Learn Python The Hard Way

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The Hard Way Is Easier

This simple book is meant to get you started in programming. The title says it's the hard way to learn to write code; but it's actually not. It's only the "hard" way because it's the way people *used* to teach things. With the help of this book, you will do the incredibly simple things that all programmers need to do to learn a language:

1. Go through each exercise.
2. Type in each sample *exactly*.
3. Make it run.

That's it. This will be *very* difficult at first, but stick with it. If you go through this book, and do each exercise for one or two hours a night, you will have a good foundation for moving onto another book. You might not really learn "programming" from this book, but you will learn the foundation skills you need to start learning the language.

This book's job is to teach you the three most essential skills that a beginning programmer needs to know: Reading and Writing, Attention to Detail, Spotting Differences.

Reading and Writing

It seems stupidly obvious, but, if you have a problem typing, you will have a problem learning to code. Especially if you have a problem typing the fairly odd characters in source code. Without this simple skill you will be unable to learn even the most basic things about how software works.

Typing the code samples and getting them to run will help you learn the names of the symbols, get familiar with typing them, and get you reading the language.

Attention to Detail

The one skill that separates bad programmers from good programmers is attention to detail. In fact, it's what separates the good from the bad in any profession. Without paying attention to the tiniest details of your work, you will miss key elements of what you create. In programming, this is how you end up with bugs and difficult-to-use systems.

By going through this book, and copying each example *exactly*, you will be training your brain to focus on the details of what you are doing, as you are doing it.

Spotting Differences

A very important skill – that most programmers develop over time – is the ability to visually notice differences between things. An experienced programmer can take two pieces of code that are slightly different and immediately start

pointing out the differences. Programmers have invented tools to make this even easier, but we won't be using any of these. You first have to train your brain the hard way, then you can use the tools.

While you do these exercises, typing each one in, you will be making mistakes. It's inevitable; even seasoned programmers would make a few. Your job is to compare what you have written to what's required, and fix all the differences. By doing so, you will train yourself to notice mistakes, bugs, and other problems.

Do Not Copy-Paste

You must *type* each of these exercises in, manually. If you copy and paste, you might as well just not even do them. The point of these exercises is to train your hands, your brain, and your mind in how to read, write, and see code. If you copy-paste, you are cheating yourself out of the effectiveness of the lessons.

A Note On Practice And Persistence

While you are studying programming, I'm studying how to play guitar. I practice it every day for at least 2 hours a day. I play scales, chords, and arpeggios for an hour at least and then learn music theory, ear training, songs and anything else I can. Some days I study guitar and music for 8 hours because I feel like it and it's fun. To me repetitive practice is natural and just how to learn something. I know that to get good at anything you have to practice every day, even if I suck that day (which is often) or it's difficult. Keep trying and eventually it'll be easier and fun.

As you study this book, and continue with programming, remember that anything worth doing is difficult at first. Maybe you are the kind of person who is afraid of failure so you give up at the first sign of difficulty. Maybe you never learned self-discipline so you can't do anything that's "boring". Maybe you were told that you are "gifted" so you never attempt anything that might make you seem stupid or not a prodigy. Maybe you are competitive and unfairly compare yourself to someone like me who's been programming for 20+ years.

Whatever your reason for wanting to quit, *keep at it*. Force yourself. If you run into an Extra Credit you can't do, or a lesson you just do not understand, then skip it and come back to it later. Just keep going because with programming there's this very odd thing that happens.

At first, you will not understand anything. It'll be weird, just like with learning any human language. You will struggle with words, and not know what symbols are what, and it'll all be very confusing. Then one day *BANG* your brain will snap and you will suddenly "get it". If you keep doing the exercises and keep trying to understand them, you will get it. You might not be a master coder, but you will at least understand how programming works.

If you give up, you won't ever reach this point. You will hit the first confusing thing (which is everything at first) and then stop. If you keep trying, keep typing it in, trying to understand it and reading about it, you will eventually get it.

But, if you go through this whole book, and you still do not understand how to code, at least you gave it a shot. You can say you tried your best and a little more and it didn't work out, but at least you tried. You can be proud of that.

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Exercise 0: The Setup

This exercise has no code. It is simply the exercise you complete to get your computer setup to run Python. You should follow these instructions as exactly as possible. For example, Mac OSX computers already have Python 2, so do not install Python 3 (or any Python).

Mac OSX

To complete this exercise, complete the following tasks:

1. Go to http://learnpythonthehardway.org/wiki/ExerciseZero with your browser, get the `gedit` text editor, and install it.
2. Put gedit (your editor) in your Dock so you can reach it easily.
   (a) Run gedit so we can fix some stupid defaults it has.
   (b) Open `Preferences` from the `gedit menu` and select the `Editor` tab.
   (c) Change `Tab width:` to 4.
   (d) Select (make sure a check mark is in) `Insert spaces instead of tabs`.
   (e) Turn on "Automatic indentation" as well.
   (f) Open the `View` tab and turn on "Display line numbers".
3. Find your "Terminal" program. Search for it. You will find it.
4. Put your Terminal in your Dock as well.
5. Run your Terminal program. It won't look like much.
6. In your Terminal program, run `python`. You run things in Terminal by just typing their name and hitting RETURN.
7. Hit CTRL-D (^D) and get out of python.
8. You should be back at a prompt similar to what you had before you typed `python`. If not find out why.
9. Learn how to make a directory in the Terminal. Search online for help.
10. Learn how to change into a directory in the Terminal. Again search online.
11. Use your editor to create a file in this directory. You will make the file, "Save" or "Save As...", and pick this directory.
12. Go back to Terminal using just the keyboard to switch windows. Look it up if you can't figure it out.
13. Back in Terminal, see if you can list the directory to see your newly created file. Search online for how to list a directory.

OSX: What You Should See

Here's me doing the above on my computer in Terminal. Your computer would be different, so see if you can figure out all the differences between what I did and what you should do.

```
Last login: Sat Apr 24 00:56:54 on ttys001
~ $ python
Python 2.5.1 (r251:54863, Feb  6 2009, 19:02:12)
[GCC 4.0.1 (Apple Inc. build 5465)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> ^D
~ $ mkdir mystuff
~ $ cd mystuff
mystuff $ ls
# ... Use Gedit here to edit test.txt....
mystuff $ ls
test.txt
mystuff $
```

Windows

Note: Contributed by zhmark.

1. Go to http://learnpythonthehardway.org/wiki/ExerciseZero with your browser, get the `gedit` text editor, and install it. You do not need to be administrator to do this.
2. Make sure you can get to `gedit` easily by putting it on your desktop and/or in `Quick Launch`. Both options are available during setup.
   (a) Run gedit so we can fix some stupid defaults it has.
   (b) Open `Edit->Preferences` select the `Editor` tab.
   (c) Change `Tab width:` to 4.
   (d) Select (make sure a check mark is in) `Insert spaces instead of tabs`.
   (e) Turn on "Automatic indentation" as well.
   (f) Open the `View` tab turn on "Display line numbers".
3. Find your "Terminal" program. It's called `Command Prompt`. Alternatively just run `cmd`.
4. Make a shortcut to it on your desktop and/or `Quick Launch` for your convenience.
5. Run your Terminal program. It won't look like much.
6. In your Terminal program, run `python`. You run things in Terminal by just typing their name and hitting RETURN.
   (a) If you run `python` and it's not there (`python is not recognized..`). Install it from http://python.org/download
   (b) *Make sure you install Python 2 not Python 3.*
   (c) You may be better off with ActiveState Python especially when you miss Administrative rights
7. Hit CTRL-Z (^Z), `Enter` and get out of `python`.
8. You should be back at a prompt similar to what you had before you typed `python`. If not find out why.
9. Learn how to make a directory in the Terminal. Search online for help.

10. Learn how to change into a directory in the Terminal. Again search online.
11. Use your editor to create a file in this directory. Make the file, "Save" or "Save As...", and pick this directory.
12. Go back to Terminal using just the keyboard to switch windows. Look it up if you can't figure it out.
13. Back in Terminal, see if you can list the directory to see your newly created file. Search online for how to list a directory.

Warning: Windows is a big problem for Python. Sometimes you install Python and one computer will have no problems, and another computer will be missing important features. If you have problems, please visit: http://docs.python.org/faq/windows.html

Windows: What You Should See

```
C:\Documents and Settings\you>python
ActivePython 2.6.5.12 (ActiveState Software Inc.) based on
Python 2.6.5 (r265:79063, Mar 20 2010, 14:22:52) [MSC v.1500 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> ^Z


C:\Documents and Settings\you>mkdir mystuff

C:\Documents and Settings\you>cd mystuff

... Here you would use gedit to make test.txt in mystuff ...

C:\Documents and Settings\you\mystuff>
   <bunch of unimportant errors if you istalled it as non-admin - ignore them - hit Enter>
C:\Documents and Settings\you\mystuff>dir
 Volume in drive C is
 Volume Serial Number is 085C-7E02

 Directory of C:\Documents and Settings\you\mystuff

04.05.2010  23:32    <DIR>          .
04.05.2010  23:32    <DIR>          ..
04.05.2010  23:32                 6 test.txt
               1 File(s)              6 bytes
               2 Dir(s)  14 804 623 360 bytes free

C:\Documents and Settings\you\mystuff>
```

You will probably see a very different prompt, Python information, and other stuff but this is the general idea. If your system is different let us know at http://learnpythonthehardway.org and we'll fix it.

Linux

Linux is a varied operating system with a bunch of different ways to install software. I'm assuming if you are running Linux then you know how to install packages so here are your instructions:

1. Go to http://learnpythonthehardway.org/wiki/ExerciseZero with your browser, get the `gedit` text editor, and install it.

2. Make sure you can get to `gedit` easily by putting it in your window manager's menu.
   (a) Run gedit so we can fix some stupid defaults it has.
   (b) Open `Preferences` select the `Editor` tab.
   (c) Change `Tab width:` to 4.
   (d) Select (make sure a check mark is in) `Insert spaces instead of tabs`.
   (e) Turn on "Automatic indentation" as well.
   (f) Open the `View` tab turn on "Display line numbers".
3. Find your "Terminal" program. It could be called `GNOME Terminal`, `Konsole`, or `xterm`.
4. Put your Terminal in your Dock as well.
5. Run your Terminal program. It won't look like much.
6. In your Terminal program, run `python`. You run things in Terminal by just typing their name and hitting RETURN. a. If you run `python` and it's not there, install it. *Make sure you install Python 2 not Python 3.*
7. Hit CTRL-D (^D) and get out of `python`.
8. You should be back at a prompt similar to what you had before you typed `python`. If not find out why.
9. Learn how to make a directory in the Terminal. Search online for help.
10. Learn how to change into a directory in the Terminal. Again search online.
11. Use your editor to create a file in this directory. Typically you will make the file, "Save" or "Save As..", and pick this directory.
12. Go back to Terminal using just the keyboard to switch windows. Look it up if you can't figure it out.
13. Back in Terminal see if you can list the directory to see your newly created file. Search online for how to list a directory.

Linux: What You Should See

```
[~]$ python
Python 2.6.5 (r265:79063, Apr  1 2010, 05:28:39)
[GCC 4.4.3 20100316 (prerelease)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>>
[~]$ mkdir mystuff
[~]$ cd mystuff
# ... Use gedit here to edit test.txt ...
[mystuff]$ ls
test.txt
[mystuff]$
```

You will probably see a very different prompt, Python information, and other stuff but this is the general idea.

Warnings For Beginners

You are done with this exercise. This exercise might be hard for you depending on your familiarity with your computer. If it is difficult, take the time to read and study and get through it, because until you can do these very basic things you will find it difficult to get much programming done.

If a programmer tells you to use `vim` or `emacs`, tell them no. These editors are for when you are a better programmer. All you need right now is an editor that lets you put text into a file. We will use `gedit` because it is simple and the same on all computers. Professional programmers use `gedit` so it's good enough for you starting out.

A programmer may try to get you to install Python 3 and learn that. You should tell them, "When all of the python code on your computer is Python 3, then I'll try to learn it." That should keep them busy for about 10 years.

A programmer will eventually tell you to use Mac OSX or Linux. If the programmer likes fonts and typography, they'll tell you to get a Mac OSX computer. If they like control and have a huge beard, they'll tell you to install Linux. Again, use whatever computer you have right now that works. All you need is `gedit`, a Terminal, and `python`.

Finally the purpose of this setup is so you can do three things very reliably while you work on the exercises:

1. *Write* exercises using `gedit`.
2. *Run* the exercises you wrote.
3. *Fix* them when they are broken.
4. Repeat.

Anything else will only confuse you, so stick to the plan.

Exercise 1: A Good First Program

Remember, you should have spent a good amount of time in Exercise 0 learning how to install a text editor, run the text editor, run the Terminal, and work with both of them. If you haven't done that then do not go on. You will not have a good time. This is the only time I'll start an exercise with a warning that you should not skip or get ahead of yourself.

```
1 print "Hello World!"
2 print "Hello Again"
3 print "I like typing this."
4 print "This is fun."
5 print 'Yay! Printing.'
6 print "I'd much rather you 'not'."
7 print 'I "said" do not touch this.'
```

Type the above into a single file named `ex1.py`. This is important as python works best with files ending in `.py`.

> **Warning:** Do not type the numbers on the far left of these lines. Those are called "line numbers" and they are used by programmers to talk about what part of a program is wrong. Python will tell you errors related to these line numbers, but *you* do not type them in.

Then in Terminal *run* the file by typing:

```
python ex1.py
```

If you did it right then you should see the same output I have below. If not, you have done something wrong. No, the computer is not wrong.

What You Should See

```
$ python ex1.py
Hello World!
Hello Again
I like typing this.
This is fun.
Yay! Printing.
I'd much rather you 'not'.
I "said" do not touch this.
$
```

You may see the name of your directory before the `$` which is fine, but if your output is not exactly the same, find out why and fix it.

If you have an error it will look like this:

```
$ python ex/ex1.py
  File "ex/ex1.py", line 3
    print "I like typing this.
                              ^
SyntaxError: EOL while scanning string literal
```

It's important that you can read these since you will be making many of these mistakes. Even I make many of these mistakes. Let's look at this line-by-line.

1. Here we ran our command in the terminal to run the `ex1.py` script.
2. Python then tells us that the file `ex1.py` has an error on line 3.
3. It then prints this line for us.
4. Then it puts a `^` (caret) character to point at where the problem is. Notice the missing `"` (double-quote) character?
5. Finally, it prints out a "SyntaxError" and tells us something about what might be the error. Usually these are very cryptic, but if you copy that text into a search engine, you will find someone else who's had that error and you can probably figure out how to fix it.

Extra Credit

You will also have `Extra Credit`. The Extra Credit contains things you should *try* to do. If you can't, skip it and come back later.

For this exercise, try these things:

1. Make your script print another line.
2. Make your script print only one of the lines.
3. Put a '#' (octothorpe) character at the beginning of a line. What did it do? Try to find out what this character does.

From now on, I won't explain how each exercise works unless an exercise is different.

Note: An 'octothorpe' is also called a 'pound', 'hash', 'mesh', or any number of names. Pick the one that makes you chill out.

Exercise 2: Comments And Pound Characters

Comments are very important in your programs. They are used to tell you what something does in English, and they also are used to disable parts of your program if you need to remove them temporarily. Here's how you use comments in Python:

```
# A comment, this is so you can read your program later.
# Anything after the # is ignored by python.

print "I could have code like this." # and the comment after is ignored

# You can also use a comment to "disable" or comment out a piece of code:
# print "This won't run."

print "This will run."
```

What You Should See

```
$ python ex2.py
I could have code like this.
This will run.
$
```

Extra Credit

1. Find out if you were right about what the # character does and make sure you know what it's called (octothorpe or pound character).
2. Take your `ex2.py` file and review each line going backwards. Start at the last line, and check each word in reverse against what you should have typed.
3. Did you find more mistakes? Fix them.
4. Read what you typed above out loud, including saying each character by its name. Did you find more mistakes? Fix them.

Exercise 3: Numbers And Math

Every programming language has some kind of way of doing numbers and math. Do not worry, programmers lie frequently about being math geniuses when they really aren't. If they were math geniuses, they would be doing math, not writing ads and social network games to steal people's money.

This exercise has lots of math symbols. Let's name them right away so you know what they are called. As you type this one in, say the names. When saying them feels boring you can stop saying them. Here are the names:

- + plus
- − minus
- / slash
- * asterisk
- % percent
- < less-than
- > greater-than
- <= less-than-equal
- >= greater-than-equal

Notice how the operations are missing? After you type in the code for this exercise, go back and figure out what each of these does and complete the table. For example, + does addition.

```
1  print "I will now count my chickens:"
2
3  print "Hens", 25 + 30 / 6
4  print "Roosters", 100 - 25 * 3 % 4
5
6  print "Now I will count the eggs:"
7
8  print 3 + 2 + 1 - 5 + 4 % 2 - 1 / 4 + 6
9
10 print "Is it true that 3 + 2 < 5 - 7?"
11
12 print 3 + 2 < 5 - 7
13
14 print "What is 3 + 2?", 3 + 2
15 print "What is 5 - 7?", 5 - 7
16
17 print "Oh, that's why it's False."
18
19 print "How about some more."
20
21 print "Is it greater?", 5 > -2
```

```
22 print "Is it greater or equal?", 5 >= -2
23 print "Is it less or equal?", 5 <= -2
```

What You Should See

```
$ python ex3.py
I will now count my chickens:
Hens 30
Roosters 97
Now I will count the eggs:
7
Is it true that 3 + 2 < 5 - 7?
False
What is 3 + 2? 5
What is 5 - 7? -2
Oh, that's why it's False.
How about some more.
Is it greater? True
Is it greater or equal? True
Is it less or equal? False
$
```

Extra Credit

1. Above each line, use the # to write a comment to yourself explaining what the line does.
2. Remember in Exercise 0 when you started python? Start python this way again and using the above characters and what you know, use python as a calculator.
3. Find something you need to calculate and write a new `.py` file that does it.
4. Notice the math seems "wrong"? There are no fractions, only whole numbers. Find out why by researching what a "floating point" number is.
5. Rewrite `ex3.py` to use floating point numbers so it's more accurate (hint: 20.0 is floating point).

Exercise 4: Variables And Names

Now you can print things with `print` and you can do math. The next step is to learn about variables. In programming a variable is nothing more than a name for something so you can use the name rather than the something as you code. Programmers use these variable names to make their code read more like English, and because they have lousy memories. If they didn't use good names for things in their software, they'd get lost when they tried to read their code again.

If you get stuck with this exercise, remember the tricks you have been taught so far of finding differences and focusing on details:

1. Write a comment above each line explaining to yourself what it does in English.
2. Read your `.py` file backwards.
3. Read your `.py` file out loud saying even the characters.

```
cars = 100
space_in_a_car = 4.0
drivers = 30
passengers = 90
cars_not_driven = cars - drivers
cars_driven = drivers
carpool_capacity = cars_driven * space_in_a_car
average_passengers_per_car = passengers / cars_driven


print "There are", cars, "cars available."
print "There are only", drivers, "drivers available."
print "There will be", cars_not_driven, "empty cars today."
print "We can transport", carpool_capacity, "people today."
print "We have", passengers, "to carpool today."
print "We need to put about", average_passengers_per_car, "in each car."
```

Note: The _ in `space_in_a_car` is called an `underscore character`. Find out how to type it if you do not already know. We use this character a lot to put an imaginary space between words in variable names.

What You Should See

```
$ python ex4.py
There are 100 cars available.
There are only 30 drivers available.
There will be 70 empty cars today.
We can transport 120.0 people today.
We have 90 to carpool today.
We need to put about 3 in each car.
$
```

Extra Credit

When I wrote this program the first time I had a mistake, and *python* told me about it like this:

```
Traceback (most recent call last):
  File "ex4.py", line 8, in <module>
    average_passengers_per_car = car_pool_capacity / passenger
NameError: name 'car_pool_capacity' is not defined
```

Explain this error in your own words. Make sure you use line numbers and explain why.

Here's more extra credit:

1. Explain why the 4.0 is used instead of just 4.
2. Remember that 4.0 is a "floating point" number. Find out what that means.
3. Write comments above each of the variable assignments.
4. Make sure you know what = is called (equals) and that it's making names for things.
5. Remember _ is an underscore character.
6. Try running `python` as a calculator like you did before and use variable names to do your calculations. Popular variable names are also `i`, `x`, and `j`.

Exercise 5: More Variables And Printing

Now we'll do even more typing of variables and printing them out. This time we'll use something called a "format string". Every time you put " (double-quotes) around a piece of text you have been making a *string*. A string is how you make something that your program might give to a human. You print them, save them to files, send them to web servers, all sorts of things.

Strings are really handy, so in this exercise you will learn how to make strings that have variables embedded in them. You embed variables inside a string by using specialized format sequences and then putting the variables at the end with a special syntax that tells Python, "Hey, this is a format string, put these variables in there."

As usual, just type this in even if you do not understand it and make it exactly the same.

```
my_name = 'Zed A. Shaw'
my_age = 35 # not a lie
my_height = 74 # inches
my_weight = 180 # lbs
my_eyes = 'Blue'
my_teeth = 'White'
my_hair = 'Brown'

print "Let's talk about %s." % my_name
print "He's %d inches tall." % my_height
print "He's %d pounds heavy." % my_weight
print "Actually that's not too heavy."
print "He's got %s eyes and %s hair." % (my_eyes, my_hair)
print "His teeth are usually %s depending on the coffee." % my_teeth

# this line is tricky, try to get it exactly right
print "If I add %d, %d, and %d I get %d." % (
    my_age, my_height, my_weight, my_age + my_height + my_weight)
```

What You Should See

```
$ python ex5.py
Let's talk about Zed A. Shaw.
He's 74 inches tall.
He's 180 pounds heavy.
Actually that's not too heavy.
He's got Blue eyes and Brown hair.
His teeth are usually White depending on the coffee.
If I add 35, 74, and 180 I get 289.
$
```

Extra Credit

1. Change all the variables so there isn't the `my_` in front. Make sure you change the name everywhere, not just where you used = to set them.
2. Try more format characters. `%r` is a very useful one. It's like saying "print this no matter what".
3. Search online for all of the Python format characters.
4. Try to write some variables that convert the inches and pounds to centimeters and kilos. Do not just type in the measurements. Work out the math in Python.

Exercise 6: Strings And Text

While you have already been writing strings, you still do not know what they do. In this exercise we create a bunch of variables with complex strings so you can see what they are for. First an explanation of strings.

A string is usually a bit of text you want to display to someone, or "export" out of the program you are writing. Python knows you want something to be a string when you put either `"` (double-quotes) or `'` (single-quotes) around the text. You saw this many times with your use of `print` when you put the text you want to go to the string inside `"` or `'` after the `print`. Then Python prints it.

Strings may contain the format characters you have discovered so far. You simply put the formatted variables in the string, and then a `%` (percent) character, followed by the variable. The *only* catch is that if you want multiple formats in your string to print multiple variables, you need to put them inside `( )` (parenthesis) separated by `,` (commas). It's as if you were telling me to buy you a list of items from the store and you said, "I want milk, eggs, bread, and soup." Only as a programmer we say, "(milk, eggs, bread, soup)".

We will now type in a whole bunch of strings, variables, formats, and print them. You will also practice using short abbreviated variable names. Programmers love saving themselves time at your expense by using annoying cryptic variable names, so let's get you started being able to read and write them early on.

```
1  x = "There are %d types of people." % 10
2  binary = "binary"
3  do_not = "don't"
4  y = "Those who know %s and those who %s." % (binary, do_not)
5
6  print x
7  print y
8
9  print "I said: %r." % x
10 print "I also said: '%s'." % y
11
12 hilarious = False
13 joke_evaluation = "Isn't that joke so funny?! %r"
14
15 print joke_evaluation % hilarious
16
17 w = "This is the left side of..."
18 e = "a string with a right side."
19
20 print w + e
```

What You Should See

```
$ python ex6.py
There are 10 types of people.
```

```
Those who know binary and those who don't.
I said: 'There are 10 types of people.'.
I also said: 'Those who know binary and those who don't.'.
Isn't that joke so funny?! False
This is the left side of...a string with a right side.
$
```

Extra Credit

1. Go through this program and write a comment above each line explaining it.
2. Find all the places where a string is put inside a string. There are four places.
3. Are you sure there's only four places? How do you know? Maybe I like lying.
4. Explain why adding the two string `w` and `e` with + makes a longer string.

Exercise 7: More Printing

Now we are going to do a bunch of exercises where you just type code in and make it run. I won't be explaining much since it is just more of the same. The purpose is to build up your chops. See you in a few exercises, and *do not skip!* Do not *paste!*

```
print "Mary had a little lamb."
print "Its fleece was white as %s." % 'snow'
print "And everywhere that Mary went."
print "." * 10  # what'd that do?

end1 = "C"
end2 = "h"
end3 = "e"
end4 = "e"
end5 = "s"
end6 = "e"
end7 = "B"
end8 = "u"
end9 = "r"
end10 = "g"
end11 = "e"
end12 = "r"

# watch that comma at the end.  try removing it to see what happens
print end1 + end2 + end3 + end4 + end5 + end6,
print end7 + end8 + end9 + end10 + end11 + end12
```

What You Should See

```
$ python
Mary had a little lamb.
Its fleece was white as snow.
And everywhere that Mary went.
..........
Cheese Burger
$
```

Extra Credit

For these next few exercises, you will have the exact same extra credit.

1. Go back through and write a comment on what each line does.

2. Read each one backwards or out loud to find your errors.
3. From now on, when you make mistakes write down on a piece of paper what kind of mistake you made.
4. When you go to the next exercise, look at the last mistakes you made and try not to make them in this new one.
5. Remember that everyone makes mistakes. Programmers are like magicians who like everyone to think they are perfect and never wrong, but it's all an act. They make mistakes all the time.

Exercise 8: Printing, Printing

```
formatter = "%r %r %r %r"

print formatter % (1, 2, 3, 4)
print formatter % ("one", "two", "three", "four")
print formatter % (True, False, False, True)
print formatter % (formatter, formatter, formatter, formatter)
print formatter % (
    "I had this thing.",
    "That you could type up right.",
    "But it didn't sing.",
    "So I said goodnight."
)
```

What You Should See

```
$ python ex8.py
1 2 3 4
'one' 'two' 'three' 'four'
True False False True
'%r %r %r %r' '%r %r %r %r' '%r %r %r %r' '%r %r %r %r'
'I had this thing.' 'That you could type up right.' "But it didn't sing." 'So I said goodnight.'
$
```

Extra Credit

1. Do your checks of your work, write down your mistakes, try not to make them on the next exercise.
2. Notice that the last line of output uses both single and double quotes for individual pieces. Why do you think that is?

Exercise 9: Printing, Printing, Printing

```
# Here's some new strange stuff, remember type it exactly.

days = "Mon Tue Wed Thu Fri Sat Sun"
months = "Jan\nFeb\nMar\nApr\nMay\nJun\nJul\nAug"

print "Here are the days: ", days
print "Here are the months: ", months

print """
There's something going on here.
With the three double-quotes.
We'll be able to type as much as we like.
"""
```

What You Should See

```
$ python ex9.py
Here's the days:  Mon Tue Wed Thu Fri Sat Sun
Here's the months:  Jan
Feb
Mar
Apr
May
Jun
Jul
Aug

There's something going on here.
With the three double-quotes.
We'll be able to type as much as we like.

$
```

Extra Credit

1. Do your checks of your work, write down your mistakes, try not to make them on the next exercise.

Exercise 10: What Was That?

In Exercise 9 I threw you some new stuff, just to keep you on your toes. I showed you two ways to make a string that goes across multiple lines. In the first way, I put the characters `\n` (back-slash `n`) between the names of the months. What these two characters do is put a `new line character` into the string at that point.

This use of the `\` (back-slash) character is a way we can put difficult-to-type characters into a string. There are plenty of these "escape sequences" available for different characters you might want to put in, but there's a special one, the `double back-slash` which is just two of them `\\`. These two characters will print just one back-slash. We'll try a few of these sequences so you can see what I mean.

Another important escape sequence is to escape a single-quote `'` or double-quote `"`. Imagine you have a string that uses double-quotes and you want to put a double-quote in for the output. If you do this `"I "understand" joe."` then Python will get confused since it will think the `"` around `"understand"` actually *ends* the string. You need a way to tell Python that the `"` inside the string isn't a *real* double-quote.

To solve this problem you *escape* double-quotes and single-quites so Python knows to include in the string. Here's an example:

```
"I am 6'2\" tall."  # escape double-quote inside string
'I am 6\'2" tall.'  # escape single-quote inside string
```

The second way is by using triple-quotes, which is just `"""` and works like a string, but does you also can put as many lines of text you as want until you type `"""` again. We'll also play with these.

```
1  tabby_cat = "\tI'm tabbed in."
2  persian_cat = "I'm split\non a line."
3  backslash_cat = "I'm \\ a \\ cat."
4
5  fat_cat = """
6  I'll do a list:
7  \t* Cat food
8  \t* Fishies
9  \t* Catnip\n\t* Grass
10 """
11
12 print tabby_cat
13 print persian_cat
14 print backslash_cat
15 print fat_cat
```

What You Should See

Look for the tab characters that you made. In this exercise the spacing is important to get right.

```
$ python ex10.py
        I'm tabbed in.
I'm split
on a line.
I'm \ a \ cat.

I'll do a list:
        * Cat food
        * Fishies
        * Catnip
        * Grass

$
```

Extra Credit

1. Search online to see what other escape sequences are available.
2. Use `'''` (triple-single-quote) instead. Can you see why you might use that instead of `"""`?
3. Combine escape sequences and format strings to create a more complex format.
4. Remember the `%r` format? Combine `%r` with double-quote and single-quote escapes and print them out. Compare %r with %s. Notice how %r prints it the way you'd write it in your file, but %s prints it the way you'd like to see it?

Exercise 11: Asking Questions

Now it is time to pick up the pace. I have got you doing a lot of printing so that you get used to typing simple things, but those simple things are fairly boring. What we want to do now is get data into your programs. This is a little tricky because you have learn to do two things that may not make sense right away, but trust me and do it anyway. It will make sense in a few exercises.

Most of what software does is the following:

1. Take some kind of input from a person.
2. Change it.
3. Print out something to show how it changed.

So far you have only been printing, but you haven't been able to get any input from a person, or change it. You may not even know what "input" means, so rather than talk about it, let's have you do some and see if you get it. Next exercise we'll do more to explain it.

```
1 print "How old are you?",
2 age = raw_input()
3 print "How tall are you?",
4 height = raw_input()
5 print "How much do you weigh?",
6 weight = raw_input()
7
8 print "So, you're %r old, %r tall and %r heavy." % (
9     age, height, weight)
```

Note: Notice that we put a `,` (comma) at the end of each `print` line. This is so that `print` doesn't end the line with a newline and go to the next line.

What You Should See

```
$ python ex11.py
How old are you? 35
How tall are you? 6'2"
How much do you weigh? 180lbs
So, you're '35' old, '6\'2"' tall and '180lbs' heavy.
$
```

Extra Credit

1. Go online and find out what Python's `raw_input` does.

2. Can you find other ways to use it? Try some of the samples you find.
3. Write another "form" like this to ask some other questions.
4. Related to escape sequences, try to find out why the last line has `'6\'2"'` with that `\'` sequence. See how the single-quote needs to be escaped because otherwise it would end the string?

Exercise 12: Prompting People

When you typed `raw_input()` you were typing the `(` and `)` characters which are `parenthesis`. This is similar to when you used them to do a format with extra variables, as in `"%s %s" % (x, y)`. For `raw_input` you can also put in a prompt to show to a person so they know what to type. Put a string that you want for the prompt inside the `()` so that it looks like this:

```
y = raw_input("Name? ")
```

This prompts the user with "Name?" and puts the result into the variable `y`. This is how you ask someone a question and get their answer.

This means we can completely rewrite our previous exercise using just `raw_input` to do all the prompting.

```
1 age = raw_input("How old are you? ")
2 height = raw_input("How tall are you? ")
3 weight = raw_input("How much do you weigh? ")
4
5 print "So, you're %r old, %r tall and %r heavy." % (
6     age, height, weight)
```

What You Should See

```
$ python ex12.py
How old are you? 35
How many tall are you? 6'2"
How much do you weight? 180lbs
So, you're '35' old, '6\'2"' tall and '180lbs' heavy.
$
```

Extra Credit

1. In Terminal where you normally run `python` to run your scripts, type: `pydoc raw_input`. Read what it says.
2. Get out of pydoc by typing `q` to quit.
3. Go look online for what the `pydoc` command does.
4. Use pydoc to also read about `open`, `file`, `os`, and `sys`. It's alright if you do not understand those, just read through and take notes about interesting things.

Exercise 13: Parameters, Unpacking, Variables

In this exercise we will cover one more input method you can use to pass variables to a script (script being another name for your `.py` files). You know how you type `python ex13.py` to run the `ex13.py` file? Well the `ex13.py` part of the command is called an "argument". What we'll do now is write a script that also accepts arguments.

Type this program and I'll explain it in detail:

```
1 from sys import argv
2
3 script, first, second, third = argv
4
5 print "The script is called:", script
6 print "Your first variable is:", first
7 print "Your second variable is:", second
8 print "Your third variable is:", third
```

On line `1` we have what's called an "import". This is how you add features to your script from the Python feature set. Rather than give you all the features at once, Python asks you to say what you plan to use. This keeps your programs small, but it also acts as documentation for other programmers who read your code later.

The `argv` is the "argument variable", a very standard name in programming. that you will find used in many other languages. This variable *holds* the arguments you pass to your Python script when you run it. In the exercises you will get to play with this more and see what happens.

Line 3 "unpacks" `argv` so that, rather than holding all the arguments, it gets assigned to four variables you can work with: `script`, `first`, `second`, and `third`. This may look strange, but "unpack" is probably the best word to describe what it does. It just says, "Take whatever is in argv, unpack it, and assign it to all of these variables on the left in order."

After that we just print them out like normal.

Hold Up! Features Have Another Name

I call them "features here" (these little things you `import` to make your Python program do more) but nobody else calls them features. I just used that name because I needed to trick you into learning what they are without jargon. Before you can continue, you need to learn their real name: `modules`.

From now on we will be calling these "features" that we `import` *modules*. I'll say things like, "You want to import the `sys` module." They are also called "libraries" by other programmers, but let's just stick with modules.

What You Should See

Run the program like this:

```
python ex13.py first 2nd 3rd
```

This is what you should see when you do a few different runs with different arguments:

```
$ python ex13.py first 2nd 3rd
The script is called: ex/ex13.py
Your first variable is: first
Your second variable is: 2nd
Your third variable is: 3rd

$ python ex13.py cheese apples bread
The script is called: ex/ex13.py
Your first variable is: cheese
Your second variable is: apples
Your third variable is: bread

$ python ex13.py Zed A. Shaw
The script is called: ex/ex13.py
Your first variable is: Zed
Your second variable is: A.
Your third variable is: Shaw
```

You can actually replace "first", "2nd", and "3rd" with any three things. You do not have to give these parameters either, you can give any 3 strings you want:

```
python ex13.py stuff I like
python ex13.py anything 6 7
```

If you do not run it correctly, then you will get an error like this:

```
python ex13.py first 2nd
Traceback (most recent call last):
  File "ex/ex13.py", line 3, in <module>
    script, first, second, third = argv
ValueError: need more than 3 values to unpack
```

This happens when you do not put enough arguments on the command when you run it (in this case just `first 2nd`). Notice when I run it I give it `first 2nd 3rd`, which caused it to give an error about "need more than 3 values to unpack" telling you that you didn't give it enough parameters.

Extra Credit

1. Try giving fewer than three arguments to your script. See that error you get? See if you can explain it.
2. Write a script that has fewer arguments and one that has more. Make sure you give the unpacked variables good names.
3. Combine `raw_input` with `argv` to make a script that gets more input from a user.
4. Remember that modules give you features. Modules. Modules. Remember this because we'll need it later.

Exercise 14: Prompting And Passing

Let's do one exercise that uses `argv` and `raw_input` together to ask the user something specific. You will need this for the next exercise where we learn to read and write files. In this exercise we'll use `raw_input` slightly differently by having it just print a simple > prompt. This is similar to a game like Zork or Adventure.

```
from sys import argv

script, user_name = argv
prompt = '> '

print "Hi %s, I'm the %s script." % (user_name, script)
print "I'd like to ask you a few questions."
print "Do you like me %s?" % user_name
likes = raw_input(prompt)

print "Where do you live %s?" % user_name
lives = raw_input(prompt)

print "What kind of computer do you have?"
computer = raw_input(prompt)

print """
Alright, so you said %r about liking me.
You live in %r.  Not sure where that is.
And you have a %r computer.  Nice.
""" % (likes, lives, computer)
```

Notice though that we make a variable `prompt` that is set to the prompt we want, and we give that to `raw_input` instead of typing it over and over. Now if we want to make the prompt something else, we just change it in this one spot and rerun the script.

Very handy.

What You Should See

When you run this, remember that you have to give the script your name for the `argv` arguments.

```
$ python ex14.py Zed
Hi Zed, I'm the ex14.py script.
I'd like to ask you a few questions.
Do you like me Zed?
> yes
Where do you live Zed?
> America
What kind of computer do you have?
```

```
> Tandy

Alright, so you said 'yes' about liking me.
You live in 'America'.  Not sure where that is.
And you have a 'Tandy' computer.  Nice.
```

Extra Credit

1. Find out what Zork and Adventure were. Try to find a copy and play it.
2. Change the `prompt` variable to something else entirely.
3. Add another argument and use it in your script.
4. Make sure you understand how I combined a `"""` style multi-line string with the `%` format activator as the last print.

Exercise 15: Reading Files

Everything you've learned about `raw_input` and `argv` is so you can start reading files. You may have to play with this exercise the most to understand what's going on, so do it carefully and remember your checks. Working with files is an easy way to *erase your work* if you are not careful.

This exercise involves writing two files. One is your usual `ex15.py` file that you will run, but the *other* is named `ex15_sample.txt`. This second file isn't a script but a plain text file we'll be reading in our script. Here are the contents of that file:

```
This is stuff I typed into a file.
It is really cool stuff.
Lots and lots of fun to have in here.
```

What we want to do is "open" that file in our script and print it out. However, we do not want to just "hard code" the name `ex15_sample.txt` into our script. "Hard coding" means putting some bit of information that should come from the user as a string right in our program. That's bad because we want it to load other files later. The solution is to use `argv` and `raw_input` to ask the user what file they want instead of "hard coding" the file's name.

```
1  from sys import argv
2
3  script, filename = argv
4
5  txt = open(filename)
6
7  print "Here's your file %r:" % filename
8  print txt.read()
9
10 print "I'll also ask you to type it again:"
11 file_again = raw_input("> ")
12
13 txt_again = open(file_again)
14
15 print txt_again.read()
```

A few fancy things are going on in this file, so let's break it down real quick:

Line 1-3 should be a familiar use of `argv` to get a filename. Next we have line 5 where we use a new command `open`. Right now, run `pydoc open` and read the instructions. Notice how like your own scripts and `raw_input`, it takes a parameter and returns a value you can set to your own variable. You just opened a file.

Line 7 we print a little line, but on line 8 we have something very new and exciting. We call a function on `txt`. What you got back from open is a `file`, and it's also got commands you can give it. You give a file a command by using the `.` (dot or period), the name of the command, and parameters. Just like with `open` and `raw_input`. The difference is that when you say `txt.read()` you are saying, "Hey txt! Do your read command with no parameters!"

The remainder of the file is more of the same, but we'll leave the analysis to you in the extra credit.

What You Should See

I made a file called "ex15_sample.txt" and ran my script.

```
$ python ex15.py ex15_sample.txt
Here's your file 'ex15_sample.txt':
This is stuff I typed into a file.
It is really cool stuff.
Lots and lots of fun to have in here.


I'll also ask you to type it again:
> ex15_sample.txt
This is stuff I typed into a file.
It is really cool stuff.
Lots and lots of fun to have in here.


$
```

Extra Credit

This is a big jump so be sure you do this extra credit as best you can before moving on.

1. Above each line write out in English what that line does.
2. If you are not sure ask someone for help or search online. Many times searching for "python THING" will find answers for what that THING does in Python. Try searching for "python open".
3. I used the name "commands" here, but they are also called "functions" and "methods". Search around online to see what other people do to define these. Do not worry if they confuse you. It's normal for a programmer to confuse you with their vast extensive knowledge.
4. Get rid of the part from line 10-15 where you use `raw_input` and try the script then.
5. Use only `raw_input` and try the script that way. Think of why one way of getting the filename would be better than another.
6. Run `pydoc file` and scroll down until you see the `read()` command (method/function). See all the other ones you can use? Skip the ones that have __ (two underscores) in front because those are junk. Try some of the other commands.
7. Startup `python` again and use `open` from the prompt. Notice how you can open files and run `read` on them right there?
8. Have your script also do a `close()` on the `txt` and `txt_again` variables. It's important to close files when you are done with them.

Exercise 16: Reading And Writing Files

If you did the extra credit from the last exercise you should have seen all sorts of commands (methods/functions) you can give to files. Here's the list of commands I want you to remember:

- close – Closes the file. Like `File->Save..` in your editor.
- read – Reads the contents of the file, you can assign the result to a variable.
- readline – Reads just one line of a text file.
- truncate – Empties the file, watch out if you care about the file.
- write(stuff) – Writes stuff to the file.

For now these are the important commands you need to know. Some of them take parameters, but we do not really care about that. You only need to remember that `write` takes a parameter of a string you want to write to the file.

Let's use some of this to make a simple little text editor:

```
1  from sys import argv
2
3  script, filename = argv
4
5  print "We're going to erase %r." % filename
6  print "If you don't want that, hit CTRL-C (^C)."
7  print "If you do want that, hit RETURN."
8
9  raw_input("?")
10
11 print "Opening the file..."
12 target = open(filename, 'w')
13
14 print "Truncating the file.  Goodbye!"
15 target.truncate()
16
17 print "Now I'm going to ask you for three lines."
18
19 line1 = raw_input("line 1: ")
20 line2 = raw_input("line 2: ")
21 line3 = raw_input("line 3: ")
22
23 print "I'm going to write these to the file."
24
25 target.write(line1)
26 target.write("\n")
27 target.write(line2)
28 target.write("\n")
29 target.write(line3)
30 target.write("\n")
```

```
31
32 print "And finally, we close it."
33 target.close()
```

That's a large file, probably the largest you have typed in. So go slow, do your checks, and make it run. One trick is to get bits of it running at a time. Get lines 1-8 running, then 5 more, then a few more, etc., until it's all done and running.

What You Should See

There are actually two things you will see, first the output of your new script:

```
$ python ex16.py test.txt
We're going to erase 'test.txt'.
If you don't want that, hit CTRL-C (^C).
If you do want that, hit RETURN.
?
Opening the file...
Truncating the file.  Goodbye!
Now I'm going to ask you for three lines.
line 1: To all the people out there.
line 2: I say I don't like my hair.
line 3: I need to shave it off.
I'm going to write these to the file.
And finally, we close it.
$
```

Now, open up the file you made (in my case `test.txt`) in your editor and check it out. Neat right?

Extra Credit

1. If you feel you do not understand this, go back through and use the comment trick to get it squared away in your mind. One simple English comment above each line will help you understand, or at least let you know what you need to research more.
2. Write a script similar to the last exercise that uses `read` and `argv` to read the file you just created.
3. There's too much repetition in this file. Use strings, formats, and escapes to print out `line1`, `line2`, and `line3` with just one `target.write()` command instead of 6.
4. Find out why we had to pass a `'w'` as an extra parameter to `open`. Hint: `open` tries to be safe by making you explicitly say you want to write a file.

Exercise 17: More Files

Now let's do a few more things with files. We're going to actually write a Python script to copy one file to another. It'll be very short but will give you some ideas about other things you can do with files.

```
from sys import argv
from os.path import exists

script, from_file, to_file = argv

print "Copying from %s to %s" % (from_file, to_file)

# we could do these two on one line too, how?
input = open(from_file)
indata = input.read()

print "The input file is %d bytes long" % len(indata)

print "Does the output file exist? %r" % exists(to_file)
print "Ready, hit RETURN to continue, CTRL-C to abort."
raw_input()

output = open(to_file, 'w')
output.write(indata)

print "Alright, all done."

output.close()
input.close()
```

You should immediately notice that we `import` another handy command named `exists`. This returns `True` if a file exists, based on it's name in a string as an argument. It returns `False` if not. We'll be using this function in the second half of this book to do lots of things, but right now you should see how you can import it.

Using `import` is a way to get tons of free code other better (well, usually) programmers have written so you do not have to write it.

What You Should See

Just like your other scripts, run this one with two arguments, the file to copy from and the file to copy it to. If we use your `test.txt` file from before we get this:

```
$ python ex17.py test.txt copied.txt
Copying from test.txt to copied.txt
The input file is 81 bytes long
Does the output file exist? False
```

```
Ready, hit RETURN to continue, CTRL-C to abort.

Alright, all done.

$ cat copied.txt
To all the people out there.
I say I don't like my hair.
I need to shave it off.
$
```

It should work with any file. Try a bunch more and see what happens. Just be careful you do not blast an important file.

> **Warning:** Did you see that trick I did with `cat`? It only works on Linux or OSX, sorry Windows people!

Extra Credit

1. Go read up on Python's `import` statement, and start `python` to try it out. Try importing some things and see if you can get it right. It's alright if you do not.
2. This script is *really* annoying. There's no need to ask you before doing the copy, and it prints too much out to the screen. Try to make it more friendly to use by removing features.
3. See how short you can make the script. I could make this 1 line long.
4. Notice at the end of the WYSS I used something called *cat*? It's an old command that "con*cat*enates" files together, but mostly it's just an easy way to print a file to the screen. Type `man cat` to read about it.
5. Windows people, find the alternative to `cat` that Linux/OSX people have. Do not worry about `man` since there is nothing like that.
6. Find out why you had to do `output.close()` in the code.

Exercise 18: Names, Variables, Code, Functions

Big title right? I am about to introduce you to *the function*! Dum dum dah! Every programmer will go on and on about functions and all the different ideas about how they work and what they do, but I will give you the simplest explanation you can use right now.

Functions do three things:

1. They name pieces of code the way variables name strings and numbers.
2. They take arguments the way your scripts take `argv`.
3. Using #1 and #2 they let you make your own "mini scripts" or "tiny commands".

You can create a function by using the word `def` in Python. I'm going to have you make four different functions that work like your scripts, and then show you how each one is related.

```
# this one is like your scripts with argv
def print_two(*args):
    arg1, arg2 = args
    print "arg1: %r, arg2: %r" % (arg1, arg2)

# ok, that *args is actually pointless, we can just do this
def print_two_again(arg1, arg2):
    print "arg1: %r, arg2: %r" % (arg1, arg2)

# this just takes one argument
def print_one(arg1):
    print "arg1: %r" % arg1

# this one takes no arguments
def print_none():
    print "I got nothin'."


print_two("Zed","Shaw")
print_two_again("Zed","Shaw")
print_one("First!")
print_none()
```

Let's break down the first function, `print_two` which is the most similar to what you already know from making scripts:

1. First we tell Python we want to make a function using `def` for "define".
2. On the same line as `def` we then give the function a name, in this case we just called it "print_two" but it could be "peanuts" too. It doesn't matter, except that your function should have a short name that says what it does.

3. Then we tell it we want `*args` (asterisk args) which is a lot like your `argv` parameter but for functions. This *has* to go inside `()` parenthesis to work.
4. Then we end this line with a `:` colon, and start indenting.
5. After the colon all the lines that are indented 4 spaces will become attached to this name, `print_two`. Our first indented line is one that unpacks the arguments the same as with your scripts.
6. To demonstrate how it works we print these arguments out, just like we would in a script.

Now, the problem with `print_two` is that it's not the easiest way to make a function. In Python we can skip the whole unpacking args and just use the names we want right inside `()`. That's what `print_two_again` does.

After that you have an example of how you make a function that takes one argument in `print_one`.

Finally you have a function that has no arguments in `print_none`.

> **Warning:** This is very important. Do *not* get discouraged right now if this doesn't quite make sense. We're going to do a few exercises linking functions to your scripts and show you how to make more. For now just keep thinking "mini script" when I say "function" and keep playing with them.

What You Should See

If you run the above script you should see:

```
$ python ex18.py
arg1: 'Zed', arg2: 'Shaw'
arg1: 'Zed', arg2: 'Shaw'
arg1: 'First!'
I got nothin'.
$
```

Right away you can see how a function works. Notice that you used your functions the way you use things like `exists`, `open`, and other "commands". In fact, I've been tricking you because in Python those "commands" are just functions. This means you can make your own commands and use them in your scripts too.

Extra Credit

Write out a `function checklist` for later exercises. Write these on an index card and keep it by you while you complete the rest of these exercises or until you feel you do not need it:

1. Did you start your function definition with `def`?
2. Does your function name have only characters and _ (underscore) characters?
3. Did you put an open parenthesis `(` right after the function name?
4. Did you put your arguments after the parenthesis `(` separated by commas?
5. Did you make each argument unique (meaning no duplicated names).
6. Did you put a close parenthesis and a colon `):` after the arguments?
7. Did you indent all lines of code you want in the function 4 spaces? No more, no less.
8. Did you "end" your function by going back to writing with no indent (`dedenting` we call it)?

And when you run (aka "use" or "call") a function, check these things:

1. Did you call/use/run this function by typing its name?
2. Did you put (character after the name to run it?
3. Did you put the values you want into the parenthesis separated by commas?
4. Did you end the function call with a) character.

Use these two checklists on the remaining lessons until you do not need them anymore.

Finally, repeat this a few times:

"To 'run', 'call', or 'use' a function all mean the same thing."

Exercise 19: Functions And Variables

Functions may have been a mind-blowing amount of information, but do not worry. Just keep doing these exercises and going through your checklist from the last exercise and you will eventually get it.

There is one tiny point though that you might not have realized which we'll reinforce right now: The variables in your function are not connected to the variables in your script. Here's an exercise to get you thinking about this:

```
def cheese_and_crackers(cheese_count, boxes_of_crackers):
    print "You have %d cheeses!" % cheese_count
    print "You have %d boxes of crackers!" % boxes_of_crackers
    print "Man that's enough for a party!"
    print "Get a blanket.\n"


print "We can just give the function numbers directly:"
cheese_and_crackers(20, 30)


print "OR, we can use variables from our script:"
amount_of_cheese = 10
amount_of_crackers = 50

cheese_and_crackers(amount_of_cheese, amount_of_crackers)


print "We can even do math inside too:"
cheese_and_crackers(10 + 20, 5 + 6)


print "And we can combine the two, variables and math:"
cheese_and_crackers(amount_of_cheese + 100, amount_of_crackers + 1000)
```

This shows all different ways we're able to give our function `cheese_and_crackers` the values it needs to print them. We can give it straight numbers. We can give it variables. We can give it math. We can even combine math and variables.

In a way, the arguments to a function are kind of like our = character when we make a variable. In fact, if you can use = to name something, you can usually pass it to a function as an argument.

What You Should See

You should study the output of this script and compare it with what you think you should get for each of the examples in the script.

```
$ python ex19.py
We can just give the function numbers directly:
You have 20 cheeses!
You have 30 boxes of crackers!
Man that's enough for a party!
Get a blanket.

OR, we can use variables from our script:
You have 10 cheeses!
You have 50 boxes of crackers!
Man that's enough for a party!
Get a blanket.

We can even do math inside too:
You have 30 cheeses!
You have 11 boxes of crackers!
Man that's enough for a party!
Get a blanket.

And we can combine the two, variables and math:
You have 110 cheeses!
You have 1050 boxes of crackers!
Man that's enough for a party!
Get a blanket.
$
```

Extra Credit

1. Go back through the script and type a comment above each line explaining in English what it does.
2. Start at the bottom and read each line backwards, saying all the important characters.
3. Write at least one more function of your own design, and run it 10 different ways.

Exercise 20: Functions And Files

Remember your checklist for functions, then do this exercise paying close attention to how functions and files can work together to make useful stuff.

```
from sys import argv

script, input_file = argv

def print_all(f):
    print f.read()

def rewind(f):
    f.seek(0)

def print_a_line(line_count, f):
    print line_count, f.readline()

current_file = open(input_file)

print "First let's print the whole file:\n"

print_all(current_file)

print "Now let's rewind, kind of like a tape."

rewind(current_file)

print "Let's print three lines:"

current_line = 1
print_a_line(current_line, current_file)

current_line = current_line + 1
print_a_line(current_line, current_file)

current_line = current_line + 1
print_a_line(current_line, current_file)
```

Pay close attention to how we pass in the current line number each time we run `print_a_line`.

What You Should See

```
$ python ex20.py test.txt
First let's print the whole file:
```

```
To all the people out there.
I say I don't like my hair.
I need to shave it off.

Now let's rewind, kind of like a tape.
Let's print three lines:
1 To all the people out there.

2 I say I don't like my hair.

3 I need to shave it off.

$
```

Extra Credit

1. Go through and write English comments for each line to understand what's going on.
2. Each time `print_a_line` is run you are passing in a variable `current_line`. Write out what `current_line` is equal to on each function call, and trace how it becomes `line_count` in `print_a_line`.
4. Find each place a function is used, and go check its `def` to make sure that you are giving it the right arguments.
5. Research online what the `seek` function for `file` does. Try `pydoc file` and see if you can figure it out from there.
6. Research the shorthand notation += and rewrite the script to use that.

Exercise 21: Functions Can Return Something

You have been using the = character to name variables and set them to numbers or strings. We're now going to blow your mind again by showing you how to use = and a new Python word `return` to set variables to be a *value from a function*. There will be one thing to pay close attention to, but first type this in:

```
def add(a, b):
    print "ADDING %d + %d" % (a, b)
    return a + b

def subtract(a, b):
    print "SUBTRACTING %d - %d" % (a, b)
    return a - b

def multiply(a, b):
    print "MULTIPLYING %d * %d" % (a, b)
    return a * b

def divide(a, b):
    print "DIVIDING %d / %d" % (a, b)
    return a / b


print "Let's do some math with just functions!"

age = add(30, 5)
height = subtract(78,4)
weight = multiply(90, 2)
iq = divide(100, 2)

print "Age: %d, Height: %d, Weight: %d, IQ: %d" % (age, height, weight, iq)


# A puzzle for the extra credit, type it in anyway.
print "Here is a puzzle."

what = add(age, subtract(height, multiply(weight, divide(iq, 2))))

print "That becomes: ", what, "Can you do it by hand?"
```

We are now doing our own math functions for `add`, `subtract`, `multiply`, and `divide`. The important thing to notice is the last line where we say `return a + b` (in `add`). What this does is the following:

1. Our function is called with two arguments: `a` and `b`.
2. We print out what our function is doing, in this case "ADDING".

3. Then we tell Python to do something kind of backward: we return the addition of `a + b`. You might say this as, "I add `a` and `b` then return them."
4. Python adds the two numbers. Then when the function ends any line that runs it will be able to assign this `a + b` result to a variable.

As with many other things in this book, you should take this real slow, break it down and try to trace what's going on. To help there's extra credit to get you to solve a puzzle and learn something cool.

What You Should See

```
$ python ex21.py
Let's do some math with just functions!
ADDING 30 + 5
SUBTRACTING 78 - 4
MULTIPLYING 90 * 2
DIVIDING 100 / 2
Age: 35, Height: 74, Weight: 180, IQ: 50
Here is a puzzle.
DIVIDING 50 / 2
MULTIPLYING 180 * 25
SUBTRACTING 74 - 4500
ADDING 35 + -4426
That becomes:  -4391 Can you do it by hand?
$
```

Extra Credit

1. If you aren't really sure what `return` does, try writing a few of your own functions and have them return some values. You can return anything that you can put to the right of an =.
2. At the end of the script is a puzzle. I'm taking the return value of one function, and *using* it as the argument of another function. I'm doing this in a chain so that I'm kind of creating a formula using the functions. It looks really weird, but if you run the script you can see the results. What you should do is try to figure out the normal formula that would recreate this same set of operations.
3. Once you have the formula worked out for the puzzle, get in there and see what happens when you modify the parts of the functions. Try to change it on purpose to make another value.
4. Finally, do the inverse. Write out a simple formula and use the functions in the same way to calculate it.

This exercise might really whack your brain out, but take it slow and easy and treat it like a little game. Figuring out puzzles like this is what makes programming fun, so I'll be giving you more little problems like this as we go.

Exercise 22: What Do You Know So Far?

There won't be any code in this exercise or the next one, so there's no WYSS or Extra Credit either. In fact, this exercise is like one giant Extra Credit. I'm going to have you do a form of review what you have learned so far.

First, go back through every exercise you have done so far and write down every word and symbol (another name for 'character') that you have used. Make sure your list of symbols is complete.

Next to each word or symbol, write its name and what it does. If you can't find a name for a symbol in this book, then look for it online. If you do not know what a word or symbol does, then go read about it again and try using it in some code.

You may run into a few things you just can't find out or know, so just keep those on the list and be ready to look them up when you find them.

Once you have your list, spend a few days rewriting the list and double checking that it's correct. This may get boring but push through and really nail it down.

Once you have memorized the list and what they do, then you should step it up by writing out tables of symbols, their names, and what they do *from memory*. When you hit some you can't recall from memory, go back and memorize them again.

> **Warning:** The most important thing when doing this exercise is: "There is no failure, only trying."

What You are Learning

It's important when you are doing a boring mindless memorization exercise like this to know why. It helps you focus on a goal and know the purpose of all your efforts.

In this exercise you are learning the names of symbols so that you can read source code more easily. It's similar to learning the alphabet and basic words of English, except this Python alphabet has extra symbols you might not know.

Just take it slow and do not hurt your brain. Hopefully by now these symbols are natural for you so this isn't a big effort. It's best to take 15 minutes at a time with your list and then take a break. Giving your brain a rest will help you learn faster with less frustration.

Exercise 23: Read Some Code

You should have spent last week getting your list of symbols straight and locked in your mind. Now you get to apply this to another week reading code on the internet. This exercise will be daunting at first. I'm going to throw you in the deep end for a few days and have you just try your best to read and understand some source code from real projects. The goal isn't to get you to understand code, but to teach you the following three skills:

1. Finding Python source code for things you need.
2. Reading through the code and looking for files.
3. Trying to understand code you find.

At your level you really do not have the skills to evaluate the things you find, but you can benefit from getting exposure and seeing how things look.

When you do this exercise, think of yourself as an anthropologist, trucking through a new land with just barely enough of the local language to get around and survive. Except, of course, that you will actually get out alive because the internet isn't a jungle. Anyway.

Here's what you do:

1. Go to bitbucket.org with your favorite web browser and search for "python".
2. Avoid any project with "Python 3" mentioned. That'll only confuse you.
3. Pick a random project and click on it.
4. Click on the `Source` tab and browse through the list of files and directories until you find a .py file (but not setup.py, that's useless).
5. Start at the top and read through it, taking notes on what you think it does.
6. If any symbols or strange words seem to interest you, write them down to research later.

That's it. Your job is to use what you know so far and see if you can read the code and get a grasp of what it does. Try skimming the code first, and then read it in detail. Maybe also try taking very difficult parts and reading each symbol you know outloud.

Now try several three other sites:

- github.com
- launchpad.net
- koders.com

On each of these sites you may find weird files ending in `.c` so stick to `.py` files like the ones you have written in this book.

A final fun thing to do is use the above four sources of Python code and type in topics you are interested in instead of "python". Search for "journalism", "cooking", "physics", or anything you are curious about. Chances are there's some code out there you could use right away.

Exercise 24: More Practice

You are getting to the end of this section. You should have enough Python "under your fingers" to move onto learning about how programming really works, but you should do some more practice. This exercise is longer and all about building up stamina. The next exercise will be similar. Do them, get them exactly right, and do your checks.

```
print "Let's practice everything."
print 'You\'d need to know \'bout escapes with \\ that do \n newlines and \t tabs.'

poem = """
\tThe lovely world
with logic so firmly planted
cannot discern \n the needs of love
nor comprehend passion from intuition
and requires an explanation
\n\t\twhere there is none.
"""

print "--------------"
print poem
print "--------------"


five = 10 - 2 + 3 - 6
print "This should be five: %s" % five

def secret_formula(started):
    jelly_beans = started * 500
    jars = jelly_beans / 1000
    crates = jars / 100
    return jelly_beans, jars, crates


start_point = 10000
beans, jars, crates = secret_formula(start_point)

print "With a starting point of: %d" % start_point
print "We'd have %d beans, %d jars, and %d crates." % (beans, jars, crates)

start_point = start_point / 10

print "We can also do that this way:"
print "We'd have %d beans, %d jars, and %d crates." % secret_formula(start_point)
```

What You Should See

```
$ python ex24.py
Let's practice everything.
You'd need to know 'bout escapes with \ that do
 newlines and          tabs.
--------------

        The lovely world
with logic so firmly planted
cannot discern
 the needs of love
nor comprehend passion from intuition
and requires an explanation

                where there is none.

--------------
This should be five: 5
With a starting point of: 10000
We'd have 5000000 beans, 5000 jars, and 50 crates.
We can also do that this way:
We'd have 500000 beans, 500 jars, and 5 crates.
$
```

Extra Credit

1. Make sure to do your checks: read it backwards, read it out loud, put comments above confusing parts.
2. Break the file on purpose, then run it to see what kinds of errors you get. Make sure you can fix it.

Exercise 25: Even More Practice

We're going to do some more practice involving functions and variables to make sure you know them well. This exercise should be straight forward for you to type in, break down, and understand.

However, this exercise is a little different. You won't be running it. Instead *you* will import it into your python and run the functions yourself.

```
def break_words(stuff):
    """This function will break up words for us."""
    words = stuff.split(' ')
    return words

def sort_words(words):
    """Sorts the words."""
    return sorted(words)

def print_first_word(words):
    """Prints the first word after popping it off."""
    word = words.pop(0)
    print word

def print_last_word(words):
    """Prints the last word after popping it off."""
    word = words.pop(-1)
    print word

def sort_sentence(sentence):
    """Takes in a full sentence and returns the sorted words."""
    words = break_words(sentence)
    return sort_words(words)

def print_first_and_last(sentence):
    """Prints the first and last words of the sentence."""
    words = break_words(sentence)
    print_first_word(words)
    print_last_word(words)

def print_first_and_last_sorted(sentence):
    """Sorts the words then prints the first and last one."""
    words = sort_sentence(sentence)
    print_first_word(words)
    print_last_word(words)
```

First, run this like normal with `python ex25.py` to find any errors you have made. Once you have found all of the errors you can and fixed them, you will then want to follow the WYSS section to complete the exercise.

What You Should See

In this exercise we're going to interact with your `.py` file inside the `python` interpreter you used periodically to do calculations.

Here's what it looks like when I do it:

```
1  $ python
2  Python 2.5.1 (r251:54863, Feb  6 2009, 19:02:12)
3  [GCC 4.0.1 (Apple Inc. build 5465)] on darwin
4  Type "help", "copyright", "credits" or "license" for more information.
5  >>> import ex25
6  >>> sentence = "All good things come to those who wait."
7  >>> words = ex25.break_words(sentence)
8  >>> words
9  ['All', 'good', 'things', 'come', 'to', 'those', 'who', 'wait.']
10 >>> sorted_words = ex25.sort_words(words)
11 >>> sorted_words
12 ['All', 'come', 'good', 'things', 'those', 'to', 'wait.', 'who']
13 >>> ex25.print_first_word(words)
14 All
15 >>> ex25.print_last_word(words)
16 wait.
17 >>> wrods
18 Traceback (most recent call last):
19   File "<stdin>", line 1, in <module>
20 NameError: name 'wrods' is not defined
21 >>> words
22 ['good', 'things', 'come', 'to', 'those', 'who']
23 >>> ex25.print_first_word(sorted_words)
24 All
25 >>> ex25.print_last_word(sorted_words)
26 who
27 >>> sorted_words
28 ['come', 'good', 'things', 'those', 'to', 'wait.']
29 >>> sorted_words = ex25.sort_sentence(sentence)
30 >>> sorted_words
31 ['All', 'come', 'good', 'things', 'those', 'to', 'wait.', 'who']
32 >>> ex25.print_first_and_last(sentence)
33 All
34 wait.
35 >>> ex25.print_first_and_last_sorted(sentence)
36 All
37 who
38 >>> ^D
39 $
```

Let's break this down line by line to make sure you know what's going on:

- Line 5 you import *your* `ex25.py` python file, just like other imports you have done. Notice you do not need to put the `.py` at the end to import it. When you do this you make a `module` that has all your functions in it to use.
- Line 6 you made a `sentence` to work with.
- Line 7 you use the `ex25` module and call your first function `ex25.break_words`. The `.` (dot, period) symbol is how you tell python, "Hey, inside `ex25` there's a function called `break_words` and I want to run it."

- Line 8 we just type `words`, and python will print out what's in that variable (line 9). It looks weird but this is a `list` which you will learn about later.
- Lines 10-11 we do the same thing with `ex25.sort_words` to get a sorted sentence.
- Lines 13-16 we use `ex25.print_first_word` and `ex25.print_last_word` to get the first and last word printed out.
- Line 17 is interesting. I made a mistake and typed the `words` variable as `wrods` so python gave me an error on Lines 18-20.
- Line 21-22 is where we print the modified words list. Notice that since we printed the first and last one, those words are now missing.

The remaining lines are for you to figure out and analyze in the extra credit.

Extra Credit

1. Take the remaining lines of the WYSS output and figure out what they are doing. Make sure you understand how you are running your functions in the `ex25` module.
2. Try doing this: `help(ex25)` and also `help(ex25.break_words)`. Notice how you get help for your module, and how the help is those odd `"""` strings you put after each function in ex25? Those special strings are called `documentation comments` and we'll be seeing more of them.
3. Type `ex25.` is annoying. A shortcut is to do your import like this: `from ex25 import *` which is like saying, "Import everything from ex25." Programmers like saying things backwards. Start a new session and see how all your functions are right there.
4. Try breaking your file and see what it looks like in `python` when you use it. You will have to quit python with CTRL-D (CTRL-Z on windows) to be able to reload it.

Exercise 26: Congratulations, Take A Test!

You are almost done with the first half of the book. The second half is where things get interesting. You will learn logic and be able to do useful things like make decisions.

Before you continue, I have a quiz for you. This quiz will be *very* hard because it requires you to fix someone else's code. When you are a programmer you often have to deal with another programmer's code, and also with their arrogance. They will very frequently claim that their code is perfect.

These programmers are stupid people who care little for others. A good programmer assumes, like a good scientist, that there's always *some* probability their code is wrong. Good programmers start from the premise that their software is broken and then work to rule out all possible ways it could be wrong before finally admitting that maybe it really is the other guy's code.

In this exercise, you will practice dealing with a bad programmer by fixing a bad programmer's code. I have poorly copied exercises 24 and 25 into a file and removed random characters and added flaws. Most of the errors are things Python will tell you, while some of them are math errors you should find. Others are formatting errors or spelling mistakes in the strings.

All of these errors are very common mistakes all programmers make. Even experienced ones.

Your job in this exercise is to correct this file. Use all of your skills to make this file better. Analyze it first, maybe printing it out to edit it like you would a school term paper. Fix each flaw and keep running it and fixing it until the script runs perfectly. Try not to get help, and instead if you get stuck take a break and come back to it later.

Even if this takes days to do, bust through it and make it right.

Finally, the point of this exercise isn't to type it in, but to fix an existing file. To do that, you must go to:

- http://learnpythonthehardway.com/wiki?name=Exercise26

Copy-paste the code into a file named `ex26.py`. This is the only time you are allowed to copy-paste.

Exercise 27: Memorizing Logic

Today is the day you start learning about logic. Up to this point you have done everything you possibly can reading and writing files, to the terminal, and have learned quite a lot of the math capabilities of Python.

From now on, you will be learning *logic*. You won't learn complex theories that academics love to study, but just the simple basic logic that makes real programs work and that real programmers need every day.

Learning logic has to come after you do some memorization. I want you to do this exercise for an entire week. Do not falter. Even if you are bored out of your mind, keep doing it. This exercise has a set of logic tables you must memorize to make it easier for you to do the later exercises.

I'm warning you this won't be fun at first. It will be downright boring and tedious but this is to teach you a very important skill you will need as a programmer. You *will* need to be able to memorize important concepts as you go in your life. Most of these concepts will be exciting once you get them. You will struggle with them, like wrestling a squid, then one day *snap* you will understand it. All that work memorizing the basics pays off big later.

Here's a tip on how to memorize something without going insane: Do a tiny bit at a time throughout the day and mark down what you need to work on most. Do not try to sit down for two hours straight and memorize these tables. This won't work. Your brain will really only retain whatever you studied in the first 15 or 30 minutes anyway.

Instead, what you should do is create a bunch of index cards with each column on the left on one side (True or False) and the column on the right on the back. You should then pull them out, see the "True or False" and be able to immediately say "True!" Keep practicing until you can do this.

Once you can do that, start writing out your own truth tables each night into a notebook. Do not just copy them. Try to do them from memory, and when you get stuck glance quickly at the ones I have here to refresh your memory. Doing this will train your brain to remember the whole table.

Do not spend more than one week on this, because you will be applying it as you go.

The Truth Terms

In python we have the following terms (characters and phrases) for determining if something is "True" or "False". Logic on a computer is all about seeing if some combination of these characters and some variables is True at that point in the program.

- `and`
- `or`
- `not`
- != (not equal)
- == (equal)
- >= (greater-than-equal)

- <= (less-than-equal)
- True
- False

You actually have run into these characters before, but maybe not the phrases. The phrases (and, or, not) actually work the way you expect them to, just like in English.

The Truth Tables

We will now use these characters to make the truth tables you need to memorize.

NOT	True?
not False	True
not True	False

OR	True?
True or False	True
True or True	True
False or True	True
False or False	False

AND	True?
True and False	False
True and True	True
False and True	False
False and False	False

NOT OR	True?
not (True or False)	False
not (True or True)	False
not (False or True)	False
not (False or False)	True

NOT AND	True?
not (True and False)	True
not (True and True)	False
not (False and True)	True
not (False and False)	True

!=	True?
1 != 0	True
1 != 1	False
0 != 1	True
0 != 0	False

==	True?
1 == 0	False
1 == 1	True
0 == 1	False
0 == 0	True

Now use these tables to write up your own cards and spend the week memorizing them. Remember though, there is no failing in this book, just trying as hard as you can each day, and then a *little* bit more.

Exercise 28: Boolean Practice

The logic combinations you learned from the last exercise are called "boolean" logic expressions. Boolean logic is used *everywhere* in programming. They are essential fundamental parts of computation and knowing them very well is akin to knowing your scales in music.

In this exercise you will be taking the logic exercises you memorized and start trying them out in `python`. Take each of these logic problems, and write out what you think the answer will be. In each case it will be either True or False. Once you have the answers written down, you will start `python` in your terminal and type them in to confirm your answers.

1. `True and True`
2. `False and True`
3. `1 == 1 and 2 == 1`
4. `"test" == "test"`
5. `1 == 1 or 2 != 1`
6. `True and 1 == 1`
7. `False and 0 != 0`
8. `True or 1 == 1`
9. `"test" == "testing"`
10. `1 != 0 and 2 == 1`
11. `"test" != "testing"`
12. `"test" == 1`
13. `not (True and False)`
14. `not (1 == 1 and 0 != 1)`
15. `not (10 == 1 or 1000 == 1000)`
16. `not (1 != 10 or 3 == 4)`
17. `not ("testing" == "testing" and "Zed" == "Cool Guy")`
18. `1 == 1 and not ("testing" == 1 or 1 == 0)`
19. `"chunky" == "bacon" and not (3 == 4 or 3 == 3)`
20. `3 == 3 and not ("testing" == "testing" or "Python" == "Fun")`

I will also give you a trick to help you figure out the more complicated ones toward the end.

Whenever you see these boolean logic statements, you can solve them easily by this simple process:

1. Find equality test (== or !=) and replace it with its truth.

2. Find each and/or inside a parenthesis and solve those first.
3. Find each not and invert it.
4. Find any remaining and/or and solve it.
5. When you are done you should have True or False.

I will demonstrate with a variation on #20:

```
3 != 4 and not ("testing" != "test" or "Python" == "Python")
```

Here's me going through each of the steps and showing you the translation until I've boiled it down to a single result:

1. **Solve each equality test:**
   (a) `3 != 4` is `True`: `True and not ("testing" != "test" or "Python" == "Python")`
   (b) `"testing" != "test"` is `True`: `True and not (True or "Python" == "Python")`
   (c) `"Python" == "Python"`: `True and not (True or True)`
2. **Find each and/or in parenthesis ():**
   (a) `(True or True)` is True: `True and not (True)`
3. **Find each not and invert it:**
   (a) `not (True)` is False: `True and False`
4. **Find any remaining and/or and solve them:**
   (a) `True and False` is False

With that we're done and know the result is False.

Warning: The more complicated ones may seem *very* hard at first. You should be able to give a good first stab at solving them, but do not get discouraged. I'm just getting you primed for more of these "logic gymnastics" so that later cool stuff is much easier. Just stick with it, and keep track of what you get wrong, but do not worry that it's not getting in your head quite yet. It'll come.

What You Should See

After you have tried to guess at these, this is what your session with `python` might look like:

```
$ python
Python 2.5.1 (r251:54863, Feb  6 2009, 19:02:12)
[GCC 4.0.1 (Apple Inc. build 5465)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> True and True
True
>>> 1 == 1 and 2 == 2
True
```

Extra Credit

1. There are a lot of operators in Python similar to != and ==. Try to find out as many "equality operators" as you can. They should be like: < or <=.
2. Write out the names of each of these equality operators. For example, I call != "not equal".
3. Play with the `python` by typing out new boolean operators, and before you hit enter try to shout out what it is. Do not think about it, just the first thing that comes to mind. Write it down then hit enter, and keep track of how many you get right and wrong.
4. Throw away that piece of paper from #3 away so you do not accidentally try to use it later.

Exercise 29: What If

Here is the next script of Python you will enter, which introduces you to the `if-statement`. Type this in, make it run exactly right, and then we'll try see if your practice has paid off.

```
people = 20
cats = 30
dogs = 15


if people < cats:
    print "Too many cats! The world is doomed!"

if people > cats:
    print "Not many cats! The world is saved!"

if people < dogs:
    print "The world is drooled on!"

if people > dogs:
    print "The world is dry!"


dogs += 5

if people >= dogs:
    print "People are greater than equal to dogs."

if people <= dogs:
    print "People are less than equal to dogs."


if people == dogs:
    print "People are dogs."
```

What You Should See

```
$ python ex29.py
Too many cats! The world is doomed!
The world is dry!
People are greater than equal to dogs.
People are less than equal to dogs.
People are dogs.
$
```

Extra Credit

In this extra credit, try to guess what you think the `if-statement` is and what it does. Try to answer these questions in your own words before moving onto the next exercise:

1. What do you think the `if` does to the code under it?
2. Why does the code under the `if` need to be indented 4 spaces?
3. What happens if it isn't indented?
4. Can you put other boolean expressions from Ex. 26 in the `if-statement`? Try it.
5. What happens if you change the initial variables for `people`, `cats`, and `dogs`?

Exercise 30: Else And If

In the last exercise you worked out some `if-statements`, and then tried to guess what they are and how they work. Before you learn more I'll explain what everything is by answering the questions you had from extra credit. You did the extra credit right?

1. What do you think the `if` does to the code under it? An if statement creates what is called a "branch" in the code. It's kind of like those choose your own adventure books where you are asked to turn to one page if you make one choice, and another if you go a different direction. The `if-statement` tells your script, "If this boolean expression is True, then run the code under it, otherwise skip it."
2. Why does the code under the `if` need to be indented 4 spaces? A colon at the end of a line is how you tell Python you are going to create a new "block" of code, and then indenting 4 spaces tells Python what lines of code are in that block. This is *exactly* the same thing you did when you made functions in the first half of the book.
3. What happens if it isn't indented? If it isn't indented, you will most likely create a Python error. Python expects you to indent *something* after you end a line with a `:` (colon).
4. Can you put other boolean expressions from Ex. 26 in the `if` statement? Try it. Yes you can, and they can be as complex as you like, although really complex things generally are bad style.
5. What happens if you change the initial variables for `people`, `cats`, and `dogs`? Because you are comparing numbers, if you change the numbers, different `if-statements` will evaluate to `True` and the blocks of code under them will run. Go back and put different numbers in and see if you can figure out in your head what blocks of code will run.

Compare my answers to your answers, and make sure you *really* understand the concept of a "block" of code. This is important for when you do the next exercise where you write all the parts of `if-statements` that you can use.

Type this one in and make it work too.

```
people = 30
cars = 40
buses = 15


if cars > people:
    print "We should take the cars."
elif cars < people:
    print "We should not take the cars."
else:
    print "We can't decide."

if buses > cars:
    print "That's too many buses."
elif buses < cars:
    print "Maybe we could take the buses."
else:
```

```
18      print "We still can't decide."
19
20  if people > buses:
21      print "Alright, let's just take the buses."
22  else:
23      print "Fine, let's stay home then."
```

What You Should See

```
$ python ex.py
We should take the cars.
Maybe we could take the buses.
Alright, let's just take the buses.
$
```

Extra Credit

1. Try to guess what `elif` and `else` are doing.
2. Change the numbers of `cars`, `people`, and `buses` and then trace through each `if-statement` to see what will be printed.
3. Try some more complex boolean expressions like `cars > people and buses < cars`.
4. Above each line write an English description of what the line does.

Exercise 31: Making Decisions

In the first half of this book you mostly just printed out things and called functions, but everything was basically in a straight line. Your scripts ran starting at the top, and went to the bottom where they ended. If you made a function you could run that function later, but it still didn't have the kind of branching you need to really make decisions. Now that you have `if`, `else`, and `elif` you can start to make scripts that decide things.

In the last script you wrote out a simple set of tests asking some questions. In this script you will ask the user questions and make decisions based on their answers. Write this script, and then play with it quite a lot to figure it out.

```
print "You enter a dark room with two doors.  Do you go through door #1 or door #2?"

door = raw_input("> ")

if door == "1":
    print "There's a giant bear here eating a cheese cake.  What do you do?"
    print "1. Take the cake."
    print "2. Scream at the bear."

    bear = raw_input("> ")

    if bear == "1":
        print "The bear eats your face off.  Good job!"
    elif bear == "2":
        print "The bear eats your legs off.  Good job!"
    else:
        print "Well, doing %s is probably better.  Bear runs away." % bear

elif door == "2":
    print "You stare into the endless abyss at Cthuhlu's retina."
    print "1. Blueberries."
    print "2. Yellow jacket clothespins."
    print "3. Understanding revolvers yelling melodies."

    insanity = raw_input("> ")

    if insanity == "1" or insanity == "2":
        print "Your body survives powered by a mind of jello.  Good job!"
    else:
        print "The insanity rots your eyes into a pool of muck.  Good job!"

else:
    print "You stumble around and fall on a knife and die.  Good job!"
```

A key point here is that you are now putting the `if-statements` *inside* `if-statements` as code that can run. This is very powerful and can be used to create "nested" decisions, where one branch leads to another and another.

Make sure you understand this concept of if-statements inside if-statements. In fact, do the extra credit to really nail

it.

What You Should See

Here is me playing this little adventure game. I do not do so well.

```
$ python ex31.py
You enter a dark room with two doors.  Do you go through door #1 or door #2?
> 1
There's a giant bear here eating a cheese cake.  What do you do?
1. Take the cake.
2. Scream at the bear.
> 2
The bear eats your legs off.  Good job!

$ python ex31.py
You enter a dark room with two doors.  Do you go through door #1 or door #2?
> 1
There's a giant bear here eating a cheese cake.  What do you do?
1. Take the cake.
2. Scream at the bear.
> 1
The bear eats your face off.  Good job!

$ python ex31.py
You enter a dark room with two doors.  Do you go through door #1 or door #2?
> 2
You stare into the endless abyss at Cthuhlu's retina.
1. Blueberries.
2. Yellow jacket clothespins.
3. Understanding revolvers yelling melodies.
> 1
Your body survives powered by a mind of jello.  Good job!

$ python ex31.py
You enter a dark room with two doors.  Do you go through door #1 or door #2?
> 2
You stare into the endless abyss at Cthuhlu's retina.
1. Blueberries.
2. Yellow jacket clothespins.
3. Understanding revolvers yelling melodies.
> 3
The insanity rots your eyes into a pool of muck.  Good job!

$ python ex31.py
You enter a dark room with two doors.  Do you go through door #1 or door #2?
> stuff
You stumble around and fall on a knife and die.  Good job!

$ python ex31.py
You enter a dark room with two doors.  Do you go through door #1 or door #2?
> 1
There's a giant bear here eating a cheese cake.  What do you do?
1. Take the cake.
2. Scream at the bear.
> apples
Well, doing apples is probably better.  Bear runs away.
```

Extra Credit

Make new parts of the game and change what decisions people can make. Expand the game out as much as you can before it gets ridiculous.

Exercise 32: Loops And Lists

You should now be able to do some programs that are much more interesting. If you have been keeping up, you should realize that now you can combine all the other things you have learned with `if-statements` and boolean expressions to make your programs do smart things.

However, programs also need to do repetitive things very quickly. We are going to use a `for-loop` in this exercise to build and print various lists. When you do the exercise, you will start to figure out what they are. I won't tell you right now. You have to figure it out.

Before you can use a for-loop, you need a way to *store* the results of loops somewhere. The best way to do this is with a `list`. A list is exactly what its name says, a container of things that are organized in order. It's not complicated; you just have to learn a new syntax. First, there's how you make a list:

```
hairs = ['brown', 'blond', 'red']
eyes = ['brown', 'blue', 'green']
weights = [1, 2, 3, 4]
```

What you do is start the list with the `[` (left-bracket) which "opens" the list. Then you put each item you want in the list separated by commas, just like when you did function arguments. Lastly you end the list with a `]` (right-bracket) to indicate that it's over. Python then takes this list and all its contents, and assigns them to the variable.

> **Warning:** This is where things get tricky for people who can't program. Your brain has been taught that the world is flat. Remember in the last exercise where you put `if-statements` inside `if-statements`? That probably made your brain hurt because most people do not ponder how to "nest" things inside things. In programming this is all over the place. You will find functions that call other functions that have `if-statements` that have lists with lists inside lists. If you see a structure like this that you can't figure out, take out pencil and paper and break it down manually bit by bit until you understand it.

We now will build some lists using some loops and print them out:

```
1  the_count = [1, 2, 3, 4, 5]
2  fruits = ['apples', 'oranges', 'pears', 'apricots']
3  change = [1, 'pennies', 2, 'dimes', 3, 'quarters']
4
5  # this first kind of for-loop goes through a list
6  for number in the_count:
7      print "This is count %d" % number
8
9  # same as above
10 for fruit in fruits:
11     print "A fruit of type: %s" % fruit
12
13 # also we can go through mixed lists too
14 # notice we have to use %r since we don't know what's in it
15 for i in change:
16     print "I got %r" % i
```

```
17
18 # we can also build lists, first start with an empty one
19 elements = []
20
21 # then use the range function to do 0 to 20 counts
22 for i in range(0, 6):
23     print "Adding %d to the list." % i
24     # append is a function that lists understand
25     elements.append(i)
26
27 # now we can print them out too
28 for i in elements:
29     print "Element was: %d" % i
```

What You Should See

```
$ python ex32.py
This is count 1
This is count 2
This is count 3
This is count 4
This is count 5
A fruit of type: apples
A fruit of type: oranges
A fruit of type: pears
A fruit of type: apricots
I got 1
I got 'pennies'
I got 2
I got 'dimes'
I got 3
I got 'quarters'
Adding 0 to the list.
Adding 1 to the list.
Adding 2 to the list.
Adding 3 to the list.
Adding 4 to the list.
Adding 5 to the list.
Element was: 0
Element was: 1
Element was: 2
Element was: 3
Element was: 4
Element was: 5
$
```

Extra Credit

1. Take a look at how you used `range`. Look up the `range` function to understand it.
2. Could you have avoided that `for-loop` entirely on line 23 and just assigned `range(0,6)` directly to `elements`?

3. Find the Python documentation on lists and read about them. What other operations can you do to lists besides `append`?

Exercise 33: While Loops

Now to totally blow your mind with a new loop, the `while-loop`. A `while-loop` will keep executing the code block under it as long as a boolean expression is `True`.

Wait, you have been keeping up with the terminology right? That if we write a line and end it with a `:` (colon) then that tells Python to start a new block of code? Then we indent and that's the new code. This is all about structuring your programs so that Python knows what you mean. If you do not get that idea then go back and do some more work with `if-statements`, functions, and the `for-loop` until you get it.

Later on we'll have some exercises that will train your brain to read these structures, similar to how we burned boolean expressions into your brain.

Back to `while-loops`. What they do is simply do a test like an `if-statement`, but instead of running the code block *once*, they jump back to the "top" where the `while` is, and repeat. It keeps doing this until the expression is `False`.

Here's the problem with `while-loops`: Sometimes they do not stop. This is great if your intention is to just keep looping until the end of the universe. Otherwise you almost always want your loops to end eventually.

To avoid these problems, there's some rules to follow:

1. Make sure that you use `while-loops` sparingly. Usually a `for-loop` is better.
2. Review your while statements and make sure that the thing you are testing will become `False` at some point.
3. When in doubt, print out your test variable at the top and bottom of the `while-loop` to see what it's doing.

In this exercise, you will learn the `while-loop` by doing the above three things:

```
1  i = 0
2  numbers = []
3
4  while i < 6:
5      print "At the top i is %d" % i
6      numbers.append(i)
7
8      i = i + 1
9      print "Numbers now: ", numbers
10     print "At the bottom i is %d" % i
11
12
13 print "The numbers: "
14
15 for num in numbers:
16     print num
```

What You Should See

```
$ python ex.py
At the top i is 0
Numbers now:  [0]
At the bottom i is 1
At the top i is 1
Numbers now:  [0, 1]
At the bottom i is 2
At the top i is 2
Numbers now:  [0, 1, 2]
At the bottom i is 3
At the top i is 3
Numbers now:  [0, 1, 2, 3]
At the bottom i is 4
At the top i is 4
Numbers now:  [0, 1, 2, 3, 4]
At the bottom i is 5
At the top i is 5
Numbers now:  [0, 1, 2, 3, 4, 5]
At the bottom i is 6
The numbers:
0
1
2
3
4
5
```

Extra Credit

1. Convert this while loop to a function that you can call, and replace `10` in the test (`i < 10`) with a variable.
2. Now use this function to rewrite the script to try different numbers.
3. Add another variable to the function arguments that you can pass in that lets you change the `+ 1` on line 8 so you can change how much it increments by.
4. Rewrite the script again to use this function to see what effect that has.
5. Now, write it to use `for-loops` and `range` instead. Do you need the incrementor in the middle anymore? What happens if you do not get rid of it?

If at any time that you are doing this it goes crazy (it probably will), just hold down `CTRL` and hit `c` (CTRL-c) and the program will abort.

Exercise 34: Accessing Elements Of Lists

Lists are pretty useful, but unless you can get at the things in them they aren't all that good. You can already go through the elements of a list in order, but what if you want say, the 5th element? You need to know how to access the elements of a list. Here's how you would access the *first* element of a list:

```
animals = ['bear', 'tiger', 'penguin', 'zebra']
bear = animals[0]
```

You take a list of animals, and then you get the first one using `0`?! How does that work? Because of the way math works, Python start its lists at 0 rather than 1. It seems weird, but there's many advantages to this, even though it is mostly arbitrary.

The best way to explain why is by showing you the difference between how you use numbers and how programmers use numbers.

Imagine you are watching the four animals in our list above (`['bear', 'tiger', 'penguin', 'zeebra']`) run in a race. They win in the *order* we have them in this list. The race was really exciting because, the animals didn't eat each other and somehow managed to run a race. Your friend however shows up late and wants to know who won. Does your friend say, "Hey, who came in *zeroth*?" No, he says, "Hey says, hey who came in *first*?"

This is because the *order* of the animals is important. You can't have the second animal without the first animal, and can't have the third without the second. It's also impossible to have a "zeroth" animal since zero means nothing. How can you have a nothing win a race? It just doesn't make sense. We call these kinds of numbers "ordinal" numbers, because they indicate an ordering of things.

Programmers, however, can't think this way because they can pick any element out of a list at any point. To a programmer, the above list is more like a deck of cards. If they want the tiger, they grab it. If they want the zeebra, they can take it too. This need to pull elements out of lists at random means that they need a way to indicate elements consistently by an address, or an "index", and the best way to do that is to start the indices at 0. Trust me on this, the math is *way* easier for these kinds of accesses. This kind of number is a "cardinal" number and means you can pick at random, so there needs to be a 0 element.

So, how does this help you work with lists? Simple, every time you say to yourself, "I want the 3rd animal," you translate this "ordinal" number to a "cardinal" number by subtracting 1. The "3rd" animal is at index 2 and is the penguin. You have to do this because you have spent your whole life using ordinal numbers, and now you have to think in cardinal. Just subtract 1 and you will be good.

Remember: ordinal == ordered, 1st; cardinal == cards at random, 0.

Let's practice this. Take this list of animals, and follow the exercises where I tell you to write down what animal you get for that ordinal or cardinal number. Remember if I say "first", "second", etc. then I'm using ordinal, so subtract 1. If I give you cardinal (0, 1, 2) then use it directly.

```
animals = ['bear', 'python', 'peacock', 'kangaroo', 'whale', 'platypus']
```

1. The animal at 1.
2. The 3rd animal.

3. The 1st animal.
4. The animal at 3.
5. The 5th animal.
6. The animal at 2.
7. The 6th animal.
8. The animal at 4.

For each of these, write out a full sentence of the form: "The 1st animal is at 0 and is a bear." Then say it backwards, "The animal at 0 is the 1st animal and is a bear."

Use your python to check your answers.

Extra Credit

1. Read about ordinal and cardinal numbers online.
2. With what you know of the difference between these types of numbers, can you explain why this really is 2010? (Hint, you can't pick years at random.)
3. Write some more lists and work out similar indexes until you can translate them.
4. Use Python to check your answers to this as well.

> **Warning:** Programmers will tell you to read this guy named "Dijkstra" on this subject. I recommend you avoid his writings on this unless you enjoy being yelled at by someone who stopped programming at the same time programming started.

Exercise 35: Branches and Functions

You have learned to do `if-statements`, functions, and arrays. Now it's time to bend your mind. Type this in, and see if you can figure out what it's doing.

```
from sys import exit

def gold_room():
    print "This room is full of gold.  How much do you take?"

    next = raw_input("> ")
    if "0" in next or "1" in next:
        how_much = int(next)
    else:
        dead("Man, learn to type a number.")

    if how_much < 50:
        print "Nice, you're not greedy, you win!"
        exit(0)
    else:
        dead("You greedy bastard!")


def bear_room():
    print "There is a bear here."
    print "The bear has a bunch of honey."
    print "The fat bear is in front of another door."
    print "How are you going to move the bear?"
    bear_moved = False

    while True:
        next = raw_input("> ")

        if next == "take honey":
            dead("The bear looks at you then pimp slaps your face off.")
        elif next == "taunt bear" and not bear_moved:
            print "The bear has moved from the door. You can go through it now."
            bear_moved = True
        elif next == "taunt bear" and bear_moved:
            dead("The bear gets pissed off and chews your crotch off.")
        elif next == "open door" and bear_moved:
            gold_room()
        else:
            print "I got no idea what that means."


def cthulu_room():
    print "Here you see the great evil Cthulu."
```

```
44      print "He, it, whatever stares at you and you go insane."
45      print "Do you flee for your life or eat your head?"
46
47      next = raw_input("> ")
48
49      if "flee" in next:
50          start()
51      elif "head" in next:
52          dead("Well that was tasty!")
53      else:
54          cthulu_room()
55
56
57  def dead(why):
58      print why, "Good job!"
59      exit(0)
60
61  def start():
62      print "You are in a dark room."
63      print "There is a door to your right and left."
64      print "Which one do you take?"
65
66      next = raw_input("> ")
67
68      if next == "left":
69          bear_room()
70      elif next == "right":
71          cthulu_room()
72      else:
73          dead("You stumble around the room until you starve.")
74
75
76  start()
```

What You Should See

Here's me taking too much gold:

```
$ python ex35.py
You are in a dark room.
There is a door to your right and left.
Which one do you take?
> left
There is a bear here.
The bear has a bunch of honey.
The fat bear is in front of another door.
How are you going to move the bear?
> taunt bear
The bear has moved from the door. You can go through it now.
> open door
This room is full of gold.  How much do you take?
> asf
Man, learn to type a number. Good job!
$
```

Extra Credit

1. Draw a map of the game and how you flow through it.
2. Fix all of your mistakes, including spelling mistakes.
3. Write comments for the functions you do not understand. Remember doc comments?
4. Add more to the game. What can you do to both simplify and expand it.
5. The `gold_room` has a weird way of getting you to type a number. What are all the bugs in this way of doing it? Can you make it better than just checking if "1" or "0" are in the number? Look at how `int()` works for clues.

Exercise 36: Designing and Debugging

Now that you know `if-statements`, I'm going to give you some rules for `for-loops` and `while-loops` that will keep you out of trouble. I'm also going to give you some tips on debugging so that you can figure out problems with your program. Finally, you are going to design a similar little game as in the last exercise but with a slight twist.

Rules For If-Statements

1. Every `if-statement` must have an `else`.
2. If this `else` should never be run because it doesn't make sense, then you must use a `die` function in the `else` that prints out an error message and dies, just like we did in the last exercise. This will find *many* errors.
3. Never nest `if-statements` more than 2 deep and always try to do them 1 deep. This means if you put an `if` in an `if` then you should be looking to move that second `if` into another function.
4. Treat `if-statements` like paragraphs, where each `if,elif,else` grouping is like a set of sentences. Put blank lines before and after.
5. Your boolean tests should be simple. If they are complex, move their calculations to variables earlier in your function and use a good name for the variable.

If you follow these simple rules, you will start writing better code than most programmers. Go back to the last exercise and see if I followed all of these rules. If not, fix it.

> **Warning:** Never be a slave to the rules in real life. For training purposes you need to follow these rules to make your mind strong, but in real life sometimes these rules are just stupid. If you think a rule is stupid, try not using it.

Rules For Loops

1. Use a `while-loop` only to loop forever, and that means probably never. This only applies to Python, other languages are different.
2. Use a `for-loop` for all other kinds of looping, especially if there is a fixed or limited number of things to loop over.

Tips For Debugging

1. Do not use a "debugger". A debugger is like doing a full-body scan on a sick person. You do not get any specific useful information, and you find a whole lot of information that doesn't help and is just confusing.

2. The best way to debug a program is to use `print` to print out the values of variables at points in the program to see where they go wrong.
3. Make sure parts of your programs work as you work on them. Do not write massive files of code before you try to run them. Code a little, run a little, fix a little.

Homework

Now write a similar game to the one that I created in the last exercise. It can be any kind of game you want in the same flavor. Spend a week on it making it as interesting as possible. For extra credit, use lists, functions, and modules (remember those from Ex. 13?) as much as possible, and find as many new pieces of Python as you can to make the game work.

There is one catch though, write up your idea for the game first. Before you start coding you must write up a map for your game. Create the rooms, monsters, and traps that the player must go through on paper before you code.

Once you have your map, try to code it up. If you find problems with the map then adjust it and make the code match.

One final word of advice: Every programmer becomes paralyzed by irrational fear starting a new large project. They then use procrastination to avoid confronting this fear and end up not getting their program working or even started. I do this. Everyone does this. The best way to avoid this is to make a list of things you should do, and then do them one at a time.

Just start doing it, do a small version, make it bigger, keep a list of things to do, and do them.

Exercise 37: Symbol Review

It's time to review the symbols and Python words you know, and to try to pick up a few more for the next few lessons. What I've done here is written out all the Python symbols and keywords that are important to know.

In this lesson take each keyword, and first try to write out what it does from memory. Next, search online for it and see what it really does. It may be hard because some of these are going to be impossible to search for, but keep trying.

If you get one of these wrong from memory, write up an index card with the correct definition and try to "correct" your memory. If you just didn't know about it, write it down, and save it for later.

Finally, use each of these in a small Python program, or as many as you can get done. The key here is to find out what the symbol does, make sure you got it right, correct it if you do not, then use it to lock it in.

Keywords

- `and`
- `del`
- `from`
- `not`
- `while`
- `as`
- `elif`
- `global`
- `or`
- `with`
- `assert`
- `else`
- `if`
- `pass`
- `yield`
- `break`
- `except`
- `import`
- `print`

- `class`
- `exec`
- `in`
- `raise`
- `continue`
- `finally`
- `is`
- `return`
- `def`
- `for`
- `lambda`
- `try`

Data Types

For data types, write out what makes up each one. For example, with strings write out how you create a string. For numbers write out a few numbers.

- `True`
- `False`
- `None`
- `strings`
- `numbers`
- `floats`
- `lists`

String Escapes Sequences

For string escape sequences, use them in strings to make sure they do what you think they do.

- `\\`
- `\'`
- `\"`
- `\a`
- `\b`
- `\f`
- `\n`
- `\r`
- `\t`

- `\v`

String Formats

Same thing for string formats: use them in some strings to know what they do.

- `%d`
- `%i`
- `%o`
- `%u`
- `%x`
- `%X`
- `%e`
- `%E`
- `%f`
- `%F`
- `%g`
- `%G`
- `%c`
- `%r`
- `%s`
- `%%`

Operators

Some of these may be unfamiliar to you, but look them up anyway. Find out what they do, and if you still can't figure it out, save it for later.

- `+`
- `-`
- `*`
- `**`
- `/`
- `//`
- `%`
- `<`
- `>`
- `<=`
- `>=`

- ==
- !=
- <>
- ( )
- [ ]
- { }
- @
- ,
- :
- .
- =
- ;
- +=
- -=
- *=
- /=
- //=
- %=
- **=

Spend about a week on this, but if you finish faster that's great. The point is to try to get coverage on all these symbols and make sure they are locked in your head. What's also important is to find out what you *do not* know so you can fix it later.

Exercise 38: Reading Code

Now go find some Python code to read. You should be reading any Python code you can and trying to steal ideas that you find. You actually should have enough knowledge to be able to read, but maybe not understand what the code does. What I'm going to teach you in this lesson is how to apply things you have learned to understand other people's code.

First, print out the code you want to understand. Yes, print it out, because your eyes and brain are more used to reading paper than computer screens. Make sure you only print a few pages at a time.

Second, go through your printout and take notes of the following:

1. Functions and what they do.
2. Where each variable is first given a value.
3. Any variables with the same names in different parts of the program. These may be trouble later.
4. Any `if-statements` without else clauses. Are they right?
5. Any `while-loops` that might not end.
6. Finally, any parts of code that you can't understand for whatever reason.

Third, once you have all of this marked up, try to explain it to yourself by writing comments as you go. Explain the functions, how they are used, what variables are involved, anything you can to figure this code out.

Lastly, on all of the difficult parts, trace the values of each variable line by line, function by function. In fact, do another printout and write in the margin the value of each variable that you need to "trace".

Once you have a good idea of what the code does, go back to the computer and read it again to see if you find new things. Keep finding more code and doing this until you do not need the printouts anymore.

Extra Credit

1. Find out what a "flow chart" is and write a few.
2. If you find errors in code you are reading, try to fix them and send the author your changes.
3. Another technique for when you are not using paper is to put # comments with your notes in the code. Sometimes, these could become the actual comments to help the next person.

Exercise 39: Doing Things To Lists

You have learned about lists. When you learned about `while-loops` you "appended" numbers to the end of a list and printed them out. There was also extra credit where you were supposed to find all the other things you can do to lists in the Python documentation. That was a while back, so go find in the book where you did that and review if you do not know what I'm talking about.

Found it? Remember it? Good. When you did this you had a list, and you "called" the function `append` on it. However, you may not really understand what's going on so let's see what we can do to lists, and how doing things with "on" them works.

When you type Python code that reads `mystuff.append('hello')` you are actually setting off a chain of events inside Python to cause something to happen to the `mystuff` list. Here's how it works:

1. Python sees you mentioned `mystuff` and looks up that variable. It might have to look backwards to see if you created with =, look and see if it is a function argument, or maybe it's a global variable. Either way it has to find the `mystuff` first.
2. Once it finds `mystuff` it then hits the `.` (period) operator and starts to look at *variables* that are a part of `mystuff`. Since `mystuff` is a list, it knows that `mystuff` has a bunch of functions.
3. It then hits `append` and compares the name "append" to all the ones that `mystuff` says it owns. If append is in there (it is) then it grabs *that* to use.
4. Next Python sees the `(` (parenthesis) and realizes, "Oh hey, this should be a function." At this point it *calls* (aka runs, executes) the function just like normally, but instead it calls the function with an *extra* argument.
5. That *extra* argument is ... `mylist`! I know, weird right? But that's how Python works so it's best to just remember it and assume that's alright. What happens then, at the end of all this is a function call that looks like: `append(mystuff, 'hello')` instead of what you read which is `mystuff.append('hello')`.

For the most part you do not have to know that this is going on, but it helps when you get error messages from python like this:

```
$ python
Python 2.6.5 (r265:79063, Apr 16 2010, 13:57:41)
[GCC 4.4.3] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> class Thing(object):
...     def test(hi):
...             print "hi"
...
>>> a = Thing()
>>> a.test("hello")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: test() takes exactly 1 argument (2 given)
>>>
```

What was all that? Well, this is me typing into the Python shell and showing you some magic. You haven't seen `class` yet but we'll get into those later. For now you see how Python said `test() takes exactly 1 argument (2 given)`. If you see this it means that python changed `a.test("hello")` to `test(a, "hello")` and that somewhere someone messed up and didn't add the argument for `a`.

That might be a lot to take in, but we're going to spend a few exercises getting this concept firm in your brain. To kick things off, here's an exercise that mixes strings and lists for all kinds of fun.

```
ten_things = "Apples Oranges Crows Telephone Light Sugar"

print "Wait there's not 10 things in that list, let's fix that."

stuff = ten_things.split(' ')
more_stuff = ["Day", "Night", "Song", "Frisbee", "Corn", "Banana", "Girl", "Boy"]

while len(stuff) != 10:
    next_one = more_stuff.pop()
    print "Adding: ", next_one
    stuff.append(next_one)
    print "There's %d items now." % len(stuff)

print "There we go: ", stuff

print "Let's do some things with stuff."

print stuff[1]
print stuff[-1] # whoa! fancy
print stuff.pop()
print ' '.join(stuff) # what? cool!
print '#'.join(stuff[3:5]) # super stellar!
```

What You Should See

```
$ python ex39.py

Wait there's not 10 things in that list, let's fix that.
Adding:  Boy
There's 7 items now.
Adding:  Girl
There's 8 items now.
Adding:  Banana
There's 9 items now.
Adding:  Corn
There's 10 items now.
There we go:  ['Apples', 'Oranges', 'Crows', 'Telephone', 'Light', 'Sugar',
      'Boy', 'Girl', 'Banana', 'Corn']
Let's do some things with stuff.
Oranges
Corn
Corn
Apples Oranges Crows Telephone Light Sugar Boy Girl Banana
Telephone#Light
```

Extra Credit

1. Take each function that is called, and go through the steps outlined above to translate them to what Python does. For example, `' '.join(things)` is `join(' ', things)`.
2. Translate these two ways to view the function calls in English. For example, `' '.join(things)` reads as, "Join things with ' ' between them." Meanwhile, `join(' ', things)` means, "Call join with ' ' and things." Understand how they are really the same thing.
2. Go read about "Object Oriented Programming" online. Confused? Yeah I was too. Do not worry. You will learn enough to be dangerous, and you can slowly learn more later.
3. Read up on what a "class" is in Python. *Do not read about how other languages use the word "class"*. That will only mess you up.
4. What's the relationship between `dir(something)` and the "class" of `something`?
5. If you do not have any idea what I'm talking about do not worry. Programmers like to feel smart so they invented Object Oriented Programming, named it OOP, and then used it way too much. If you think that's hard, you should try to use "functional programming".

Exercise 40: Dictionaries, Oh Lovely Dictionaries

Now I have to hurt you with another container you can use, because once you learn this container a massive world of ultra-cool will be yours. It is the most useful container ever: the dictionary.

Python calls them "dicts", other languages call them, "hashes". I tend to use both names, but it doesn't matter. What does matter is what they do when compared to lists. You see, a list lets you do this:

```
>>> things = ['a', 'b', 'c', 'd']
>>> print things[1]
b
>>> things[1] = 'z'
>>> print things[1]
z
>>> print things
['a', 'z', 'c', 'd']
>>>
```

You can use numbers to "index" into a list, meaning you can use numbers to find out what's in lists. You should know this by now, but what a `dict` does is let you use *anything*, not just numbers. Yes, a dict associates one thing to another, no matter what it is. Take a look:

```
>>> stuff = {'name': 'Zed', 'age': 36, 'height': 6*12+2}
>>> print stuff['name']
Zed
>>> print stuff['age']
36
>>> print stuff['height']
74
>>> stuff['city'] = "San Francisco"
>>> print stuff['city']
San Francisco
>>>
```

You will see that instead of just numbers we're using strings to say what we want from the `stuff` dictionary. We can also put new things into the dictionary with strings. It doesn't have to be strings though, we can also do this:

```
>>> stuff[1] = "Wow"
>>> stuff[2] = "Neato"
>>> print stuff[1]
Wow
>>> print stuff[2]
Neato
>>> print stuff
{'city': 'San Francisco', 2: 'Neato',
    'name': 'Zed', 1: 'Wow', 'age': 36,
```

```
    'height': 74}
>>>
```

In this one I just used numbers. I could use anything. Well almost but just pretend you can use anything for now.

Of course, a dictionary that you can only put things in is pretty stupid, so here's how you delete things, with the `del` keyword:

```
>>> del stuff['city']
>>> del stuff[1]
>>> del stuff[2]
>>> stuff
{'name': 'Zed', 'age': 36, 'height': 74}
>>>
```

We'll now do an exercise that you *must* study very carefully. I want you to type this exercise in and try to understand what's going on. It is a very interesting exercise that will hopefully make a big light turn on in your head very soon.

```
cities = {'CA': 'San Francisco', 'MI': 'Detroit',
                      'FL': 'Jacksonville'}

cities['NY'] = 'New York'
cities['OR'] = 'Portland'

def find_city(themap, state):
    if state in themap:
        return themap[state]
    else:
        return "Not found."

# ok pay attention!
cities['_find'] = find_city

while True:
    print "State? (ENTER to quit)",
    state = raw_input("> ")

    if not state: break

    # this line is the most important ever! study!
    city_found = cities['_find'](cities, state)
    print city_found
```

Warning: Notice how I use `themap` instead of `map`? That's because Python has a function called map, so if you try to use that you can have problems later.

What You Should See

```
$ python ex40.py
State? (ENTER to quit) > CA
San Francisco
State? (ENTER to quit) > FL
Jacksonville
State? (ENTER to quit) > O
Not found.
State? (ENTER to quit) > OR
```

```
Portland
State? (ENTER to quit) > VT
Not found.
State? (ENTER to quit) >
```

Extra Credit

1. Go find the Python documentation for dictionaries (a.k.a. dicts, dict) and try to do even more things to them.
2. Find out what you *can't* do with dictionaries. A big one is that they do not have order, so try playing with that.
3. Try doing a `for-loop` over them, and then try the `items()` function in a `for-loop`.

Exercise 41: A Room With A View Of A Bear With A Broadsword

Did you figure out the secret of the function in the dict from the last exercise? Can you explain it to yourself? Let me explain it and you can compare your explanation with mine. Here are the lines of code we are talking about:

```
cities['_find'] = find_city
city_found = cities['_find'](cities, state)
```

Remember that functions can be variables too. The `def find_city` just makes another variable name in your current module that you can use anywhere. In this code first we are putting the function `find_city` into the dict `cities` as `'_find'`. This is the same as all the others where we set states to some cities, but in this case it's actually the function we put in there.

Alright, so once we know that `find_city` is in the dict at `_find`, that means we can do work with it. The 2nd line of code (used later in the previous exercise) can be broken down like this:

1. Python sees `city_found =` and knows we want to make a new variable.
2. It then reads `cities` and finds that variable, it's a dict.
3. Then there's `['_find']` which will *index* into the `cities` dict and pull out whatever is at `_find`.
4. What is at `['_find']` is our function `find_city` so Python *then* knows it's got a function, and when it hits `(` it does the function call.
5. The parameters `cities, state` are passed to this function `find_city`, and it runs because it's called.
6. `find_city` then tries to look up `states` inside `cities`, and returns what it finds or a message saying it didn't find anything.
7. Python takes what `find_city` returned, and *finally* that is what is assigned to `city_found` all the way at the beginning.

I'm going to teach you a trick. Sometimes these things read better in English if you read the code backwards, so let's try that. Here's how I would do it for that same line (remember *backwards*):

1. `state` and `city` are...
2. passed as parameters to...
3. a function at...
4. `'_find'` inside...
5. the dict `cities`...
6. and finally assigned to `city_found`.

Here's another way to read it, this time "inside-out".

1. Find the center item of the expression, in this case `['_find']`.

2. Go counter-clock-wise and you have a dict `cities`, so this finds the element `_find` in cities.
3. That gives us a function. Keep going counter-clock-wise and you get to the parameters.
4. The parameters are passed to the function, and that returns a result. Go counter-clock-wise again.
5. Finally, we are at the `city_found =` assignment, and we have our end result.

After decades of programming I do not even think about these three ways to read code. I just glance at it and know what it means, and I can even glance at a whole screen of code, and all the bugs and errors jump out at me. That took an incredibly long time and quite a bit more study than is sane. To get that way, I learned these three ways of reading most any programming language:

1. Front to back.
2. Back to front.
3. Counter-clock-wise.

Try them out when you have a difficult statement to figure out.

Let's now type in your next exercise, and then go over after that. This one is gonna be fun.

```
from sys import exit
from random import randint

def death():
    quips = ["You died.  You kinda suck at this.",
             "Your mom would be proud. If she were smarter.",
             "Such a luser.",
             "I have a small puppy that's better at this."]

    print quips[randint(0, len(quips)-1)]
    exit(1)


def princess_lives_here():
    print "You see a beautiful Princess with a shiny crown."
    print "She offers you some cake."

    eat_it = raw_input("> ")

    if eat_it == "eat it":
        print "You explode like a pinata full of frogs."
        print "The Princess cackles and eats the frogs. Yum!"
        return 'death'

    elif eat_it == "do not eat it":
        print "She throws the cake at you and it cuts off your head."
        print "The last thing you see is her munching on your torso. Yum!"
        return 'death'

    elif eat_it == "make her eat it":
        print "The Princess screams as you cram the cake in her mouth."
        print "Then she smiles and cries and thanks you for saving her."
        print "She points to a tiny door and says, 'The Koi needs cake too.'"
        print "She gives you the very last bit of cake and shoves you in."
        return 'gold_koi_pond'

    else:
        print "The princess looks at you confused and just points at the cake."
        return 'princess_lives_here'
```

```
40
41 def gold_koi_pond():
42     print "There is a garden with a koi pond in the center."
43     print "You walk close and see a massive fin poke out."
44     print "You peek in and a creepy looking huge Koi stares at you."
45     print "It opens its mouth waiting for food."
46
47     feed_it = raw_input("> ")
48
49     if feed_it == "feed it":
50         print "The Koi jumps up, and rather than eating the cake, eats your arm."
51         print "You fall in and the Koi shrugs than eats you."
52         print "You are then pooped out sometime later."
53         return 'death'
54
55     elif feed_it == "do not feed it":
56         print "The Koi grimaces, then thrashes around for a second."
57         print "It rushes to the other end of the pond, braces against the wall..."
58         print "then it *lunges* out of the water, up in the air and over your"
59         print "entire body, cake and all."
60         print "You are then pooped out a week later."
61         return 'death'
62
63     elif feed_it == "throw it in":
64         print "The Koi wiggles, then leaps into the air to eat the cake."
65         print "You can see it's happy, it then grunts, thrashes..."
66         print "and finally rolls over and poops a magic diamond into the air"
67         print "at your feet."
68
69         return 'bear_with_sword'
70
71     else:
72         print "The Koi gets annoyed and wiggles a bit."
73         return 'gold_koi_pond'
74
75
76 def bear_with_sword():
77     print "Puzzled, you are about to pick up the fish poop diamond when"
78     print "a bear bearing a load bearing sword walks in."
79     print '"Hey! That\' my diamond! Where\'d you get that!?"'
80     print "It holds its paw out and looks at you."
81
82     give_it = raw_input("> ")
83
84     if give_it == "give it":
85         print "The bear swipes at your hand to grab the diamond and"
86         print "rips your hand off in the process.  It then looks at"
87         print 'your bloody stump and says, "Oh crap, sorry about that."'
88         print "It tries to put your hand back on, but you collapse."
89         print "The last thing you see is the bear shrug and eat you."
90         return 'death'
91
92     elif give_it == "say no":
93         print "The bear looks shocked.  Nobody ever told a bear"
94         print "with a broadsword 'no'.  It asks, "
95         print '"Is it because it\'s not a katana?  I could go get one!"'
96         print "It then runs off and now you notice a big iron gate."
97         print '"Where the hell did that come from?" You say.'
```

```
98
99          return 'big_iron_gate'
100     else:
101         print "The bear look puzzled as to why you'd do that."
102         return "bear_with_sword"
103
104 def big_iron_gate():
105     print "You walk up to the big iron gate and see there's a handle."
106
107     open_it = raw_input("> ")
108
109     if open_it == 'open it':
110         print "You open it and you are free!"
111         print "There are mountains.  And berries! And..."
112         print "Oh, but then the bear comes with his katana and stabs you."
113         print '"Who\'s laughing now!?  Love this katana."'
114
115         return 'death'
116
117     else:
118         print "That doesn't seem sensible.  I mean, the door's right there."
119         return 'big_iron_gate'
120
121
122 ROOMS = {
123     'death': death,
124     'princess_lives_here': princess_lives_here,
125     'gold_koi_pond': gold_koi_pond,
126     'big_iron_gate': big_iron_gate,
127     'bear_with_sword': bear_with_sword
128 }
129
130
131 def runner(map, start):
132     next = start
133
134     while True:
135         room = map[next]
136         print "\n--------"
137         next = room()
138
139 runner(ROOMS, 'princess_lives_here')
```

It's a lot of code, but go through it, make sure it works, play it.

What You Should See

Here's me playing the game. Bears are cool.

```
$ python ex41.py

--------
You see a beautiful Princess with a shiny crown.
She offers you some cake.
> make her eat it
The Princess screams as you cram the cake in her mouth.
Then she smiles and cries and thanks you for saving her.
```

```
She points to a tiny door and says, 'The Koi needs cake too.'
She gives you the very last bit of cake and shoves you in.

--------
There is a garden with a koi pond in the center.
You walk close and see a massive fin poke out.
You peek in and a creepy looking huge Koi stares at you.
It opens its mouth waiting for food.
> throw it in
The Koi wiggles, then leaps into the air to eat the cake.
You can see it's happy, it then grunts, thrashes...
and finally rolls over and poops a magic diamond into the air
at your feet.

--------
Puzzled, you are about to pick up the fish poop diamond when
a bear bearing a load bearing sword walks in.
"Hey! That' my diamond! Where'd you get that!?"
It holds its paw out and looks at you.
> say no
The bear looks shocked.  Nobody ever told a bear
with a broadsword 'no'.  It asks,
"Is it because it's not a katana?  I could go get one!"
It then runs off and now you notice a big iron gate.
"Where the hell did that come from?" You say.

--------
You walk up to the big iron gate and see there's a handle.
> open it
You open it and you are free!
There are mountains.  And berries! And...
Oh, but then the bear comes with his katana and stabs you.
"Who's laughing now!?  Love this katana."

--------
I have a small puppy that's better at this.
$
```

Extra Credit

1. Explain how returning the next room works.
2. Create more rooms, making the game bigger.
3. Instead of having each function print itself, learn about "doc comments". See if you can write the room description as doc comments, and change the runner to print them.
4. Once you have doc comments as the room description, do you need to have the function prompt even? Have the runner prompt the user, and pass that in to each function. You functions should just be if-statements printing the result and returning the next room.
5. This is actually a small version of something called a "finite state machine". Go read about them. They might not make sense but try anyway.

Exercise 42: Getting Classy

While it's fun to put functions inside of dictionaries, you'd think there'd be something in Python that does this for you. There is and it's the `class` keyword. Using `class` is how you create an even more awesome "dict with functions" than the one you made in the last exercise. Classes have all sorts of powerful features and uses that I could never go into in this book. Instead, you will just use them like they are fancy dictionaries with functions.

A programming language that uses classes is called an "Object Oriented Programming". This is an old style of programming where you make "things" and you "tell" those things to do work. You have been doing a lot of this. A whole lot. You just didn't know it. Remember when you were doing this:

```
stuff = ['Test', 'This', 'Out']
print ' '.join(stuff)
```

You were actually using classes. The variable `stuff` is actually a `list class`. The `' '.join(stuff)` is calling the `join` function of the string `' '` (just an empty space) is *also* a class, a string class. It's all classes!

Well, and objects, but let's just skip that word for now. You will learn what those are after you make some classes. How do you make classes? Very similar to how you made the `ROOMS` dict, but easier:

```
class TheThing(object):

    def __init__(self):
        self.number = 0

    def some_function(self):
        print "I got called."

    def add_me_up(self, more):
        self.number += more
        return self.number

# two different things
a = TheThing()
b = TheThing()

a.some_function()
b.some_function()

print a.add_me_up(20)
print a.add_me_up(20)
print b.add_me_up(30)
print b.add_me_up(30)

print a.number
print b.number
```

Warning: Alright, this is where you start learning about "warts". Python is an old language with lots of really ugly obnoxious pieces that were bad decisions. To cover up these bad decisions they make new bad decisions and then yell at people to adopt the new bad decisions. The phrase `class TheThing(object)` is an example of a bad decision. I won't get into it right here, but you shouldn't worry about why your class has to have `(object)` after its name, just type it this way all the time or other Python programmers will yell at you. We'll get into why later.

You see that `self` in the parameters? You know what that is? That's right, it's the "extra" parameter that Python creates so you can type `a.some_function()` and then it will translate *that* to really be `some_function(a)`. Why use `self`? Your function has no idea what you are calling any one "instance" of `TheThing` or another, you just use a generic name `self`. That way you can write your function and it will always work.

You could actually use another name rather than `self` but then every Python programmer on the planet would hate you, so do not. Only jerks change things like that and I taught you better. Be nice to people who have to read what you write because ten years later all code is horrible.

Next, see the `__init__` function? That is how you setup a Python class with internal variables. You can set them on `self` with the `.` (period) just like I will show you here. See also how we then use this in `add_me_up()` later which lets you add to the `self.number` you created. Later you can see how we use this to add to our number and print it.

Classes are very powerful, so you should go read about them. Read everything you can and play with them. You actually know how to use them, you just have to try it. In fact, I want to go play some guitar right now so I'm not going to give you an exercise to type. You are going to go write an exercise using classes.

Here's how we would do exercise 41 using classes instead of the thing we created:

```
from sys import exit
from random import randint

class Game(object):

    def __init__(self, start):
        self.quips = [
            "You died.  You kinda suck at this.",
             "Your mom would be proud. If she were smarter.",
             "Such a luser.",
             "I have a small puppy that's better at this."
        ]
        self.start = start

    def play(self):
        next = self.start

        while True:
            print "\n--------"
            room = getattr(self, next)
            next = room()


    def death(self):
        print self.quips[randint(0, len(self.quips)-1)]
        exit(1)


    def princess_lives_here(self):
        print "You see a beautiful Princess with a shiny crown."
        print "She offers you some cake."

```

```
33          eat_it = raw_input("> ")
34
35          if eat_it == "eat it":
36              print "You explode like a pinata full of frogs."
37              print "The Princess cackles and eats the frogs. Yum!"
38              return 'death'
39
40          elif eat_it == "do not eat it":
41              print "She throws the cake at you and it cuts off your head."
42              print "The last thing you see is her munching on your torso. Yum!"
43              return 'death'
44
45          elif eat_it == "make her eat it":
46              print "The Princess screams as you cram the cake in her mouth."
47              print "Then she smiles and cries and thanks you for saving her."
48              print "She points to a tiny door and says, 'The Koi needs cake too.'"
49              print "She gives you the very last bit of cake and shoves you in."
50              return 'gold_koi_pond'
51
52          else:
53              print "The princess looks at you confused and just points at the cake."
54              return 'princess_lives_here'
55
56      def gold_koi_pond(self):
57          print "There is a garden with a koi pond in the center."
58          print "You walk close and see a massive fin poke out."
59          print "You peek in and a creepy looking huge Koi stares at you."
60          print "It opens its mouth waiting for food."
61
62          feed_it = raw_input("> ")
63
64          if feed_it == "feed it":
65              print "The Koi jumps up, and rather than eating the cake, eats your arm."
66              print "You fall in and the Koi shrugs than eats you."
67              print "You are then pooped out sometime later."
68              return 'death'
69
70          elif feed_it == "do not feed it":
71              print "The Koi grimaces, then thrashes around for a second."
72              print "It rushes to the other end of the pond, braces against the wall..."
73              print "then it *lunges* out of the water, up in the air and over your"
74              print "entire body, cake and all."
75              print "You are then pooped out a week later."
76              return 'death'
77
78          elif feed_it == "throw it in":
79              print "The Koi wiggles, then leaps into the air to eat the cake."
80              print "You can see it's happy, it then grunts, thrashes..."
81              print "and finally rolls over and poops a magic diamond into the air"
82              print "at your feet."
83
84              return 'bear_with_sword'
85
86          else:
87              print "The Koi gets annoyed and wiggles a bit."
88              return 'gold_koi_pond'
89
90
```

```
91      def bear_with_sword(self):
92          print "Puzzled, you are about to pick up the fish poop diamond when"
93          print "a bear bearing a load bearing sword walks in."
94          print '"Hey! That\' my diamond! Where\'d you get that!?"'
95          print "It holds its paw out and looks at you."
96
97          give_it = raw_input("> ")
98
99          if give_it == "give it":
100             print "The bear swipes at your hand to grab the diamond and"
101             print "rips your hand off in the process.  It then looks at"
102             print 'your bloody stump and says, "Oh crap, sorry about that."'
103             print "It tries to put your hand back on, but you collapse."
104             print "The last thing you see is the bear shrug and eat you."
105             return 'death'
106
107         elif give_it == "say no":
108             print "The bear looks shocked.  Nobody ever told a bear"
109             print "with a broadsword 'no'.  It asks, "
110             print '"Is it because it\'s not a katana?  I could go get one!"'
111             print "It then runs off and now you notice a big iron gate."
112             print '"Where the hell did that come from?" You say.'
113
114             return 'big_iron_gate'
115
116     def big_iron_gate(self):
117         print "You walk up to the big iron gate and see there's a handle."
118
119         open_it = raw_input("> ")
120
121         if open_it == 'open it':
122             print "You open it and you are free!"
123             print "There are mountains.  And berries! And..."
124             print "Oh, but then the bear comes with his katana and stabs you."
125             print '"Who\'s laughing now!?  Love this katana."'
126
127             return 'death'
128
129         else:
130             print "That doesn't seem sensible.  I mean, the door's right there."
131             return 'big_iron_gate'
132
133
134 a_game = Game("princess_lives_here")
135 a_game.play()
```

What You Should See

The output from this version of the game should be exactly the same as the previous version, and in fact you will notice that some of the code is nearly the same. Compare this new version of the game and with the last one so you understand the changes that were made. Key things to really get are:

1. How you made a `class Game(object)` and put functions inside it.
2. How `__init__` is a special intialization method that sets up important variables.
3. How you added functions *to* the class by indenting them so they were deeper under the `class` keyword. This

is important so study carefully how indentation creates the class structure.

4. How you indented again to put the contents of the functions under their names.
5. How colons are being used.
6. The concept of `self` and how it's used in `__init__`, `play`, and `death`.
7. Go find out what `getattr` does inside `play` so that you understand what's going on with the operation of `play`. In fact, try doing this by hand inside Python to really get it.
8. How a `Game` was created at the end and then told to `play()` and how that got everything started.

Extra Credit

1. Go find out what the `__dict__` is and figure out how to get at it.
2. Try adding some rooms to make sure you know how to work with a class.
3. Create a two-class version of this, where one is the `Map` and the other is the `Engine`. Hint: `play` goes in the `Engine`.

Exercise 43: You Make A Game

You need to start learning to feed yourself. Hopefully as you have worked through this book, you have learned that all the information you need is on the internet, you just have to go search for it. The only thing you have been missing are the right words and what to look for when you search. Now you should have a sense of it, so it's about time you struggled through a big project and tried to get it working.

Here are your requirements:

1. Make a different game from the one I made.
2. Use more than one file, and use `import` to use them. Make sure you know what that is.
3. Use *one class per room* and give the classes names that fit their purpose. Like `GoldRoom`, `KoiPondRoom`.
4. Your runner will need to know about these rooms, so make a class that runs them and knows about them. There's plenty of ways to do this, but consider having each room return what room is next or setting a variable of what room is next.

Other than that I leave it to you. Spend a whole week on this and make it the best game you can. Use classes, functions, dicts, lists anything you can to make it nice. The purpose of this lesson is to teach you how to structure classes that need other classes inside other files.

Remember, I'm not telling you *exactly* how to do this because you have to do this yourself. Go figure it out. Programming is problem solving, and that means trying things, experimenting, failing, scrapping your work, and trying again. When you get stuck, ask for help and show people your code. If they are mean to you, ignore them, focus on the people who are not mean and offer to help. Keep working it and cleaning it until it's good, then show it some more.

Good luck, and see you in a week with your game.

Exercise 44: Evaluating Your Game

In this exercise you will evaluate the game you just made. Maybe you got part-way through it and you got stuck. Maybe you got it working but just barely. Either way, we're going to go through a bunch of things you should know now and make sure you covered them in your game. We're going to study how to properly format a class, common conventions in using classes, and a lot of "textbook" knowledge.

Why would I have you try to do it yourself and then show you how to do it right? From now on in the book I'm going to try to make you self-sufficient. I've been holding your hand mostly this whole time, and I can't do that for much longer. I'm now instead going to give you things to do, have you do them on your own, and then give you ways to improve what you did.

You will struggle at first and probably be very frustrated but stick with it and eventually you will build a mind for solving problems. You will start to find creative solutions to problems rather than just copy solutions out of textbooks.

Function Style

All the other rules I've taught you about how to make a function nice apply here, but add these things:

- For various reasons, programmers call functions that are part of classes `methods`. It's mostly marketing but just be warned that every time you say "function" they'll annoyingly correct you and say "method". If they get too annoying, just ask them to demonstrate the mathematical basis that determines how a "method" is different from a "function" and they'll shut up.
- When you work with classes much of your time is spent talking about making the class "do things". Instead of naming your functions after what the function does, instead name it as if it's a command you are giving to the class. Same as `pop` is saying "Hey list, `pop` this off." It isn't called `remove_from_end_of_list` because even though that's what it does, that's not a *command* to a list.
- Keep your functions small and simple. For some reason when people start learning about classes they forget this.

Class Style

- Your class should use "camel case" like `SuperGoldFactory` rather than `super_gold_factory`.
- Try not to do too much in your `__init__` functions. It makes them harder to use.
- Your other functions should use "underscore format" so write `my_awesome_hair` and not `myawesomehair` or `MyAwesomeHair`.
- Be consistent in how you organize your function arguments. If your class has to deal with users, dogs, and cats, keep that order throughout unless it really doesn't make sense. If you have one function takes `(dog, cat, user)` and the other takes `(user, cat, dog)`, it'll be hard to use.

- Try not to use variables that come from the module or globals. They should be fairly self-contained.
- A foolish consistency is the hobgoblin of little minds. Consistency is good, but foolishly following some idiotic mantra because everyone else does is bad style. Think for yourself.
- Always, *always* have `class Name(object)` format or else you will be in big trouble.

Code Style

- Give your code vertical space so people can read it. You will find some very bad programmers who are able to write reasonable code, but who do not add *any* spaces. This is bad style in any language because the human eye and brain use space and vertical alignment to scan and separate visual elements. Not having space is the same as giving your code an awesome camouflage paint job.
- If you can't read it out loud, it's probably hard to read. If you are having a problem making something easy to use, try reading it out loud. Not only does this force you to slow down and really read it, but it also helps you find difficult passages and things to change for readability.
- Try to do what other people are doing in Python until you find your own style.
- Once you find your own style, do not be a jerk about it. Working with other people's code is part of being a programmer, and other people have really bad taste. Trust me, you will probably have really bad taste too and not even realize it.
- If you find someone who writes code in a style you like, try writing something that mimics their style.

Good Comments

- There are programmers who will tell you that your code should be readable enough that you do not need comments. They'll then tell you in their most official sounding voice that, "Ergo you should never write comments." Those programmers are either consultants who get paid more if other people can't use their code, or incompetents who tend to never work with other people. Ignore them and write comments.
- When you write comments, describe *why* you are doing what you are doing. The code already says how, but why you did things the way you did is more important.
- When you write doc comments for your functions , make the comments documentation for someone who will have to use your code. You do not have to go crazy, but a nice little sentence about what someone does with that function helps a lot.
- Finally, while comments are good, too many are bad, and you have to maintain them. Keep your comments relatively short and to the point, and if you change a function, review the comment to make sure it's still correct.

Evaluate Your Game

I want you now to pretend you are me. Adopt a very stern look, print out your code, and take a red pen and mark every mistake you find. Anything from this exercise and from other things you have known. Once you are done marking your code up, I want you to fix everything you came up with. Then repeat this a couple of times, looking for anything that could be better. Use all the tricks I've given you to break your code down into the smallest tiniest little analysis you can.

The purpose of this exercise is to train your attention to detail on classes. Once you are done with this bit of code, find someone else's code and do the same thing. Go through a printed copy of some part of it and point out all the mistakes and style errors you find. Then fix it and see if your fixes can be done without breaking their program.

I want you to do nothing but evaluate and fix code for the week. Your own code and other people's. It'll be pretty hard work, but when you are done your brain will be wired tight like a boxer's hands.

Exercise 45: Is-A, Has-A, Objects, and Classes

An important concept that you have to understand is the difference between a `Class` and an `Object`. The problem is, there is no real "difference" between a class and an object. They are actually the same thing at different points in time. I will demonstrate by a Zen koan:

```
What is the difference between a Fish and a Salmon?
```

Did that question sort of confuse you? Really sit down and think about it for a minute. I mean, a Fish and a Salmon are different but, wait, they are the same thing right? A Salmon is a *kind* of Fish, so I mean it's not different. But at the same time, becase a Salmon is a particular *type* of Fish and so it's actually different from all other Fish. That's what makes it a Salmon and not a Halibut. So a Salmon and a Fish are the same but different. Weird.

This question is confusing because most people do not think about real things this way, but they intuitively understand them. You do not need to think about the difference between a Fish and a Salmon because you *know* how they are related. You know a Salmon is a *kind* of Fish and that there are other kinds of Fish without having to understand that.

Let's take it one step further, let's say you have a bucket full of 3 Salmon and because you are a nice person, you have decided to name them Frank, Joe, and Mary. Now, think about this question:

```
What is the difference between Mary and a Salmon?
```

Again this is a weird question, but it's a bit easier than the Fish vs. Salmon question. You know that Mary is a Salmon, and so she's not really different. She's just a specific "instance" of a Salmon. Joe and Frank are also instances of Salmon. But, what do I mean when I say instance? I mean they were created from some other Salmon and now represent a real thing that has Salmon-like attributes.

Now for the mind bending idea: Fish is a `Class`, and Salmon is a `Class`, and Mary is an `Object`. Think about that for a second. Alright let's break it down real slow and see if you get it.

A Fish is a `Class`, meaning it's not a *real* thing, but rather a word we attach to instances of things with similar attributes. Got fins? Got gills? Lives in water? Alright it's probably a Fish.

Someone with a Ph.D. then comes along and says, "No my young friend, *this* Fish is actually *Salmo salar*, affectionately known as a Salmon." This professor has just clarified the Fish further and made a new `Class` called "Salmon" that has more specific attributes. Longer nose, reddish flesh, big, lives in the ocean or fresh water, tasty? Ok, probably a Salmon.

Finally, a cook comes along and tells the Ph.D., "No, you see this Salmon right here, I'll call her Mary and I'm going to make a tasty fillet out of her with a nice sauce." Now you have this *instance* of a Salmon (which also is an instance of a Fish) named Mary turned into something real that is filling your belly. It has become an `Object`.

There you have it: Mary is a kind of Salmon that is a kind of Fish. `Object` is a `Class` is a `Class`.

How This Looks In Code

This is a weird concept, but to be very honest you only have to worry about it when you make new classes, and when you use a class. I will show you two tricks to help you figure out whether something is a `Class` or `Object`.

First, you need to learn two catch phrases "is-a" and "has-a". You use the phrase is-a when you talk about objects and classes being related to each other by a class relationship. You use has-a when you talk about objects and classes that are related only because they *reference* each other.

Now, go through this piece of code and replace each `##??` comment with a replacement comment that says whether the next line represents an `is-a` or a `has-a` relationship, and what that relationship is. In the beginning of the code, I've laid out a few examples, so you just have to write the remaining ones.

Remember, is-a is the relationship between Fish and Salmon, while has-a is the relationship between Salmon and Gills.

```
## Animal is-a object (yes, sort of confusing) look at the extra credit
class Animal(object):
    pass

## ??
class Dog(Animal):

    def __init__(self, name):
        ## ??
        self.name = name

## ??
class Cat(Animal):

    def __init__(self, name):
        ## ??
        self.name = name

## ??
class Person(object):

    def __init__(self, name):
        ## ??
        self.name = name

        ## Person has-a pet of some kind
        self.pet = None

## ??
class Employee(Person):

    def __init__(self, name, salary):
        ## ?? hmm what is this strange magic?
        super(Employee, self).__init__(name)
        ## ??
        self.salary = salary

## ??
class Fish(object):
    pass

## ??
class Salmon(Fish):
    pass
```

```
45
46  ## ??
47  class Halibut(Fish):
48      pass
49
50
51  ## rover is-a Dog
52  rover = Dog("Rover")
53
54  ## ??
55  satan = Cat("Satan")
56
57  ## ??
58  mary = Person("Mary")
59
60  ## ??
61  mary.pet = satan
62
63  ## ??
64  frank = Employee("Frank", 120000)
65
66  ## ??
67  frank.pet = rover
68
69  ## ??
70  flipper = Fish()
71
72  ## ??
73  crouse = Salmon()
74
75  ## ??
76  harry = Halibut()
```

About class Name(object)

Remember how I was yelling at you to always use `class Name(object)` and I couldn't tell you why? Now I can tell you, because you just learned about the difference between a `class` and an `object`. I couldn't tell you until now because you would have just been confused and couldn't learn to use the technology.

What happened is Python's original rendition of `class` was broken in many serious ways. By the time they admitted the fault it was too late, and they had to support it. In order to fix the problem, they needed some "new class" style so that the "old classes" would keep working but you could use the new more correct version.

This is where "class is-a object" comes in. They decided that they would use the word "object", lowercased, to be the "class" that you inherit from to make a class. Confusing right? A class inherits from the class named object to make a class but it's not an object really it's a class, but do not forget to inherit from object.

Exactly. The choice of one single word meant that I couldn't teach you about this until now. Now you can try to understand the concept of a class that is an object if you like.

However, I would suggest you do not. Just completely ignore the idea of old style vs. new style classes and assume that Python always requires (object) when you make a class. Save your brain power for something important.

Extra Credit

1. Research why Python added this strange `object` class, and what that means.

2. Is it possible to use a `Class` like it's an `Object`?
3. Fill out the animals, fish, and people in this exercise with functions that make them do things. See what happens when functions are in a "base class" like Animal vs. in say Dog.
4. Find other people's code and work out all the is-a and has-a relationships.
5. Make some new relationships that are lists and dicts so you can also have "has-many" relationships.
6. Do you think there's a such thing as a "is-many" relationship? Read about "multiple inheritance", then avoid it if you can.

Exercise 46: A Project Skeleton

This will be where you start learning how to setup a good project "skeleton" directory. This skeleton directory will have all the basics you need to get a new project up and running. It will have your project layout, automated tests, modules, and install scripts. When you go to make a new project, just copy this directory to a new name and edit the files to get started.

Skeleton Contents: Linux/OSX

First, create the structure of your skeleton directory with these commands:

```
~ $ mkdir -p projects
~ $ cd projects/
~/projects $ mkdir skeleton
~/projects $ cd skeleton
~/projects/skeleton $ mkdir bin NAME tests docs
```

I use a directory named `projects` to store all the various things I'm working on. Inside that directory I have my `skeleton` directory that I put the basis of my projects into. The directory `NAME` will be renamed to whatever you are calling your project's main module when you use the skeleton.

Next we need to setup some initial files:

```
~/projects/skeleton $ touch NAME/__init__.py
~/projects/skeleton $ touch tests/__init__.py
```

That creates empty Python module directories we can put our code in. Then we need to create a `setup.py` file we can use to install our project later if we want:

```
try:
    from setuptools import setup
except ImportError:
    from distutils.core import setup

config = {
    'description': 'My Project',
    'author': 'My Name',
    'url': 'URL to get it at.',
    'download_url': 'Where to download it.',
    'author_email': 'My email.',
    'version': '0.1',
    'install_requires': ['nose'],
    'packages': ['NAME'],
    'scripts': [],
    'name': 'projectname'
}
```

```
18
19 setup(**config)
```

Edit this file so that it has your contact information and is ready to go for when you copy it.

Finally you will want a simple skeleton file for tests named `tests/NAME_tests.py`:

```
1  from nose.tools import *
2  import NAME
3
4  def setup():
5      print "SETUP!"
6
7  def teardown():
8      print "TEAR DOWN!"
9
10 def test_basic():
11     print "I RAN!"
```

Installing Python Packages

Make sure you have some packages installed that makes these things work. Here's the problem though. You are at a point where it's difficult for me to help you do that and keep this book sane and clean. There are so many ways to install software on so many computers that I'd have to spend 10 pages walking you through every step, and let me tell you I am a lazy guy.

Rather than tell you how to do it exactly, I'm going to tell you what you should install, and then tell you to figure it out and get it working. This will be really good for you since it will open a whole world of software you can use that other people have released to the world.

Next, nstall the following python packages:

1. pip from http://pypi.python.org/pypi/pip
2. distribute from http://pypi.python.org/pypi/distribute
3. nose from http://pypi.python.org/pypi/nose/
4. virtualenv from http://pypi.python.org/pypi/virtualenv

Do not just download these packages and install them by hand. Instead see how other people recommend you install these packages and use them for your particular system. The process will be different for most versions of Linux, OSX, and definitely different for Windows.

I am warning you, this will be frustrating. In the business we call this "yak shaving". Yak shaving is any activity that is mind numblingly irritatingly boring and tedious that you have to do before you can do something else that's more fun. You want to create cool Python projects, but you can't do that until you setup a skeleton directory, but you can't setup a skeleton directory until you install some packages, but you can't install pacakages until you install package installers, and you can't install package installers until you figure out how your system installs software in general, and so on.

Struggle through this anyway. Consider it your trial-by-annoyance to get into the programmer club. Every programmer has to do these annoying tedious tasks before they can do something cool.

Testing Your Setup

After you get all that installed you should be able to do this:

```
~/projects/skeleton $ nosetests
.
----------------------------------------------------------------------
Ran 1 test in 0.007s

OK
```

I'll explain what this `nosetests` thing is doing in the next exercise, but for now if you do not see that, you probably got something wrong. Make sure you put `__init__.py` files in your `NAME` and `tests` directory and make sure you got `tests/NAME_tests.py` right.

Using The Skeleton

You are now done with most of your yak shaving. Whenever you want to start a new project, just do this:

1. Make a copy of your skeleton directory. Name it after your new project.
2. Rename (move) the NAME module to be the name of your project or whatever you want to call your root module.
3. Edit your setup.py to have all the information for your project.
4. Rename `tests/NAME_tests.py` to also have your module name.
5. Double check it's all working using `nosetests` again.
6. Start coding.

Required Quiz

This exercise doesn't have extra credit but a quiz you should complete:

1. Read about how to use all of the things you installed.
2. Read about the `setup.py` file and all it has to offer. Warning, it is not a very well-written piece of software, so it will be very strange to use.
3. Make a project and start putting code into the module, then get the module working.
4. Put a script in the `bin` directory that you can run. Read about how you can make a Python script that's runnable for your system.
5. Mention the `bin` script you created in your `setup.py` so that it gets installed.
6. Use your `setup.py` to install your own module and make sure it works, then use `pip` to uninstall it.

Exercise 47: Automated Testing

Having to type commands into your game over and over to make sure it's working is annoying. Wouldn't it be better to write little pieces of code that test your code? Then when you make a change, or add a new thing to your program, you just "run your tests" and the tests make sure things are still working. These automated tests won't catch all your bugs, but they will cut down on the time you spend repeatedly typing and running your code.

Every exercise after this one will not have a `What You Should See` section, but instead it will have a `What You Should Test` section. You will be writing automated tests for all of your code starting now, and this will hopefully make you an even better programmer.

I won't try to explain why you should write automated tests. I will only say that, you are trying to be a programmer, and programmers automate boring and tedious tasks. Testing a piece of software is definitely boring and tedious, so you might as well write a little bit of code to do it for you.

That should be all the explanation you need because *your* reason for writing unit tests is to make your brain stronger. You have gone through this book writing code to do things. Now you are going to take the next leap and write code that knows about other code you have written. This process of writing a test that runs some code you have written *forces* you to understand clearly what you have just written. It solidifies in your brain exactly what it does and why it works and gives you a new level of attention to detail.

Writing A Test Case

We're going to take a very simple piece of code and write one simple test. We're going to base this little test on a new project from your project skeleton.

First, make a `ex47` project from your project skeleton. Make sure you do it right and rename the module and get that first `tests/ex47_tests.py` test file going right. Also make sure nose runs this test file. *IMPORTANT* make sure you also delete `tests/skel_tests.pyc` if it's there.

Next, create a simple file `ex47/game.py` where you can put the code to test. This will be a very silly little class that we want to test with this code in it:

```
class Room(object):

    def __init__(self, name, description):
        self.name = name
        self.description = description
        self.paths = {}

    def go(self, direction):
        return self.paths.get(direction, None)

    def add_paths(self, paths):
        self.paths.update(paths)
```

Once you have that file, change unit test skeleton to this:

```
from nose.tools import *
from ex47.game import Room


def test_room():
    gold = Room("GoldRoom",
                """This room has gold in it you can grab. There's a
                door to the north.""")
    assert_equal(gold.name, "GoldRoom")
    assert_equal(gold.paths, {})

def test_room_paths():
    center = Room("Center", "Test room in the center.")
    north = Room("North", "Test room in the north.")
    south = Room("South", "Test room in the south.")

    center.add_paths({'north': north, 'south': south})
    assert_equal(center.go('north'), north)
    assert_equal(center.go('south'), south)

def test_map():
    start = Room("Start", "You can go west and down a hole.")
    west = Room("Trees", "There are trees here, you can go east.")
    down = Room("Dungeon", "It's dark down here, you can go up.")

    start.add_paths({'west': west, 'down': down})
    west.add_paths({'east': start})
    down.add_paths({'up': start})

    assert_equal(start.go('west'), west)
    assert_equal(start.go('west').go('east'), start)
    assert_equal(start.go('down').go('up'), start)
```

This file imports the `Room` class you made in the `ex47.game` module so that you can do tests on it. There are then a set of tests that are functions starting with `test_`. Inside each test case there's a bit of code that makes a Room or a set of Rooms, and then makes sure the rooms work the way you expect them to work. It tests out the basic room features, then the paths, then tries out a whole map.

The important functions here are `assert_equal` which makes sure that variables you have set or paths you have built in a `Room` are actually what you think they are. If you get the wrong result, then `nosetests` will print out an error message so you can go figure it out.

Testing Guidelines

Follow these general loose set of guidelines when making your tests:

1. Test files go in `tests/` and are named `BLAH_tests.py` otherwise `nosetests` won't run them. This also keeps your tests from clashing with your other code.
2. Write one test file for each module you make.
3. Keep your test cases (functions) short, but do not worry if they are a bit messy. Test cases are usually kind of messy.
4. Even though test cases are messy, try to keep them clean and remove any repetitive code you can. Create helper functions that get rid of duplicate code. You will thank me later when you make a change and then have to

change your tests. Duplicated code will make changing your tests more difficult.

5. Finally, do not get too attached to your tests. Sometimes, the best way to redesign something is to just delete it, the tests, and start over.

What You Should See

```
~/projects/simplegame $ nosetests
...
----------------------------------------------------------------------
Ran 3 tests in 0.007s

OK
```

That's what you should see if everything is working right. Try causing an error to see what that looks like and then fix it.

Extra Credit

1. Go read about nosetests more, and also read about alternatives.
2. Learn about Python's "doc tests" and see if you like them better.
3. Make your Room more advanced, and then use it to rebuild your game yet again but this time, unit test as you go.

Exercise 48: Advanced User Input

Your game probably was coming along great, but I bet how you handled what the user typed was becoming tedious. Each room needed its own very exact set of phrases that only worked if your player typed them perfectly. What you'd rather have is a device that lets users type phrases in various ways. For example, we'd like to have all of these phrases work the same:

- open door
- open the door
- go THROUGH the door
- punch bear
- Punch The Bear in the FACE

It should be alright for a user to write something a lot like English for your game, and have your game figure out what it means. To do this, we're going to write a module that does just that. This module will have a few classes that work together to handle use input and convert it into something your game can work with reliably.

In a simple version of English the following elements:

- Words separated by spaces.
- Sentences composed of the words.
- Grammar that structures the sentences into meaning.

That means the best place to start is figuring out how to get words from the user and what kinds of words those are.

Our Game Lexicon

In our game we have to create a Lexicon of words:

- Direction words: north, south, east, west, down, up, left, right, back.
- Verbs: go, stop, kill, eat.
- Stop words: the, in, of, from, at, it
- Nouns: door, bear, princess, cabinet.
- Numbers: any string of 0 through 9 characters.

When we get to nouns, we have a slight problem since each room could have a different set of Nouns, but let's just pick this small set to work with for now and improve it later.

Breaking Up A Sentence

Once we have our lexicon of words we need a way to break up sentences so that we can figure out what they are. In our case, we've defined a sentence as "words separated by spaces", so we really just need to do this:

```
stuff = raw_input('> ')
words = stuff.split()
```

That's really all we'll worry about for now, but this will work really well for quite a while.

Lexicon Tuples

Once we know how to break up a sentence into words, we just have to go through the list of words and figure out what "type" they are. To do that we're going to use a handy little Python structure called a "tuple". A tuple is nothing more than a list that you can't modify. It's created by putting data inside two `()` with a comma, like a list:

```
first_word = ('direction', 'north')
second_word = ('verb', 'go')
sentence = [first_word, second_word]
```

This creates a pair of (TYPE, WORD) that lets you look at the word and do things with it.

This is just an example, but that's basically the end result. You want to take raw input from the user, carve it into words with `split`, then analyze those words to identify their type, and finally make a sentence out of them.

Scanning Input

Now you are ready to write your scanner. This scanner will take a string of raw input from a user and return a sentence that's composed of a list of tuples with the (TOKEN, WORD) pairings. If a word isn't part of the lexicon then it should still return the WORD, but set the TOKEN to an error token. These error tokens will tell the user they messed up.

Here's where it gets fun. I'm not going to tell you how to do this. Instead I'm going to write a `unit test` und you are going to write the scanner so that the unit test works.

Exceptions And Numbers

There is one tiny thing I will help you with first, and that's converting numbers. In order to do this though, we're going to cheat and use exceptions. An exception is an error that you get from some function you may have run. What happens is your function "raises" an exception when it encounters an error, then you have to handle that exception. For example, if you type this into python:

```
~/projects/simplegame $ python
Python 2.6.5 (r265:79063, Apr 16 2010, 13:57:41)
[GCC 4.4.3] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> int("hell")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: invalid literal for int() with base 10: 'hell'
>>
```

That `ValueError` is an exception that the `int()` function threw because what you handed `int()` is not a number. The `int()` function could have returned a value to tell you it had an error, but since it only returns integers, it'd have a hard time doing that. It can't return -1 since that's a number. Instead of trying to figure out what to return when there's an error, the `int()` function raises the `ValueError` exception and you deal with it.

You deal with an exception by using the `try` and `except` keywords:

```
def convert_number(s):
    try:
        return int(s)
    except ValueError:
        return None
```

You put the code you want to "try" inside the `try` block, and then you put the code to run for the error inside the `except`. In this case, we want to "try" to call `int()` on something that might be a number. If that has an error, then we "catch" it and return None.

In your scanner that you write, you should use this function to test if something is a number. You should also do it as the last thing you check for before declaring that word an error word.

What You Should Test

Here are the files `tests/lexicon_tests.py` that you should use:

```
from nose.tools import *
from ex48 import lexicon


def test_directions():
    assert_equal(lexicon.scan("north"), [('direction', 'north')])
    result = lexicon.scan("north south east")
    assert_equal(result, [('direction', 'north'),
                          ('direction', 'south'),
                          ('direction', 'east')])

def test_verbs():
    assert_equal(lexicon.scan("go"), [('verb', 'go')])
    result = lexicon.scan("go kill eat")
    assert_equal(result, [('verb', 'go'),
                          ('verb', 'kill'),
                          ('verb', 'eat')])


def test_stops():
    assert_equal(lexicon.scan("the"), [('stop', 'the')])
    result = lexicon.scan("the in of")
    assert_equal(result, [('stop', 'the'),
                          ('stop', 'in'),
                          ('stop', 'of')])


def test_nouns():
    assert_equal(lexicon.scan("bear"), [('noun', 'bear')])
    result = lexicon.scan("bear princess")
    assert_equal(result, [('noun', 'bear'),
                          ('noun', 'princess')])

def test_numbers():
    assert_equal(lexicon.scan("1234"), [('number', 1234)])
    result = lexicon.scan("3 91234")
    assert_equal(result, [('number', 3),
                          ('number', 91234)])
```

```
39
40
41 def test_errors():
42     assert_equal(lexicon.scan("ASDFADFASDF"), [('error', 'ASDFADFASDF')])
43     result = lexicon.scan("bear IAS princess")
44     assert_equal(result, [('noun', 'bear'),
45                           ('error', 'IAS'),
46                           ('noun', 'princess')])
```

Remember that you will want to make a new project with your skeleton, type in this test case (do not copy-paste!) and write your scanner so that the test runs. Focus on the details and make sure everything works right.

Design Hints

Focus on getting one test working at a time. Keep this simple and just put all the words in your lexicon in lists that are in your `lexicon.py` module. Do not modify the input list of words, but instead make your own new list with your lexicon tuples in it. Also, use the `in` keyword with these lexicon lists to check if a word is in the lexicon.

Extra Credit

1. Improve the unit test to make sure you cover more of the lexicon.
2. Add to the lexicon and then update the unit test.
3. Make your scanner handles user input in any capitalization and case. Update the test to make sure this actually works.
4. Find another way to convert the number.
5. My solution was 37 lines long. Is yours longer? Shorter?

Exercise 49: Making Sentences

What we should be able to get from our little game lexicon scanner is a list that looks like this:

```
>>> from ex48 import lexicon
>>> print lexicon.scan("go north")
[('verb', 'go'), ('direction', 'north')]
>>> print lexicon.scan("kill the princess")
[('verb', 'kill'), ('stop', 'the'), ('noun', 'princess')]
>>> print lexicon.scan("eat the bear")
[('verb', 'eat'), ('stop', 'the'), ('noun', 'bear')]
>>> print lexicon.scan("open the door and smack the bear in the nose")
[('error', 'open'), ('stop', 'the'), ('noun', 'door'), ('error', 'and'),
('error', 'smack'), ('stop', 'the'), ('noun', 'bear'), ('stop', 'in'),
('stop', 'the'), ('error', 'nose')]
>>>
```

Now let us turn this into something the game can work with, which would be some kind of Sentence class.

If you remember grade school, a sentence can be a simple structure like:

    Subject Verb Object

Obviously it gets more complex than that, and you probably did many days of annoying sentence graphs for English class. What we want is to turn the above lists of tuples into a nice Sentence object that has subject, verb, and object.

Match And Peek

To do this we need four tools:

1. A way to loop through the list of tuples. That's easy.
2. A way to "match" different types of tuples that we expect in our Subject Verb Object setup.
3. A way to "peek" at a potential tuple so we can make some decisions.
4. A way to "skip" things we do not care about, like stop words.

We use the peek function to say look at the next element in our tuple list, and then match to take one off and work with it. Let's take a look at a first peek function:

```
def peek(word_list):
    if word_list:
        word = word_list[0]
        return word[0]
    else:
        return None
```

Very easy. Now for the match function:

```
def match(word_list, expecting):
    if word_list:
        word = word_list.pop(0)

        if word[0] == expecting:
            return word
        else:
            return None
    else:
        return None
```

Again, very easy, and finally our skip function:

```
def skip(word_list, word_type):
    while peek(word_list) == word_type:
        match(word_list, word_type)
```

By now you should be able to figure out what these do. Make sure you understand them.

The Sentence Grammar

With our tools we can now begin to build Sentence objects from our list of tuples. What we do is a process of:

1. Identify the next word with `peek`.
2. If that word fits in our grammar, we call a function to handle that part of the grammar, say `parse_subject`.
3. If it doesn't, we `raise` an error, which you will learn about in this lesson.
4. When we're all done, we should have a Sentence object to work with in our game.

The best way to demonstrate this is to give you the code to read, but here's where this exercise is different from the previous one: You will write the test for the parser code I give you. Rather than giving you the test so you can write the code, I will give you the code, and you have to write the test.

Here's the code that I wrote for parsing simple sentences using the `ex48.lexicon` module:

```
class ParserError(Exception):
    pass


class Sentence(object):

    def __init__(self, subject, verb, object):
        # remember we take ('noun','princess') tuples and convert them
        self.subject = subject[1]
        self.verb = verb[1]
        self.object = object[1]


def peek(word_list):
    if word_list:
        word = word_list[0]
        return word[0]
    else:
        return None


def match(word_list, expecting):
```

```
    if word_list:
        word = word_list.pop(0)

        if word[0] == expecting:
            return word
        else:
            return None
    else:
        return None


def skip(word_list, word_type):
    while peek(word_list) == word_type:
        match(word_list, word_type)


def parse_verb(word_list):
    skip(word_list, 'stop')

    if peek(word_list) == 'verb':
        return match(word_list, 'verb')
    else:
        raise ParseError("Expected a verb next.")


def parse_object(word_list):
    skip(word_list, 'stop')
    next = peek(word_list)

    if next == 'noun':
        return match(word_list, 'noun')
    if next == 'direction':
        return match(word_list, 'direction')
    else:
        raise ParseError("Expected a noun or direction next.")


def parse_subject(word_list, subj):
    verb = parse_verb(word_list)
    obj = parse_object(word_list)

    return Sentence(subj, verb, obj)


def parse_sentence(word_list):
    skip(word_list, 'stop')

    start = peek(word_list)

    if start == 'noun':
        subj = match(word_list, 'noun')
        return parse_subject(word_list, subj)
    elif start == 'verb':
        # assume the subject is the player then
        return parse_subject(word_list, ('noun', 'player'))
    else:
        raise ParserError("Must start with subject, object, or verb not: %s" % start)
```

A Word On Exceptions

You briefly learned about exceptions, but not how to raise them. This code demonstrates how to do that with the `ParserException` at the top. Notice that it uses classes to give it the type of `Exception`. Also notice the use of `raise` keyword to raise the exception.

In your tests, you will want to work with these exceptions, which I'll show you how to do.

What You Should Test

For Exercise 49 is write a complete test that confirms everything in this code is working. That includes making exceptions happen by giving it bad sentences.

Check for an exception by using the function `assert_raises` from the nose documentation. Learn how to use this so you can write a test that is *expected* to fail, which is very important in testing. Learn about this function (and others) by reading the nose documentation.

When you are done, you should know how this bit of code works, and how to write a test for other people's code even if they do not want you to. Trust me, it's a very handy skill to have.

Extra Credit

1. Change the `parse_` methods and try to put them into a class rather than be just methods. Which design do you like better?
2. Make the parser more error resistant so that you can avoid annoying your users if they type words your lexicon doesn't understand.
3. Improve the grammar by handling more things like numbers.
4. Think about how you might use this Sentence class in your game to do more fun things with a user's input.

Exercise 50: Your First Work Assignment

I'm now going to give you a work assignment, similar to what you might get as a professional programmer. The assignment will be to convert the list of features I give you into a complete little game that I may buy. Your job is to take my vague descriptions of things I want and make something I can use.

The purpose of this exercise is to see if you have grasped the concepts you have learned so far. We only have 2 exercises after this, but this will be your last actual assigned piece of coding.

Review What You Know

At this point you should know how to do the following:

- Create classes and structure rooms from them.
- Throw and raise exceptions.
- Use functions, variables, dictionaries, lists, and tuples.
- Turn a user's input into a list of tuples using a lexicon scanner.
- Turn the list of tuples into a Sentence you can analyze using a parser.

Make sure you know how to do these things as you will be using them to complete this assignment.

Implementing A Feature List

Typically when you work on software you will be given a list vague and inconsistent features they want. This sucks, I won't lie to you. Typically people have no ability to think clearly about the things they want, and even less ability to describe them.

As a programmer, it is your job to take the vague things they tell you and work with them to create something they want. In fact, sometimes *you* will have a problem articulating what *you* want.

The best way to implement a feature list like this is to follow this pattern:

1. Dump everything out of the person's head *without* criticizing or judging the ideas.
2. As you dump, write these down in a spread sheet or on index cards.
3. Take a break, collect all the features and go back through to prioritize them into MUST (have) or NICE (to have).
4. Sort the list so that you can see what is MUST vs. what is NICE to have.
5. Pick a piece of the MUST work, and start working on it.

6. After about a week, show the person who wants the software your, and repeat this process again based on your new feedback.

This pattern can be found in one form or another in different "methodologies" programmers use to organize their work.

I'm going to give you a list of features that I want in my game, and I've already prioritized them so this is just the MUST requirements. Your job is to spend one week working on the list and getting it done.

The Feature List

- I want a game that is set on an alien space ship.
- The game should have a human hero who has to escape from the clutches of an alien race who has enslaved him.
- The game will be a text adventure game, like that bear and broadsword game you did. I like games like that.
- Oh, lasers. Totally gotta have lasers.
- But not too powerful lasers. It should be hard to finish the game.
- But not too hard to finish the game, just right to keep players interested. You know, like `Worlf of Warcraft`. I hear people make tons of money off WoW.
- The ship should have about 10 rooms at first, then we want to expand them.
- I'd like to be able to change the description of the rooms without changing the code. Can you do that?
- My friend says farms are big now, so have a scene where there's a farm and stuff.
- The aliens should be some kind of Mafia aliens. Mafia stuff is huge now too.
- I should be able to move around with real sentences like "go north", "open door", etc.
- It's alright if the way the rooms are laid out is in code, but players will need a printed map. Can you keep track of the map?
- There needs to be a story behind this, and maybe a love interest.
- Probably a couple of geek culture references. But no Star Trek! Ok, first season is cool but nothing after that.
- I want to be able to install it on my computer with python so can you make it install from a setup.py? That'll make it easy to package later.

Tips On Working The List

1. Make your map, characters, and story first on paper.
2. Write unit tests so you do not have to constantly check things by hand.
3. Design your game engine so it's easy to test.
4. Actually play your game once in a while.
5. When in doubt, ask for help and show people your code.

Good luck, see you in a week to review your game.

Exercise 51: Reviewing Your Game

You worked hard on your Mafia Alien Slave Ship game. You made a great story, filled out rooms, created a nice game engine, and got it working. You are now going to get your game reviewed by a *real* user and take notes on what they find wrong. This is called "usability testing" and it helps you get good feedback on your game and find new bugs you didn't anticipate.

When you wrote your game you probably only tested the things you knew about. The problem is someone else doesn't know how your game is structured, so they'll try weird things you wouldn't have thought they'd do. The only way to find these weird actions is to actually put your game before a human and let them trash it.

Find one person, preferably a relative or a friend. You could even get together with a bunch of other people going through this book and have a little sharing session to try out your games. Turn it into a competition even. Anything to get people to try your game in-person.

How To Study A User

Studying a user is easy. Put them in front of your game and watch two things:

1. The screen while they use it.
2. Their face while they use it.

Sit at a slight angle so you can glance at both while they play your game. This will help you see how they are reacting to your game by watching their face.

Let them play your game, but have them talk out loud about your game. They will probably not give you feedback if you do not tell them to talk while they play, but if you get them to talk and play they'll tell you all sorts of things.

Once they are playing and talking, take notes on paper and *do not judge or argue*. Just write down what they say and continue. You want their honest feedback to your game and taking their comments personally will mean you do not get real feedback.

Let them struggle with parts they have a problem with, then help them to move things forward. You should be writing down parts that are too hard, broken, too difficult to navigate, and anything that is just plain confusing.

Finally, thank them for helping you out and review what you found with them. They'll usually want to do it again if you do that, and it's just polite.

Implement The Changes

With your list of defects you will make a new list of things you have to change. Spend one week changing them and try to get your friend(s) to review your game one more time.

Whether they enjoyed your game or not doesn't matter. What does matter is you have completed a full project with vague specifications and got feedback from a person, then fixed your game to meet their demands. Your game can suck hard, but you at least wrote one.

Take this lesson seriously. Even though there is no code, it is probably the most important less you can have. It teaches you that software is written for people, so caring about their opinions is important.

Exercise 52: Teach Someone Else What You Know

By going through this book and learning to write software, you have done something that many other people haven't. However, you might not realize how much you actually know about the subject. In order for you to get a perspective on your knowledge, and to help you understand what you know I'm going to ask you to do something intimidating:

Teach someone else exercises 1 through 5 of this book.

That's right, you are going to be a teacher for a day and get a new person into programming. Who knows, maybe they'll become interested and continue after you are done. Maybe they'll think it's stupid and just forget about it.

The purpose of this lesson is to get you to articulate what you know and try to explain it to someone. Doing this will help you get an even firmer and cleaner grasp of what you know.

A piano teacher I took a few lessons from told me that he played professionally in many jazz bands, playing all sorts of complex music, but it wasn't until he started *teaching* jazz that he actually understood what he was doing.

Teaching someone else forces you to really understand what you are doing.

Extra Credit

- Find your local "python group" and go to a meeting. If there isn't one, try starting one with some of your friends.

Next Steps

You are not a programmer quite yet. I like to think of this book as giving you your "programming brown belt". You know enough to be able to start another book on programming and handle it just fine. This book should have given you the mental tools and attitude you need to go through most Python books and actually learn something. It might even make it easy.

On the http://learnpythonthehardway.org/ website there are a few free books you should move onto next. Try them out and see how far you can get.

You could probably start hacking away at some programs right now, and if you have that itch, go ahead. Just understand, anything you write will probably suck. That's alright though, I suck at every programming language I first start using. Nobody writes pure perfect gold when they are a beginner, and anyone who tells you they did is a huge liar.

Finally, remember that this is something you have to do for a while and for at least a couple hours every night. If it helps, while you are struggling through learning Python every night, I'm hard at work learning to play guitar. I work at it about 2 or 4 hours a day and still practice scales.

Everyone is a beginner at something.

Advice From An Old Programmer

You have finished this book and have decided to continue with programming. Maybe it will be a career for you, or maybe it will be a hobby. You will need some advice to make sure you continue on the right path, and get the most enjoyment out of your newly chosen hobby.

I have been programming for a very long time. So long that it is incredibly boring to me. At the time that I wrote this book I knew about 20 programming languages and could learn new ones in about a day to a week depending on how weird they were. Eventually though this just became boring and couldn't hold my interest.

What I discovered after this journey of learning is that the languages did not matter, it's what you do with them. Actually, I always knew that, but I'd get distracted by the languages and forget it periodically. Now I never forget it, and neither should you.

Which programming language you learn and use does not matter. Do *not* get sucked into the religion surrounding programing languages as that will only blind you to their true purpose of being your tool for doing interesting things.

Programming as an intellectual activity is the *only* art form that allows you to create interactive art. You can create projects that other people can play with, and you can talk to them indirectly. No other art form is quite this interactive. Movies flow to the audience in one direction. Paintings do not move. Code goes both ways.

Programming as a profession is only moderately interesting. It can be a good job, but if you want to make about the same money and be happier, you could actually just go run a fast food joint. You are much better off using code as your secret weapon in another profession.

People who can code in the world of technology companies are a dime a dozen and get no respect. People who can code in biology, medicine, government, sociology, physics, history, and mathematics are respected and can do amazing things to advance those disciplines.

Of course, all of this advice is pointless. If you liked learning to write software with this book, you should try to use it to improve your life any way you can. Go out and explore this weird wonderful new intellectual pursuit that barely anyone in the last 50 years has been able to explore. Might as well enjoy it while you can.

Finally, I will say that learning to create software changes you and makes you different. Not better or worse, just different. You may find that people treat you harshly because you can create software, maybe using words like "nerd". Maybe you will find that because you can dissect their logic that they hate arguing with you. You may even find that simply knowing how a computer works makes you annoying and weird to them.

To this I have one just piece of advice: they can go to hell. The world needs more weird people who know how things work and who love to figure it all out. When they treat you like this, just remember that this is *your* journey, not theirs. Being different is not a crime, and people who tell you it is are just jealous that you have picked up a skill they never in their wildest dreams could acquire.

You can code. They cannot. That is pretty damn cool.

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