SI 506: Programming I
Fall 2019
Lecture 17

Anthony Whyte <arwhyte@umich.edu>
Lecturer III, School of Information
715 N. University Ave, Ann Arbor, MI 48109
Roumanis Square, 2nd floor ("the loft")

UMSI

preliminaries

UMSI

Exercises

paths

lectures/lecture_16/
    lecture_16_exercise.py
    scary_films.json

lectures/lecture_17/
    lecture_17_exercise_solution.py
    un-americas_country_areas_dev.csv
    un-americas_country_areas.csv
    un-americas_regions_country_areas.csv
    world_bank_americas_economies.csv

UMSI

tuples

Tuples

data type characteristics

- sequence: siblings: list, string
- ordered: access items via indexing, slicing
- immutable: item reassignment not permitted
- comparable: comparison operator friendly
- hashable: can be used as dictionary keys

Tuple

create (packing)

```
>>> jamaica = ('Jamaica', 'JAM', 'Kingston')

>>> type(jamaica)

<class 'tuple'>
```

iterable

```
>>> cuba = tuple(['Cuba', 'CUB', 'Havana'])

>>> print(cuba)

('Cuba', 'CUB', 'Havana')
```

Tuple

single item syntax (trailing comma)

```
>>> puerto_rico = ('PRI')

>>> type(puerto_rico)
<class 'str'>
```

```
>>> puerto_rico = ('PRI',)
```


```
>>> type(puerto_rico)
<class 'tuple'>
```

Tuple
delete

```
>>> del cuba

>>> print(cuba)

Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'cuba' is not defined
```

Tuple

use indexing to access individual items

```
>>> print(jamaica[0], jamaica[1], jamaica[2])

Jamaica JAM Kingston
```

Tuple

use slicing to return a “filtered” tuple

```
>>> print(jamaica[1:])

('JAM', 'Kingston')
```

```
>>> print(jamaica[0::2])

('Jamaica', 'Kingston')
```

Tuple

immutable: item reassignment *not permitted*

```
>>> jamaica[0] = 'Jamaican Jerk Pit'

Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: 'tuple' object does not support
item assignment
```

Tuple
concatenation

```
>>> jamaica = ('Jamaica', 'JAM', ‘Kingston')

>>> economy = ('Developing', 'Upper middle income')

>>> jamaica_economy = jamaica + economy
```

```
>>> print(jamaica_economy)

('Jamaica', 'JAM', 'Kingston', 'Developing', 'Upper
middle income’)
```

Tuple
multiplication

```
>>> jamaica * 2

('Jamaica', 'JAM', 'Kingston', 'Jamaica', 'JAM',
'Kingston')
```

Tuple

useful built-in functions

```
>>> len(jamaica)
3

>>> fibonacci = (0, 1, 1, 2, 3, 5, 8, 13, 21)

>>> max(fibonacci)
21

>>> min(fibonacci)
0
```

Tuple

comparison operators

```
>>> (0, 1, 2) < (2, 3, 4)
True
```

```
>>> (0, 5, 10) < (0, 4, 9)
False
```

Tuple
unpacking

```
>>> (country, iso_alpha3_code, capital) = jamaica

>>> print(country)
Jamaica

>>> print(iso_alpha3_code)
JAM

>>> print(capital)
Kingston

>>> country, iso_alpha3_code, capital = cuba
```


UMSI

Tuple

convert to a list

```
>>> jamaica = list(jamaica)

>>> type(jamaica)
<class ‘list'>

>>> print(jamaica)
['Jamaica', 'JAM', 'Kingston']
```

Dictionaries and tuples

dict.items() returns tuples

```
json_str = """{
    "name": "Wolverine",
    "powers": ["accelerated_healing", "super_strength",
        "animal_oriented_powers", "enhanced_senses",
        "regeneration", "natural_weapons"
    ]
}
"""
```

```
hero = json.loads(json_str)

print(hero.items())
```

output:

```
dict_items([('name', 'Wolverine'),
('powers', ['accelerated_healing', 'super_strength',
'animal_oriented_powers', 'enhanced_senses', 'regeneration',
'natural_weapons'])])
```

Dictionaries and tuples

dict.items() returns tuples

```
for k, v in hero.items():
    print(k, v)
```

output:

```
name Wolverine
powers ['accelerated_healing', 'super_strength',
'animal_oriented_powers', 'enhanced_senses',
'regeneration', 'natural_weapons']
```

JSON

UMSI

JSON

two structures: object {} (unordered), list [] (ordered)

```
[
  {
    "name": "Black Panther",
    "full_name": "T'Challa",
    "team": "Avengers",
    "place_of_birth": {
      "country": "Wakanda",
      "continent": "Africa"
    },
    "place_of_death": null,
    "powers": ["agility",
       "stealth",
       "weapons_master",
       "enhanced_senses"
    ],
    "first_appearance": 1966,
    "active": true
  }
]
```

{} = unordered set of name/value pairs

[] = ordered list of values

UMSI

JSON

data types: string, integer, boolean, null, object, array

```
{
  "name": "Black Panther",
  "full_name": "T'Challa",
  "team": "Avengers",
  "place_of_birth": {
    "country": "Wakanda",
    "continent": "Africa"
  },
  "place_of_death": null,
  "powers": ["agility",
     "stealth",
     "weapons_master",
     "enhanced_senses"
  ],
  "first_appearance": 1966,
  "active": true
}
```

Read a JSON file

use json.load(); returns a dictionary

```
import json


def read_data(filename):
    """Get JSON"""
    with open(filename, 'r') as file_obj:
        data = json.load(file_obj)

    return data

data_file = 'data.json'
scary_source_data = read_data(data_file)
```

Read a JSON string

use json.loads(): returns a dictionary

```
import json

json_str = """{
  "name": "Black Panther",
  "powers": ["agility",
     "stealth",
     "weapons_master",
     "enhanced_senses"
  ]
}"""

region_counts = json.loads(json_str)

print(f"type = {type(region_counts)}\n")

type = <class 'dict'>
```

Write to a JSON file

use json module

```
import json # a treat

def write_data(filename, data):
    """Write dictionary to JSON file"""
    with open(filename, 'w') as file_obj:
        json.dump(data, file_obj, indent=2)

filename = 'characters.json'
write_scary_data(filename, scary_output_data)
```

CSV

CSV file

*.csv: comma-delimited strings

```
subregion,intermediate_region,country_area
Latin America/Caribbean,Caribbean,Anguilla
Latin America/Caribbean,Caribbean,Antigua and Barbuda
Latin America/Caribbean,Caribbean,Aruba
Latin America/Caribbean,Caribbean,Bahamas
Latin America/Caribbean,Caribbean,Barbados
Latin America/Caribbean,Caribbean,"Bonaire, Sint Eustatius and Saba"
Latin America/Caribbean,Caribbean,British Virgin Islands
Latin America/Caribbean,Caribbean,Cayman Islands
Latin America/Caribbean,Caribbean,Cuba
Latin America/Caribbean,Caribbean,Curaçao
Latin America/Caribbean,Caribbean,Dominica
Latin America/Caribbean,Caribbean,Dominican Republic
Latin America/Caribbean,Caribbean,Grenada
Latin America/Caribbean,Caribbean,Guadeloupe
Latin America/Caribbean,Caribbean,Haiti
Latin America/Caribbean,Caribbean,Jamaica
Latin America/Caribbean,Caribbean,Martinique
Latin America/Caribbean,Caribbean,Montserrat
Latin America/Caribbean,Caribbean,Puerto Rico
. . .
```

strings with commas "*x, y*"

special character (UTF-8)

UMSI

Read a CSV file: return lists

use csv.reader(); rows returned as lists

```
import csv

def read_csv(filename):
    """Read csv file. Specify encoding; filter out byte order
    mark (BOM) \ufeff. """
    data = []

    with open(filename, 'r', encoding='utf-8-sig') as file_obj:
        reader = csv.reader(file_obj, delimiter=',')
        for row in reader:
            data.append(row)

    return data
```

Read a CSV file: return lists

use csv.writer(); write to file row by row

```
import csv

def write_csv(filename, data):
    """Write csv file."""
    with open(filename, 'w') as csv_file:
        csv_writer = csv.writer(csv_file, delimiter = ',')
        csv_writer.writerow(["id", "name"])

        for item in data:
            csv_writer.writerow([item[0], item[1]])
```

Read a CSV file; return dictionaries

use csv.DictReader(); rows returned as OrderedDict

```
import csv

def read_csv_to_dict(filename):
    """Read csv file. Generate dictionaries"""
    data = []

    with open(filename, 'r', encoding='utf-8-sig') as file_obj:
        reader = csv.DictReader(file_obj, fieldnames=['‘country',
                                                      'iso_alpha3_code'])
        row = 0
        for dictionary in map(dict, reader):
            if row > 0:
                data.append(dictionary)
            row += 1

    return data
```

gimme plain dictionaries

ignore header row

OrderedDict: dictionary that maintains insertion order

UMSI

exercise

lecture_17_exercise_solution.py

script anatomy

load

```
import csv
import json
```

entry

```
CONSTANTS
```

```
main()
```

process, delegate tasks

call

```
format_keys(name)
get_region_count(data, region)
get_country_area_locations(regions, headers, country_area)
get_dev_status(dev_status, country_area)
get_economic_status(world_bank_economies, iso_code)
read_csv(filename, seq_type=SEQ_TYPE[0])
write_json(filename, data)
```

```
if __name__ == '__main__':
    main() # call main method
```


UMSI

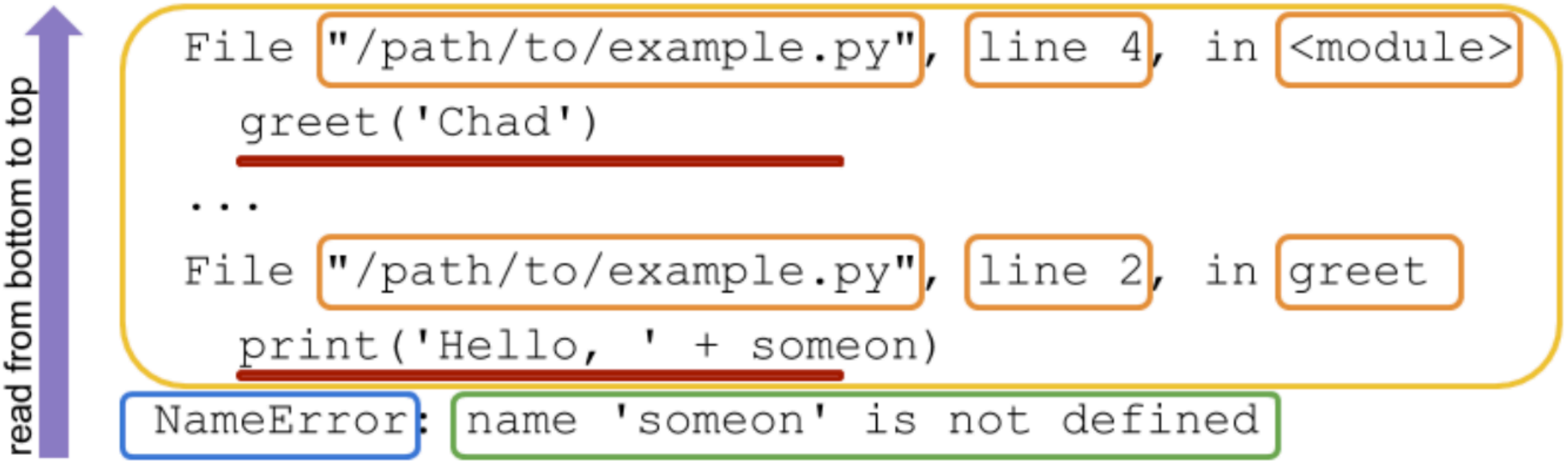
finis

directors cut

UMSI

Exceptions

traceback horror



Source: https://realpython.com/python-traceback/

UMSI

It: Chapter One (2017)

scary clown

It: Chapter One (2017)

scary movie, scary clown

```
it = {}
it['title'] = 'It: Chapter One'
it['year_released'] = 2017
it['budget'] = 35000000
it['box_office'] = 700000000
it['scary_character'] = {}. # nested dictionary
it['scary_character']['name'] = 'Pennywise the Dancing Clown'
it['scary_character']['signature_weapon'] = None
```

Friday the 13th (1980)

scary hockey mask

Friday the 13th (1980)

scary movie, scary hockey mask

```
friday_13th = {
    'title': 'Friday the 13th',
    'year_released': 1980,
    'budget': 5500000,
    'box_office': 59800000,
    'scary_character': {
        'name': 'Jason Vorhees',
        'signature_weapon': 'machete'
    }
}
```

JSON

Javascript Object Notation (data interchange format)

```
{
    "scary_films": [
      {
        "title": "The Wizard of Oz",
        "year_released": 1939,
        "budget": 2800000,
        "box_office": 26100000,
        "scary_character": {
            "name": "The Wicked Witch of the West",
            "signature_weapon": "evil spells"
        }
      }
    ]
}
```

nested object {}

UMSI

Read a JSON file

use json module

```
import json # a treat


def read_scary_data(filename):
    """Get JSON"""
    with open(filename, 'r') as scary_file_obj:
        data = json.load(scary_file_obj) # a trick

    return data

scary_file = 'scary_films.json'
scary_source_data = read_scary_data(scary_file)
```

Write to a JSON file

use json module

```
import json # a treat

def write_scary_data(filename, data):
    """Write dictionary to JSON file"""
    with open(filename, 'w') as scary_file_obj:
        json.dump(data, scary_file_obj, indent=4)

filename = 'scary_characters.json'
write_scary_data(filename, scary_output_data)
```

Utility functions

return dictionary, return string

```
def get_scary_film_character(film):
    """Return dictionary object."""
    return film['scary_character']
```

```
def get_scary_film_character_name(film):
    """Return scary character name."""
    character = get_scary_film_character(film)

    return character['name']
```

Utility functions

check films list for film

```
def has_film_credit(films, title):
    """Check if film is in the films list."""
    if films:
        for film in films:
            if film['title'] == title:
                return True

    return False
```

Utility functions

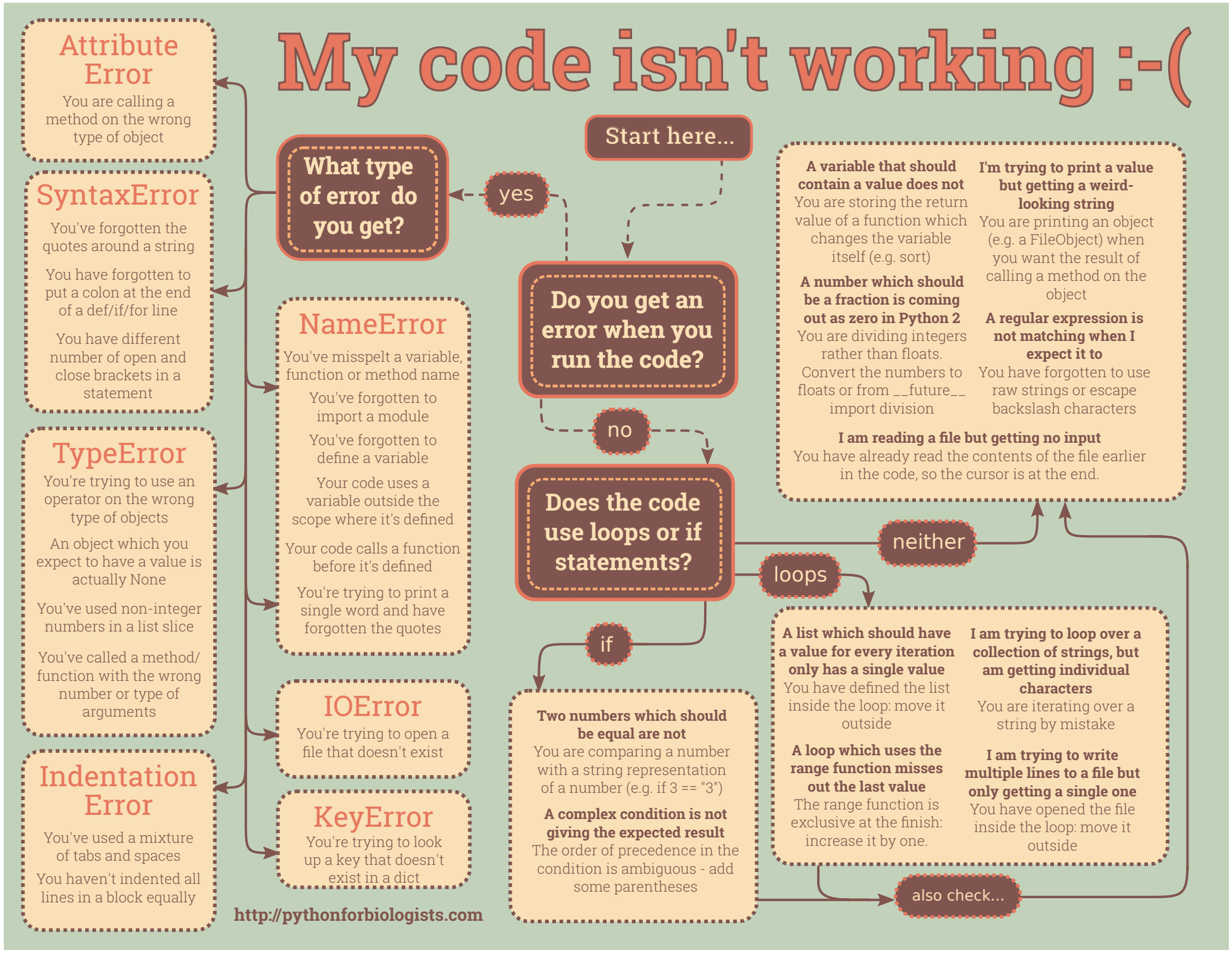
add film credits to scary character

```
def add_film_credits_to_scary_characters(characters, films):
    """Add scary character film credits."""
    for character in characters:
        character.setdefault('films', [])  # add property if missing
        for film in films:

            if character['name'] == film['scary_character']['name'] \
               and not has_film_credit(character['films'], film['title']):
                character['films'].append({
                    'title': film['title'],
                    'year_released': film['year_released'],
                    'budget': film['budget'],
                    'box_office': film['box_office'],
                })

    return characters
```

start exercise

When your code misbehaves

debug flowchart



UMSI

Weeks 8-15

weeks 1-7 topics +

- data types
  - dictionaries
  - tuples
- modules
  - csv
  - json (encode/decode)
  - pathlib
  - requests
- functions
  - lambdas (anonymous functions)
- lists
  - list comprehensions
- classes
- local dev environment
  - Python install
  - source code editor/IDE
  - command line
- debugging
- file types
  - *.csv
  - *.json
- data structures
  - structured data
  - semi-structured data
- RESTful APIs
  - HTTP request/response
  - JSON

final individual project assignment

UMSI

Slide deck revisions

errata: corrections and other changes

Slide no(s).	Fix ver.	Description
	v1p1	