Using SAS and the SAS windowing environment

1 Introduction

This is not a mathematical course, but it does involve computing. Specifically, we will be using the statistical package SAS: learning how to analyze data using the methods we learn, and how to interpret the output.

SAS has been around for years (now on version 9), and has become the standard in industry, government and suchlike places for ”routine” statistical analysis (that is, where more or less well-known statistical procedures are to be used). If you can say, therefore, that you have experience with SAS, it makes you that much more employable! SAS runs on Windows, Unix, the Mac, etc; it is big, and expensive, but there are certain common themes, and, as we will see, once you see how to run one analysis, you can easily learn how to run another. SAS is not point-and-click: you write a ”program” and then run it, but you then have the advantage of knowing exactly what you did, and being able to run the program again, or modify it. Is SAS user-friendly? No. But SAS, as we run it, looks exactly the same in every environment: Windows, Unix, running on your machine or some remote machine. So what you learn here will definitely be transferrable to what you might see later.

SAS can be run in two ways: a “batch mode”, and a windowing or development environment that looks nicer. The windowing environment also makes it possible to get nicer plots.

2 Setup

If you happen to be running Linux (or a Mac), there’s no setup required, beyond being able to open a terminal (command-line) window. Go straight to the next section.

In the likelier event that you’re running Windows, you have a couple of things to organize first.

First you need a program called `Xming` that allows SAS’s windowing environment to happen in Windows (even though Mathlab runs Ubuntu

Linux). Download this from sourceforge.net/projects/xming, clicking on the big green button, and install it in the usual way. Allow it to place a shortcut on your desktop for ease of use later.

Then you need a program called putty, which you can get from putty.org. This actually enables you to connect to Mathlab. Just download putty.exe and save it on your desktop — there's no install required. (Choose "save" rather than "run" to download it.)

To test your installation, first run Xming by double-clicking on its icon. This will appear to do nothing except put a big X in your system tray. Now start Putty as well (ignoring any "unknown publisher" warnings). There are a few things to enter before you can connect to Mathlab. In the Host name box, enter mathlab.utsc.utoronto.ca. Leave Port 22 and Connection Type SSH as they are. Then in the Category window on the left, look for SSH with a plus sign next to it (down near the bottom). Click on the plus sign. Look for X11 in the choices that pop out (the fourth one). Click on it. On the right there is "Enable X11 forwarding" with a check box next to it. Click on the check box. Then look in the Category window on the left for Session (right at the top) and click on it. This takes you back to where you started. Save this (so you don't have to do it every time) by first typing a name like mathlab into the Saved Sessions box, and then clicking on the Save button on the right. The name you chose appears in the bottom box below Default Settings.

Now you can get connected. In Putty, click Open. This will bring up a black screen asking for your Mathlab username and password (the same as your UTSCid ones). If you can't log in, check your password, and if you still can't, let me know. If you can, you'll see some stuff including "Ubuntu comes with ABSOLUTELY NO WARRANTY", and then it waits for you to type something. Type sas, and you should (eventually) see a splash screen and a whole bunch of windows appear, including SAS Explorer, SAS Log and SAS Program Editor. (If you get some kind of error message, check that you do have Xming running.) If you want to explore further, you can, but this is enough to show that you have SAS running. To exit, go to SAS Explorer's File menu, select Exit, and then confirm this in the dialog box that follows.

3 Starting SAS

On Linux or a Mac, open up a terminal window and type

```
ssh -X username@mathlab.utsc.utoronto.ca
```

where you replace `username` with your actual UTSC username. Jump over the next paragraph, and ignore anything about Xming.

On Windows, start up Xming, then run Putty, loading your saved `mathlab` profile (click on `mathlab`, then click Load). Click Open to connect. Enter your username (UTSCid) when prompted.

Then enter your password (the one that goes with your UTSCid). If it doesn't work, check it and try again; if it still doesn't work, ask me.

You'll see a whole bunch of things indicating that you are connected to Mathlab. At the command prompt type `sas`, and in due course a whole bunch of windows will appear with names like SAS Explorer, SAS Log and SAS Program Editor. If typing SAS gets you an error, the likely cause is that you forgot to start Xming first.

4 Using SAS

From here on, it's the same whatever system you are running, or whatever machine you are running SAS on. (If you happen to have SAS installed on your own machine, it looks exactly the same.)

To give SAS something to work on, find the Program Editor window (with a list of line numbers down the left side). This works something like most editors you may have seen, with a couple of non-intuitive features. First off, the program editor's default is "overwrite mode", where anything you type overwrites anything that was there before. Most editors you know probably use "insert mode"; to switch to insert mode here, press the "insert" key, and now any text you already typed will get shunted to the right when you type in something new.

The URL

```
http://tinyurl.com/sas-editor
```

redirects to the SAS support page on using the program editor. (The original URL is rather imposingly long.)

As an example, type the below (with the semicolons exactly as shown) into the Program Editor. (Confusingly, hitting Enter at the end of a line doesn't insert a new line, even in insert mode. To insert a new line, go back onto the line numbers, type "i" and Enter, and a blank line will be inserted below where you typed the "i".)

```
data x;
  input x;
  cards;
1
2
3
5
7
;

proc print;

proc means;

run;
```

This means the following:

- Here comes a data set called x, with one variable, also called x.
- Here come the data values. (You can use datalines instead of cards, but I like the throwback to the days of punched cards.)
- The five values for x are 1,2,3,5 and 7.
- proc print just lists the data, so you can check that the values were read in properly.
- proc means calculates means and SDs for all the variables (just x, here).

Once you have this right to your satisfaction, see whether it works by either: finding the SAS Toolbar and clicking on the running human over to the right, or clicking on the Run Menu in the Program Editor and selecting Submit. This (rather worryingly) makes your painstakingly-typed SAS commands disappear (don't worry, you can get them back) and runs SAS on them. If everything (or even something) is OK, the Output window will pop up, and you will see your results (use Page Up to see previous pages); if not (for example, you see some of what you were expecting but not all), find the Log window, and look for any errors there. I mistakenly typed proc mean as proc meanbubbles, and got an output window with just the output from proc print in it, and this in the Log window:

```
1    data x;
2      input x;
3      cards;

NOTE: The data set WORK.X has 5 observations and 1 variables.
NOTE: DATA statement used (Total process time):
      real time           0.46 seconds
      cpu time            0.01 seconds



9    ;
10
11   proc print;
12

NOTE: There were 5 observations read from the data set WORK.X.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.20 seconds
      cpu time            0.05 seconds


13   proc meanbubbles;
ERROR: Procedure MEANBUBBLES not found.
14
15   run;

NOTE: The SAS System stopped processing this step because of errors.
NOTE: PROCEDURE MEANBUBBLES used (Total process time):
      real time           0.05 seconds
      cpu time            0.00 seconds
```

This all means:

- The data were read in properly (there should be 5 observations on 1 variable).
- `proc print` worked just fine (no errors) and any output from it will appear in the Output window.
- `proc meanbubbles` does not exist, so SAS can't run it. This is (predictably) an Error.

To get your commands back, bring up the Program Editor window, click on Run, and select Recall Last Submit. Go down to line 13 (the line with `proc meanbubbles` on it), and change it to the correct `proc means`. (You might need to use Page Down rather than the cursor down key to get to this line.)

The output looks like this:

```
                          The SAS System         09:57 Monday, January 10, 2011   2

                             Obs    x

                              1     1
                              2     2
                              3     3
                              4     5
                              5     7
```

which is the output of `proc print`, and on the next page:

```
                          The SAS System         09:57 Monday, January 10, 2011   3

                       The MEANS Procedure

                      Analysis Variable : x

N            Mean         Std Dev         Minimum         Maximum
-----------------------------------------------------------------
5       3.6000000       2.4083189       1.0000000       7.0000000
-----------------------------------------------------------------
```

`proc print` confirms that the data were read in correctly, while `proc means` actually tells us something interesting about the data.

You see that the output is rather wide, and needs to be shrunk quite a bit to get it on the page. You can change this by going to the SAS Explorer window, selecting Tools, Options and System (in order), clicking the plus sign next to Log and Procedure Output Control, then clicking on SAS log and procedure output. Not exactly easy to find. In the right-hand part of the window, find Linesize (by default 100) and *right*-click on it to change it to something like 80.

Go back to the Program Editor, recall the commands you just submitted (Run and Recall Last Submit), and then submit them again. The output from `proc means` now looks like this:

```
                          The SAS System                                5
                                           09:57 Monday, January 10, 2011

                       The MEANS Procedure

                      Analysis Variable : x

N            Mean         Std Dev         Minimum         Maximum
-----------------------------------------------------------------
5       3.6000000       2.4083189       1.0000000       7.0000000
-----------------------------------------------------------------
```

which required a good bit less shrinking to get it onto the page.

5 Saving and opening

This is a good place to mention that you can save your commands (and embedded data) should you wish to use them again later. Recall the commands into the Program Editor, then select Save or Save As from the Program Editor's File Menu. This will enable you to put them in a file *on the Mathlab machine*. By tradition, the file uses a `.sas` extension. I called mine `testing.sas`. Likewise, you can re-open a file of commands. If the Program Editor has anything in it, you'll probably want to clear it first (SAS by default adds any read-in lines to the end of the code that's already there) by selecting Edit and Clear All. Then you can open a file of commands in the way you'd guess: File and Open. You can open, edit and re-save something other than commands by looking at the bottom of the Open dialog box for File Type, and changing it to All Files.

Rather than embedding your data into your programming code, you can also save your data into a file. One way to do this is to type your data into the (empty) Program Editor and then save it into a file on Mathlab, traditionally with the extension `.dat`. The data layout (unless you are prepared to go through some contortions in SAS) is one observation per line, with values for all the variables separated by whitespace. The data below are values of a response variable y from three groups labelled a, b, and c:

```
a 20
a 21
a 16
b 11
b 14
b 17
b 15
c 13
c 9
c 12
c 13
```

You can type these, one per line, into the Program Editor, and then save everything in a file called `threegroups.dat`. Then you can clear the Program Editor window (Edit, Clear All: don't try to submit these lines!) and type the following program:

```
data groups;
  infile 'threegroups.dat';
  input group $ y;

proc print;

proc means;
  class group;
  var y;

run;
```

Note that the filename has *single* quotes around it. This a bit cleaner than the code with `cards` (or `datalines`) and the actual data in it, because you can see rather more clearly what's going on. Running this produces no errors (check the Log window to be sure) and two pages of output. The first just lists the data, like this:

```
  The SAS System                                6
                   09:57 Monday, January 10, 2011

Obs    group     y

  1      a      20
  2      a      21
  3      a      16
  4      b      11
  5      b      14
  6      b      17
  7      b      15
  8      c      13
  9      c       9
 10      c      12
 11      c      13
```

and the second shows the means for each group separately:

```
                                 The SAS System                                 7
                                                      09:57 Monday, January 10, 2011

                               The MEANS Procedure

                             Analysis Variable : y

             N
group      Obs    N            Mean         Std Dev         Minimum         Maximum
-------------------------------------------------------------------------------
a            3    3      19.0000000       2.6457513      16.0000000      21.0000000

b            4    4      14.2500000       2.5000000      11.0000000      17.0000000

c            4    4      11.7500000       1.8929694       9.0000000      13.0000000
-------------------------------------------------------------------------------
```

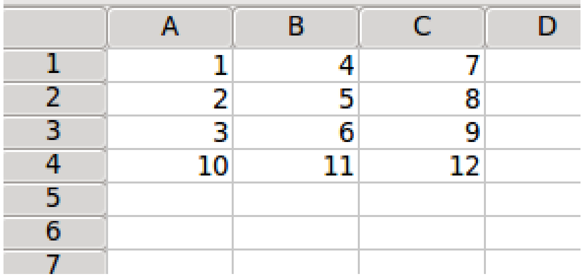
As you would guess from looking at the data, group A has the largest mean and group C the smallest.

6 Copying and pasting

Copying into SAS is mainly straightforward: if your data have been typed into a text editor like Notepad, you can copy the values as normal and then select Edit and Paste within SAS.

One (solvable) problem is if your data are in a spreadsheet and you copy them from there. The values wind up in SAS separated by tabs rather than spaces (even though it doesn't look like it) and they have to be read into SAS carefully.

For example, suppose your spreadsheet contains this:



	A	B	C	D
1	1	4	7	
2	2	5	8	
3	3	6	9	
4	10	11	12	
5				
6				
7				

You can copy the values into the SAS Program Editor and save them as a file, say `x.dat`, but then you need to read them like this:

```
data x;
  infile 'x.dat' delimiter='09'x;
  input a b c;

proc print;

run;
```

where the gobbledegook after `delimiter` means (to SAS) that the data values are separated by tabs, and you correctly get this output:

```
                                          The SAS System                                10
                                                             09:57 Monday, January 10, 2011

                                     Obs     a     b     c

                                      1      1     4     7
                                      2      2     5     8
                                      3      3     6     9
                                      4     10    11    12
```

If you don't put in the `delimiter` part, you will get a large number of incomprehensible error messages.

Copying *from* SAS might work all right for you (try it). But since you will need to copy things from the Output window into a Word doc (or whatever) to hand in for your assignments, let me explain what seems to be working for me, so that you don't get stuck. To get the above output into this document, I went to the Output window, scrolled back a few pages (even though the bit I wanted was at the end), selected the *whole window* using Edit and Select All, then I copied it using Edit and Copy. I pasted the whole lot into my document and then edited out the many lines that I didn't want.

The same procedure can be used to copy from the Log or even Program Editor windows (making sure, of course, to Recall the Last Submit if you want to copy your code).

A final remark: when you paste into your Word doc (or whatever), note that SAS output comes in a monospaced (non-proportional) font, so it needs to look the same way when you hand it in. A font like Courier, or Lucida Console, is good. Also, you want to make the font small enough so that lines don't wrap (bearing in mind that SAS output lines are rather long). Otherwise it looks *really* ugly.