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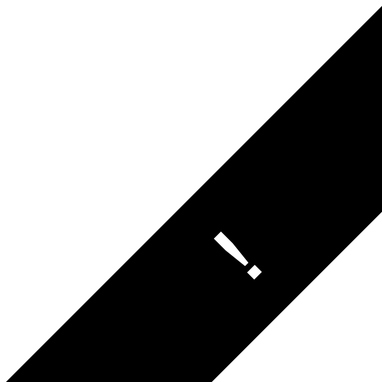
CSCI 120
Introduction to CompSci and Programming I
Review

Jetic Gū

Announcement

- No lab 10
- Last Week
  - No class this Friday
  - Tomorrow’s class: consider it an extra office hour
  - Today: 1st half review, 2nd half QA



Overview

- Focus: Python Programming
- Architecture: von Neumann
- Core Ideas:
    1. Native Data Structures
    2. Subroutines
    3. Algorithm Analysis

P1
Basics

Native Data Structures

Review

Why Python

- Easy, Powerful
  - Loads of useful libraries such as Panda, PyTorch, etc.
- Scientific Computation
  - Autonomous Driving, Machine Translation, Virtual Assistant, etc.
- Data Analysis
  - Big Data, Smart Business, etc.

Review

P1
Basics

Python Versions

- Python 2.7
  - Most of the tutorials on the Internet
  - Huge codebases on the Internet
  - Discontinued since 2020. Do NOT use Python 2 now
- Python 3
  - Current version 3.9, but anything after 3.6 should be fine
  - Differences: better optimisation, more features, improved security and stability

Review

P1
Basics

Python Variables

- In Python, all variables are objects
  - Numbers: `int`, `float`
    - Boolean: `True`, `False` (yes, booleans are actually numbers)
  - String: `str`
  - Advanced native data structures: `list`, `dict`
  - Object-Oriented Programming: `class`
  - `None`

Review

P1
Basics

Python Variables

- Type Conversion
  - Numbers: `int(x), float(x), str(x)`
    Type conversion is automatic between `float` and `int` when doing calculation
  - `list` and `tuple`
    - You can convert a `tuple` to a `list`; this might not work v.v.
    - You can modify elements in a `list`; You cannot use a `list` as a `key` in `dict`
    - You cannot modify elements in a `tuple`; You can use a `tuple` as a `key` in `dict`

Review

P1
Basics

Python Variables

- Numerical Arithmetics
  - `x + y`
  - `x - y`
  - `x ** y`
  - `x / y`
  - `x // y`
  - `x / float(y)`
  - `x % y`

- String
  - `str(x) + " + " + str(y)`

Review

P1
Basics

Python Variables

- strings
  - strings are like lists of characters

```
a = 'Hello world\twhatsup'
b = "cheese\tburger\n"
print(len(a), len(b))
a.lower()
b.upper()
a.split()
b.strip()
" ".join(["Hello", "World"])
```

Review

List

- Collections: `list`, this is like mutable arrays.

```
names = ['Fry', 'Leela']
names[0] == 'Fry'
names.append('Bender')
len(names) == 3
print(names)
names.extend(['Amy', 'Prof'])
print(names)
names = []              # Creates an empty list
names = list()          # Also creates an empty list
stuff = [1, ['hi', 'bye'], -0.12, None]  # Can mix types
```

Review

List

- `list` methods. Assuming `a` is a list of numbers, here are some common ones:
  - `a.append(stuff)`
  - `a.insert(index, stuff)`
  - `a.sort(), a.reverse()`

Review

List

- Slicing a `list` (not a pizza)

- Basic format: `some_list[start_index:end_index]`

```
numbers = [0, 1, 2, 3, 4, 5, 6]
numbers[0:3] == numbers[:3] == [0, 1, 2]
numbers[5:] == numbers[5:7] == [5, 6]
numbers[:] == numbers = [0, 1, 2, 3, 4, 5, 6]
numbers[-1] == 6                  # Negative index wraps around
numbers[-3:] == [4, 5, 6]
numbers[3:-2] == [3, 4]           # Can mix and match
```

Review

Tuples

- Collections: `tuple`, these are immutable arrays

```
names = ('Charles', 'The Cat')  # Note the parentheses
names[0] == 'Charles'
len(names) == 2
print(names)
names[0] = 'Richard' # This will not work
empty = tuple()      # Empty tuple
empty = (,)          # Empty tuple
single = (10,)       # Single-element tuple. Comma matters!
```

- Same slicing like `list`

Review

Dict

- Collections: `dict`, essentially `key-value` map

```
Age = dict()                    # Empty dictionary
Age = {}                        # Empty dictionary
Age = {'Jetic': '44'}           # Dictionary with one item
Age['Papa'] = '68'
print('Jetic' in Age)
print('Kevin' in Age)
print(Age['Jetic'])
del Age['Papa']
print(Age)
```

Review

Dict

- `dict` methods. Assuming `a` is a `dict` object
  - `a.items()`
    Return `list` of `(key, value)` tuples
  - `a.values()`
    Return `list` of all `value`s
  - `a.keys()`
    Return `list` of all `key`s

Review

P1
Basics

Class

- `Class` are custom data structures
- `Class`es can have methods, and attributes
- `object`s of the same `class` share all methods, but have their own attribute values
- Special method: `def __init__(self,…)`

Review

Python Routines

Review

Indentation

- Routines are created using indentation
- You can use space (2, 3, 4) or tabs, but be consistent!
- What is the following code doing?

```
def fib(n):
  # Indent level 1: function body
  if n <= 1:
    # Indent level 2: if statement body
    return 1
  else:
    # Indent level 2: else statement body
  return fib(n-1)+fib(n-2)
```

Review

Loops

```
for name in ['Fry', 'Leela', 'Bender']:
  print('Hi ' + name + '!')
while True:
  print 'We\'re stuck in a loop...'
  break
```

- You can create a new list using `for` loops

```
a = [word.upper() for word in words]
```

- You can have `for` loops inside `for` loops

```
for i in range(n):
  for j in range(m):
    print(matrix[i][j])
```

Review

Loops

- `range()` function returns an iterator, which can be converted to a `list` when not used in a `for` loop
  - `list(range(10))`
  - `range()` has starting indices, `list(range(5, 10))`
  - `range()` has steps, `list(range(5, 10, 2))`

Review

if conditions

```
if condition:
  do stuff
else:
  do other stuff
```

- Conditions
  - See if something is `None`
    ```
    if x is None:
        do stuff
    ```
  - See if something is not `None`
    ```
    if x is not None:
        do stuff
    ```

Review

if conditions

- Conditions
  - `key` inside a `dict`

```
if key in aDict:
    do stuff
```

  - `key` not inside a `dict`

```
if key not in aDict:
    do stuff
```

Review

if conditions

- Conditions
  - Multiple conditions: use boolean operators (`and`, `or`, `not`)

```
if Leela.likes(Fry) and Fry.likes(Leela):
    break
```

Review

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Routines

Functions / Methods

- Declaration

```
def func(params):
  do stuff
  return values    # optional
```

- Parameters:
  - No parameter: `def func()`
  - Fixed parameter: `def func(a, b, c)`
  - Fixed parameters with defaults: `def func(a, b='1', c=None)`
    - parameters with default values are considered optional and you cannot have non-optionals after optionals

Review

Functions / Methods

- Function calls

```
func(param)
a = func()    # No param or all using defaults
a = func('Jetic', 44)  # Multiple parameters
a = func(name='Jetic', age=44)  # Named parameters
a = func(age=44, name='Jetic')  # Equivalent to above
```

Review

Algorithm Analysis

Review

Understanding an algorithm

- Reading the code

```
def fib(n):
  if n <= 1:
    return 1
  else:
    return fib(n-1)+fib(n-2)
```

- Line-by-line: what is each line doing? what is the complexity of each line?
- Finally: what is the whole code doing? what is the overall complexity?

Review

P3
Algorithms

Understanding an algorithm

- Reading the pseudocode

```
Function travel(root)
  root.visited()
  if root has left child:
    travel(root.left)
  if root has right child:
    travel(root.right)
```

- Pseudocode may not be real programming code, but should be understandable

Review

P3
Algorithms

The Big-O Notation

- Mathematical notation that describes the limiting behaviour of a function when the argument tends towards a particular value or infinity
  - Ignore constants
  - Ignore terms with lesser power
- Time complexity
- Memory complexity

Review

P3
Algorithms

Important Algorithms

- Binary Search
- Binary Tree Preorder Traversal

Review