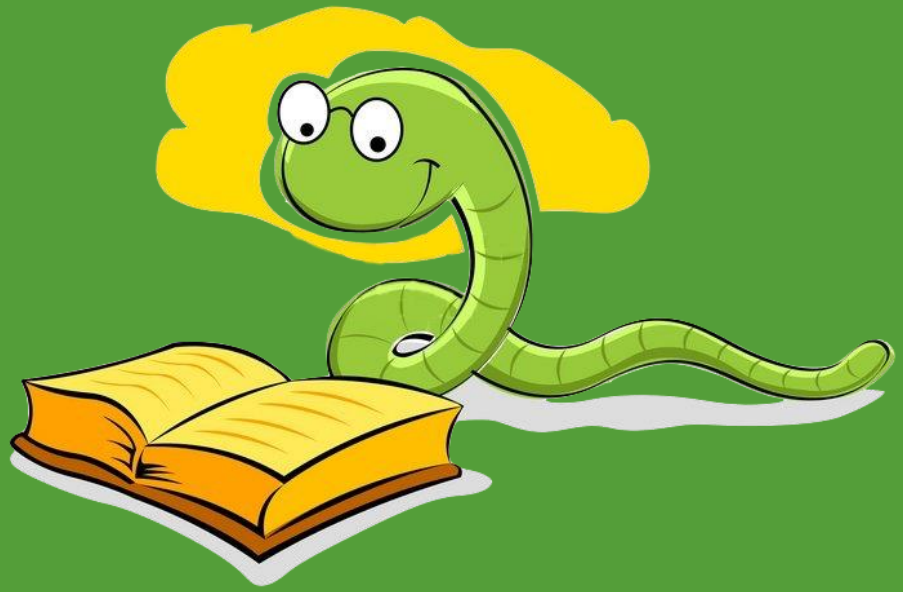
TUTORIAL 9



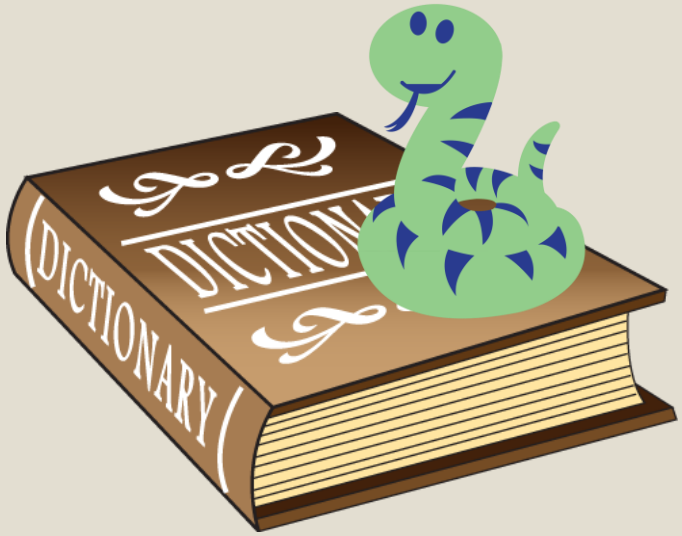
DICTIONARIES AND CLASSES

REMINDER/UPDATE

- Assignment 8 will be due on April 15th.
  - We recommend that you start this assignment early, so you have more time to seek help.
- Stay tuned to Piazza for information about the development of the last few weeks of the course.
- Office Hours are now available by request, see Piazza for details.

OVERVIEW

- Dictionaries
- Classes
  - `__init__`
  - `__repr__`
  - `__eq__`
  - User defined class methods



DICTIONARIES

```
d = {key1:value1, key2:value2, …}
```

- Each element has a key (a way to look up info) and a value associated with the key
- Unordered collection of key-value pairs

```
{keyX: valueX, keyY: valueY} == {keyY: valueY, keyX: valueX} => True
```

- Like a REAL dictionary (a real dictionary is a *word-definition* pair; word = key, definition = value)

USEFUL DICTIONARIES FUNCTIONS

- `d[k]` → Get the value of `k`
- `d[k]= v` → Set key-value pair where key = `k` and value = `v`
- `d.keys()` → Creates a view of all the keys in `d`
- `d.values()` → Creates a view of all the values in `d`
- `d.pop(k)` → Removes key-value pair of `k` from `d` and returns the value associated with `k`
- `k in d` → returns **`True`** if `k` is a key in `d`

USEFUL DICTIONARIES FUNCTIONS (RUNTIMES)

- `d[k]` → O(1)
- `d[k]= v` → O(1)
- `list(d.keys())` → O(n)
- `list(d.values())` → O(n)
- `d.pop(k)` → O(1)
- `k in d` → O(1)

Note: the dictionary runtimes are more complicated than this slide reflects, but we will work under these assumptions.

QUESTION 1: LIST_MULTIPLES

Write a function `list_multiples` that consumes a string `s` and returns a list in ***alphabetical order*** containing every character in `s` that appears more than once. Use dictionaries.

Examples:

```
list_multiples("abcd") => []
list_multiples("bacaba") => ["a", "b"]
list_multiples("gtddyucaadsa") => ["a", "d"]
```

QUESTION 2: XOR

Write a function `xor` that consumes two dictionaries (`d1` and `d2`) and returns a dictionary.

The returned dictionary will contain all the keys that appear in exactly one of `d1` or `d2` (but not both).

The value associated with each key will be the same as the one found in the original dictionary.

EXAMPLES

```
d1 = {1:'a', 2:'b', 3:'c', 4:'d'}
d2 = {5:'e', 6:'f', 7:'g', 8:'h'}

xor(d1,d2) => {1:'a', 2:'b', 3:'c', 4:'d',
               5:'e', 6:'f', 7:'g', 8:'h'}

d3 = {5:'q', 6:'l', 7:'c', 8:'e'}

xor(d2,d3) => {}

d4 = {1:'a', 3:'f', 8:'u', 9:'t'}

xor(d1,d4) => {2:'b', 4:'d', 8:’u', 9:'t'}
```

CLASSES

- Python’s version of Racket structures
- Allows related information to be grouped together
- We’ll use `__init__`, `__repr__`, and `__eq__` with the class
- We'll also write our own class methods
- We will use classes like we use any other type of data: lists, dictionaries, and as arguments and return values for external functions

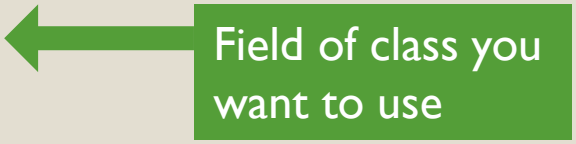
__init__ (initialize)

```
class name:
    def __init__(self, f1, f2, …):
        self.field1 = f1
        self.field2 = f2
            …                …
```

- Creates **an object of this class:**

```
x = name(field1_val,field2_val,…)
```

- Call the fields by: `x.field1`



- *Racket's* version:

```
(define-struct name (field1_val field2_val …))
(name-field1 x)
```

__repr__

- If we try to print a class object, we'd get something like

```
<__main__.name instance at 0x12361c0>
```

- We can print a more informative message using the `__repr__` command within the class definition

```
def __repr__(self):
    return "name: {0},{1},…"\
           .format(self.field1,
                   self.field2,…)
```

You can put the class representation into any form you like, so long as you understand what each field is

- `__repr__` does not print anything itself; it is called indirectly when we print or otherwise display an object from the class
- Think of `__repr__` as "representation"

__eq__

```
def __eq__(self, other):
    return isinstance(other, name) and \
        self.field1 == other.field1 and \
        self.field2 == other.field2 and \
            ...             ...
```

- It will allow you to compare objects to see if they have same fields:

x == y => **True**

CLASS METHODS

```
class name:
  def __init__(self, f1, f2, …):…
  def __repr__(self):…
  def __eq__(self, other):…

  def foo(self, …):
    # Access field values: self.field1, …
    # fn may update field values, use field values
    #   for calculations, print information, or
    #   return information
```

Note: * `self` is an implicit parameter; we don't need to provide it

DEFINITION FOR THE STUDENT CLASS

The remaining questions will use the following class:

A **`Student`** is a class with fields **`name, faculty, program, year`** , and **`courses`**

- **`name`** is a non-empty string representing the student's full name;
- **`faculty`** is a non-empty string representing the student's faculty;
  - We will use the full version; e.g `"Environment"` rather than `"Env"`
- **`program`** is a non-empty string representing the person's program (or major);
- **`year`** is a natural number representing the student's academic year;
- **`courses`** is a list of strings representing the courses the student is taking in the current term;

EXAMPLES OF STUDENT OBJECTS:

- `YQ_W = Student("Y.Q. Wang", "Mathematics", "Math/Teaching", 2, ["MATH 239", "MATH 237", "Math 235"])`

- `Paul_S = Student("Paul Shen", "Applied Health Science", "Health Studies", 2, ["Math 106", "CS 234", "CS 200", "HLTH 273", "ECON 101"])`

- `Dan_W = Student("Dan Wolczuk", "Mathematics", "Pure \ Mathematics", 1, ["MATH 148", "MATH 146", "CS 116"])`

- `Logan_S = Student("Logan Stanley", "Science", "Chemistry", 1, ["CHEM 120", "MATH 127", "PHYS 111"])`

QUESTION 3: ADD_COURSES

Write a class method `add_courses` in the `Student` class, which consumes a `Student` object, `self`, and a list of strings, `courses`. It adds the courses in `courses` to the student's list of courses and prints a message indicating the number of courses the student is now taking.

Examples:

```
Paul_S.add_courses(["HLTH 230"]) will print
"Paul Shen is currently taking 6 course(s)."
and Paul_S.courses becomes ["Math 106", "CS
234", "CS 200", "HLTH 273", "ECON 101", "HLTH
230"])
```

```
YQ_W.add_courses([]) will print
"Y.Q. Wang is currently taking 3 course(s)."
and YQ_W.courses is unchanged
```

QUESTION 4: ORGANIZE_BY_YEAR

Write a function `organize_by_year` outside the class, which consumes a list of `Student` objects, `los`, and returns a dictionary where the keys will be natural numbers associating with the students' years and its associated values is a list of names of the `Student` in the corresponding year.

Example:

```
L = [Paul_S, Nicole_V, Dan_W, Logan_S]

organize_by_year(L)
=> {1:["Dan Wolczuk", "Logan Stanley"],
    2:[”Paul Shen", "Y.Q. Wang"]}
```

QUESTION 5: IS_SAME_FACULTY

Write a function `is_same_faculty` that consumes a non-empty list of students, `los`, and returns `True` if all the students belongs in the same faculty. Otherwise, the function returns `False`.

Example:

```
Mathies = [YQ_W, Dan_W]
is_same_faculty(Mathies) => True

is_same_faculty([Nicole_V]) => True
is_same_faculty([Paul_S, Logan_S]) => False
```