SI 506: Programming I
Fall 2019
Lecture 03

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

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preliminaries

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Top 20 programming languages

IEEE Spectrum 2019 survey: Python ranked no. 1

Institute of Electrical and Electronics Engineers

Rank	Language	Type	Score
1	Python	web, desktop, system	100.0
2	Java	web, mobile, desktop	96.3
3	C	mobile, desktop, system	94.4
4	C++	mobile, desktop, system	87.5
5	R	desktop	81.5
6	JavaScript	web	79.4
7	C#	web, mobile, desktop, system	74.5
8	Matlab	desktop	70.6
9	Swift	mobile, desktop	69.1
10	Go	web, desktop	68.0

"Python's popularity is driven in no small part by the vast number of specialized libraries available for it, particularly in the domain of artificial intelligence, where the Keras library is a heavyweight among deep-learning developers: Keras provides an interface to the TensorFlow, CNTK, and Theano deep-learning frameworks and tool kits. Deep learning isn't the only field where Python is having an impact that could not have been anticipated when the language was first released in 1991. The dramatic increase in computing power found in microcontrollers means that embedded versions of Python, such as CircuitPython and MicroPython, are becoming increasingly popular among makers."

Source: https://spectrum.ieee.org/computing/software/the-top-programming-languages-2019

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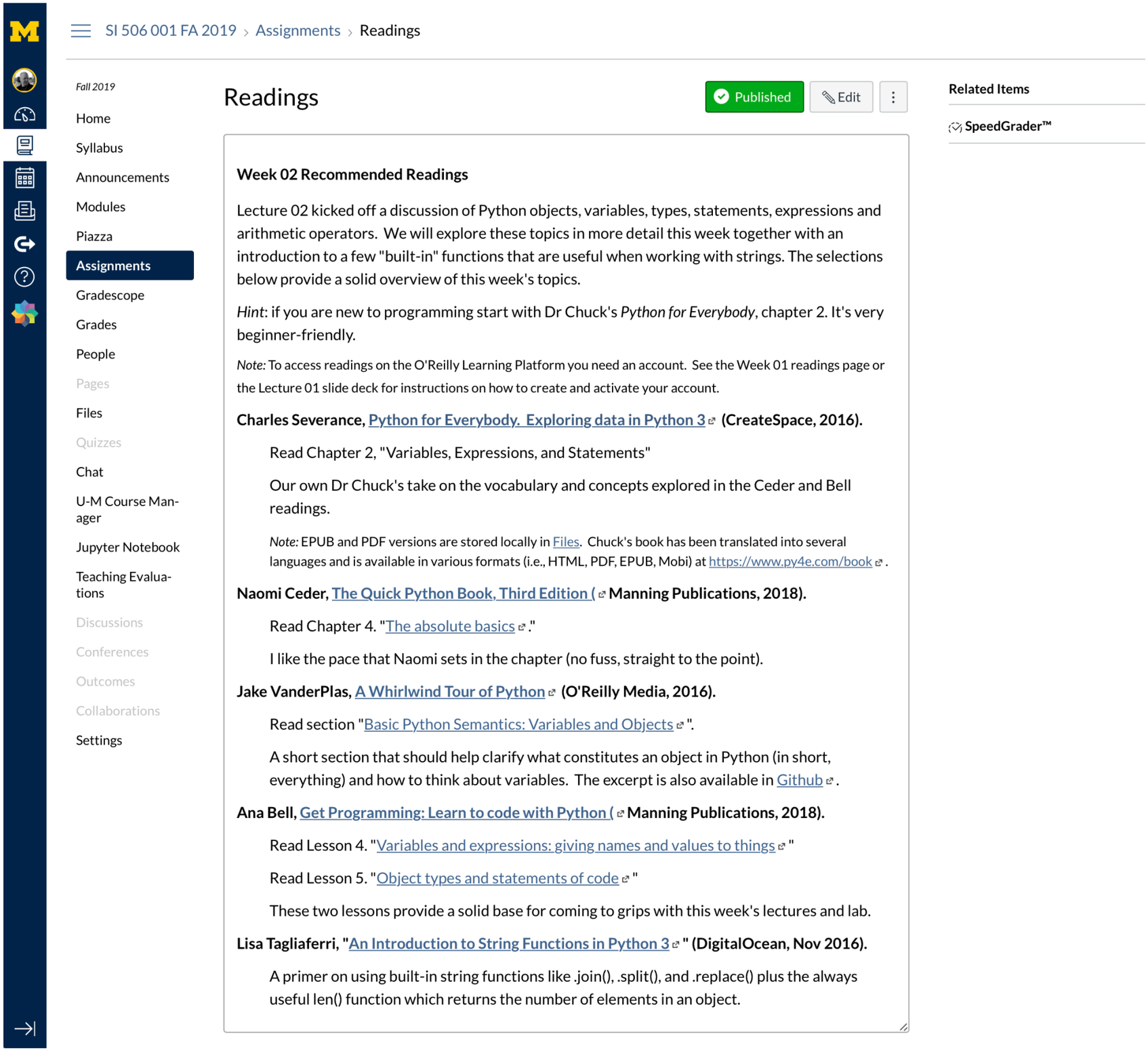
Readings

Available on Saturday per request



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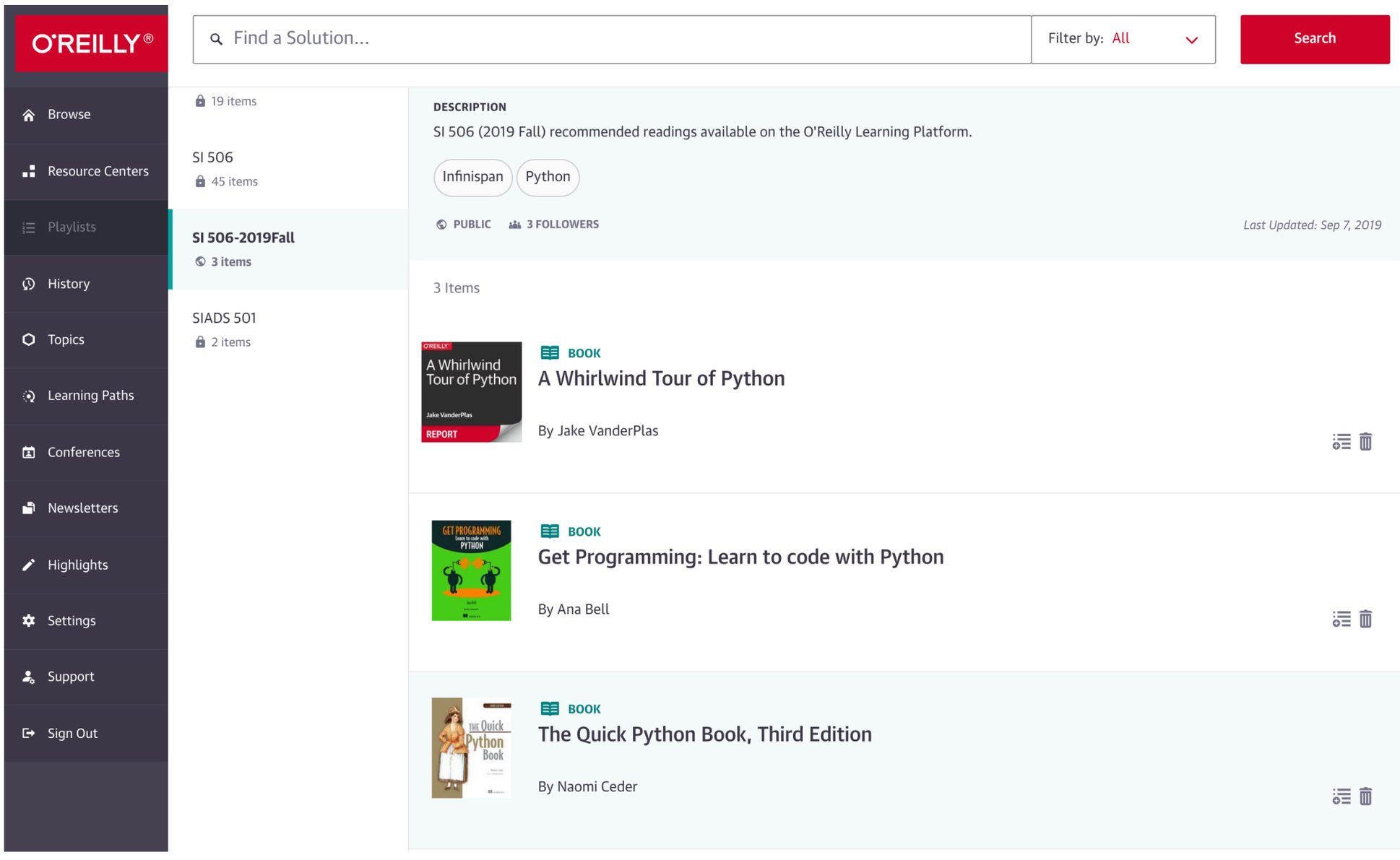
O'Reilly playlist

per request

http://bit.ly/2IDVxYI



https://learning.oreilly.com/playlists/d48870e7-033e-48b8-907d-1a56868bb089

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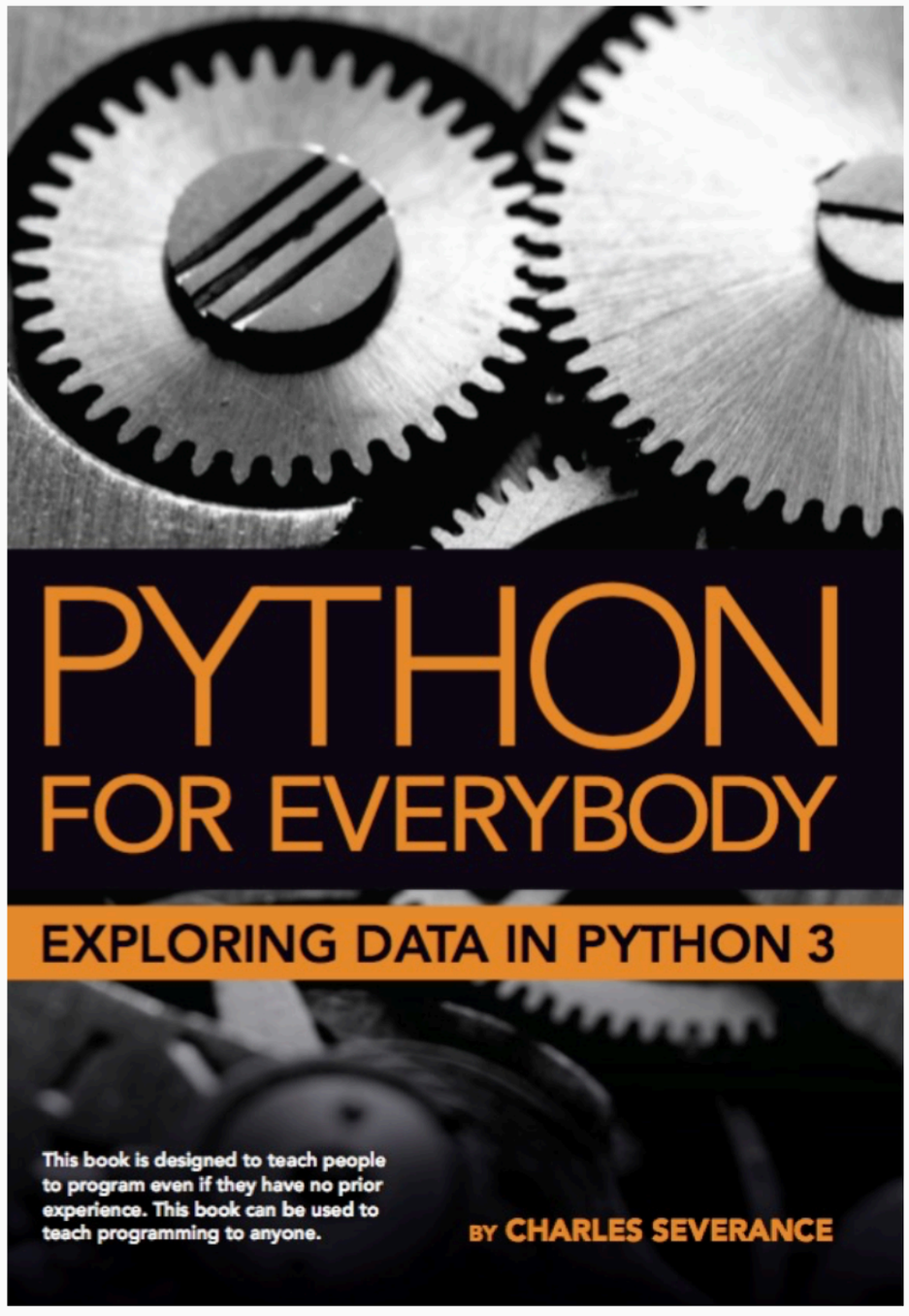
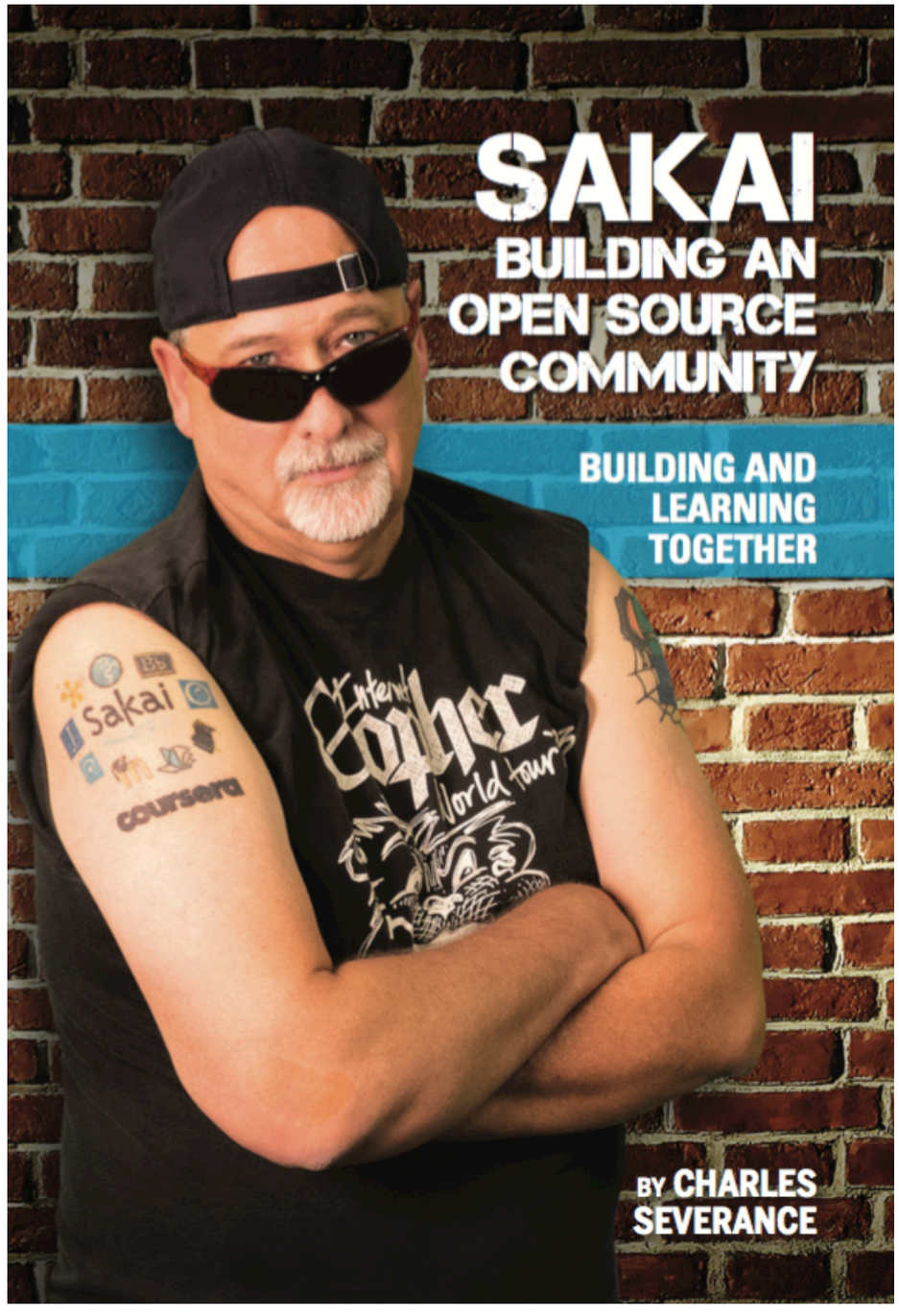
Readings: Dr Chuck

If new to programming, start with P4E chapters





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assignments

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Problem set 01/Lab exercise 02

design, workflow

SI 506: Problem Set 01

This week's problem set includes six (6) one to two line problems that focus on variables creation and value assignment, string concatenation, use of arithmetic operators, and use of certain built-in functions discussed in the lectures and the readings.

Retrieve the problem set 01 template file at https://github.com/umsi-arwhyte/SI506-2019Fall/code/gradescope/problem_set_01.py

When you have completed the problem set click on the Gradescope link in Canvas and upload your `problem_set_01.py` file to the Gradescope site. Your submission will be auto-graded and any runtime errors encountered will be recoded and displayed. You may re-submit your assignment as many times as is necessary before the close date. Late submissions will be penalized as described in the syllabus.

The general layout of a SI 506 problem set resembles the following:

```
# START PROBLEM SET 01
print('PROBLEM SET 01 \n')

# PROBLEM 01A (25 points)
# Instructions for problem 01A provided here. Read carefully.

# BEGIN 01A SOLUTION

# Write your 01A solution between the BEGIN/END comments.
# Not that for certain problems a required variable may be
# initialized with a default value (e.g., var_int = 0, var_str = '')
# that you will then change. print() statements are occasionally
# provided as a courtesy in order to output variable values
# to the screen.

# END 01A SOLUTION


# START PROBLEM 01B SETUP (do not modify)

# WARNING: For some problems a "setup" section is included in order
# to provide variables, functions or other working code for use
# with the problem(s). Do not change any code located between
# START/END SETUP.

# END SETUP

# PROBLEM 01B (25 points)
# Instructions for problem 01A provided here. Read carefully.

# BEGIN 01B SOLUTION

# Write your 01B solution between the BEGIN/END comments. . . .

# END 01B SOLUTION

# Additional problems will follow, structured similarly to problems 01A and 01B above.

# END PROBLEM SET
```

SI 506: Lab Exercise 02

This week's lab exercise includes two (2) one to two line problems that focus on variables creation and value assignment, string concatenation, and use a certain built-in function discussed in the lectures and the readings.

Retrieve the lab exercise 02 template file at https://github.com/umsi-arwhyte/SI506-2019Fall/code/gradescope/lab_exercise_02.py

When you have completed the problem set click on the Gradescope link in Canvas and upload your `lab_exercise_02.py` file to the Gradescope site. Your submission will be auto-graded and any runtime errors encountered will be recoded and displayed. You may re-submit your exercise as many times as is necessary before the close date. Late submissions will be penalized as described in the syllabus.

The general layout of a SI 506 lab exercise resembles the following:

```
# START LAB EXERCISE 01
print('LAB EXERCISE 01 \n')

# PROBLEM 01A (25 points)
# Instructions for problem 01A provided here. Read carefully.

# BEGIN 01A SOLUTION

# Write your 01A solution between the BEGIN/END comments.
# Not that for certain problems a required variable may be
# initialized with a default value (e.g., var_int = 0, var_str = '')
# that you will then change. print() statements are occasionally
# provided as a courtesy in order to output variable values
# to the screen.

# END 01A SOLUTION


# START PROBLEM 01B SETUP (do not modify)

# WARNING: For some problems a "setup" section is included in order
# to provide variables, functions or other working code for use
# with the problem(s). Do not change any code located between
# START/END SETUP.

# END SETUP

# PROBLEM 01B (25 points)
# Instructions for problem 01A provided here. Read carefully.

# BEGIN 01B SOLUTION

# Write your 01B solution between the BEGIN/END comments. . . .

# END 01B SOLUTION

# Additional problems may follow, structured similarly to problems 01A and 01B above.

# END LAB EXERCISE
```


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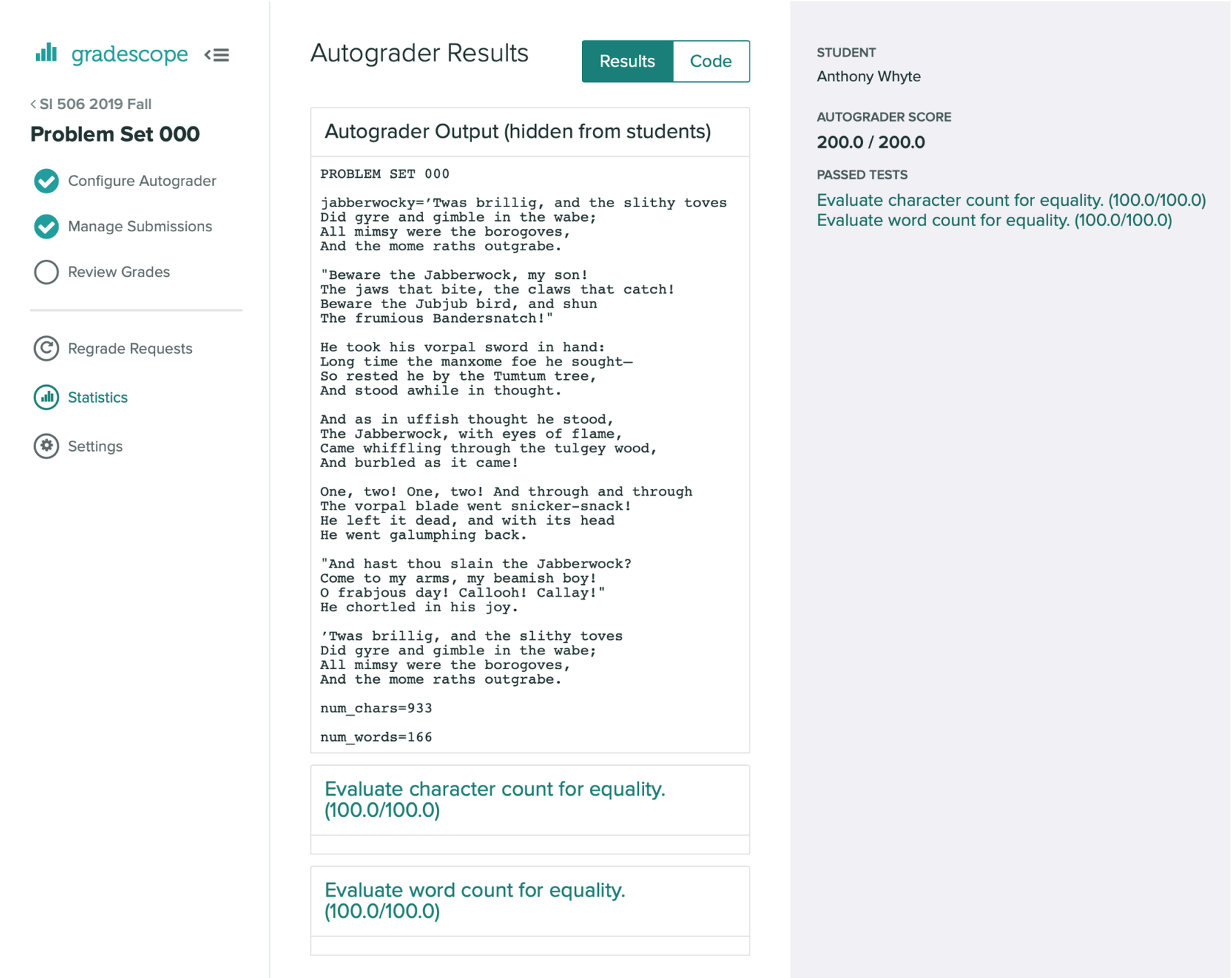
Lab: Gradescope workflow

auto grading with Python



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back to Python

Python objects

object thinking

"everything is an object"

Jake VanderPlas, *A Whirlwind Tour of Python*

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Python variables

not a container; think name or label

"The name *variable* is somewhat misleading . . .; *name* or *label* would be more accurate."

Naomi Ceder, *The Quick Python Book*, chapter 4

Python variables

the good doctor agrees

"A variable is a name that refers to a value."

Charles Severance Python for Everybody, chapter 2

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Python variables

Jake likes the notion of a 'pointer'

"... variables are simply pointers [to objects], and the variable names themselves have no attached type information."

Jake VanderPlas, *A Whirlwind Tour of Python*

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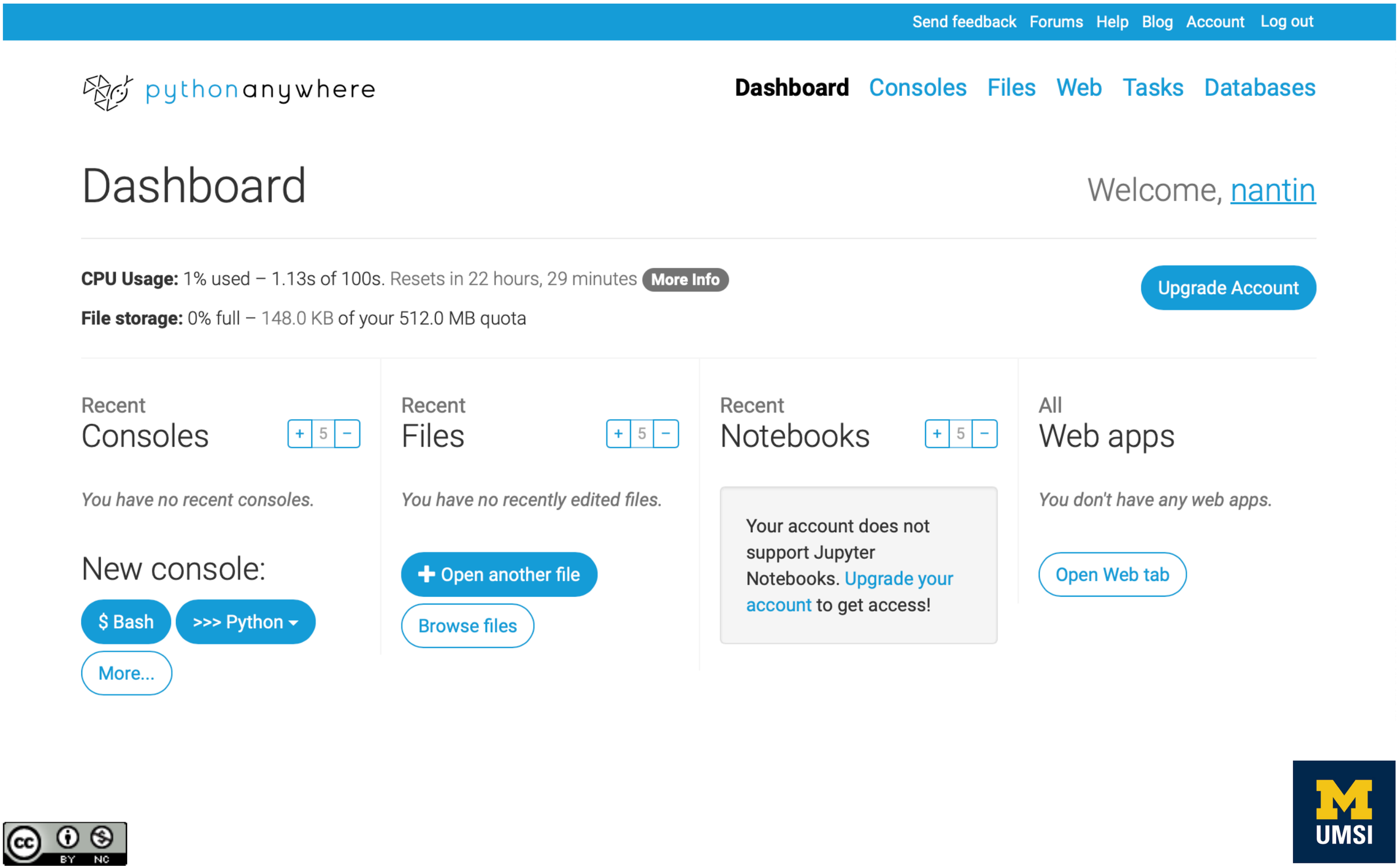
Test the assertions

Start your Python console



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Test the assertions

interactive shell (type this)

```
$ python3
>>> x = [506, 507]
>>> y = x
>>> x.append(508)
>>> print(x)
>>> print(y)
>>> x = ‘five oh six’
>>> print(y)
```

```
>>> x = y
>>> print(x)
>>> del x  # delete
>>> print(x) # oops
>>> print(y)
```

Objects and variables (cont.)

name error *not* object not found error

```
$ python3
. . .
>>> del x
>>> print(x)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'x' is not defined
```


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Observations

regarding x and y name/label/pointers

1. x and y point to the same list (object)
2. new element added to list referenced by x
3. list that y references also changes (same object, *beware*)
4. x assigned to new object (override previous assignment)
5. y continues to reference list
6. x (re)assigned to list referenced by y
7. x deleted
8. print(x) throws traceback (NameError)
9. y continues to reference list
10. types are associated with objects *not* variables

built-in functions

Function

custom code block that encapsulates a unit of work

```
def some_func(arg_01, arg_02):
    """
    docstring (describes what this function does)
    """
    # Do something useful, e.g.,
    # Accept two inputs (i.e., parameters/arguments)
    # Process inputs
    # Provide a result

    return something
```

Built-in functions

Python Interpreter provides a set of pre-defined functions

69 built-in functions currently available

Our focus (this week)

print()

type()

len()

input()

Built-in function: print()

print one or more objects to a stream or file-like object

print(*objects, sep=' ',end='\n', file=sys.stdout, flush=False)

Print objects to the text stream file, separated by *sep* and followed by *end*. *sep*, *end*, *file* and *flush*, if present, must be given as keyword arguments.

Source: https://docs.python.org/3/library/functions.html#print. See also https://realpython.com/python-print/

Built-in function: type()

evaluate object type

type(object)

With one argument, return the type of an object. The return value is a type object and generally the same object as returned by `object.__class__`.

Source: https://docs.python.org/3/library/functions.html#type

Built-in function: len()

evaluate sequences and collections

len(object)

Return the length (the number of items) of an object. The argument may be a sequence (such as a string, bytes, tuple, list, or range) or a collection (such as a dictionary, set, or frozen set).

Source: https://docs.python.org/3/library/functions.html#len

Built-in function: input()

request/return user input

input([prompt])

If the prompt argument is present, it is written to standard output without a trailing newline. The function then reads a line from input, converts it to a string (stripping a trailing newline), and returns that. When EOF is read, EOFError is raised.

Source: https://docs.python.org/3/library/functions.html#input

Built-in functions

interactive shell (type this)

```
$ python3
>>> y = input("Type 'spam' 3 times: ")
>>> print(y)
>>> type(y)
>>> y.__class__ # just to confirm
>>> z = y
>>> print(y, z, sep=' wonderful ', end='\n\n\n')
>>> len(z)
>>> type(len(z)) # function as argument
```

string functions

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String functions

Built-in types also provisioned with functions (very handy)

Our focus (this week)

str.split()

str.replace()

str.join()

Built-in function: str.split()

return a list of character chunks per chosen delimiter

str.split(sep=None, maxsplit=-1)

Return a list of the words in the string, using sep as the delimiter string. If maxsplit is given, at most maxsplit splits are done (thus, the list will have at most maxsplit+1 elements). If maxsplit is not specified or -1, then there is no limit on the number of splits (all possible splits are made).

If sep is given, consecutive delimiters are not grouped together and are deemed to delimit empty strings ….

Source: https://docs.python.org/3/library/stdtypes.html#str.split

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Built-in function: str.split()

interactive shell (type this)

```
$ python3
>>> s = 'spam,spam,spam'
>>> s.split()
>>> s.split(',')
>>> s.split(sep=',', maxsplit=1)
>>> s = 'spam spam spam'
>>> p = s.split()
>>> type(p)
>>> len(p)
```

Built-in function: str.replace()

swap out one substring for another

str.replace(old, new[, count])

Return a copy of the string with all occurrences of substring old replaced by new. If the optional argument count is given, only the first count occurrences are replaced.

Source: https://docs.python.org/3/library/stdtypes.html#str.replace

Built-in functions

interactive shell (type this)

```
$ python3
>>> e = s.replace('spam', 'egg')
>>> print(e)
>>> print(s)
>>> b = s.replace('spam', 'egg bacon +', 1)
>>> print(b)
>>> m = s[:9].replace('spam', 'egg bacon +', 1)
>>> print(m) # actually on the menu (Spam skit)
```

See: https://en.wikipedia.org/wiki/Spam_(Monty_Python)

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Built-in function: str.join()

concatenate strings with an iterable (say what?)

str.join(iterable)

Return a string which is the concatenation of the strings in iterable. A TypeError will be raised if there are any non-string values in iterable, including bytes objects. The separator between elements is the string providing this method.

Source: https://docs.python.org/3/library/stdtypes.html#str.replace

Iterable?: better check stackoverflow

wisdom of the crowd (with limits)

http://bit.ly/2kCbgXL

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Built-in function: str.join()

interactive shell (type this)

```
$ python3
>>> print(s)
>>> t = s + ' ' + s # operator
>>> print(t)
>>> t = ''.join([s, ' ', s]) # join to empty string
>>> print(t)
>>> u = ''.join([t, ' baked beans ', s, ' and spam'])
>>> print(u) # also on the menu (Spam skit)
```

See: https://en.wikipedia.org/wiki/Spam_(Monty_Python)

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MENU
EGG + SPAM
EGG BACON + SPAM
EGG BACON SAUSAGE + SPAM
SPAM BACON SAUSAGE + SPAM
SPAM EGG SPAM SPAM BACON
+ SPAM
SPAM SPAM SPAM EGG + SPAM
SPAM SPAM SPAM SPAM SPAM
SPAM BAKED BEANS SPAM
SPAM SPAM + SPAM
LOBSTER THERMIDOR AUX
CREVETTES WITH MORNAY
SAUCE GARNISHED WITH
TRUFFLE PATE
BRANDY + FRIED EGG + SPAM

finis

directors cut

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si506_lab_01.py

script anatomy and workflow

load

```
import ...
```
module imports

instructions

entry point

```
main(argv)
```
process, delegate, print

```
huzzah(name)
```
delegate, build, format

```
umich_now()
```
transform

invoke

```
if __name__ == '__main__':
    main(sys.argv[1:]) # do something
```


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Python object

the stuff of an object

Identity

Type

Value

Source: https://docs.python.org/2.0/ref/objects.html

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Built-in Types

a.k.a integer, float, boolean, string, list, dictionary, tuple, class, etc.

- numerics
- sequences
- mappings
- classes
- instances
- exceptions

Variable

naming do's and don'ts

Good

```
course_short_name = 'SI506'
course_list = ['SI506', 'SI507', 'SI508']
```

Bad

```
c = 'SI506' # opaque (unfriendly)
courseList = ['SI506', 'SI507', 'SI508'] # camelcase
```

Ugly (interpreter will complain)

```
506_umsi = 'SI506'
$number = 506
course-list = ['SI506', 'SI507', 'SI508']
course name = 'SI506'
```


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Keywords

reserved: cannot be used as ordinary identifiers

False	await	else	import	pass
None	break	except	in	raise
True	class	finally	is	return
and	continue	for	lambda	try
as	def	from	nonlocal	while
assert	del	global	not	with
async	elif	if	or	yield

Source: *https://docs.python.org/3/reference/lexical_analysis.html?highlight=reserved%20keywords#keywords*

Console exercise

interactive shell (type this)

```
$ python3
. . .
>>> class = ‘SI 506’
```

operators and operands

(a brief intro)

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Operators

Types

- arithmetic
- comparison
- assignment
- logical (and, or, not)
- membership (in, not in)
- identity (is, is not)
- bitwise

Arithmetic operators

operations on operands x and y

Operator	Description	Example
+	Addition	x + y = 506
-	Subtraction	x - y = 494
*	Multiplication	x * y = 3000
/	Division	x / y = 83.33
%	Modulus (divides x by y and returns remainder)	x % y = 2
**	Exponent (exponential power calculation)	x**y = 15625000000000000
//	Floor division (result rounded to whole number)	x // y = 83

Q: what are the values assigned to x and y?

and now for something completely different

Zen of Python

type this

```
$ python3
. . .
>>> import this
```