or think there's only one way to accomplish this.
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## Abstract Word Problem #2

- Make a program that asks the user for 3 coefficients of the values in the quadratic formula:  
 $Ax^2 + Bx + C$
- Best to make this as a function so we can return two x values.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$