Introduction to Programming for Public Policy Week 3 (Lists, Strings, and Dictionaries)

Eric Potash

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Lists

List operations: +

Can concatenate lists just like strings:

```
>>> [1, 2, 3] + ['a', 'b', 'c']
[1, 2, 3, 'a', 'b', 'c']
```

List operations: ∗

Can also repeat a list with ∗:

```
>>> [0] * 5
[0, 0, 0, 0, 0]
>>> [1,2,3] * 2
[1, 2, 3, 1, 2, 3]
```

List operator: `in`

You can check whether a value is in a list using the `in` operator:

```
>>> ls = [1,3,5,7]
>>> 3 in ls
True
>>> 4 in ls
False
```

List slices

As with strings we can slice lists. Note that, as with strings, we can omit either end: the slice will then start at the beginning or end at the end of the list.

```
>>> a = ['a', 'b', 'c', 'd', 'e', 'f']
>>> a[2:]
['c', 'd', 'e', 'f']
>>> a[:3]
['a', 'b', 'c']
```

List append

```
>>> a = ['a', 'b', 'c']
>>> a.append('d')
>>> a
['a', 'b', 'c', 'd']
```

List extend

```
>>> a = ['a', 'b', 'c']
>>> a.extend(['d', 'e', 'f'])
>>> a
['a', 'b', 'c', 'd', 'e', 'f']
```

List sort

The sort function sorts the list:

```
>>> a = [15, 11, 2, 23, 13]
>>> a.sort()
>>> a
[2, 11, 13, 15, 23]
```

Inplace

Note that the above list functions (`append`, `extend`, `sort`) modify
the functions *inplace* and return None.

Removing elements

Two ways to remove elements from a list:

- Remove by value:

```
>>> a = ['a','b','c','d']
>>> a.remove('d')
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['a', 'b', 'c']
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- Remove by value:

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```

- Remove by index and return value:

```
>>> a.pop(1)
'b'
>>> a
['a', 'c']
```

Median

We can use sorting to find the median in a list. Sort and take the middle value:

```
>>> a = [15, 11, 2, 23, 13]
>>> b = sorted(a)
>>> b[int(len(b)/2)]
13
```

Here `int(len(b)/2) = 2`, the middle index. Note that this code will give the wrong answer for lists of even length.

Percentile

More generally, we can find an arbitrary percentile p:

```
>>> b = sorted(a)
>>> b[int(len(b)*p)]
```

E.g. when p=.5 this is the median. Note that this is a crude version of percentile– in practice we use interpolation to refine.

Example: Reading a CSV file

What is parsing?

The process of reading through a string to break it down or interpret it is called *parsing*.

- Command line programs do this in order to interpret options and arguments
- Python does this to execute your code
- Google does it to execute a search query
- Etc.

String parsing example

On the next slide we'll write a script that runs like this:

- ```
$ python city_state.py
Enter City, State: Chicago, IL

City: Chicago
State: IL
```

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$ python city_state.py
Enter City, State: Chicago, IL

City: Chicago
State: IL
```

```
$ python city_state.py
Enter City, State: New York City
Traceback (most recent call last):
  File "parse_city.py", line 4, in <module>
    raise ValueError('no comma')
ValueError: no comma
```

String functions

- string.endswith(ending): does string end in ending?

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- `string.startswith(beginning)`: does `string` start with `beginning`?

```
>>> 'Chicago, IL'.startswith('New York')
False
```

- `substring in string`: does `string` contain `substring`?

```
>>> ',' in 'Chicago, IL'
True
```

More string functions

- string.find(substring): what is the (first!) index of substring in string? (or -1 if substring not in string)

```
>>> 'Hello, World'.find(',')
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```

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```

- string.split(sep): split string on sep into list of strings

```
>>> 'Chicago, IL, USA'.split(',')
['Chicago', ' IL', ' USA']
```

Errors

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```
NameError: name 'Pi' not found
```

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NameError: name 'Pi' not found
```

- We can throw our own errors:

```
raise ValueError("Invalid value")
```

String parsing example code

```python
# city_state.py
city_state = input('Enter City, State: ')
if ',' not in city_state: # substring
    raise ValueError('no comma')

comma_index = city_state.find(',')
city = city_state[:comma_index]
state = city_state[comma_index+2:]

if len(state) != 2:
    raise ValueError('invalid state abbrev: ' + state)

print('\nCity:', city)
print('State:', state)
```

Command Line Arguments

A python script can use command line arguments through the `argv`
list in the `sys` module:

```python
# cmd_args.py
import sys
print(sys.argv)
```

```
$ python cmd_args.py -o -h arguments
['cmd_args.py', '-o', '-h', 'arguments']
```

Opening a file

Open a file using the `open` function:

```
>>> file = open('salaries.csv')
>>> print(file)
<_io.TextIOWrapper name='salaries.csv' mode='r' encoding='U
```

This `TextIOWrapper` object facilitates I/O (input/output).

Reading a line

- Read a line from the file:

```
>>> file = open('salaries.csv')
>>> line = file.readline()
>>> line
'Name,Job Titles,Department,Full or Part-Time,
 Salary or Hourly,Typical Hours,Annual Salary,
 Hourly Rate\n'
```

- \n is the *line feed* character. It is a single character. One way to remove it in this example:

```
>>> line[:-1]
'Name,Job Titles,Department,Full or Part-Time,
 Salary or Hourly,Typical Hours,Annual Salary,
 Hourly Rate'
```

Reading many lines

You can iterate over the lines in a file similarly to a list:

```
>>> file = open('salaries.csv')
>>> lines = []
>>> for line in file:
...     lines.append(line[:-1])

['Name,Job Titles,Department,Full or Part-Time,Salary or Ho
 '"AARON,  JEFFERY M",SERGEANT,POLICE,F,Salary,,$101442.00,
 '"AARON,  KARINA ",POLICE OFFICER (ASSIGNED AS DETECTIVE),
...]
```

Splitting fields

This list of lines is not very useful for analysis. The first step is to
break up the lines into fields.

```
>>> file = open('salaries.csv')
>>> line = file.readline()[:-1]
>>> line.split(',')
['Name',
 'Job Titles',
 'Department',
 'Full or Part-Time',
 'Salary or Hourly',
 'Typical Hours',
 'Annual Salary',
 'Hourly Rate']
```

2d list

```
>>> file = open('salaries.csv')
>>> lines = []
>>> for line in file:
...     fields = line[:-1].split(',')
...     lines.append(fields)
>>> lines
[['Name',
  'Job Titles',
  'Department',
  'Full or Part-Time',
  'Salary or Hourly',
  'Typical Hours',
  'Annual Salary',
  'Hourly Rate'],
 ['"AARON',
  ' JEFFERY M"',
```

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  - i.e. it is a list in which each item (a row) is itself a list (of fields)
- We can subset rows lines[2] or a group of columns with a slice lines[2:4]
- lines[1:] will return everything except the header

Aggregating

We can aggregate the number of full time employees:

```
count = 0
for line in lines:
    if line[4] == 'F':
        count = count + 1
```

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- You'll do this in your assignment this week
- In the future we'll use existing python modules to parse CSVs

Dictionaries

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- In a list, indices are integers.
- In a dictionary, indices can take almost any type.

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- A dictionary can also be thought of as a mapping between *keys* (indices) and *values*.
- Each key maps to a value. The keys are unique but the values need not be.
- The combination of a key and a value is called a *key-value pair* or an *item*.

dict construction

- Can construct a list using the dict function (so don't call your
  dictionaries dict):

```
>>> d = dict()
>>> d
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- {} is an empty dictionary.
- Curly braces are the analogue for dicts of the square braces [] for lists.

Adding items to a dictionary

Add items to a dictionary using square brackets:

```
>>> eng2esp = dict()
>>> eng2esp['one'] = 'uno'
>>> eng2esp
{'one': 'uno'}
```

Now eng2esp maps 'one' to 'uno'.

Alternative dictionary constructor

You can also create a `dict` with curly brace syntax:

```
>>> eng2esp = {'one':'uno', 'two':'dos', 'three':'tres'}
```

Dictionaries are unordered

- Dictionaries are *unordered* meaning their items do not have a sequence:

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>>> eng2esp = {'one':'uno', 'two':'dos', 'three':'tres'
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```

- So you cannot rely on the order of elements in a dictionary. But it's okay because we index the elements using their keys, not their order:

```
>>> eng2esp['two']
'dos'
```

KeyError

If you try to get a value for a non-existent key you'll get a
KeyError:

```
>>> eng2esp['four']
KeyError: 'four'
```

in operator

To determine whether a key is in a dictionary you can use the in operator:

```
>>> 'one' in eng2esp
True
>>> 'uno' in eng2esp
False
```

Accessing keys and values

A dictionary has three useful "lists" associated with it:

- keys() is like a list of the keys:

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dict_keys(['three', 'one', 'two'])
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- values() is like a list of the values:

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dict_values(['tres', 'uno', 'dos'])
```

- items() is like list of lists, each of which is the pair (length 2)
  [key, value]:

```
>>> eng2esp.items()     # items is like a two dimensior
dict_items([('three', 'tres'), ('one', 'uno'), ('two',
```