Full Circle

THE INDEPENDENT MAGAZINE FOR THE UBUNTU LINUX COMMUNITY

PROGRAMMING SERIES SPECIAL EDITION

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PROGRAM IN PYTHON

Volume Nine

Parts 49-53

Full Circle Magazine Specials

Full Circle

THE INDEPENDENT MAGAZINE FOR THE UBUNTU LINUX COMMUNITY

About Full Circle

Full Circle is a free, independent, magazine dedicated to the Ubuntu family of Linux operating systems. Each month, it contains helpful how-to articles and reader-submitted stories.

Full Circle also features a companion podcast, the Full Circle Podcast which covers the magazine, along with other news of interest.

Welcome to another 'single-topic special'

In response to reader requests, we are assembling the content of some of our serialised articles into dedicated editions.

For now, this is a straight reprint of the series **'Programming in Python', Parts 49-53** from issues #79 through #84, allowing peerless Python professor Gregg Walters #83 as time off for good behaviour.

Please bear in mind the original publication date; current versions of hardware and software may differ from those illustrated, so check your hardware and software versions before attempting to emulate the tutorials in these special editions. You may have later versions of software installed or available in your distributions' repositories.

Enjoy!

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Programming In Python - Part 49

Written by Greg Walters

While I was working this week, a very wise person by the name of Michael W. suggested that I should consider what happens with floating-point numbers and equality.

Take for example a simple calculation: 1.1 + 2.2

The answer, you say, is 3.3! Any school-kid who has dealt with fractions knows that. Well, tell your computer. If you start up the Python Interactive Shell and at the prompt type

```
(1.1+2.2) == 3.3
```

you might be surprised that the shell responds

```
“False”
```

WHAT?!!?!?

Now, confused, you type at the prompt:

```
>>>1.1+2.2
```

And the shell responds back:

```
3.3000000000000003
```

You stare at the screen in disbelief and first think “I must have typed something wrong”. Then you realize that you didn’t. So you type:

```
>>>2.2+3.3

5.5
```

Now you are even more confused and you think to yourself “Ok. This is either a bug or some kind of sick Easter egg.” No, it’s neither a bug nor an Easter egg. It’s real. While I knew about this a very long time ago, it had slipped into the cobwebs hidden in the dark recesses of my old mind, so I had to bring it up here. What we are seeing is the joy of binary floating-point numbers.

We all know that ⅓ equates to .3333333333333333… for ever and a day, but take, for example, the fraction 1/10. Everyone knows that 1/10 is equal to .1, right? If you use the interactive shell you can see that:

```
>>>1/10

0
```

Oh, right. We have to have at least one of the values a floating-point value to show any decimal points since an integer/integer returns an integer. So we try again.

```
>>>1/10.0

0.1
```

Ok. Reality is back. No, not really. Python is simply showing you a rounded version of the answer. So, how do we see the “real” answer? We can use the decimal library to see what’s really happening.

```
>>> from decimal import *

>>> Decimal(1/10.0)

Decimal('0.1000000000000000005
5511151231257827021181583404S
41015625')
```

WOW. So let’s try our original formula and see what that would show:

```
>>> Decimal(1.1+2.2)

Decimal('3.3000000000000000266
45352591003756970167160034179
6875')
```

It seems to just be getting worse and worse. So what is really happening?

This is called Representation Error, and exists in almost every modern programming language (Python, C, C++, Java, and even Fortran and more), and on almost every modern computer. This is because these machines use IEEE-754 floating-point arithmetic which (on most machines and OS platforms) maps to an IEEE-754 double-precision number. This double-precision number has a precision of 53 bits. So, our 0.1, when represented in this 53-bit double-precision, turns into:

```
0.00011001100110011001100110011001100
11001100110011001100110011010
```

That’s close to .1, but not close enough to avoid issues.

So what do we do about it? Well, the quick answer is that you probably can live with it for 90% of the things we have to do out there in the real world – by using the round() method. While you have to decide on the number of decimal points that you must have in your world to carry the precision that you need, for the most part, this will be an acceptable workaround.

I honestly don't remember if we have gone over the round method, so I'll briefly go over it. The syntax is very simple:

```
round(v,d)
```

where v is the value you want to round and d is the number of decimals (maximum) you want after the decimal point. According to the Python documentation, "Values are rounded to the closest multiple of 10 to the power of minus n digits; if two multiples are equally close, rounding is done away from 0". All that being said, if the number is 1.4144, and we round it to 3 decimal places, the returned value will be 1.414. If the number is 1.4145 it would be returned as 1.415.

For example, let's use the value of pi that comes from the math library. (You must import the math library before you can do this, by the way.)

```
>>> math.pi

3.141592653589793
```

Now, if we wanted to round that value down to 5 decimal places, we would use:

```
>>> round(math.pi,5)

3.14159
```

That is the "standard" value of pi that most everyone knows off the top of their head. That's great. However, if we set the number of decimal places to be returned to 4, look what happens.

```
>>> round(math.pi,4)

3.1416
```

All that sounds good until you run into a value like 2.675 and try to round it to 2 decimal places. The assumption (since it is exactly halfway between 2.67 and 2.68) is that the returned value will be 2.68. Try it.

```
>>> round(2.675,2)

2.67
```

That might cause a problem. It goes back to the initial issue we have been talking about. The actual conversion to a binary floating-point number that is 53 bits long, the number becomes:

```
2.67499999999999982236431605997495353221893310546875
```

which then rounds down to 2.67.

The bottom line here is when trying to compare floating-point numbers, be aware that some things just don't translate well.

See you next time!

Greg Walters is owner of RainyDay Solutions, LLC, a consulting company in Aurora, Colorado, and has been programming since 1972. He enjoys cooking, hiking, music, and spending time with his family. His website is www.thedesignatedgeek.net.

Programming In Python - Part 50

Written by Greg Walters

This month, I thought I'd talk about a couple of lesser known functions, maketrans and translate.

We'll start with the translate method. The translate method returns a copy of a string – with all characters in the translate table replaced, or has the characters in the optional parameter deletechars removed from the string. Here's the syntax.

```
s =
str.translate(table[,deletech
aracters])
```

Before we get to the table portion of the method, let's look at the delete portion. Let's say that you have the string "The time has come". And you want to delete all the vowels (for some weird reason) from that string. You can code it like this:

```
astr = "The time has come"

astr.translate(None,'aeiou')
```

will return:

```
"Th tm hs cm"
```

Notice that we included None as the translate table. While this part is cool, it gets better. There is a function called maketrans. It takes an input string and an output string as parameters and returns a table that is used as the first parameter into the translate method. Here (top right) is a very simple example.

```
intable = 'aeiou'
outtable = '12345'
trantable = maketrans(intable,outtable)
astr = "The time has come"
astr.translate(trantable)
```

It returns:

```
"Th2 t3m2 h1s c4m2"
```

Let's look at what this does. We assign intable to a string of vowels as before. outtable is assigned the numbers 1,2,3,4,5 as a string. When we make the call to maketrans, our actual trantable is as follows (shown below. The "\x" means that it is hexadecimal char):

```
'\x00\x01\x02\x03\x04\x05\x06\x07\x08\t\n\x0b\x0c\r\x0e\x0f\x10\x11\x12\x13\x14\
x15\x16\x17\x18\x19\x1a\x1b\x1c\x1d\x1e\x1f !"#$%&\'()*+,-./0123456789:;<=>?@ABC
DEFGHIJKLMNOPQRSTUVWXYZ[\\]^_`1bcd2fgh3jklmn4pqrst5vwxyz{|}~\x7f\x80\x81\x82\x83
\x84\x85\x86\x87\x88\x89\x8a\x8b\x8c\x8d\x8e\x8f\x90\x91\x92\x93\x94\x95\x96\x97
\x98\x99\x9a\x9b\x9c\x9d\x9e\x9f\xa0\xa1\xa2\xa3\xa4\xa5\xa6\xa7\xa8\xa9\xaa\xab
\xac\xad\xae\xaf\xb0\xb1\xb2\xb3\xb4\xb5\xb6\xb7\xb8\xb9\xba\xbb\xbc\xbd\xbe\xbf
\xc0\xc1\xc2\xc3\xc4\xc5\xc6\xc7\xc8\xc9\xca\xcb\xcc\xcd\xce\xcf\xd0\xd1\xd2\xd3
\xd4\xd5\xd6\xd7\xd8\xd9\xda\xdb\xdc\xdd\xde\xdf\xe0\xe1\xe2\xe3\xe4\xe5\xe6\xe7
\xe8\xe9\xea\xeb\xec\xed\xee\xef\xf0\xf1\xf2\xf3\xf4\xf5\xf6\xf7\xf8\xf9\xfa\xfb
\xfc\xfd\xfe\xff'
```

If you look at it carefully, you'll see that the lowercase vowel letters are replaced with the numbers we specified:

```
1bcd2fgh3jklmn4pqrst5vwxyz
```

If you look even closer, you'll see that there actually 256 entries starting with "\x00" and ending with "\xff". So the table contains the entire 256 possible ascii character set. So, when the translate method gets the table, it iterates (or walks through) each character, getting that characters value in Hex, and then finds that value in the translate table and substitutes it in the output string. The Hex representation of our original astr string ('The time has come') is shown below.

```
\x54\x68\x65\x20\x74\x69\x6d\x65\x20\x68\x61\x73\x20\x63\x6f\x6d\x65
  T   h   e       t   i   m   e       h   a   s       c   o   m   e
```

So now it should be making sense.

Now the purpose of this whole thing. Think back to your schooling where you learned about Julius Ceasar. Whenever he wanted to send a message of a confidential matter, he would use a cipher that would shift all the letters of the alphabet three characters to the right. So, using todays english alphabet:

```
ABCDEFGHIJKLMNOPQRSTUVWXYZabc
defghijklmnopqrstuvwxyz
```

becomes:

```
DEFGHIJKLMNOPQRSTUVWXYZabcdef
ghijklmnopqrstuvwxyzABC
```

While this seems very simple by today's standards, when I was a school kid, we used this all the time to send messages to each other. We used a different index into the string to start the encryption string, the logic behind it was the same.

No one knows how effective this actually was for good old Julius. One would think that if someone intercepted the message, they would have thought that it was in some foreign language. We can only speculate.

We can easily use the translate method and the maketrans helper function to allow us to have fun with this. Let's say we want to make a simple program that allows us to enter a string of "plain text" and get back an encrypted string using the same side right method that Caesar used. For simplicity sake, let's only use uppercase characters (shown top right).

```
from string import maketrans
#----------------------
intab  = "ABCDEFGHIJKLMNOPQRSTUVWXYZ"
outtab = "DEFGHIJKLMNOPQRSTUVWXYZABC"
EncTrantab = maketrans(intab,outtab) #Encode
DecTrantab = maketrans(outtab,intab) #Decode
instring = raw_input("Enter the plaintext string -> ")
EncString = instring.translate(EncTrantab)
DecString = EncString.translate(DecTrantab)
print("Encoded string is - %s" % EncString)
print("Decoded string is - %s" % DecString)
```

Everything in the above code is pretty much what we've covered above or in earlier Python articles, but I'll go over it quickly.

The first two lines are the in and out strings. We've just shifted the characters and wrapped around to create the out string. The next two lines create a table for encoding and one for decoding. Line 5 prompts the user to enter a string to encode. We then encode that string (EncString) in the next line. To decode it, we simply use the translate method on the encoded string to get the plain text back. Finally we print both strings out. Here's the output of the program.

```
Enter the plaintext string ->
THE TIME HAS COME
Encoded string is -
WKH WLPH KDV FRPH
Decoded string is -
THE TIME HAS COME
```

Just like back in school. But let's flesh it out just a bit to make it a bit more usable. The code is almost the same with a few exceptions. First, we have added a space to the end of the intab string and in between the "Z" and the "A" in the outtab string. This helps keep the actual words from being too obvious in the encrypted string. The next change is where we ask if the user wants to encode or decode the string. Finally we added an if statement to control what we print (shown bottom right).

The output from the program is:

```
Encode or Decode (E or D) -> E
Enter the string -> THE TIME HAS
COME
Encoded string is -
WKHCWLPHCKDVCFRPH
```

And to test the decode side of things:

```
Encode or Decode (E or D) -> D
Enter the string ->
WKHCWLPHCKDVCFRPH
Decoded string is - THE TIME HAS
COME
```

Well, hopefully you are starting to get ideas about how to use this new information in your own code.

```
from string import maketrans

#Be sure to include the space character in the strings
intab  = "ABCDEFGHIJKLMNOPQRSTUVWXYZ "
outtab = "DEFGHIJKLMNOPQRSTUVWXYZ ABC"
EncTrantab = maketrans(intab,outtab) #Encode
DecTrantab = maketrans(outtab,intab) #Decode

which = raw_input("Encode or Decode (E or D) -> ")
instring = raw_input("Enter the string -> ")
EncString = instring.translate(EncTrantab)
DecString = instring.translate(DecTrantab)

if which == "E":
    print("Encoded string is - %s" % EncString)
else:
    print("Decoded string is - %s" % DecString)
```

Programming In Python - Part 51

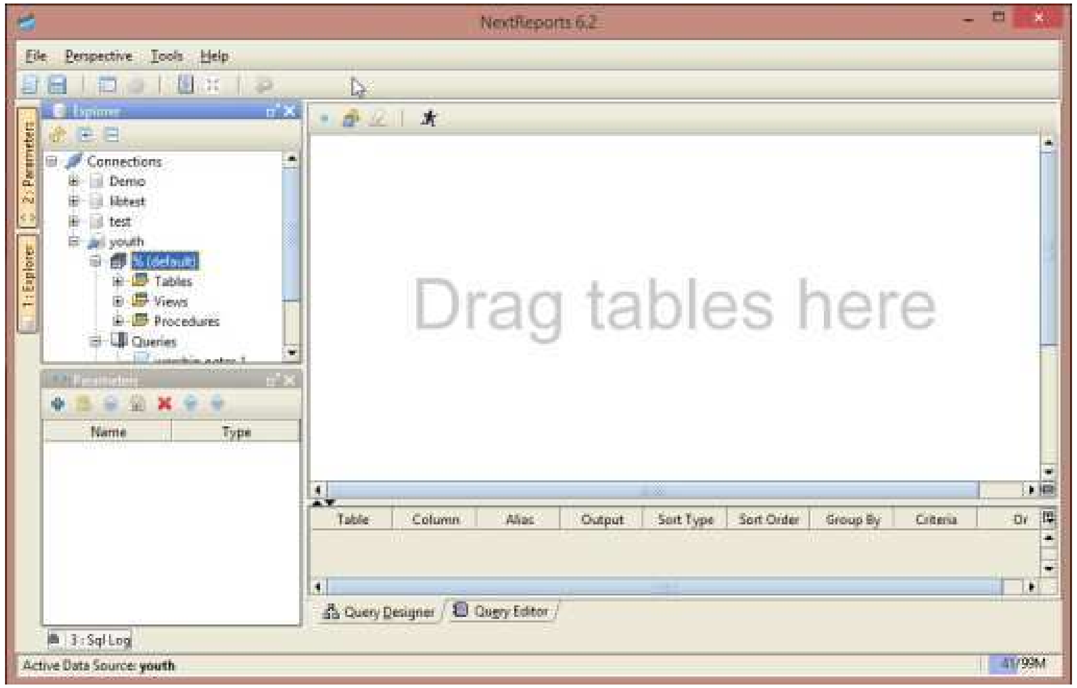
Written by Greg Walters

This month, I'm going to discuss a product that is new to me, but has apparently been around for a number of years. It's called NextReports from Advantage Software Factory, and you can get it free from http://www.next-reports.com/ . Not only that, but it's open source and it runs under Windows and Linux!

Before I start telling you about the product, let me get on my soapbox and vent for a moment or two. For a long time, I've been working with databases and reports. One of the things that I've had issues with is that while there are free database solutions out there, like SQLite and MySql, there was precious little available that was free for report designer tools. More times than not, any reports either had to be done with very expensive software tools, or the developer had to roll his own. Some tools were available, but were lacking. When it came to charting, well, you pretty much had no choice but to use the expensive stuff. Believe me, I've looked for years for really good free reporting tools, and I'm not sure how I have missed this package for so many years (version 2.1 was released in March of 2009 and they are currently up to version 6.3). But now that I've found it, I'm absolutely pumped about it.

Now that I've stepped down from my soap box, I can begin to sing its praises. It is a suite of three parts, a reports designer, a report engine and a report server. All I have had a chance to play with is the reports designer, but if the designer is any indication of the power, ease and flexibility of the rest of the suite, this thing is a winner.

This month, we are going to concentrate on the designer. Because of some constraints on my time, I'm working on a Windows machine, but everything that I show can be done in Linux (so please forgive me in advance).

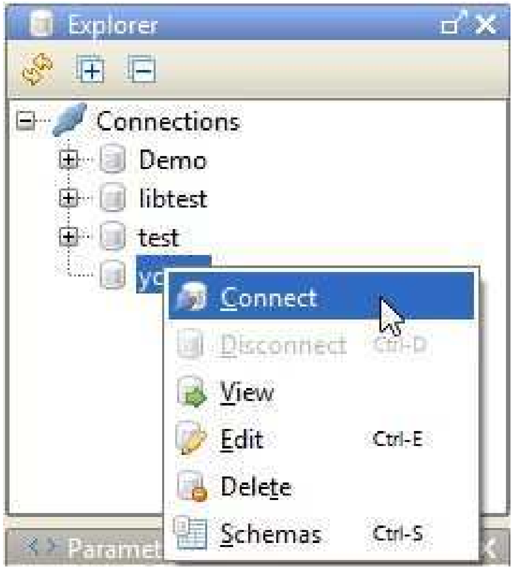


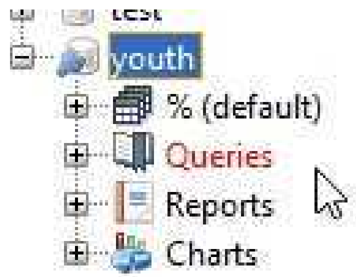
One of the first things you should know is that it supports databases like Oracle, MySql, SQLite, MSSQL and more. Everything is based on queries and a really good thing is that only SELECT type queries are allowed. This means that nothing in the source database can be changed by accident. You can enter your own queries or use a visual designer.

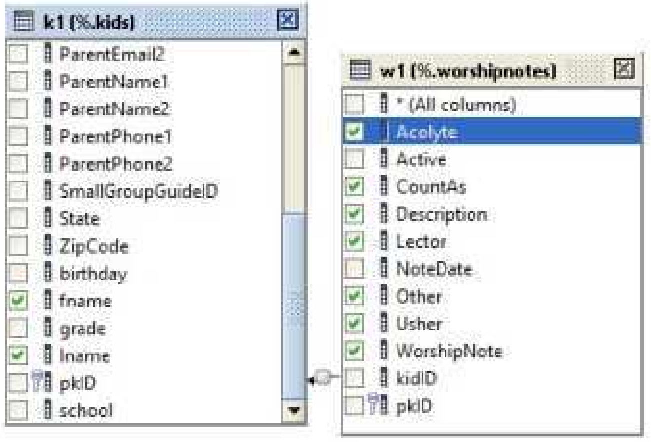
The screenshot shows how nice a UI it is. Things are pretty intuitive and it won't take you long to be productive at this. Let's take a look at the steps to get going.

Start with File | New | Data Source. Next, name your source whatever you want to call it.

Now tell NextReports what kind of database it is in the dropdown called "Type:". You can skip over the Driver section and go to the URL: section. This is where you put the path to the database. If you are using, for example, a SQLite database, this will be filled in for you: "jdbc:sqlite:<dbfile-path>". Replace the <dbfile-path> with the path to your database. Other types of databases have similar types of information already populated to help you. Next, click the "Test" button to make sure you can connect. If everything goes correctly, then click "Save" and you'll see it added to the Connetions tree. The next thing you need to do is make a connection to your database that you have just added. Now, right click on the database and then click on Connect.







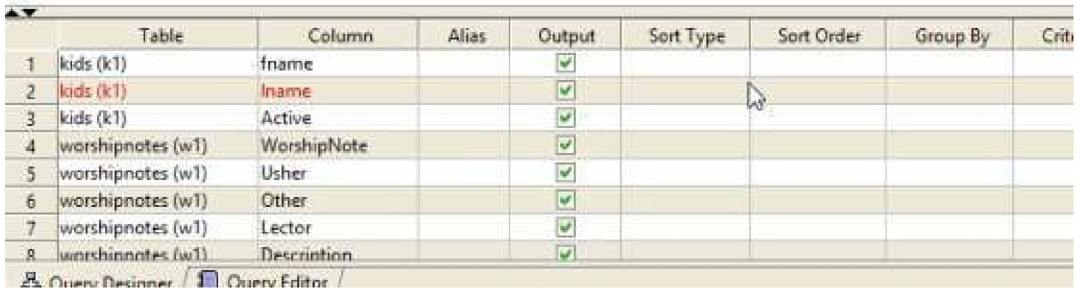


	Table	Column	Alias	Output	Sort Type	Sort Order	Group By	Crit
1	kids (k1)	fname		✓				
2	kids (k1)	lname		✓				
3	kids (k1)	Active		✓				
4	worshipnotes (w1)	WorshipNote		✓				
5	worshipnotes (w1)	Usher		✓				
6	worshipnotes (w1)	Other		✓				
7	worshipnotes (w1)	Lector		✓				
8	worshipnotes (w1)	Description		✓				

Once you are connected, you'll see that you have four possible things to choose from. The "%" is the database tables. The next three are so you can create new queries, reports and charts. Simple enough. Now click on the "+" sign to the left of "%" which will open up your database table display. Now you will have Tables, Views and Procedures in the tree. Once again, click on the "+" sign next to "Tables". This will show all your tables. Now if you want to use the visual query designer, just drag the table(s) you want to deal with onto the designer canvas to the right.

Once you have all your tables there, you can start making connections between the tables.

In the example here, I have two tables, one with information about kids in a confirmation class and the other with entries for worship notes taken. The worship note table doesn't have the kid's name in it, just an id that points to the kid information table. I did a drag and drop to make that link between the kidID field and the pkID of the kid table. Then I selected each field I wanted to have in the result set. In this case, the kid's first and last name and an active (or not-deleted) flag in the kids table and multiple fields from the notes table. The grid below shows each of the fields, which table it comes from, and other information.

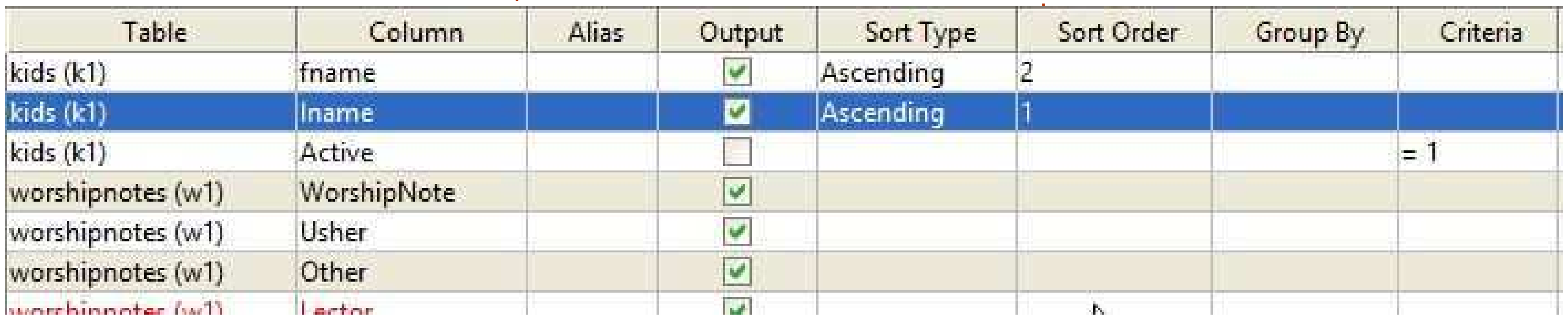
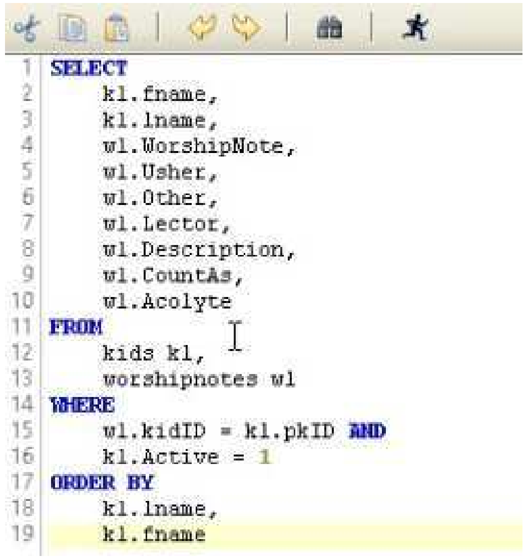


Table	Column	Alias	Output	Sort Type	Sort Order	Group By	Criteria
kids (k1)	fname		✓	Ascending	2		
kids (k1)	lname		✓	Ascending	1		
kids (k1)	Active						= 1
worshipnotes (w1)	WorshipNote		✓				
worshipnotes (w1)	Usher		✓				
worshipnotes (w1)	Other		✓				
worshipnotes (w1)	Lector		✓				

As you can see, we can set criteria like “Active = 1”, choose to display a field or not, and set sort type and sort order. Once you are satisfied with this, you can click on the tab below and see your actual SQL query.



```
SELECT
     k1.fname,
     k1.lname,
     wl.WorshipNote,
     wl.Usher,
     wl.Other,
     wl.Lector,
     wl.Description,
     wl.CountAs,
     wl.Acolyte
FROM
     kids k1,
     worshipnotes wl
WHERE
     wl.kidID = k1.pkID AND
     k1.Active = 1
ORDER BY
     k1.lname,
     k1.fname
```

To test your query, simply click on the “running man” and you will (hopefully if you did it correctly) get the query results in a grid below the editor. If you want to add manual lines you can. For example, I want to combine the kids first and last names (fname and lname) into a full name. We can do that by putting a line after the “k1.lname,” line like this:

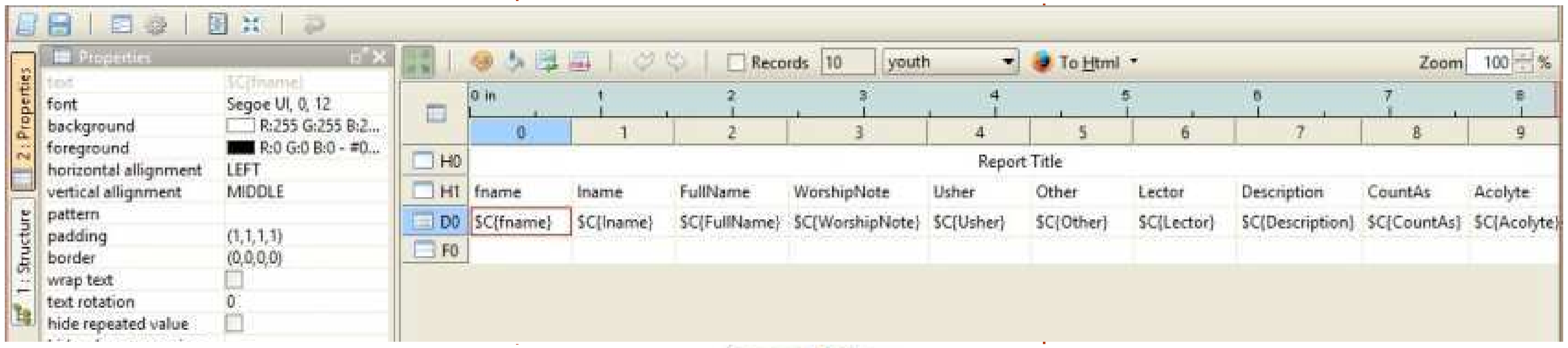
```
k1.fname || “ “ || k1.lname
as FullName,
```

The “||” characters are concatenation characters so we will have the two fields with a space between in a field named “FullName”. Don’t forget the comma at the end. Once you have your query the way you want it, click on the save button to save the query. You will be asked what you want to call it.

Next, click on the Query item in the tree and right click on the query you just created. Select “New Report from Query”. The query designer canvas goes away and is replaced by the report designer.

On the left is the properties window for any given field or the entire report. On the right is the report designer itself. Notice that it looks like a spreadsheet. Each row is considered a “band” and holds information for that report row. In the case of this example, we have four rows, two header rows, one detail row and a footer row. You can add or delete rows as needed. This method is not quite as free-form as some other report designers, but makes for a very nice and clean report.

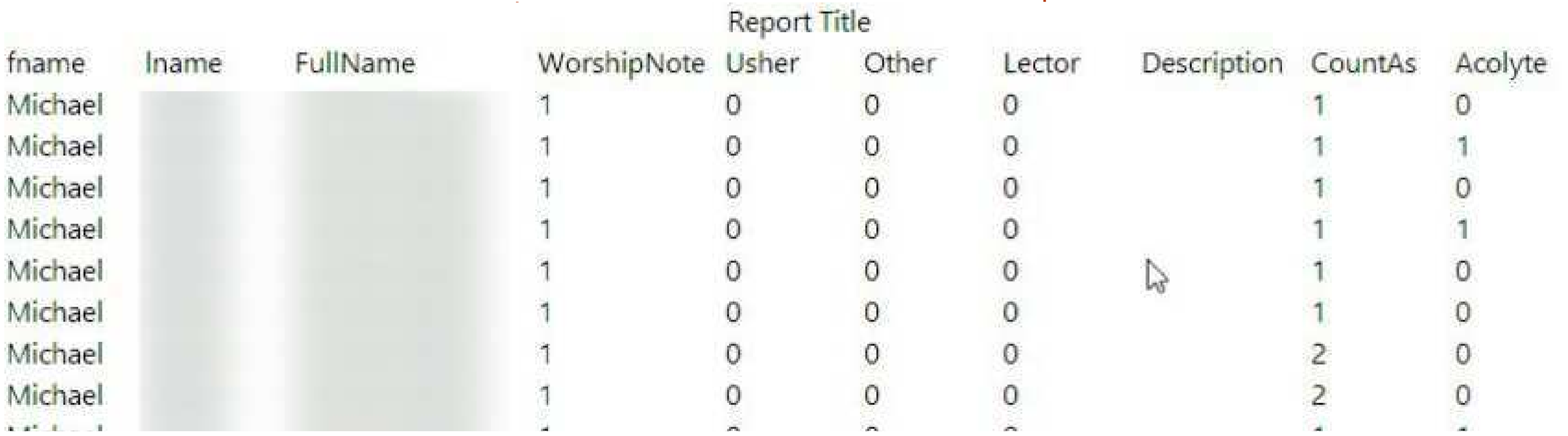
The two header rows hold our report title and column headers. The detail row has each field we will be reporting on and the footer row is the report footer. Let’s take a look at how the report looks as a default. Click on the button at the



text	$C{fname}
font	Segoe UI, 0, 12
background	R:255 G:255 B:2...
foreground	R:0 G:0 B:0 - #0...
horizontal allignment	LEFT
vertical allignment	MIDDLE
pattern	
padding	(1,1,1,1)
border	(0,0,0,0)
wrap text	☐
text rotation	0
hide repeated value	☐

Records 10 youth Zoom 100 %

	0	1	2	3	4	5	6	7	8	9
H0	Report Title									
H1	fname	lname	FullName	WorshipNote	Usher	Other	Lector	Description	CountAs	Acolyte
D0	$C{fname}	$C{lname}	$C{FullName}	$C{WorshipNote}	$C{Usher}	$C{Other}	$C{Lector}	$C{Description}	$C{CountAs}	$C{Acolyte}
F0										



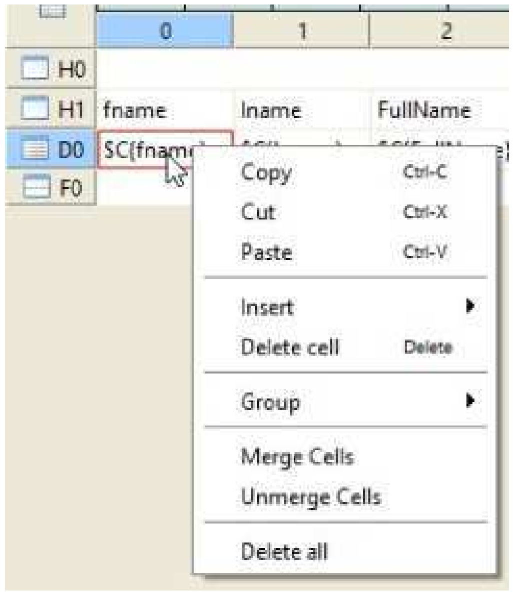
Report Title

fname	lname	FullName	WorshipNote	Usher	Other	Lector	Description	CountAs	Acolyte
Michael			1	0	0	0		1	0
Michael			1	0	0	0		1	1
Michael			1	0	0	0		1	0
Michael			1	0	0	0		1	1
Michael			1	0	0	0		1	0
Michael			1	0	0	0		1	0
Michael			1	0	0	0		2	0
Michael			1	0	0	0		2	0

top of the bar marked “To Html” to see the report. (I blurred the kids last names, that’s not an issue in the generator.)

For a report with almost no work, that’s really nice. But let’s pretty it up a bit. Let’s create a group that puts all of the data for any given kid under the kid’s name.

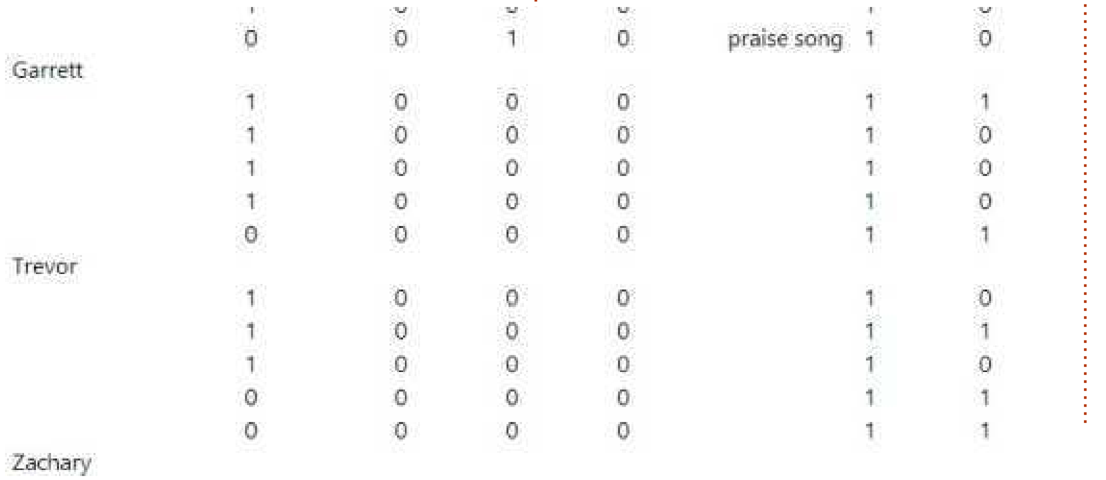
Right click on the first column of the data row. Select Group and then Add.



You will be presented with a new window asking which of the fields you want to create the group upon. In this case, I select FullName and then click the Ok button. Now we have a grouping break. We can also get rid of the three fields (fname, lname and FullName) in the detail section, since we’ll be displaying the name in the group band. SImply right-click on them and select “Delete Cell”. Now you can resize the three empty cells on the left to make the gap less obvious.

Taking a quick peek at what the report looks like now will show you that the information for each kid is all nicely grouped together.

That’s nicer, but now let’s do something kind of fun. All the 1s and 0s obviously stand for yes and no. That’s rather boring for a report, so let’s add an advanced conditional statement for each of those fields that will show a box with a check for Yes (or 1) and an empty box for No (or 0). It’s really easy to do, but makes your report look like you spent days on it. By using the Wingdings font from Windows, the two characters we want are 0x6F(0168) for an empty box and 0xFE (0254) for a checked box.

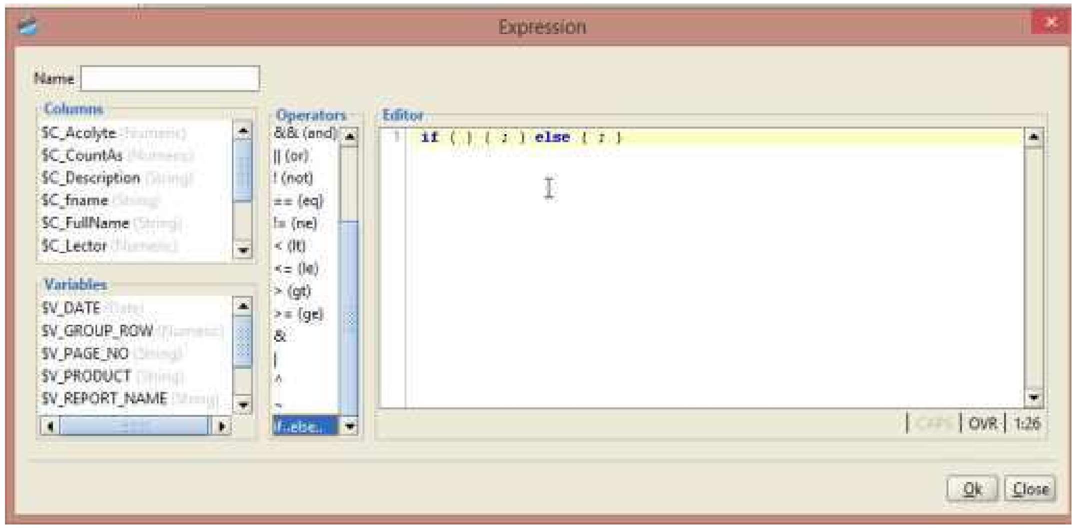


	0	0	1	0	praise song	1	0
Garrett							
	1	0	0	0		1	1
	1	0	0	0		1	0
	1	0	0	0		1	0
	1	0	0	0		1	0
	0	0	0	0		1	1
Trevor							
	1	0	0	0		1	0
	1	0	0	0		1	1
	1	0	0	0		1	0
	0	0	0	0		1	1
	0	0	0	0		1	1
Zachary							

Before I go on, the one thing that Windows does better than Linux (that I have found) is the use of the Alt+NumPad entry of special characters. Linux doesn’t allow that. There was a work around that used Ctrl+Shift+U then the unicode value for the character you wanted. However, that doesn’t work on all machines. The easiest way I’ve found to do this on Linux, is to open Character Map, use the search function to find the unicode character you want, double-click the character to copy it to the “Text to copy:” box, then click the “Copy” and then paste it into your document. The unicode characters for them are 2610 (empty box) and 2611 (checked box) using the WingDings 2 font. I’m sure there are many other easier ways to deal with this, but I’m shy on time. (Be sure you have Common selected in the Script list.)

We’ll start with the WorshipNotes field. On the detail row, right click on the field you want to do. In this case it’s marked $C{WorshipNote}. Choose Insert, then Expression. Yet another wonderful thing that NextReports gives us it the ability to do pretty much everything with as little typing as possible. Look in the center of window where it says Operators. Double click on the “if..else..” selection, and it will fill that into the editor for you as a template so you don’t make a mistake.

Now, we want to put the WorshipNotes field in the parentheses of the editor. Simply click in between the two parentheses to place the cursor and then double-click on the field



```
if ( ) { ; } else { ; }
```

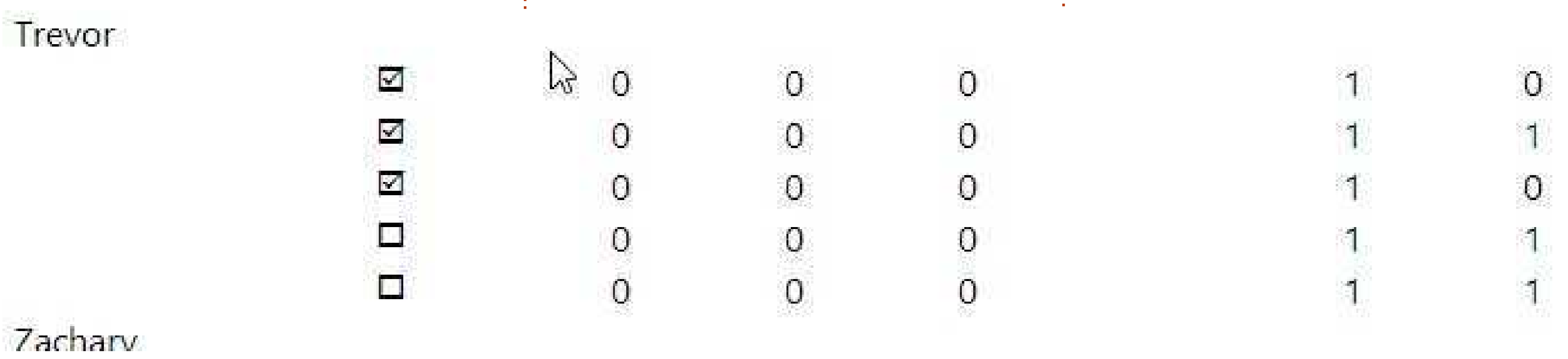
you want to go in there. BAM! It's filled in for you. Now click after the field name in the editor and then double-click on the "== (eq)" operator. Then add a "1", so the editor line reads

```
if ( $C_WorshipNote == 1 ) {
; } else { ; }
```

We are almost finished with our expression The first set of curly brackets define what to do if the expression is True and the second is what to do if it's false. In this case, we'll use the CharMap (in windows, Linux has one as well, for example gucharmap if you are using Gnome) to copy the characters into our editor string. Or, under windows, you can hold the {Alt} key and press 0168 for the empty box and 0254 for the checked box. So now our expression is (at least in Windows):

```
 if ( $C_WorshipNote == 1 ) {
"þ"; } else { "o"; }
```

Name the expression (I used WNotes) and save it. Under properties for that field, select the font (WingDings is what I used here) and this is what it will look



Trevor						
	☑	0	0	0	1	0
	☑	0	0	0	1	1
	☑	0	0	0	1	0
	☐	0	0	0	1	1
	☐	0	0	0	1	1
Zachary						

like.

There's our pretty little boxes. Doing this to the other fields is just as simple.

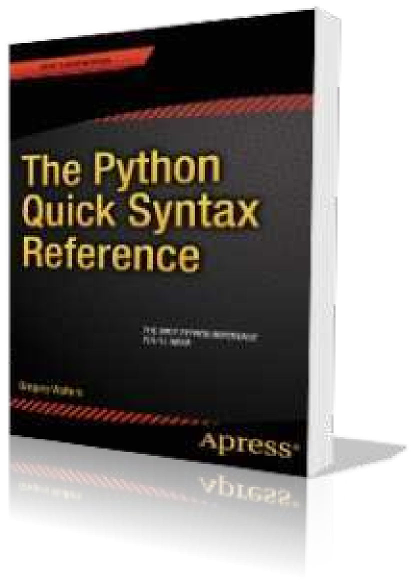
It only took me about 3 hours of playing with the package to get to this point and a whole lot further. I can truly say that I have a great amount more to learn but that's for another day. You can use templates to color your report, you can add images, and much more.

Next time, I'll talk about how we might go about embedding these reports into a Python program. Until then, have fun playing with this wonder FREE software.

Greg Walters is owner of RainyDay Solutions, LLC, a consulting company in Aurora, Colorado, and has been programming since 1972. He enjoys cooking, hiking, music, and spending time with his family. His website is www.thedesignatedgeek.net.

Programming In Python - Part 52

Written by Greg Walters



Before we get started on this month's actual python subject, let me toot my own horn for just a minute. In late December and early January, my first book on Python was published by Apress. It is named "The Python Quick Syntax Reference", and is available from a number of places. You can find it on the Apress site (http://www.apress.com/9781430264781), Springer.com (http://www.springer.com/computer/book/978-1-4302-6478-1) and Amazon (http://www.amazon.com/The-Python-Quick-Syntax-Reference/dp/1430264780) as well as others. It is, as the title suggests, a syntax reference that will help those of us who program in other languages as well as Python, to remember how a certain command works and the requirements for that command. Please help a poor old programmer make a living by buying the book, if you can.

Now on to bigger and better things.

While I was working on my latest book for Apress, I rediscovered a SQL command that I didn't discuss when we were working with SQL databases a long time ago, so I thought I'd share the information with you. It is the CREATE TABLE AS SELECT command, which allows us to pull a query from one table (or joined tables) and create another table on the fly. The general syntax is:

```
CREATE TABLE [IF NOT EXISTS]
{New Table Name} AS SELECT
{query}
```

The part in square brackets (IF NOT EXISTS) is totally optional, which will create the table only if it doesn't exist already. The part in curly brackets, however, is not. The first is the new table name and the second is the query that you want to use to pull data and create the new table.

Assume we have a database that has multiple tables in it. One of the tables is named "study" that holds data from a receiving operation. There are six fields which are shown below.

```
pkID - Integer, Primary Key, AutoIncrement
DOM -  Integer - Day of the month (1-31)
DOW -  Integer - Day of week (1-7 (Sunday = 1, Monday = 2, etc))
pkgs - Integer - Number of packages received that day
DayName - TEXT - "Sunday","Monday", etc
Holiday - Integer 0 or 1 (Is this day considered a holiday or not) 1 means yes
```

One of the datasets that we will need to produce from this raw data is a grouping of package count and the number of days within the study that quantity of packages came in on, assuming that the days are weekdays (Monday thru Friday) and that the day is not a holiday, since holidays have less than normal number of packages. Our query is shown above.

```
SELECT pkgs, Count(DOW) as CountOfDOW FROM study
   WHERE (Holiday <> 1)
      AND DayName in ("Monday","Tuesday","Wednesday","Thursday","Friday")
   GROUP BY pkgs
```

This then provides us with data

that would look something like this:

```
pkgs          CountOfDow
31                1
32                2
33                1
...
48                3
```

So the data is showing that during the study of 65 days, only one weekday had 31 packages but 3 weekdays had 48 packages and so on. Similar queries could be created that would cover holidays and weekends.

While having the data simply as a returned dataset from the query, we might want to do further analysis on the data, so we want to put the resulting data from the query into a table. That's why we would create a table from the query. So in the following example, shown above right, we create a table named "weekdays" using the same query we just showed above.

```
CREATE TABLE IF NOT EXISTS weekdays AS
   SELECT pkgs, Count(DOW) as CountOfDOW FROM study
   WHERE (Holiday <> 1)
      AND DayName in ("Monday","Tuesday","Wednesday","Thursday","Friday")
   GROUP BY pkgs
```

Now anytime we need the data for that weekday result set, we can just run a query on the weekdays table.

Once we know what we need, and have tested the query, then we can begin our code. Assuming we already have the study table created and populated, we can use Python to then create our new table in the main database. Just as an FYI, I am using the APSW SQLite library to do the database work.

We, of course, have to open a connection (right) and create a cursor to the SQLite database. We have covered this in a number of past articles.

```
def OpenDB():
     global connection
     global cursor
     connection = apsw.Connection("labpackagestudy.db3")
     cursor = connection.cursor()
```

Now we need to create the routine that will actually create the table with the returned dataset from the query, shown below, then alter it and run some calculations.

As you can see, we want to create a second cursor, so that we don't run any risk of the first cursor having data we need to maintain. We will be using it in the final part of the code. We then drop the table if it exists and run our query on the "study" table.

Now we create three more columns (shown below) within the weekdays table named "probability", "lower" and "upper". We do this by using the "ALTER TABLE" SQL command.

```
addcolquery = 'ALTER TABLE weekdays ADD COLUMN probability REAL'
cursor.execute(addcolquery)
addcolquery = 'ALTER TABLE weekdays ADD COLUMN lower REAL'
cursor.execute(addcolquery)
addcolquery = 'ALTER TABLE weekdays ADD COLUMN upper REAL'
cursor.execute(addcolquery)
```

```
def DoWeekDays():
    # Create a second cursor for updating the new table
     cursor2 = connection.cursor()
     q1 = "DROP TABLE IF EXISTS weekdays"
     cursor.execute(q1)
     query = '''CREATE TABLE IF NOT EXISTS weekdays AS SELECT pkgs,
                Count(DOW) as CountOfDOW FROM study WHERE (Holiday <> 1)
                AND DayName in
                ("Monday","Tuesday","Wednesday","Thursday","Friday")
                GROUP BY pkgs'''
     cursor.execute(query)
```

The next step (top right) will be to sum the data in the CountOfDOW field.

```
sumquery = "SELECT Sum(CountOfDOW) as Sm FROM weekdays"
tmp = cursor.execute(sumquery)
for t in tmp:
    DaySum = t[0]
```

There is only one record returned, but we do the for loop thing anyway. Remember from the above discussion that the "CountOfDow" field holds the number of days during the study that a particular number of packages came in. This gives us a value that contains the sum of all of the "CountOfDow" entries. Just so you have a reference as we go forward, the number I got from all my dummy data is 44.

```
upquery = "SELECT * FROM
weekdays"

c1 = cursor.execute(upquery)
```

Here we have done a 'SELECT all' query so every record in the datatable is in the 'c1' cursor. We'll walk through each row of the dataset, pulling the pkgs (row[0]) and CountOfDow (row[1]) data into variables.

```
LastUpper = .0
for row in c1:
   cod = row[1]
   pkg = row[0]
```

Now we will create a probability of each daily package count in the database and calculate an upper and lower value that will be used in another process later on. Notice that we check to see if the LastUpper variable contains '.0'. If it does, we set it to the probability value, otherwise we set it to the lower plus the probability value.

```
        prob = cod / float(DaySum)
        if LastUpper != .0:
            lower = LastUpper
            LastUpper = (lower + prob)
        else:
            lower = .0
            LastUpper = prob
```

Finally we use an update SQL statement to put the new computed values into the database.

```
          nquery = 'UPDATE weekdays SET probability = %f, \
                    lower = %f, upper = %f WHERE pkgs = %d' \
                    % (prob,lower,LastUpper,pkg)
        u = cursor2.execute(nquery)
#====================================
#      End of DoWeekDays
#====================================
```

What we end up with is a package count (pkgs), a count of the number of days that package count came in, a probability of that occurring within the whole of the study (31 packages on 1 day out of a total of 44 (weekdays in that 60+ day study), will have a probability of 0.02.).

If we add up all the probability values in the table it should add up to 1.0 .

The upper and lower values then reflect a number between floating point number 0 and 1 that will mirror the possibility of any random number within that range that will give us a randomized number of packages. This number can then be used for a statistics analysis of this data. A "normal real-world" example would be to predict the number of cars that arrive at a carwash based on observational data done in the field. If you want to understand more, you could look at http://www.algebra.com/algebra/homework/Probability-and-statistics/Probability-and-statistics.faq.question.309110.html to see an example of this. All we did is generate (the hard part) easily with Python.

The code for the two routines that we presented this time is at: http://pastebin.com/kMc9EXes

Until next time.

Greg Walters is owner of RainyDay Solutions, LLC, a consulting company in Aurora, Colorado, and has been programming since 1972. He enjoys cooking, hiking, music, and spending time with his family. His website is www.thedesignatedgeek.net.

Program In Python - Part 53

Written by Greg D. Walters

This month, I thought I would create a routine that makes a license key from an email. We all know the reason for having a license key, and if you ever need to have a quick and dirty set of routines to do it, you can use this. Remember, Python is a scripting language, so the source is always readable. There are ways around this; we'll discuss them in another article. Let's take a look at the "gross" logic behind the code, before we actually dive into the code.

First, we will ask for an email address and then break it into two parts, the local part (the part before the "@" character) and the domain part (the part after the "@" character). There are very specific rules for email address validity, and it can get very complicated. For our purposes, we will only use some of the rules and only on the local part. You can do a web search on the actual rule set. In our code, we will only look at:
• lowercase characters
• upper case characters
• numbers between 0 and 9
• special characters (!#$%&'*+-/=?^_`{|}~.)
• period characters are allowed, but may not be repeated next to each other (..., etc)

Once we have validated the email, we then will create a "checksum character" which is based on the ascii value of each character in the entire email address, and then divide it by the number of characters in the email address. For example, let's use a mythical email address of fredjones@someplace.com. If we walk through the email address, we can get the ascii value of each character by using the ord() function. When we add up each of the ascii values, we get a sum of 1670, then we divide that by the length of the email address (23); we get 72. Remember we are using integer division here, so our result will be an integer.

Now that we have our checksum value, we subtract 68 from that (ascii 'D') to create an offset. We use this offset when we encode each character in the email. Just to make things a bit harder to decode, we put the length (with offset) as character position 2 and the checksum as character position 4.

So for the email fredjones@someplace.com we get a license key of:

```
j[vHihnsriwDwsqitpegi2gsq
```

Lets get started with the code. Since this is the 53rd article in the series, I won't be quite as verbose from here on out.

First our imports.

```
import sys
```

```
localvalid1 = "abcdefghijklmnopqrstuvwxyz"
localvalid2 = "ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890"
localvalid3 = "!#$%&'*+-/=?^_`{|}~."
Offset = 0
```

Now (as shown above right) we will create a string that will include all of our "legal" characters for the IsValidEmail function. I've split it into 3 strings so it fits nicely for the magazine. We combine them in the IsValidEmail routine. We also set a global variable 'Offset' to 0. This will be the value that we add (later on) to each character when we create the encoded string.

Now for our first function. This (below) is the IsValidEmail routine. Basically we pass the email in the variable s, and an optional debug flag. We use the debug flag, as we have done in the past, to provide

```
def IsValidEmail(s,debug=0):
    email = s
    pos = email.rfind("@")
    local = email[:pos]
    domain = email[pos+1:]
    if debug == 1:
        print local
        print domain
    isgood = False
    localvalid = localvalid1 + localvalid2 + localvalid3
```

some print statements to see how things are going. Usually we would simply pass a 1 as the second parameter if we want to see the progress verbosely.

First we assign the passed in email address to the variable 'email' and find the '@' character that separates the local from the domain portions of the email. We then assign the local portion of the email to (I think it's appropriate) 'local', and the domain portion to 'domain'. We then set the boolean isgood flag to False and finally create the 'localvalid' string from the 3 shorter strings we set up earlier.

Next (top right) we simply walk through each character in the local portion of the email against the list of valid characters using the in keyword. If any character in the local portion of the email fails the test, we break out of the for loop, setting the 'isgood' flag to False.

Finally, we look for any set of period characters that are contiguous. We use the string.find routine that will match anything that is like '..' or '...' and so on. Being a lazy programmer, I used only a single "double dot" check that works for anything more.

```
    r = email.find("..")
    if r > -1:
        isgood = False
```

The last thing we do in the routine is return the value of the 'isgood' flag.

```
    return isgood
```

The next routine (bottom right) is the CheckSum routine which is fairly short. We walk each character in the email and create a running sum of the ascii value of each using the built-in 'ord' type conversion. As I stated earlier, we take that sum and divide it by the length of the email address. We return the checksum value and the character represented by that checksum.

Now for the EncodeKey routine. While it looks simple, it requires some concentration so pay attention! We assign the Offset variable to global status so we can change it within the function and so it can be used in other functions. We then set the Offset variable to the checksum minus 68. As in the example presented at the beginning of the article, it would be 72-68 which equals 4. We then step through each character of the email address adding the offset to the ascii value of that character. For the 'f' in 'fredjones', it would be 102 + 4 or 106 which equates to 'i'. Using the counter variable 'cntr', we then determine what we add to the 'NewEmail' string we build up character by character. Notice in the code that we go from 0 to the length of the email, so character 0 is 'f', character 1 is 'r' and so on. Now comes the part that might confuse some of you. If cntr is a value of 1 ('r'), we insert the character for the length of the email + 68 and then the offset character, which using our example would be iYt. The next time we go through the loop, cntr will equal 2, but we already have 3 characters in the email. That's where we want to insert the checksum character ('F') and then the third character offset. From there, we simply add each offset character to the string, and when the loop is done, we return the key (top right).

```
    # Check Local Part
    for cntr in range(0,len(local)):
        if local[cntr] in localvalid:
            if debug == 1:
                print local[cntr],ord(local[cntr]),"True"
            isgood = True
        else:
            if debug == 1:
                print local[cntr],ord(local[cntr]),"False"
            isgood = False
            break
```

```
def CheckSum(s,debug = 0):
    sum = 0
    email = s.upper()
    for cntr in range(0,len(email)):
        if debug == 1:
            print email[cntr],ord(email[cntr])
        sum += ord(email[cntr])
    cs = sum/len(email)
    if debug == 1:
        print('Sum = %d' % sum)
        print('ChkSum = %d' % cs)
        print('ChkSum = %s' % chr(cs))
    return cs,chr(cs)
```

The DecodeKey routine (bottom right) basically reverses the process we used in the EncodeKey routine. One thing you might notice here is that in the first 'if debug' statement of this function, I used '!= 0' rather than '== 1', simply to remind you that the two can be interchangeable.

The DoIt function (below) asks for an email address using 'raw_input', then calls the functions in order to create the license key.

Lastly, we call the DoIt routine.

```
if __name__ == "__main__":
    DoIt()
```

Now, obviously the output is not super-encrypted, and if someone were to put in a fair amount of time, they could figure out what we used to create the key fairly easily. However, it should give you enough of a starting point that you could simply modify the code to make it much harder to break. You could, for example, use a random number rather than the 'D' (68). If you do that, set a seed in the code so that it will always generate the same random number. You could also go a bit deeper and put the offset value somewhere into the license key, maybe the last character so you could use that as the decryption offset.

As always, the full source is available at http://pastebin.com/MH9nVTNK. Until next time, enjoy.

Greg Walters is owner of RainyDay Solutions, LLC, a consulting company in Aurora, Colorado, and has been programming since 1972. He enjoys cooking, hiking, music, and spending time with his family. His website is www.thedesignatedgeek.net.

```
def DoIt():
    email = raw_input("Please enter email address -> ")
    isok = IsValidEmail(email,0)
    if isok == True:
        csum,csumchr = CheckSum(email)
        ke = EncodeKey(email,csum,0)
        print("License Key    = %s" % ke)
        print("Original email = %s" % DecodeKey(ke,0))
```

```
def EncodeKey(s, csum, debug = 0):
    global Offset
    email = s
    Offset = csum - 68
    if debug == 1:
        print("Offset is %d" % Offset)
    NewEmail = ""
    for cntr in range(0,len(email)):
        ch = ord(email[cntr]) + Offset
        if cntr == 1:
            NewEmail = NewEmail + (chr(len(email)+68)) +
chr(ch)
        elif cntr == 2:
            NewEmail = NewEmail + chr(csum) + chr(ch)
        else:
            NewEmail = NewEmail + chr(ch)
    if debug == 1:
        print cntr, NewEmail
    return NewEmail
```

```
def DecodeKey(s,debug = 0):
    global Offset
    eml = ""
    for cntr in range(0,len(s)):
        if debug != 0:
            print cntr,s[cntr],ord(s[cntr])-
Offset,chr(ord(s[cntr])-Offset)
        if cntr == 0:
            eml = eml + chr(ord(s[cntr])-Offset)
        elif cntr == 1:
            emllen = ord(s[cntr])-Offset
        elif cntr == 3:
            csumchr=s[cntr]
        else:
            eml = eml + chr(ord(s[cntr])-Offset)
    if debug == 1:
        print eml
    return eml
```