

Python Tutorial

A Gentle Introduction

Yann Tambouret

Scientific Computing and Visualization
Information Services & Technology
Boston University
111 Cummington St.
yannpaul@bu.edu

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This Tutorial

- This tutorial is for someone with any programming experience.
- First a brief intro to
 - 1 variables
 - 2 types
 - 3 if-statement
 - 4 functions
- Then I'll cover the basics of
 - 1 lists
 - 2 loops
 - 3 dictionaries
 - 4 modules

Python Overview

- Python is named after the BBC show "Monty Python's Flying Circus"
- We will focus on Python 2 today.
- Python on [Katana](#) and on [Windows](#) or [Mac](#)
- This tutorial borrows largely from a tutorial by the [Boston Python Group](#)



Python is Interpreted

- Python can be run interactively.
- Code \Rightarrow execution is almost instant; No explicit compilation step required.
- This allows for a faster development process
- The final product is usually more resource intensive, and as a side effect slower then comparable C/Fortran code.

Python is Interactive

Practice running python, type **python** in the terminal, hit Enter:

```
1 % python
2 Python 2.7 (#1, Feb 28 2010, 00:02:06)
3 Type "help", "copyright", "credits" or "license" for more information.
4 >>>
```

- The `>>>` is a prompt asking for the next python line of code.
- Sometimes you'll see `...` as a prompt too.
- To exit, type `exit()` and Enter
Try it!

Interactive Python

- Python can be used as a calculator:

```
1 >>> 7*9
2 63
3 >>> 1/2 + 10
4 10
5 >>> 1.0 / 2 + 20 / 2.0
6 10.5
```

- Use up/down arrows to navigate history of commands you typed.

type() and Variables

- `type()` returns what Python thinks something is.
- Variable names: start with letter or '_', then letters, '_' or numbers
- Don't need to declare a type
- You can re-assign a variable using a different type, automatically!

```
1 >>> type(1)
2 <type 'int'>
3 >>> x = 2.0
4 >>> type(x)
5 <type 'float'>
```

About Numbers

- A Python **Int** corresponds to **C** long, usually...
- A python **Float** is traditionally a **C** double
- **Complex** is type that corresponds to a real and imaginary float
- And there are other standard [types](#)

Strings

- 'Hello' or "Hello"

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- But don't forget to escape:
Yes: 'I\'m a happy camper'
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- "Hello" + 1 results in an error: `TypeError`

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Yes: `"I'm a happy camper"`
No: `'I'm a happy camper'`
- Concatenation: `"Hello " + "World"`
- `print` sends string to standard output
- `"Hello" + 1` results in an error: `TypeError`
- `"Yes" * 3` allowed, repeats: `'YesYesYes'`
`"3"*3` does not become `"9"` or `9`

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`"H" in "Hello"` is `True`
- `not` let's you do the opposite:
`"Perl" not in "Python Tutorial"` is also `True`

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if, elif and else

```
1 sister_age = 15
2 brother_age = 12
3 if sister_age > brother_age:
4     print "sister is older"
5 elif sister_age == brother_age:
6     print "sister and brother are the same age"
7 else:
8     print "brother is older"
```

- `if` takes a Boolean, and executes code if `True`
- `elif` is an alternative tested if the first case is `False`
- `else` occurs if all previous fail.
- And indentation is important!

Indentation, what's up with that?

- If you've programmed in other languages, this indentation thing might seem weird.
- Python prides itself as an easy-to-read language, and indentation makes it easy to read **code blocks**.
- So Python requires indentation over if/end-if, begin-block/end-block organization.

Indentation - example

```
1 # this looks like other languages,
2 # but I use a comment to organize
3 if 1 == 1:
4     print "Everything is going to be OK!"
5     if 10 < 0:
6         print "or is it?"
7     #end if
8     print "Inside first code block!"
9 #end if
```

Don't use `#end if`, just keep it in your mind if it gets confusing...

Functions

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Functions

Defining code for re-use:

- 1 Declare signature using `def`:
`def myFunction(name, age, hair_color):`
- 2 Add a useful **code block**; indent!
- 3 Return a result using the `return` statement

```
1 def add(x, y):  
2     return x + y  
3  
4 result = add(1234, 5678)  
5 print result  
6 result = add(-1.5, .5)  
7 print result
```

Python as a Scripting Language

You can store statements in a file, and pass that file to Python for execution.

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See for example `examples\nobel.py`.

- 1 How do you comment code in Python?
- 2 How do you print a newline?
- 3 How do you print a multi-line string so that whitespace is preserved?

Lists - Initialization

In it's simplest form, a list is a comma-separated list of values surrounded by square brackets [and]:

```
1 alist = ['a', 'b', 'c']  
2 alist  
3 [1, 2, 3]  
4 [1, 2.0, '3']
```

Try this out ...

Lists - Initialization

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2 alist  
3 [1, 2, 3]  
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```

results in ...

```
1 >>> alist = ['a', 'b', 'c']  
2 >>> alist  
3 ['a', 'b', 'c']  
4 >>> [1, 2, 3]  
5 [1, 2, 3]  
6 >>> [1, 2.0, '3']  
7 [1, 2.0, '3']
```

len() and Access

`len()` is a list method that returns the length of the list:

```
1 >>> len(alist)
2 3
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We can access elements starting at 0, ending at

`len(alist)-1`:

```
1 print alist[0], alist[1], alist[2]
```

len() and Access

len() is a list method that returns the length of the list:

```
1 >>> len(alist)
2 3
```

We can access elements starting at 0, ending at

len(alist)-1:

```
1 print alist[0], alist[1], alist[2]
```

results in ...

```
1 >>> print alist[0], alist[1], alist[2]
2 a b c
```

Access

And negative indices access the elements in reverse order, from -1 to `-len(list)`:

```
1 >>> print alist[-1], alist[-2], alist[-3]
2 c b a
```

Access

And negative indicies access the elements in reverse order, from -1 to `-len(list)`:

```
1 >>> print alist[-1], alist[-2], alist[-3]
2 c b a
```

And we can use list values as if they were single value variables:

```
1 >>> print "I am " + alist[0] + " list"
2 I am a list
```

Dot Product

- The dot product involves taking two equal-length sequences to create a single value.
- If we have two vectors:
 $vec_1 = (1, 8, 3)$; $vec_2 = (7, 0, 9)$
- The dot product is

$$\begin{aligned}vec_1 \cdot vec_2 &= 1 * 7 + 8 * 0 + 3 * 9 \\&= vec_1[0] * vec_2[0] + vec_1[1] * vec_2[1] + \dots \\&= 34\end{aligned}$$

Dot product

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and try the assignment and I'll show the solution next.
Solution:

```
1 def dot_product(vec1, vec2):  
2     """Returns the dot product of two vectors  
3  
4     'vec1' and 'vec2' are each 3 element vectors  
5     """  
6     # put your code here:  
7     return a[0] * b[0] + a[1] * b[1] + a[2] * b[2]
```

Modifying a List

You can `append()` a list:

```
1 >>> alist.append('d')
2 >>> alist
3 ['a', 'b', 'c', 'd']
```


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1 >>> alist.append('d')
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You can concatenate lists by "adding" them:

```
1 >>> new_alist = alist + ['e', 'g']
2 >>> new_alist
3 ['a', 'b', 'c', 'd', 'e', 'g']
```

Modifying a List

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1 >>> alist.append('d')
2 >>> alist
3 ['a', 'b', 'c', 'd']
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You can concatenate lists by "adding" them:

```
1 >>> new_alist = alist + ['e', 'g']
2 >>> new_alist
3 ['a', 'b', 'c', 'd', 'e', 'g']
```

You can also `insert(pos, value)`:

```
1 >>> new_alist.insert(5, 'f')
2 >>> print new_alist
3 ['a', 'b', 'c', 'd', 'e', 'f', 'g']
```

Modifying a List

You can also change individual elements of a list:

```
1 >>> new_alist[2] = 'C'
2 >>> print new_alist
3 ['a', 'b', 'C', 'd', 'e', 'f', 'g']
```

Slice

You can *slice* a list, access a portion of it.

```
1 >>> new_alist[1:3]
2 ['b', 'C']
```

This gets a new list from the 1 index (inclusive) to the 3 index (exclusive). So [1,3)

Slice

You can *slice* a list, access a portion of it.

```
1 >>> new_alist[1:3]
2 ['b', 'C']
```

This gets a new list from the 1 index (inclusive) to the 3 index (exclusive). So [1,3)

Now try (explore) some other options:

```
1 new_alist = ['a', 'b', 'C', 'd', 'e', 'f', 'g']
2 new_alist[:]
3 new_alist[-3:-1]
4 new_alist[1:]
5 new_alist[:4]
```

Slice - Output

```
1 >>> new_alist = ['a', 'b', 'C', 'd', 'e', 'f', 'g']
2 >>> new_alist[:]
3 ['a', 'b', 'C', 'd', 'e', 'f', 'g']
4 >>> new_alist[-3:-1]
5 ['e', 'f']
6 >>> new_alist[1:]
7 ['b', 'C', 'd', 'e', 'f', 'g']
8 >>> new_alist[:4]
9 ['a', 'b', 'C', 'd']
```

Modifying by Slicing

You can update many values at once with *slicing*.
What happens when you try:

```
1 new_alist[0:2] = ['A', 'B']  
2 print new_alist
```

Modifying by Slicing

You can update many values at once with *slicing*.
What happens when you try:

```
1 >>> new_alist[0:2] = ['A', 'B']  
2 >>> print new_alist  
3 ['A', 'B', 'C', 'd', 'e', 'f', 'g']
```


Deleting

You can delete an element too, using `del`. Try:

```
1 del new_alist[5]
2 print new_alist
```

Deleting

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```
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```

```
1 >>> del new_alist[5]
2 >>> print new_alist
3 ['A', 'B', 'C', 'd', 'e', 'g']
```

Strings and Lists

Strings can act like lists:

```
1 >>> name = "Tommy"
2 >>> name[0:3]
3 'Tom'
4 >>> len(name)
5 5
```

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1 >>> name = "Tommy"
2 >>> name[0:3]
3 'Tom'
4 >>> len(name)
5 5
```

But Strings can't be changed like lists:

```
1 >>> name[1] = 'a'
2 Traceback (most recent call last):
3   File "<console>", line 1, in <module>
4   TypeError: 'str' object does not support item assignment
```

Loops - For Loop

`for` is used to repeat a task on each element in a list:

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```
1 a = ['cat', 'window', 'defenestrate']  
2 for x in a:  
3     print x, len(x)
```

Loops - For Loop

`for` is used to repeat a task on each element in a list:

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1 a = ['cat', 'window', 'defenestrate']
2 for x in a:
3     print x, len(x)
```

```
1 >>> a = ['cat', 'window', 'defenestrate']
2 >>> for x in a:
3 ...     print x, len(x)
4 ...
5 cat 3
6 window 6
7 defenestrate 12
```

if and for

You can control what happens inside a `for` loop using `if` `elif` `else` statements.

if and for

You can control what happens inside a `for` loop using `if` `elif` `else` statements.

Don't change the list in the loop though!!!!. Make a copy:

```
1 >>> for x in a[:]: # make a slice copy of the entire list
2     ...     if len(x) > 6: a.insert(0, x)
3     ...
4 >>> a
5 ['defenestrate', 'cat', 'window', 'defenestrate']
```

range()

In other languages (I'm thinking of C), `for` loops traditionally involve counting to a certain value. In Python this is accomplished by using the `range()` function.

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```
1 >>> range(10)
2 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

range()

In other languages (I'm thinking of C), `for` loops traditionally involve counting to a certain value. In Python this is accomplished by using the `range()` function.

```
1 >>> range(10)
2 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

`range()` can actually take three arguments. Try:

```
1 range(5, 10)
2 range(0, 10, 3)
3 range(-10, -40, -70)
```

What does it mean to supply only one argument?
What does it mean to supply only two arguments?
What does it mean to supply all three arguments?

range()

```
1 >>> range(5, 10)
2 [5, 6, 7, 8, 9]
3 >>> range(0, 10, 3)
4 [0, 3, 6, 9]
5 >>> range(-10, -100, -30)
6 [-10, -40, -70]
```

`range(10)` - returns a list of numbers from 0 (default) to 9 (10-1) in steps of 1 (default)

`range(5, 10)` - returns a list of numbers from 5 to 9 (10-1) in steps of 1 (default)

`range(0, 10, 3)` - returns a list of numbers from 0 to 9 (10-1) in steps of 3

range()

One way to get both the element and index of a list is to loop in a more traditional fashion:

```
1 >>> a = ['Mary', 'had', 'a', 'little', 'lamb']
2 >>> for i in range(len(a)):
3 ...     print i, a[i]
4 ...
5 0 Mary
6 1 had
7 2 a
8 3 little
9 4 lamb
```

More dot product

Look at `practice\dot_product2.py` and try the assignment.

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Solution:

```
1 def dot_product(length, vec1, vec2):
2     """Returns the dot product of two vectors
3
4     'vec1' and 'vec2' are each 'length' elements long
5     """
6     product = 0
7     for i in range(length):
8         product += vec1[i] * vec2[i]
9     return product
```

Note, I use the *operator* `+=`, and line 8 is the same as `product = product + vec1[i] * vec2[i]`.

File Access

I have some data in `examples\life_expectancies_usa.txt`
go there (`% cd examples`) and try this out:

```
3 data = open("life_expectancies_usa.txt", "r")
4 type(data)
5 for line in data:
6     print line
```

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```

`open(name, mode)` - mode can be

- read ('r')
- write ('w')
- append ('a')
- Adding 'b' to mode makes it binary, 'rb' is read binary

File Access

- `file.read()` - everything as a string
- `file.readline()` - read only next line
- `file.readlines()` - read all lines as a list
- `file.write()`: don't forget the newline `'\n'`

While Loops

Python also provides a `while` looping method. While a condition is `True`, the **code block** is *repeatedly* executed:

```
1 count = 0
2 while (count < 4):
3     print 'The count is:', count
4     count = count + 1
```

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```
1 >>> count = 0
2 >>> while (count < 4):
3 ...     print 'The count is:', count
4 ...     count = count + 1
5 ...
6 The count is: 0
7 The count is: 1
8 The count is: 2
9 The count is: 3
```

Infinite Loops

You need to be careful because you can end up in *infinite loops* when using `while` blocks:

```
1 arrived = False
2 while not arrived:
3     print "Are we there yet?"
```

This is a never ending program, 1) how does it end?
2) why do this?

Infinite Loops

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2 while not arrived:
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```

This is a never ending program, 1) how does it end?
2) why do this?

Answers:

- 1) Ctrl-C (KeyboardInterrupt)
- 2) You are waiting for an unpredictable event to occur.

break

`break` is the keyword that causes a loop, of any kind, to stop happening:

```
1 count = 0
2 while True: #infinite loop!!
3     print "Back-seat: Are we there yet?"
4     count = count + 1
5     if count > 10:
6         print "Front-seat: Yes!"
7         break
8     else:
9         print "Front-seat: Nope!"
```


Getting info from user

Python provides a method, `raw_input()`, that is used to prompt the user to respond through the console. The only argument is the value of the prompt:

```
1 name = raw_input("What's your name? ")
2 print "The user's name is " + name
```

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Python provides a method, `raw_input()`, that is used to prompt the user to respond through the console. The only argument is the value of the prompt:

```
1 name = raw_input("What's your name? ")
2 print "The user's name is " + name
```

This only works in Python scripts.

Also keep in mind, the returned value is a string.

Use `int()` or `float()` to convert this string to an integer or a float.

Dict - Purpose

- A python `dict` type is an *associative array*
- Unlike lists, which are indexed by integers, dictionaries are indexed by *keys*, which can be any *immutable* type.
- Numbers and Strings are immutable, so they can be used as keys.
- Expert tip: What if I need 'variable' variable names?
... Use a dictionary.

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- Each key, value pair is connected by a semi-colon:
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```
1 >>> tel = {'jack': 4098, 'sape': 4139}
2 >>> tel
3 {'sape': 4139, 'jack': 4098}
4 >>> type(tel)
5 <type 'dict'>
```

Initialization

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Accessing Elements

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- You can `get('key', 'default')` an element, which will safely return a value if the 'key' does not exist.

```
1 >>> tel['jack']
2 4098
3 >>> print "sape's telephone number is", tel['sape']
4 sape's telephone number is 4139
5 >>> print "guido's telephone number is", tel.get('guido', 4127)
6 guido's telephone number is 4127
7 >>> tel
8 {'sape': 4139, 'jack': 4098}
```

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- You can also `setdefault('key', 'value')`, which acts much like `get()`, but also saves the pair.

```
1 >>> tel['guido'] = 4127
2 >>> tel
3 {'sape': 4139, 'guido': 4127, 'jack': 4098}
4 >>> print "john's telephone number is", tel.setdefault('john', 4118)
5 john's telephone number is 4118
6 >>> tel
7 {'sape': 4139, 'john': 4118, 'jack': 4098, 'guido': 4127}
```

Changing Elements

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Changing Elements

- You change elements of a dictionary in much the same fashion as with a list: `my_dict['key'] = 'value'`
- `del` allows you to delete a key, value pair.

```
1 >>> tel
2 {'sape': 4139, 'john': 4118, 'jack': 4098, 'guido': 4127}
3 >>> tel['sape'] = 4039
4 >>> del tel['jack']
5 >>> tel
6 {'sape': 4039, 'john': 4118, 'guido': 4127}
```

keys() and values()

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keys() and values()

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- values() returns a *list* of the dict's values

```

1 >>> print "There are", len(tel.values()), "telephone numbers"
2 There are 3 telephone numbers
3 >>> for key in tel.keys():
4 ...     print key, "has telephone number", tel[key]
5 ...
6 sape has telephone number 4039
7 john has telephone number 4118
8 guido has telephone number 4127

```

How is the order of keys determined?

Modules - Purpose

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- Each module is contained within a file, so every script you write is in fact a module, too.

Modules - Purpose

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- Each module is contained within a file, so every script you write is in fact a module, too.
- Modules can be used like a *namespace*.
- This means they can be used to isolate your code from other code that has the same name.
- What if you wanted to make your own `len` function? There would be a conflict with the default `len`. Use a module.

imports

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`import my_module as mymod`
- You can get just one component by using `from`:
`from my_module import some_func`. Now just use `some_func`.
- In a pinch you can get everything using `*`

Use `*` with caution, it can lead to bugs.

random

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random

- `random` is a module that has several functions to perform (*pseudo*) random operations.
- In `random.py` is some functions we are going to use for a little project
- `randint` returns a random integer from `a` to `b`
- `choice` returns a random value from a list.

random.randint

```
1 >>> import random
2 >>> help(random.randint)
3 Help on method randint in module random:
4
5 randint(self, a, b) method of random.Random instance
6     Return random integer in range [a, b], including both end points
7
8 >>> random.randint(0,9)
9 1
10 >>> random.randint(0,9)
11 4
12 >>> random.randint(0,9)
13 4
14 >>> random.randint(0,9)
15 8
```

random.choice

```
1 import random
2 help(random.choice)
3 lucky = ['Tim', 'Tom', 'Ted', 'Tony']
4 type(lucky)
5 random.choice(lucky)
6 random.choice(lucky)
7 random.choice(lucky)
```

Try this out...

random.choice

```
1 >>> import random
2 >>> help(random.choice)
3 Help on method choice in module random:
4
5 choice(self, seq) method of random.Random instance
6     Choose a random element from a non-empty sequence
7
8 >>> lucky = ['Tim', 'Tom', 'Ted', 'Tony']
9 >>> type(lucky)
10 <type 'list'>
11 >>> random.choice(lucky)
12 'Tony'
13 >>> random.choice(lucky)
14 'Tony'
15 >>> random.choice(lucky)
16 'Ted'
```

An Example

Check out `examples\state_capitals.py` .

- 1 Run it.
- 2 Open it and read how it works.
- 3 Ask questions if you are lost...

End of Tutorial

Thanks!

Fill out the survey please!

References

- This Tutorial was based on a tutorial presented by the Boston Python Group:

https://openhatch.org/wiki/Boston_Python_Workshop_6

Look at "Saturday projects" for your next step.

- Follow the official Python tutorial for a full look at all the basic features:

<http://docs.python.org/tutorial/index.html>

- Code, code, code; codingbat.com, udacity.com, etc.
- Ask for help: yannpaul@bu.edu

http://codingbat.com/python

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Python

Python practice problems. See also [Python Example Code](#). Python help docs: [Python Strings](#) | [Python Lists](#)

[Python If Boolean](#)

[forgot password](#)

Warmup-1

Simple warmup problems to get started, no loops (solutions available)

✓ [sleep_in](#) H ✓ [monkey_trouble](#) H
✓ [sum_double](#) H [more](#)

Warmup-2

Medium warmup string/list problems with loops (solutions available)

✓ [string_times](#) H ✓ [front_times](#) H
✓ [string_bits](#) H [more](#)

String-1

Basic python string problems -- no loops

✓ [hello_name](#) ✓ [make_abba](#) ✓ [make_tags](#) [more](#)

List-1

Basic python list problems -- no loops.

✓ [first_last6](#) ✓ [same_first_last](#) ✓ [make_pi](#)
[more](#)

Logic-1

Basic boolean logic puzzles -- if else and or not

✓ [cigar_party](#) H ✓ [date_fashion](#) H
✓ [squirrel_play](#) [more](#)

Logic-2

Medium boolean logic puzzles -- if else and or not

✓ [make_bricks](#) ✓ [lone_sum](#) ✓ [lucky_sum](#) [more](#)

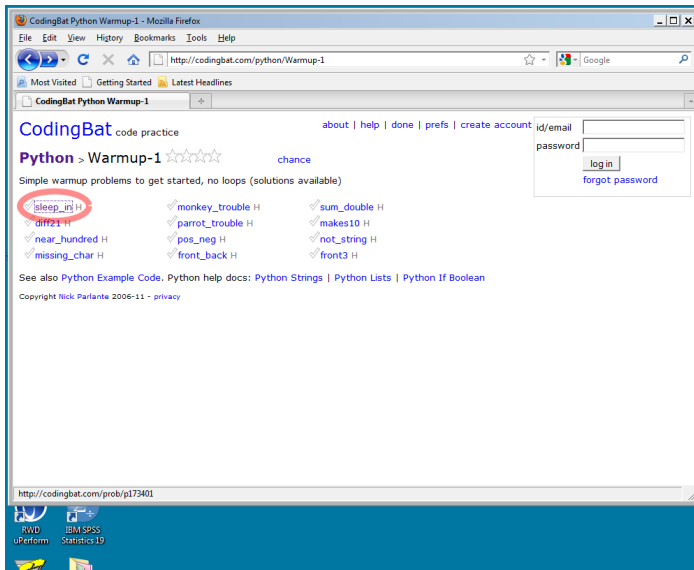
String-2

Medium python string problems -- 1 loop.

List-2

Medium python list problems -- 1 loop.

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Python > Warmup-1 > sleep_in

prev | next | chance

The parameter weekday is True if it is a weekday, and the parameter vacation is True if we are on vacation. We sleep in if it is not a weekday or we're on vacation. Return True if we sleep in.

sleep_in(False, False) → True
sleep_in(True, False) → False
sleep_in(False, True) → True

(2) Click Go!

Go Save, Compile, Run Show Solution

(1) Code Here

def sleep_in(weekday, vacation):

id/email
password
log in
forgot password

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Go ...Save, Compile, Run Show Solution

```
def sleep_in(weekday, vacation):
    return True
```

Expected	This Run	
sleep_in(False, False) → True	True	OK
sleep_in(True, False) → False	True	X
sleep_in(False, True) → True	True	OK
sleep_in(True, True) → True	True	OK

Correct for more than half the tests

Progress Graph for this problem new

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```

id/email
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log in
forgot password

Compile problems:

Error: expected an indented block (line 2)

see Python Example Code to help with compile problems

More dot product

Look at `practice\dot_product3.py` and try the assignment.

More dot product

Look at `practice\dot_product3.py` and try the assignment.

Solution:

```

1 def get_length():
2     """Get the length of the vectors from the user"""
3     print "What length should the vectors be?"
4     return int(raw_input("0 length will stop the program: "))
5
6 def get_vector(length):
7     print "What is the value of the vector?"
8     vec = []
9     for i in range(length):
10         vec.insert(i, int(raw_input("Vec[" + str(i) + "]: ")))
11     return vec

```

Note, I used the `str()` method to convert the integer to a string, so that it could be concatenated.