UMassAmherst
The Commonwealth's Flagship Campus

Intro to Python

ECE 241 – Data Structures

Fall 2018

What is Python

- *“Python is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Python’s elegant syntax and dynamic typing, together with its interpreted nature, make it an ideal language for scripting and rapid application development in many areas on most platforms”.*

Source: https://docs.python.org/3/tutorial/index.html

Syntax for Python 3*

```
>>> 3 + 4 - 2
5
```
Sum/Subtraction

```
>>> 3 * 4
12
```
Multiplication

```
>>> 12 / 3
4.0
>>> 10 / 3
3.3333333333333335
```
Division

```
>>> 2**7
128
```
Exponentiation

```
>>> 12 % 5
2
```
Remainder

```
>>> True
True
```
Boolean

```
>>> 4 == 2
False
```
Comparison

*Python 2 will not be maintained past 2020

Declaring variables

```
>>> a = 5
>>> b = 7.0
>>> a + b
12.0
>>> c = True
>>> s1 = ‘Hello, world!’
>>> s2 = “Another string”
```

Notice:

No type declaration!

No semicolon!

Strings can be declared with single or double quotes, same result.

Strings are list of characters. More on that later.

*The Python Enhancement Proposal (PEP) 484 introduced Type Annotations (see appendix)

Loops - For

```
>>> for i in range(5):
...     print(i)
0
1
2
3
4
```

Notice:

No brackets!
Watch indentation! (4 spaces)

Loops - While

```
>>> counter = 1
>>> while counter <= 5:
...     print (counter)
...     counter += 1
1
2
3
4
5
```

No Do-While loops

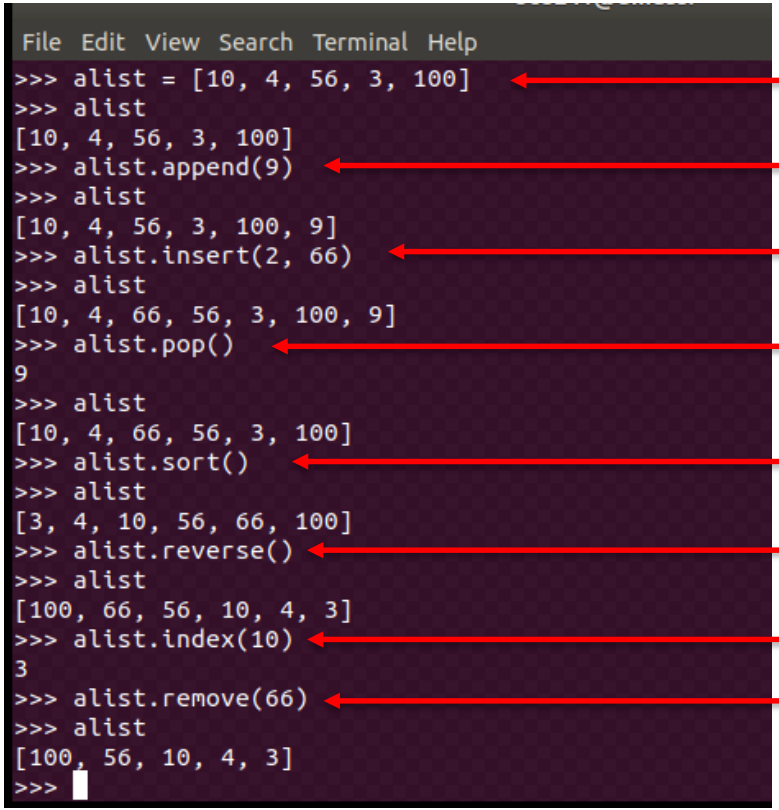
Control statements

```
>>> x = int(input('Enter a number: '))
Enter a number: 5
>>> if x < 0:
...     x = 0
...     print('x is negative')
... elif x == 0:
...     print(x)
... else:
...     print(x)
...
5
```

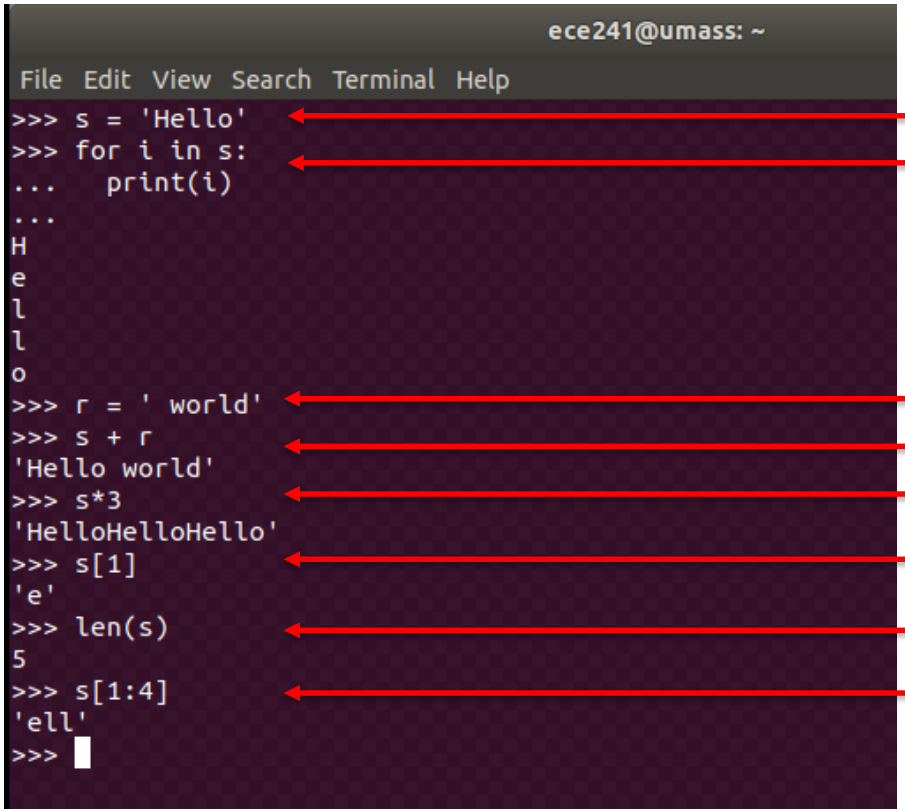
No Switch/Case

‘elif’ is short for Else If

Lists


File Edit View Search Terminal Help
>>> alist = [10, 4, 56, 3, 100]
>>> alist
[10, 4, 56, 3, 100]
>>> alist.append(9)
>>> alist
[10, 4, 56, 3, 100, 9]
>>> alist.insert(2, 66)
>>> alist
[10, 4, 66, 56, 3, 100, 9]
>>> alist.pop()
9
>>> alist
[10, 4, 66, 56, 3, 100]
>>> alist.sort()
>>> alist
[3, 4, 10, 56, 66, 100]
>>> alist.reverse()
>>> alist
[100, 66, 56, 10, 4, 3]
>>> alist.index(10)
3
>>> alist.remove(66)
>>> alist
[100, 56, 10, 4, 3]
>>>
Create a list
Append an element
Insert element at position
Pop an element and remove from list
Sort list
Sort descending
Returns the index of first occurrence of item
Remove first occurrence of item

String/List operations



List comprehensions

```
>>> squares = []
>>> for i in range(5):
...     squares.append(i**2)
...
>>> squares
[0, 1, 4, 9, 16]
>>>
```

Create an empty list and append the squares of i

```
>>> squares = [i**2 for i in range(5)]
>>> squares
[0, 1, 4, 9, 16]
>>>
```

We can accomplish this with list comprehension in one line

Tuples

- Tuples are very similar to **Lists** in the sense that they are heterogeneous, but similar to **Strings** in the sense that they are immutable.

```
>>> atuple = (34, 'abc', False, 5.03)
>>> atuple
(34, 'abc', False, 5.03)
>>> len(atuple)
4
>>> atuple*2
(34, 'abc', False, 5.03, 34, 'abc', False, 5.03)
>>> atuple[1:3]
('abc', False)
>>> atuple[2] = True
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: 'tuple' object does not support item assignment
>>>
```

Python yells at you when you try to modify a Tuple

Dictionaries

- Dictionaries are unordered lists of **‘key’ : ‘value’** pairs.
- Examples of dictionaries in real life:
  - Phone book (names : phone numbers)
  - Word dictionary (word : meaning)
  - Password file (user : password hash)
  - Gradebook (course : grade)
- In Python, dictionary keys are unique.

Dictionaries

```
>>> food_allergies = {'banana':'no', 'peanuts':'yes', 'milk':'yes', 'eggs':'no'}
>>> food_allergies['shellfish'] = 'yes'
>>> food_allergies['pineapple'] = 'no'
>>> food_allergies
{'banana': 'no', 'peanuts': 'yes', 'milk': 'yes', 'eggs': 'no', 'shellfish': 'yes'
, 'pineapple': 'no'}
>>> food_allergies.keys()
dict_keys(['banana', 'peanuts', 'milk', 'eggs', 'shellfish', 'pineapple'])
>>> food_allergies.values()
dict_values(['no', 'yes', 'yes', 'no', 'yes', 'no'])
>>> del food_allergies['banana']
>>> food_allergies
{'peanuts': 'yes', 'milk': 'yes', 'eggs': 'no', 'shellfish': 'yes', 'pineapple': '
no'}
>>>
```

Create a dictionary

Add key:value

Display keys

Display values

Delete item

Remember, dictionary keys are unordered and unique!
The order in which keys are added is based on the idea of hashing, discussed later in the course.

Functions

- Functions provide an abstraction, or a black box, to the programmer.
- In Python, the keyword **def** defines a function, followed by the function **name**, and a list of **parameters**.
- For example, the function **print_to_std_out** prints a string on the screen.

```
>>> def print_to_std_out(astring):
...     print(astring)
...
>>> print_to_std_out('Hello, world!')
Hello, world!
>>>
```

Classes

Template:

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

# Fraction.py

class Fraction:
        # This is the constructor
        def __init__(self, num, den):
                self.num = num
                self.den = den

        # Overriding the __str()__ standard method
        def __str__(self):
                return str(self.num) + '/' + str(self.den)

        # Declaring the show() method
        def show(self):
                print (self.num,'/',self.den)
```

Usage:

```
>>> from Fraction import Fraction
>>>
>>> f1 = Fraction(1, 4)
>>> print (f1)
1/4
>>> print (f1.__str__())
1/4
>>> f1.show()
1 / 4
>>>
```

More resources

- Python 3 documentation
  https://docs.python.org/3/tutorial/datastructures.html
- Stack Overflow
  https://stackoverflow.com/questions/tagged/python
  (your questions are most likely already answered)

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Appendix – PEP 484 – Type Hints

- Python is a dynamic typed language, i.e., variable types are associated with the value, not with the variable itself. For example:

```
>>> year = 2018
>>> print(year)
2018
>>> year = 'two thousand eighteen'
>>> print(year)
two thousand eighteen
>>>
```

- Type hints help developers to understand the code and what a variable should be, but it does not alter the program execution. i.e., type hints are not enforced in runtime.

Appendix – PEP 484 – Type Hints

- Examples

```
>>> year: int = 2018
>>> print(year)
2018
>>> year: int = 'two thousand eighteen'
>>> print(year)
two thousand eighteen
```

Type hint that variable `year` is intended to be of integer type.
But it does not prevent us from assigning a string.

```
>>> def greeting(name: str) -> str:
...     return 'Hello ' + name
...
>>> print(greeting('student'))
Hello student
```

One can also use type hints on a function. Here, the input variable `name` is intended to be a string, and the function is intended to return a string.

See PEP 484 for more details