

Student Intros

- Name
- 2 facts about yourself
(can be anything: favorite color, major in college, hometown, etc.)

Tools and Principles for the DSI

Lecture Objectives

Understand the following:

1. Development Tools
2. Clean Code
3. Efficient Code
4. Pair Programming

Development Tools

Terminal (iTerm)

- command line (i.e. text-based) way of interacting with system
- useful for
 - git commands
 - installing python packages
 - running python scripts
 - launching IPython
- iTerm is a nicer version of Terminal



IPython

- It's a more feature-rich substitute for the Python shell

IPython - View Docstring

View the docstring for any python object using `?object`, this is a shortcut for `help(obj)`.

```
?In [5]: ?map
```

```
Type:          builtin_function_or_method
```

```
String form: <built-in function map>
```

```
Namespace:     Python builtin
```

```
Docstring:
```

```
map(function, sequence[, sequence, ...]) -> list
```

Return a `list` of the results of applying the function to the items of...

IPython - tab completion

```
In [8]: ma #Press tab...
```

```
%macro
```

```
%magic
```

```
%man
```

```
%matplotlib map
```

```
max
```


IPython - access previous results

Use `_` for a variable containing the result of the last executed command:

```
In [1]: 9 * 54
```

```
Out[1]: 486
```

```
In [2]: _
```

```
Out[2]: 486
```

```
In [3]: x = _
```

```
In [4]: x
```

```
Out[4]: 486
```

IPython - more resources

<https://ipython.org/ipython-doc/dev/interactive/tutorial.html>

IPython Notebooks

- An interactive notebook for Python based on IPython
- Great for
 - exploratory data analysis (EDA)
 - demonstration
- Terrible for
 - robustly engineered code
- Conclusion:
 - only use notebooks for simple exploratory tasks
 - use IDE such as Atom for actual development

Writing Clean Code

Style and Structure

- Code is read more than it is written; style *is* substance
- Structure your code into functions, modules, and classes
- Follow the DRY principle:
 - DRY = “don’t repeat yourself”
 - in contrast to WET = “we enjoy typing”
- Read this, a lot:
<http://legacy.python.org/dev/peps/pep-0008/>
- Also this: <https://google-styleguide.googlecode.com/svn/trunk/pyguide.html>

Writing Efficient Code

Writing Efficient Code

- Code that analyzes a lot of data can run out of memory or take forever to complete
- Optimizing your code can be the difference between code that takes a few minutes to run and code that will effectively never finish running
- “Runtime analysis” is a very popular interview topic

Generators

- The `range` function will create a list of length `n` and then we iterate over it.
 - `for i in range(n):`
 `print i`
 - This wastes memory by creating a list of length `n`
- We can use a *generator* to save the memory:
 - `for i in xrange(n):`
 `print i`
 - The `xrange` function will generate the next value when it's needed, but won't return an entire list like the `range` function.

Looping Tools

- Simplest, most Pythonic loop
 - `for item in L:`
`print item`
- Use `enumerate` (a generator) when you need the index too
 - `for i, item in enumerate(L):`
`print i, item`
 - `for i in xrange(len(L)):`
`print i, L[i]`
- Use `zip` or `itertools.izip` (a generator) to combine two lists:

```
first_names = ['Giovanna', 'Ryan', 'Jon']
```

```
last_names = ['Thron', 'Orban', 'Dinu']
```

```
In [3]: zip(first_names, last_names)
```

```
Out[3]: [('Giovanna', 'Thron'), ('Ryan', 'Orban'), ('Jon', 'Dinu')]
```

Writing Efficient Code

```
1  def find_anagrams (lst):
2      result = []
3      for word1 in lst:
4          for word2 in lst:
5              if word1 != word2 and sorted(word1) == sorted(word2):
6                  if word1 not in result:
7                      result.append(word1)
8                  if word2 not in result:
9                      result.append(word2)
10     return result
```

How many comparisons does this code perform?

Assume N words in the input list, K of which will go in the outcome list.

$N*N$ comparisons between each item in the input, plus $>K*(K-1)$ total comparisons for lines 6 and 8.

Writing Efficient Code

```
1 def find_anagrams (lst):
2     result = []
3     d = defaultdict (list)
4     for word in lst:
5         d[tuple(sorted(word))].append(word)
6     for key, value in d.iteritems():
7         if len(value) > 1:
8             result.extend(value)
9     return result
```

How many comparisons does this code perform?

Assuming N words in the input list, then there are N lookups in the dictionary to fill it with the input, and a loop through <N items to determine the output.

How?

Hashing!

Dicts and Hash Tables

- A hash table is a data structure that maps keys to values

```
homestate = {"giovanna": "maine", "ryan": "california",  
             "katie": "michigan", "zack": "new york"}
```

- Python dictionaries are an implementation of hash tables
- Instead of iterating through a list of tuples:

```
( "giovanna", "maine" ), ( "ryan", "california" ),  
( "katie", "michigan" ), ( "zack", "new york" )]
```

You can access a key's value directly:

```
homestate['katie']
```

- Key takeaway: use dict (and similar structures) instead of list to organize your data

Mutability

- Mutable objects can change their value but keep their `id()`
 - lists
 - sets
 - dictionaries
- Immutable objects cannot be altered. A new object has to be created if a different value has to be stored.
 - They play an important role in places where a constant hash value is needed, for example as a key in a dictionary.
- Key point: only immutable types are hashable, so only immutable types can be used in sets or as dictionary keys

Dict operations

Looping

GOOD: `for key in dictionary:`

BAD: `for key in dictionary.keys():`

GOOD: `for key, value in dictionary.items():`

BAD: `for key, value in dictionary.items():`

Equality

`dict1 == dict2`

Checking Membership

GOOD: `key in dictionary`

BAD: `key in dictionary.keys()`

Set

- A set is like a dictionary with only keys and no values
- Sets are useful for checking membership and deduplication. For example:
 - `n in my_list` takes `len(my_list)` steps
 - `n in my_set` takes 1 step
- Example: get all the unique words in a string that are longer than 3 characters:

```
s = set()
for word in string.split():
    if len(word) > 3:
        s.add(word)
```

- Sets are also useful for removing duplicates in a list (if you don't care about order):

```
L_unique = list(set(L))
```


Itertools

Combinatoric generators:

Iterator	Arguments	Results
<code>product()</code>	<code>p, q, ...</code> <code>[repeat=1]</code>	cartesian product, equivalent to a nested for-loop
<code>permutations()</code>	<code>p, r]</code>	r-length tuples, all possible orderings, no repeated elements
<code>combinations()</code>	<code>p, r</code>	r-length tuples, in sorted order, no repeated elements
<code>combinations_with_replacement()</code>	<code>p, r</code>	r-length tuples, in sorted order, with repeated elements
<code>product('ABCD', repeat=2)</code>		AA AB AC AD BA BB BC BD CA CB CC CD DA DB DC DD
<code>permutations('ABCD', 2)</code>		AB AC AD BA BC BD CA CB CD DA DB DC
<code>combinations('ABCD', 2)</code>		AB AC AD BC BD CD
<code>combinations_with_replacement('ABCD', 2)</code>		AA AB AC AD BB BC BD CC CD DD

From: <https://docs.python.org/2/library/itertools.html>

Lambda Functions

```
def add(x, y):  
    z = x + y  
    return z
```

```
lambda x, y: x+y
```

Pair Programming

What is it?

- One computer, 2 keyboards
- Driver + Navigator

Pair Programming

Why?

- Learn more
- Higher quality output
- Good practice
 - collaborating and communicating at length about complex problem
 - working with different skill sets and personalities
- Increasingly popular in industry

Pair Programming Core Principles

- Get to know your partner: “What did you think about the lecture?”
- Take turns: trade driver and navigator roles every 30 minutes.
- Listen: if your partner asks “Why are we doing that?” then take the time to answer. Don’t interrupt.
- Be patient: if your partner types something that looks wrong, try to understand it before correcting it.
- Be clear: explaining technical concepts is hard. Practice.
- Be humble
- Disagree productively
- Switch partners daily (partners will usually be assigned)