Progress on Gwx: the G Regression and Model-building Program Rewritten with Open-Source, Cross-platform Tools.

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At the 20th Inforum World Conference, I announced (in absentia) that I was undertaking to rewrite the G7 regression and model-building system with open-source, cross-platform tools, namely with wxWidgets and the GNU C++ compiler. A year later, I am beginning to get results, but the program is still several months from reaching a useful stage. In this report, I want to explain again my motivation for undertaking this work and to give a report on progress to date.

Motivation

Initially, my motivation was simply fear. Gradually, however, other, nobler motives have emerged.

The fear motive arises from the fact that G7 is built with Borland Builder 6 and the Borland C++ compiler. Borland went out of business in 2003, and Builder was taken over first by CodeGear and then by Embarcadero Software, which offers a current version for about $2000. Before it went out of business, Borland produced a version of Builder that worked on a small number of Linux distributions but does not work on current distributions. Builder 6 did not work on Windows Vista but worked again on Windows 7. (Corel PhotoPaint also stopped working under Vista.) I do not know whether or not it works on Windows 8, with which I have had only enough experience to know that I don't like it. Recently, Microsoft has announced that it is terminating support for Windows XP; machines running XP in the University of Maryland are being converted to Windows 7. I mention these facts to emphasize (1) that there is a very close connection between Builder and Builder-like programs and the operating system and (2) that Microsoft has not the least interest in maintaining support for Builder, a program which for two years or so was far ahead of anything Microsoft had to offer.

On the positive side, the reasons for wanting to use cross-platform tools are increasing. The current versions of the Apple computers are doing very well commercially, in part because they are running on a solid, Unix-based operating system. Linux, while a minor player in the desk-top and lap-top market, is the major player in the hand-held devices, where it accounts for about two-thirds of the new sales, with Apple's similar Unix-based systems being most of the rest of the market. Consequently, a young programmer will definitely want to learn to deal with Unix and its look-alike Linux. I personally use Ubuntu Linux but with the Gnome desktop, which is more traditional than the Unity desktop currently the Ubuntu default. I took the time to become fairly proficient with Unity – which aims to be nearly the same on laptops and hand-held devices, hence the name – but in the end, I found it less efficient than the traditional Gnome desktop. (One of the nice things about Linux is that you have a choice of a number of different desktops; Apple and Windows remind one of Henry Ford's famous dictum: “You can have your Ford in any color you want so long as it is black.”)

I find Ubuntu Linux a very stable operating system with a wide variety of high-quality, free, open-source software available with a few mouse clicks. The LibreOffice suite, which installs with Ubuntu, includes Writer (a word-processor superior to MS Word), Calc, Impress, and Base closely paralleling Excel, PowerPoint, and Approach. I also use Gimp for image processing (a free alternative to PhotoShop), MuseScore for writing musical notation (a free alternative to Finale), the OpenShot video editor (a superior alternative to MS MovieMaker), the Gramps genealogical program, the Audacity audio editor, Google Earth and various utilities for Internet access, scanning, OCR conversion, and the full set of Unix command-line

software. Code::Blocks with wxSmith and the GNU C++ compiler is fully the equivalent of Borland Builder 6 for writing programs – and it is cross-platform. All of that is free and most of it open-source. In fact, everything I ever want is there – except a good time-series regression and model-building program like G7. I would like for G7 to join this distinguished company.

As I dug into the project, I found that there were other reasons for doing it. The code for G7 has become very complicated and difficult to read. Any programmer new to the code who was expected to step into it and make some correction or add some feature would have a very difficult time. The original code was much simpler and clearer. The documentation of how it was supposed to work was, from the outset, limited to comments in the code. But many changes have been made in the code, usually with the original code left as a comment and the new code marked with the changer's initials and date but with no explanation of why the change was made. In the work that I have done so far, I have been able to simply copy G7 code in only three instances: (1) writing data to a standard G data bank, (2) the inversion part of the regression program, and (3) the GDate class. Elsewhere, the G7 code has become hopelessly – and I often feel – needlessly complex. I want to produce code which is eminently readable by humans and is documented not only with comments in the code but with a tutorial description of what it is doing. To date, this description is a document of over 150 pages. While I intend to make the whole code open-source, I also intend to keep my own copy and to keep it intelligible. I want it – in conjunction with the tutorials – to be easy and clear reading for anyone who understands the basics of C++ and the algorithms being used. The tutorials should serve as an introduction for anyone who later needs to maintain and update the code.

Overview of Progress to Date

At last year's Inforum conference, I was able to report getting the basic G7 mechanism set up with a command drop-down box, a results window, and two buttons, one for picking a starting directory and one to draw and save the Giotto figure – a red circle and an octagon around it. Since then have been added the following commands:

data	for adding time series one at a time to the workspace bank
matdata	for adding a number of time series arranged in a matrix to the workspace bank
type	for displaying a time series in the workspace numerically on the results screen
f	for forming a new variable in the workspace bank by arithmetic operations with existing series. The log() and exp() functions are also recognized.
r	for performing linear regression of one variable on a number of others
gr	for graphing one or more variables.
title	to provide a title for a regression or graph
subtitle	to provide a subtitle for a regression or graph
_dates	tdates, fdates, rdates, and gdates, to provide date ranges for the *type*, *f*, *r*, and *gr* commands
add	to execute any of the above command from a file specified following the *add* command.
quit	to exit the program.

While that is a fairly short list, users of G7 will recognize that these commands cover much of the basic

operation of the program. The main missing pieces are:

enrichment of the graph command with vertical range control, saving and various options.

other bank commands – *bank*, *cbk*, *hbk*, and *vam*

extension of the *r* command with *con*, *sma*, *showt*, and the saving commands *sav* and *cat*.

tabular display of items in a vam file

matrix algebra on matrices and vectors in a vam file

more functions for use in f commands.

specialized regression commands *recur* and *sur*

I intend to work on these more or less in the order given.

In building models, G7 works with Build for macro models and IdBuild for multisectoral models. Both Build and IdBuild are pure command-line C++ programs and should convert to the cross-platform GNU compiler rather easily. I do not anticipate any major problems there.

Much recent work on G7 has concerned interaction with a spreadsheet program. Unfortunately, Excel was chosen instead of Calc so that none of that work can be carried over easily to the open-source environment, and I do not have on my personal agenda any plans for extension of Gwx in that direction.

Illustrations of Gwx at Work

I put some made-up data in a file called integers.dat and gave Gwx the command add integers.dat. Here is what I got in the Results pane, with the input set in bold italics

```
# Example with date on first line
data integers 1970
0 1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17 18 19
20 21 22;
tdates 1970 1990
tdateA input 1970
tdateB input 1990
Year 1970 Frequency 1 Period 1 Day 0.
Year 1990 Frequency 1 Period 1 Day 0.
type integers
Here is integers:
1970        0.0000       1.0000       2.0000       3.0000       4.0000
1975        5.0000       6.0000       7.0000       8.0000       9.0000
1980       10.0000      11.0000      12.0000      13.0000      14.0000
1985       15.0000      16.0000      17.0000      18.0000      19.0000
1990       20.0000
```

```
# Example without date on the first line:
data threes
1970  3 6 9 12 15
1975 18 21 24 27 30
1980 33 36 39 42 45;
type threes
Here is threes:
1970        3.0000       6.0000       9.0000      12.0000      15.0000
1975       18.0000      21.0000      24.0000      27.0000      30.0000
1980       33.0000      36.0000      39.0000      42.0000      45.0000
1985       -0.0000      -0.0000      -0.0000      -0.0000      -0.0000
1990       -0.0000

# Example with date and all data on the first line
data fives 1970 0 -5 10 -15 20 -25 30 -35 40 -45 50;
type fives
Here is fives:
1970        0.0000      -5.0000      10.0000     -15.0000      20.0000
1975      -25.0000      30.0000     -35.0000      40.0000     -45.0000
1980       50.0000      -0.0000      -0.0000      -0.0000      -0.0000
1985       -0.0000      -0.0000      -0.0000      -0.0000      -0.0000
1990       -0.0000
```

Handling of dates has been improved. Initially, G used floating point numbers to store dates. Annual dates looked like 2010, 2011, 2012. The four quarters of 2010 were expressed as 2010.1, 2010.2, 2010.3, and 2010.4. Monthly dates for January through December of 2010 looked like 2010.001, 2010.002, … 2010.012. The monthly dates looked rather strange, and the system could not be extended to daily dates, which become important in financial data. So a new system called GDate was devised and is available in G7 and Gwx, where it is implemented as a C++ structure, a ***struct***. Most of the coding here is new and simpler than in G7 for Windows.

A GDate can be specified by the user in any of the just-mentioned ways and also as shown by the following examples:

2010q1	the first quarter of 2010
2010m01	January of 2010
2010m07d04	2010 July 4

Note that the month and day must always be two characters.

When Gwx starts, a daily time series called *timed* is placed in the workspace bank. We can use it to illustrate daily dates and the *type* command with daily data.

```
tdates 1970m01d01 1971m12d31

tdateA input 1970m01d01
tdateB input 1971m12d31
Year 1970 Frequency 13 Period 1 Day 1.
Year 1971 Frequency 13 Period 12 Day 31.
ty timed
```

```
Here is timed:

 1970 1
      1.000      2.000      3.000      4.000      5.000      6.000      7.000
      8.000      9.000     10.000     11.000     12.000     13.000     14.000
     15.000     16.000     17.000     18.000     19.000     20.000     21.000
     22.000     23.000     24.000     25.000     26.000     27.000     28.000
     29.000     30.000     31.000
 1970 2
     32.000     33.000     34.000     35.000     36.000     37.000     38.000
     39.000     40.000     41.000     42.000     43.000     44.000     45.000
     46.000     47.000     48.000     49.000     50.000     51.000     52.000
     53.000     54.000     55.000     56.000     57.000     58.000     59.000
```

Note that the output looks a bit like a calendar, except that every month begins on a Sunday. Note also that the program knows that January has 31 days and that February of 1970 had only 28 days. It also knows the full rule for detecting a leap year. Daily data is given a frequency of 13.

Now here is real, quarterly data on coal usage introduced with the *matdata* command:

```
matdata 2009q1 21
CoalElec CoalCoke CoalOthInd CoalTotal
# The 21 in the first line means to skip the first 21 spaces
# on each       data line. A line beginning with a # is just a comment.
#                       U.S. Coal Consumption
#                        (Thousand Short Tons)
#        Year and        Electric Coke   Other        Total
#        Quarter         Power    Plants Industry
#
#
#2009
   January - March        236842    4398    12075     254383
   April - June           216502    3402    10542     231110
   July - September       244445    3450    11107     259621
   October - December     235838    4076    11590     252363
#
#2010
   January - March        246445    4857    12600     264939
   April - June           229469    5353    11914     247344
   July - September       267943    5491    12284     286361
   October - December     231195    5391    12490     249870
#
#2011
   January - March        234847    5188    12489     253541
   April - June           223540    5392    11036     240611
   July - September       261534    5407    11168     278638
   October - December     208637    5447    11543     226233 ;
```

We can illustrate the f command with these lines:

```
f  CoalSum = CoalElec + CoalCoke + CoalOthInd
f  CoalResid = CoalTotal - CoalSum
f  ShareElec = 100.*CoalElec/(CoalElec + CoalCoke + CoalOthInd + CoalResid)
type ShareElec
```

with this result

```
Here is ShareElec:
2009q1        93.104       93.679       94.155       93.452
2010q1        93.020       92.773       93.568       92.526
2011q1        92.627       92.905       93.862       92.222
```

And we can now illustrate regression with a somewhat nonsensical example:

```
title Coal Used for Coke
r CoalCoke = CoalResid,CoalOthInd
```

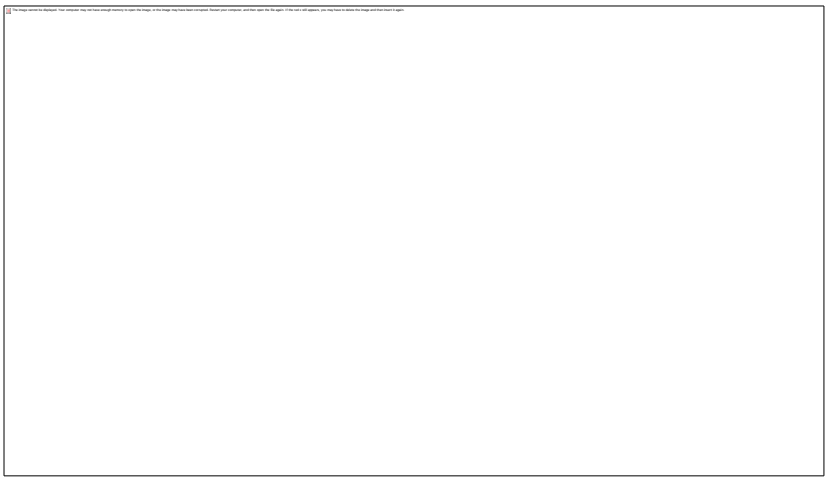
The result looks like this:

```
:                                Coal Used for Coke
SEE =      567.6 RSQ =    0.870 RHO =    0.735 DW =    0.531
  Variable name              RegCoef  Mexval   Elas  NorRes     Means
  1 intercept              -162.19922     0.3  -0.03    7.69      1.00
  2 CoalResid                -1.86559    12.2  -0.29    4.31    757.25
  3 CoalOthInd                0.54496   107.5   1.33    1.00  11736.50
```

The graph of the fit is then obtained by

```
gr predic, depvar
```

One tiny point should be noted: the comma between the two variable names. It is there because Gwx allows expressions in the list of items to be graphed, not just names of variables already in the data banks. Since spaces are legal in expressions, the comma is necessary to delimit the items to be graphed.



Here is the graph.

It is basically working, but it still lacks labeling of the vertical axis and the labeling of the horizontal presently works only with fairly short series of quarterly data. Moreover, the graph was not properly saved as a .png file but caught with a screen shot program. With a few days work, however, it should be a pretty competent graphing program.

Chinese and Russian colleagues may by pleased by these two graphs which were obtained simply by putting the Chinese and Russian on the *title* command.

This is somewhat less than I had hoped to have ready to present, but it at least represents progress on basics and shows that the project is still alive. Moreover, there is the 150+ page document *Tutorials on the Construction of Gwx, a Cross-Platform Version of G7* with 12 tutorials explaining the program thus far.