SAS®
Workshop

Manitoba Centre for Health Policy

University of Manitoba

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Outline

The MCHP SAS workshop will provide the necessary SAS programming skills to work with SAS and administrative data. The workshop unfortunately cannot provide an introduction to a wide variety of statistical analyses. It will provide an understanding of how to use SAS statistical procedures and how to find the necessary statements and options to use the procedures. The SAS programming language is stressed in this course instead of interactive analysis for a number of reasons: a) replications of results, b) efficiency of programming, c) access to 'advanced' options, d) helping fulfill the requirements for documentation of research outlined in UofM Policy 1406: Guidelines on Responsibilities for Research Ethics.

The workshop is broken down into five half day sessions with examples and problems to work through. The workshop was setup to complete with an instructor as not all of the code is fully documented.

Session 1: Using basic SAS procedures

I. Viewing data
II. Exploring data.

Session 2: Creating and Manipulating Data

I. Import of data into SAS
   Use of formats to modify displayed data
II. Manipulating data
   Use of logical if/then/else statements
   Creating new variables.
III. Getting Data out of SAS

Session 3: Combining Datasets

I. SAS Options (printing)
II. Sorting of data
III. Setting or concatenation of data
IV. Merging or adding variables using a 'by' statement.
V. Use of Put() with formats for creating variables
VI. Type conversions put/input

Session 4: Longitudinal and Cross sectional Processing

I. By group processing for longitudinal data (first, last, retain).
II. Variable Groups & Array processing for cross sectional data.

Session 5: Date processing, SQL, and Interactive SAS;

I. Date time processing
II. SQL
III. Interactive SAS, SAS Enterprise Guide
IV. Finish up anything not covered earlier

Textbook

Delwiche, Lora D., and Slaughter, Susan J. 'The Little SAS Book: A Primer, 4th edition, 2008.

This book is recommended for anyone working with SAS. It provides a basic overview of the SAS language with practical examples - it covers more material than is covered in the MCHP workshops. It does not provide much direction or help with statistical procedures or analysis. Although we do not follow the order of information presented in the book the text throughout this course provides further reading and references. Specific reading material is identified with LSB (Little SAS Book) followed by a section number and page range.

SAS Online Documentation (9.2, 9.3)
http://support.sas.com/documentation/

Google suggestion for further help
When using Google to search for material start your search string with 'SAS', 'PROC' or both. Adding SGF or SUGI will usually identify papers from the SAS international conferences – these are reviewed and typically well written with good examples.

CD Content

A CD or DVD should be provided with this material that contains all of the data, programs (including log/list files) and supporting documentation that is used in this workshop.

Getting SAS (UofM Students and Staff only)

If you need to get a copy of SAS for your own computer please contact the UofM ACN support desk (474-8600, support@cc.umanitoba.ca) to make arrangements. You can find license information on the WWW at:
http://umanitoba.ca/computing/ist/software/licensed.html
Look under SAS and click on the link 'home/campus use' to get the forms to fill out. You will need the Standard Install package - you might be able to work with your peers to get only one copy of the media. You might need to contact the ACN Support Desk at the Fort Garry campus (010 Dafoe Tunnel) at 474-8600, or by E-mail at support@cc.umanitoba.ca for distribution details.

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Data Use Agreement

The Manitoba Health (MH) monitors use of medical administrative data through the Health Information Privacy Committee (HIPC). The importance of the Manitoba Health data repository has been recognised in an agreement reached between the University of Manitoba and MH. The University has accepted responsibility for assuring confidentiality of these data. Any effort to determine the identity of any reported cases, or to use the information for any purpose other than for health statistical reporting and analysis, would be against the law. MH and the University do everything possible to assure that the identity of data subjects cannot be disclosed through public-use data sets; all direct identifiers, as well as any characteristics that might lead to identification are omitted from the data set. Nevertheless, it may be possible in rare instances, through complex analysis and with outside information on sample cases, to ascertain from the data set the identity of particular persons or establishments. Considerable harm could ensue if this were done.

The data provided for the MCHP SAS workshop, have been simulated to resemble data from MH, and are provided for educational purposes only. They contain no information that would allow identification of individuals or physicians except as described in the preceding paragraph.

The undersigned gives the following assurances with respect to use of simulated data for the SAS workshop:

- The data in these sets will not be used in any way except for statistical reporting and analysis;
- The data sets or any part of them will not be released to any other person;
- The data sets will not be used in a manner to learn the identity of any person or establishment included in any set;
- If the identity of any person or establishment should be discovered inadvertently, then (a) no use will be made of this knowledge, (b) the course instructors will be advised of the incident, (c) the information that would identify an individual or establishment will be safe-guarded or destroyed, as requested by the course instructors, and (d) no one else will be informed of the discovered identity; and
- After completion of the course, the original data will be returned to the course instructors and all newly created data sets will be destroyed.

Signed: _____

Name (printed): _____

Address or Contact: _____

_____

Date: _____

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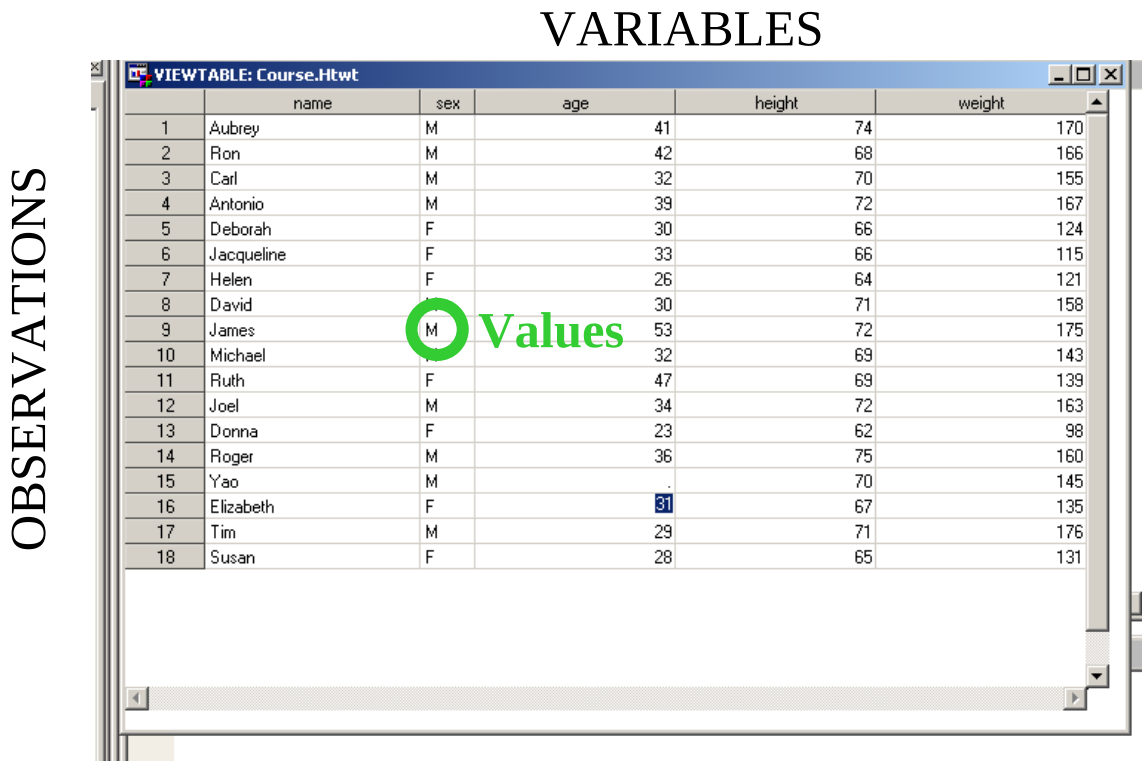
Overview

The following overview based on the introductory PowerPoint presentation for the workshop it does not contain all of the information covered in the presentation.

Why Programming?

Programming, rather than 'Point-and-Click' interface, provides the ability to quickly replicate results once code is written, provides some efficiency through the ability to copy and 'tweak' existing code. Programming saves time by not having to step through an iterative process every time a new analysis is required. Use of code provides access to advanced options and capabilities. Finally, if nothing else, it helps meet the requirements outlined in UofM Research Policy (1406). Although this workshop is primarily focused on programming in SAS an introduction to SAS IML Studio and SAS Enterprise Guide has been included. These two applications provide a graphic user interface to many SAS procedures and data manipulation tools.

SAS Dataset Structure



	name	sex	age	height	weight
1	Aubrey	M	41	74	170
2	Ron	M	42	68	166
3	Carl	M	32	70	155
4	Antonio	M	39	72	167
5	Deborah	F	30	66	124
6	Jacqueline	F	33	66	115
7	Helen	F	26	64	121
8	David		30	71	158
9	James	M	53	72	175
10	Michael		32	69	143
11	Ruth	F	47	69	139
12	Joel	M	34	72	163
13	Donna	F	23	62	98
14	Roger	M	36	75	160
15	Yao	M	.	70	145
16	Elizabeth	F	31	67	135
17	Tim	M	29	71	176
18	Susan	F	28	65	131

SAS definition of a SAS Data Set (LSB s1.2 pp4-5, s1.11 pp22-23, s2.20 pp70-71): A SAS data set consists of data values and their associated descriptive information organized in a rectangular form that can be recognized by the SAS System. SAS data sets always contain the following two components:

1) Data values that are organized into variables (columns) and observations (rows)

2) Descriptor information that identifies the attributes of both the data set and its data values.

The columns, or data elements, are called variables in SAS data sets. The rows, or records, are called observations. Each observation is a collection of values for the variables.

Programming Structure

The Base SAS programming language is an interpreted language that is written as ASCII text and 'submitted' to SAS to compile and run. The program is written as a set of statements. Statements typically start with a keyword and end with a semicolon. Most statements are grouped into steps (LSB s1.3 pp6-7). SAS also comes with several other related languages (SAS Macro, Screen Control, Template, and Interactive Matrix). It is possible to compile SAS statements into stored code for general use but that process is outside the scope of this workshop.

When first writing and debugging a SAS program it is best to use a structure that is easy to read, run the programs in small sections, and test with small datasets (obs=__ option). If possible, use a syntax sensitive editor (e.g. SAS editor) that colourizes your text depending on the context.

SAS Statements (Basic Building Block)

- Start with key word, and end with semi colon
- Typically a there is one statement/line

```
bmi = (weight/2.2)/(height*0.0254)**2;
```

Statements are grouped into Steps for analytic and data management.

- Start with PROC or DATA statement & end with RUN;
- PROC steps are used to do analyses or view data
- DATA steps are used to manipulate Data

```
proc print data=htwt ;
     var name sex age height weight ;
run;
```

```
data test ;
     set test ;
     bmi = (weight/2.2)/(height*0.0254)**2;
run;
```

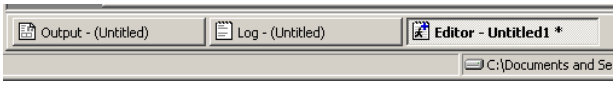
SAS Display Manager Interface

When you first run SAS a display with multiple screens appears by default. These screens are the place where you interact with SAS; you tell it what to do and where results are displayed.

There are three primary windows.

1. Enhanced Program Editor.
    a. This is a basic text editor and is really the only place (for this session) that you will input commands and interact with SAS.
    b. Colorized words
        i. Green comments
        ii. Dark blue SAS statements and step boundaries
        iii. Blue statements and key words
        iv. Purple quoted text
    c. Programs can be run as a whole or in parts.
        i. Select portion that you want to run click the running man.
        ii. Alternatively F3 or F8 can be used from the key board.
    d. The program editor is where you would save and recall your programs.
2. Log Window
    a. This displays how SAS has interpreted your request (or program)
    b. The log should always be reviewed for warnings and errors prior to looking at any results.
    c. Colorized sections
        i. Black is your original code
        ii. Blue text is information notes. Generally notes mean that things have run OK but always check to see that there is a note after a data step or procedure and that the numbers of records (and sometimes variables) makes sense. Look for notes containing uninitialized variables, character or numeric conversions, and
        iii. Green text is warnings that should be resolved. These generally will not stop SAS from running but might reset some options and usually will cause data problems.
        iv. Red text identifies errors that must be resolved.
    d. The log file continues to grow as you run portions of your SAS program.
3. Output Windows
    a. The output window contains the resulting output (generally statistical results) that has been generated by any SAS procedures.
    b. The output window continues to grow as you run portions of your SAS program.

You can move between these primary windows by clicking on the log/output/program buttons on the bottom task bar.

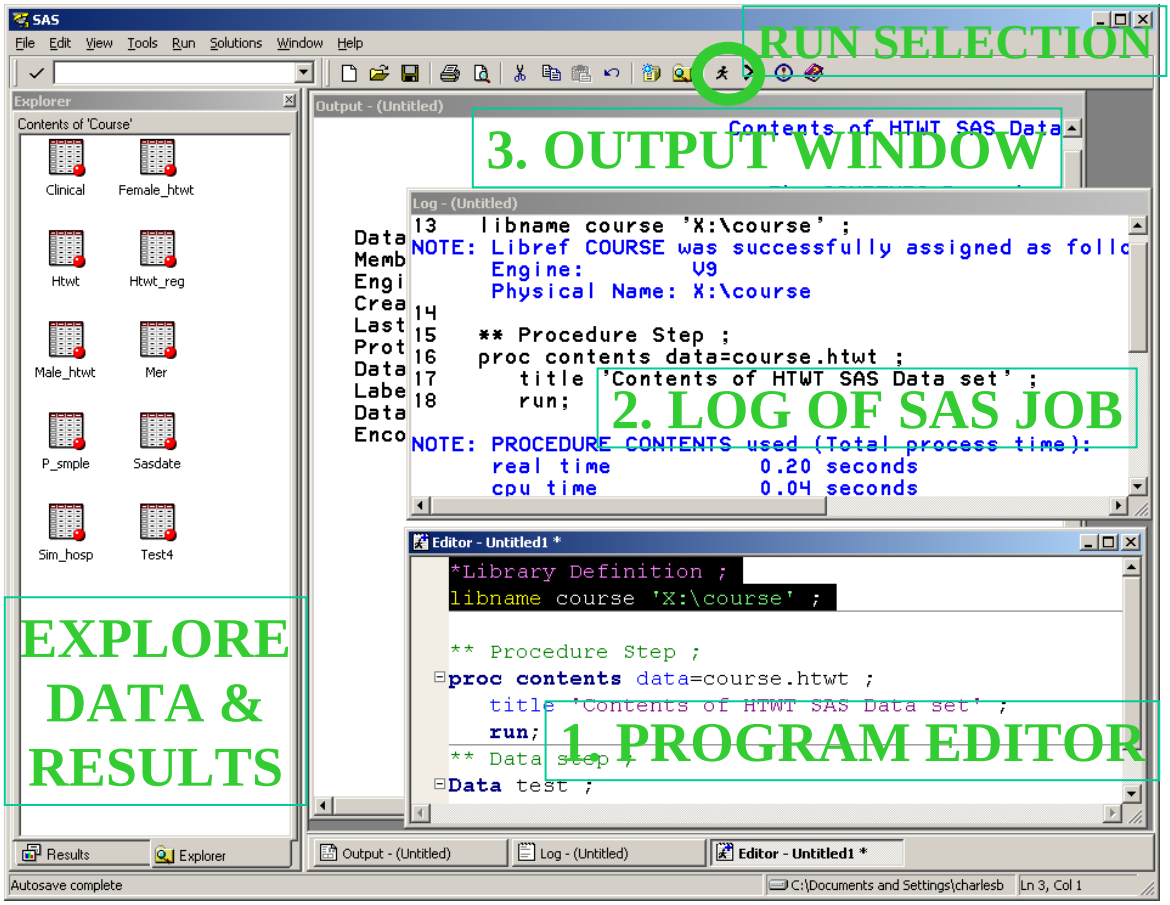


When you are working in SAS it is generally a good idea to save your program, log, and output (list). This way you can review the results and log at a later point in time.

A good practice is to write and test small portions of your then clear the log/output windows and run the whole program once to make sure that your log and output are all consistent and are using the data that you expect/want. Try to enter separate SAS statements on each line with comments to describe what is being done.

There are two other secondary windows that allow you to explore the SAS environment and results. These are found on the left side of the main SAS Windows.

1. The explorer window will allow you to open SAS datasets, get information on SAS datasets, copy and delete SAS datasets. When you open A SAS dataset from the explore window you can see the value it contains.
2. The results window allows you to quickly access all of the results in your output window.



More recent versions of SAS may start the SAS Enterprise Guide interface by default.

Structured SAS Code Suggestions.

The following are some suggestions for SAS programming structure. Some alternatives have also been mentioned.

General suggestions.

1. Maintain one case (upper or lower) mixing cases with out reason makes code difficult to read. As a side note: on systems that allow upper and lower case most programmers use lower case - it is generally easier to read.
2. Every program should have an introductory comment.

```
/******
File name:                    Date:
Author:
Description:
Study:
If applicable the following should also be added.
    Principal Investigator:
    Input Data:
    Output Data:
    Variables Generated:
    External files:
*******/
```

3. The introductory comment may be enclosed in a box.
4. If multiple programs have been used to generate some result a file titled README.txt or readme.txt should be included in the directory with the purpose and order of each program.
5. SAS program files should end with .sas, list files with .lst, and log files with .log.
6. Code so you and others can understand your code.

   Remember Occam's Razor. (After William of Ockham (1300-1349? English philosopher) a philosophical or scientific principle according to which the best explanation of an event is the one that is the simplest, using the fewest assumptions, hypotheses, etc...)

7. If possible all libraries, %include files, formats, macros and other general code should go at the top of the program, or be referenced in the initial comment.
8. Data set names should reflect the contents of the data set. A data set label should be added to any permanent SAS data sets.
9. Try to keep individual lines shorter than 80 characters.

Data step

1. Data statement should be left justified. If options carry over then line up with initial brackets or indented 8 spaces.

2. All other SAS statements should be indented at least 3-4 spaces. If code carries over to next line indent another 3-4 spaces.
3. Only use one statement/line.
4. New SAS variables should have an appropriate type, and length. A descriptive label should also be added to new variables.
5. Do statements
   Do is lined up with prior code.
   The do block is indented 3-4 spaces.
   The end statement is lined up with do. ** ALT indent end with do block.

```
data iterate1 ;
   input x ;
   exit=10 ;
   do i=1 to exit ;
      y=x*normal(o) ;
      if y>25 then i=exit ;
      output ;
      end ;
   cards ;
   ...
   ;
```

6. If-Then-do/Else statements
   If statement is lined up with prior code.
   If block is indented 3-4 spaces. ** ALT Do command may be left justified on separate line.
   else is lined up with associated if statement
   end statement is line up with if (or else). ** ALT indent end with indent of if block.

```
if answer=9 then do ;
   answer=. ;
   put 'INVALID ANSWER FOR' id= ;
   end ;
else do ;
   answer=answer10 ;
   valid+1 ;
   end ;
 More SAS CODE ;
```

7. Cards data should be left justified.
8. Each data step should end with a left justified run statement ** ALT indent run with data step code.
9. Leave a blank line after each run statement.
10. Array dimensions, and references should be in curly {} brackets.
11. Keep declarative statements together.
    Retain, Length at top of program.
    Label, Drop at bottom of program.
    ** ALT Some programmers prefer to use drop statements at the point in the program where a variable is no longer needed.

Macro code

1. Follows same indenting rules as data step code.
2. All internal code should be indented after the %macro statement.
3. Clearly comment all your macro code, and variables.
    - %* comments will not show up in the resolved macro code
    - * comments will appear in resolved code
4. Macros should not be defined, and compiled from within a macro.

Procedures

1. Proc statement should be left justified. If options carry over to the next line they should be indented 8 spaces.
2. Use only one statement/line.
3. Indent procedure statements 3-4 spaces. If the statement is longer than one line then each subsequent line should be indented at least 8 spaces.
4. Each procedure should end with a run, and or quit statement.
5. Leave a blank line after each run statement.

```
proc format data=jumbo.data ;
   where slice='1' ;
   tables a*b c*d / noprint out=temp ;
   run;

proc chart data=interm.grades ;
   block section / midpoints='Mon' 'Wed' 'Fri'
                   group=sex
                   sumvar=grade type=mean ;
   title 'Comparing the Mean for GRADE among Sections' ;
   run;
```

Comments

1. Justify to the code that is being commented.
2. Use `** ;` type comments within code, or data statements This will allow `/** **/` to be used to block out and run test sections.
3. Comments apply to next line or block of code.

Test code

If you want to add test code to your program such as `put _all_` ; it should be left justified. This will make it much easier to see and remove the code later ;

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SAS Programming Examples

Example 1

```
* f=htwt_example1.sas                    *
*                                        *
* Part I Viewing the data using PROC CONTENTS *
* and PROC PRINT                         *
* Part II Exploring the data using PROC FREQ   *
* and PROC MEANS                         *
*****************************************;

* Introduction to workshop
* SAS Program and Language (LSB s1.1 pp2-3, s1.3 pp6-7).
  The SAS programming language is an interpreted language that
  is written as ASCII text and 'submitted' to compile and run.
  The program is written as a set of statements.
  Statements typically start with a keyword and end with a semicolon.
  Most statements are grouped into steps (LSB s1.3 pp6-7) ;

* Writing SAS programs that work (LSB s10.1 pp278-279).
  When writing a SAS program it is best to use a structure that is easy to
  read.  Run the programs in small sections, possibly with small datasets.
  If possible, use a syntax sensitive editor (e.g. SAS editor) that colourizes
  your text depending on the context.

  Review log messages after each step and resolve any errors, warnings or
  notes.  After basic syntax problems, the most common mistakes are
  caused by missing semi-colons and unclosed quotes.

* Introduction to SAS Procedures (LSB s1.3 6-7, s4.1 pp104-1-5):
  1) Proc Contents - provides a description of the contents of a SAS data set
  2) Proc Print - provides a print out of a SAS data set
  3) Proc Freq - provides frequency distributions of variables
  4) Proc Means - provides descriptive statistics of variables;

* SAS procedures are used to analyze data.
  They are always invoked with the SAS keyword, PROC, followed by the name
  of the procedure.;

*SAS definition of a SAS Data Set (LSB s1.2 pp4-5, s1.11 pp22-23, s2.19, S2.20 pp68-71).
  A SAS data set consists of data values and their associated descriptive
  information organized in a rectangular form that can be recognized by the
  SAS System. SAS data sets always contain the following two components:

1)data values that are organized into columns and rows

2)descriptor information that identifies the attributes of both the data set
and its data values.

The columns, or data elements, are called variables in SAS data sets. The
rows, or records, are called observations. Each observation is a collection
of values for the variables.;

* SAS data sets can be permanent or temporary (LSB s2.19 pp68-69).
  Permanent SAS data sets are permanently stored in a SAS library.
  Temporary SAS data sets are created within a SAS session and are available
```

```
  throughout the SAS session.  They are destroyed when the SAS session is over.;

* This program uses a permanent SAS data set called HTWT.  It is stored on
  your computer in a folder called X:\course.;


                    * Part I: Viewing Data ;
* To access a permanent SAS data set, you must specify a library reference
  to the folder/path where the data are stored (external storage location);

* Use the libname statement to describe the path where the permanent
  SAS data sets are stored (LSB s2.20 pp70-71);
libname course 'X:\course\data';

* Use title and footnote statements to give your output titles and
footnotes (LSB s4.1 p105).  These can be used with all procedures that
produce output.;
title 'Data= Course.HTWT';
footnote 'SAS Workshop';

* Proc contents describes what is in a SAS dataset, i.e.
  its contents (LSB s2.22 pp74-75).  The 'data=' procedure option
  identifies the SAS dataset that you want to use.;
title 'Proc Contents of Course.htwt';
proc contents  data=course.htwt ;
run;

*If you want to know about all of the datasets in a library, use the keyword
_all_.  Proc contents has many such options.  Use the online help or SAS
reference manuals to find out more options;
title 'Proc Contents of Course._all_';
proc contents  data=course._all_ ;
run;

* Proc print prints out SAS datasets to the output window (LSB s4.4 pp110-111).
If you have a large dataset, use the dataset option obs= to limit the
number of observations printed.  SAS has many dataset options available.
You can specify data set options in parentheses after the data set name.  I
was able to find a list of the data set options by going through SAS Help:
   - SAS System Help -> Index -> Data Set Options -> summary of   (or by category)
   - SAS System Help -> Contents tab -> SAS Products -> Base SAS ->
     SAS Language Dictionary -> SAS Data Set Options
- http://support.sas.com/onlinedoc/913/docMainpage.jsp
     - Base SAS, SAS Language Reference: Dictionary,
       Dictionary of Language Elements, SAS Data Set Options
     - Index tab - Jump to: data options -> press the next link at the bottom
(LSB s6.1 pp198-99);

title 'Proc Print with obs=10 Data Set Option';
proc print data=course.htwt(obs=10);
run;

* Use the proc print option noobs to suppress the observation number in the
output.  Proc Print has many options available.  Each procedure has its own
set of specific options and statements (s4 pp102-149).
- http://support.sas.com/onlinedoc/913/docMainpage.jsp
```

```
     - Base SAS, Base SAS Procedures Guide, Procedures, SAS Data Set Options
     - Index tab - Jump to: Print Procedure -> Proc Print statement   ;
title 'Proc Print with NOOBS option';
proc print data=course.htwt noobs;
run;

* Use the var statement within proc print to limit the variables printed;
title 'Proc Print with VAR statement';
proc print data=course.htwt;
   var name sex age;
run;

* Use title and footnote statements to give your output titles and
footnotes (LSB s4.1 p105).  These can be used with all procedures that
produce output.;
title 'Data= Course.HTWT';
footnote 'SAS Workshop';
proc print data=course.htwt;
run;
```

* Part II: Exploring the data;

```
* Proc Freq creates frequency tables and crosstabulations(1-way, 2-way...N-way).
  Proc Freq also calculates a variety of statistics
- http://support.sas.com/onlinedoc/913/docMainpage.jsp
    - Base SAS, Base SAS Procedures Guide: Statistical Procedures,
      The FREQ Procedure
  (LSB s4.11 pp124-125, s8.10, s8.11 pp 244-245).;
title 'Proc Freq - 1-Way Frequency of Sex, Weight, Height and Age';
proc freq data=course.htwt;
   tables sex weight height age;
run;

* Proc means calculates means, standard deviations, maximums, minimums and
several other descriptive statistics (LSB s4.9 pp120-121). ;
title 'Proc Means - Default Output';
proc means data=course.htwt;
run;

* To specify specific statistics use proc means options;
* For a list of options available with PROC means see:
- http://support.sas.com/onlinedoc/913/docMainpage.jsp
    - Base SAS, Base SAS Procedures Guide, Procedures,
      The Means Procedure, Proc Means Statement
     (scroll down to statistic-keyword(s))
(LSB s4.9 p120, s8.9 p242-243);
title 'Proc Means with MEAN, STDERR and NMISS options';
proc means data=course.htwt mean stderr nmiss;
run;

* To specify analysis on specific variables use the var statement in proc means;
title 'Proc Means with Var statement';
proc means data=course.htwt mean stderr nmiss;
   var age;
run;
```

```
* To specify analysis by a classification variable use the class statement in proc means.
The Class statement in means, univariate, tabulate procedures divides the data into each
value of the class variables.  SAS/STAT procedures the the BY statement divides the
analysis into groups and class statement identifies categorical or character variables
used in analysis or models.;
title 'Proc Means with Class Statement';
proc means data=course.htwt mean stderr nmiss;
   class sex;
   var age height;
run;

* Distribution of Numeric Variables can also be done with
  proc univariate.  This is a powerful procedure for exploring
  the distribution of numeric variables.
  http://support.sas.com/onlinedoc/913/docMainpage.jsp
    - Base SAS, Base SAS Procedures Guide, Procedures,
      The Univariate Procedure
  (LSB s8.7, s8.8 pp238-241) ;
Proc univariate data=course.htwt plot normal ;
   var age ;
       ** histogram age / normal ;
       ** there are other options on histogram statement if
          you want to test more distributions.  If you want the
          tests but do not want the histogram use / nochart ;
run;

* Output Data from SAS Procedures:
* Most SAS procedures have at least one option to output a
* dataset that contains the numbers from the specified analysis. ;
* To output a SAS dataset use the output statement in proc
* means
 http://support.sas.com/onlinedoc/913/docMainpage.jsp
    - Base SAS, Base SAS Procedures Guide, Procedures,
      The Means Procedure, OUTPUT Statement
(LSB s4.10 p122);
* The NOPRINT option suppresses the printed output generated
* by proc means;
proc means data=course.htwt noprint;
   class sex;
   var age height;
        ** summary statistics with variable names
           can be defined on the output statement.
           If variable names are not used the input
           variable names are used in the output. ;
   output out=summary mean=mean_age mean_height;
run;

proc print data=summary;
title 'Dataset Output from Proc Means using the Output statement: Data=summary';
run;

* The AUTONAME option causes the output variables to be called
  age_mean height_mean.  If you have many summary statistics
  it shortens the lenght of the output statement. ;
proc means data=course.htwt noprint;
   class sex;
   var age height;
```

```
   output out=summary mean= nmiss= /autoname;
run;

proc print data=summary;
title 'Dataset Output from Proc Means using the Output statement & autoname:
Data=summary';
run;
```

Example 2

```
* f=htwt_example2.sas                                          *
*                                                             *
* Part I                                                      *
     Import data into SAS                                     *
     Use of formats to label or group displayed data          *
* Part II                                                     *
     Create or use subsets of data
     Create new variables using if/then/else logic            *
     Create new variables using SAS functions
*  Part III
     Getting Data out of SAS
   ************************************************************;


    * Part I: Import Data, Use of Formats and Labels ;

libname course 'X:\course\data';

* read htwt data into a temporary SAS dataset from in-line data using
* a DATA STEP (LSB s2.4 pp38-45) Temporary data sets are stored in the WORK
* library (LSB s2.19 pp68-69). The WORK library is automatically created at the
* beginning of the SAS session. Temporary data sets are present in the
* WORK library until the current SAS session is finished. The WORK library
* and its contents are automatically deleted at the end of the session.;

data htwt;                  /* Begin the DATA step */
          /* Describe variable names and locations */
  * Raw data is read using an INPUT statement;
  * Each line of data in the raw data file = 1 observation in the SAS dataset;
  * Each variable is read from the same column(s) in every line of data
   (LSB s2.6 pp42-43).;
  * This style of input is known as column input.  SAS can read in several
    styles of input including (LSB s2.1-2.7 pp32-45):
    1) List Input - Data values are not required to be aligned in columns
       but must be separated by at least one blank or other defined
       delimiter (such as a comma or a tab).
    2) Formatted Input - Formatted input allows you to read in non-standard
       data such as numbers with commas embedded or unusual numeric formats
       such as packed decimal.
    3) Named Input - really weird records where data values are preceded by
       the name of the variable and an equal sign.;
  * Each variable is assumed to be numeric unless you tell SAS it is
    character using $;
  input name $ 1-10 sex $ 12 age 14-15
        height 17-18 weight 20-22;
           /* Read the following lines of raw data */
           /*the key word CARDS can also be used */
datalines;
Aubrey     M 41 74 170
Ron        M 42 68 166
Carl       M 32 70 155
Antonio    M 39 72 167
Deborah    F 30 66 124
Jacqueline F 33 66 115
Helen      F 26 64 121
```

```
David      M 30 71 158
James      M 53 72 175
Michael    M 32 69 143
Ruth       F 47 69 139
Joel       M 34 72 163
Donna      F 23 62  98
Roger      M 36 75 160
Yao        M  . 70 145
Elizabeth  F 31 67 135
Tim        M 29 71 176
Susan      F 28 65 131
;            /* End the lines of raw data */
run;         /* End the DATA step */

/* Print the values of hte htwt dataset */
proc print data=htwt;  /* Begin a PROC step */
   title1 'Reading Raw Data into a SAS dataset';
   title2 'HTWT Data';
run;                           /* End the PROC step */

* the label statement labels variables (LSB s4.1 p105);
* add labels to variables in a SAS dataset;
data htwt;
   set htwt;
   label name='First Name of Client';
   label sex='Male/Female';
   label age='Age of Client';
   label height='Height in Inches';
   label weight='Weight in Pounds';
run;

proc contents data=htwt;
   title1 'Adding Variable Labels to a SAS Dataset';
run;


* Use of formats to label or group displayed data ;
* Formats can be used to label the values of variables (LSB s4.5 pp112-113);
* You create formats to label values of variables using a SAS procedure
  called PROC FORMAT. Once formats are created, they are available for
  use in a Data Step or a Proc Step. Notice that you can group values
  into a single category in a format;
Proc format;
   value $sexL
        'M'='Male'
         'F'='Female';
   value agegrp
        0-9 = '00-09'
         10-19='10-19'
         20-29='20-29'
         30-39='30-39'
         40-49='40-49'
         50-59='50-59'
         60-69='60-69'
         70-high='70+';
run;
```

```
* Once formats have been created (by the PROC FORMAT step), you can
  start to use them using a format statement.;
* You can associate a format with a variable in a Data Step;
* This will associate the format with a variable permanently;
data htwt;
   set htwt;
   * The format statement associates the format ($SEXL) with a variable (SEX);
   * format sex $sexL.; ** run this code twice and uncomment the second time ;
run;

proc print data=htwt;
   title1 'Adding Value Labels to a SAS variable using FORMAT Statement';
run;

* You can associate a format with a variable in a Proc Step;
* This will associate the format with a variable temporarily ;
Proc freq data=htwt;
   tables sex age;
   format age agegrp.;
run;

* Notice that you can combine all of these statements into a single
   Data Step.  This step is reduced by moving the datalines to
   an external file.;
data htwt;                  /* Begin the DATA step */
  * Identify the location of the raw data file using
  * an infile statement instead of datalines or cards
  * (LSB s2.4 pp38-39, s2.6 pp 42-43, s2.14 pp 58-59) ;
infile 'X:\course\Raw Data\htwt.raw' ;

         /* Describe variable names and locations */
  * Raw data is read using an INPUT statement;
  * Each line of data in the raw data file = 1 observation in the SAS dataset;
  * Each variable is read from the same column(s) in every line of data;
  * Each variable is assumed to be numeric unless you tell SAS it is
    character using $;
  input name $ 1-10 sex $ 12 age 14-15
        height 17-18 weight 20-22;
   label name='First Name of Client';
   label sex='Male/Female';
   label age='Age of Client';
   label height='Height in Inches';
   label weight='Weight in Pounds';
   format sex $sexL.;

   /*** CARDS or DATALINES removed and identified by infile ***/

run;         /* End the DATA step */

* PC SAS can also read in various kinds of raw data
  from other software such as EXCEL (LSB s2.3 pp36-37, s2.17 pp64-65);
* See File -> Import Data for a wizard to step you through this process.
  The wizard will generate SAS code which can be save and re-used without
  the wizard any time.;
* Here is an example of the code generated by the import wizard in
  reading in an EXCEL worksheet called HTWT.xls.;
```

```
PROC IMPORT OUT= WORK.htwt2
            DATAFILE= "C:\temp\htwt.xls"
            DBMS=EXCEL2000 REPLACE;
     GETNAMES=YES;
RUN;

** Library names can also be used to directly access many kinds of
   files directly (e.g. MS Access, SPSS, DBase, ODBC compliant files, etc...).
   Library names follow the basic format
   libname  NAME ENGINE 'PATH'
       NAME is a user defined name that will represent the data location in SAS
       ENGINE defines the type of data
       PATH is the actual path to the directory or file that contains the
            data.  The use of a directory or specific file depends on the
            type of engine (see engine specific
            online help for each OS);
libname HTWT_MDB  ACCESS 'c:\temp\htwt.mdb' ;

proc contents data=htwt_mdb.htwt ;
run;

proc print data=htwt_mdb.htwt ;
run;
```

* Part II: Sub-setting & Manipulating data, & Creating Variables;

```
* Data manipulation is generally done in a DATA step;
* Subsetting data in the DATA STEP using IF statement (LSB s3.6 pp88-89);

* You can create more than one dataset in a single DATA STEP
  (LSB s6.9 pp194-495);
* This example creates two datasets (MEN and WOMEN) from the HTWT dataset;

* Implied Loop within a datastep (LSB s1.4 pp8-9);

data men women;

        /*Read in the "htwt" data set, keeping only
           3 of the variables */
  set htwt (keep=sex name age );

       /*For the "men" data set keep only the records
          that have a value of "M" for sex */
  if sex='M' then output men;

     /*For the "women" data set keep only the records
        that have a value of "F" for sex */
      /*(Note that records missing values for sex
           would not go into either data set) */
  else if sex='F' then output women;


run;
```

```
proc print data=men;
   title 'Data = Men Subsetted From Data=HTWT using an IF statement';
run;

proc print data=women;
   title 'Data = Women Subsetted From Data=HTWT using an IF statement';
run;


* Temporarily Subset the data in a PROC Step using the where statement
(LSB s4.2 pp106-107);
proc freq data=htwt;
   /* Do this only for age 40+*/
  where age>=40;

  /* Create a table of distribution of sex */
  tables age*sex;

    /* Display formatted values*/
  format sex $sexL. ;

  title1 'Limiting age to 40+ using a where statement';

run;

* We can also use an if statement to subset the data;
data subset40;
   set htwt;
   if age>=40;
   * note this is similar to using if age>=40 then output
        except any processing done after output is not executed
     or we could also have used the statement
     if age<40 then delete;
run;

proc freq data=subset40;
   title1 'Limiting age to 40+ using a subsetting if statement';
   tables age;
run;

* What is the difference between an IF statement and a WHERE statement? (LSB Appendix D,
pp 330-331);
* IF statements can only be used in a DATA STEP;
* WHERE statements can be used in both DATA STEPS AND PROC STEPS;
* WHERE statements can only be used on variables present on the set data;
* IF statements can be used on new variables created in the current data step;


* create new variables in the DATA STEP using various techniques;


proc format;

  value $agelbl     '1' = '1: 0 to 29 yrs'
                    '2' = '2: 30 to 39 yrs'
                    '3' = '3: 40 to 49 yrs'
```

```
                  '4' = '4: 50+ years old';
run;

*******************************************
* Create a new temporary SAS data set,    *
* with the same name, to add 4 new variables *
*******************************************;

data htwt;
   set course.htwt;

*-----------------------------------------------------*
* 1. Numeric Operations (LSB s3.1 pp78-79)            *
* Example: Calculate Body Mass Index (BMI)            *
* BMI measures your height/weight ratio. It is your *
* weight in kilograms divided by the square of your  *
* height in meters.                                   *
*-----------------------------------------------------*;

   bmi = (weight/2.2) / (height*.0254)**2;
   label bmi = 'Body Mass Index';

   ** Created an indicator or dummy variable for high BMI values ;
   high_bmi = (bmi>25) ;
   label high_bmi = 'High BMI values' ;

  ** Alternative;
   If bmi>25 then high_bmi2 = 1 ;
   Else high_bmi2 = 0 ;

*-----------------------------------------------------------*
* 2. IF/THEN/ELSE statements (LSB s3.5 pp86-89)             *
* Example: Create a multi-value variable called "agegroup" *
* using if/then/else statements.                            *
*-----------------------------------------------------------*;

   if 0<=age<=29 then agegroup='1';
   else if 30<=age<=39 then agegroup='2';
   else if 40<=age<=49 then agegroup='3';
   else if age>49 then agegroup='4';

   /* label one of the new variables */
   label agegroup = 'Age grouped into 4 categories';

*-----------------------------------------------------------*
* 3. Functions (LSB s3.2-s3.4 pp80-85)                      *
* SAS provides a large number of built-in functions to help  *
* you create new variables from old variables.              *
* Use the SAS help to find a list of SAS function categories.*
*                                                           *
* Numeric Function Examples:
*   LOG function takes the log to the base e                *
*   ROUND returns a rounded value of a provided variable    *
*
* Numeric functions typically ignore missings unlike
* normal mathematical expressions
*-----------------------------------------------------------*;
```

```
   log_weight=log(weight);
   rounded_log = round(log_weight,.01) ;

*-------------------------------------------------------------*
* String Function Example:
*   SUBSTR extract a portion of variable.                     *
*   UPCASE returns an uppercase string                        *
*-------------------------------------------------------------*;

   name3=substr(name,1,3);
   up_name = upcase(name) ;

run;

proc freq data=htwt;
   tables age * agegroup  /list missing;
   format agegroup $agelbl.; /* add labels to the values of the new variables */
   title1 'The height/weight data set';
   title2 'Check new age group variable against original age variable';
run;

**** NOTE: PROC MEANS excludes the observations with a missing class
     variable value from the analysis unless the / missing class
     statement option is used. ;
proc means data=htwt n nmiss mean;
   title2 'Mean Value of BMI Classified by Age Group';
   class agegroup;
   var bmi high_bmi;
   format agegroup $agelbl.;
run;

proc contents data=htwt;
   title2;      /* remove 2nd title for remaining procs */
run;

proc print data=htwt (obs=10);
run;


* Special Note: Notice how SAS divides programming statements into two
compartments (LSB s1.3 pp6-7):
       1) DATA Steps - Data steps begin with the keyword DATA.  Data steps
       can be used to read in raw data and manipulate SAS data.
       2) PROC Steps - Proc steps begin with the keyword PROC.  Proc steps
       access pre-existing SAS procedures to analyze data.;

***********  SPECIAL TOPIC *********************************
```

* Part III: Getting Data Out of SAS through PROC EXPORT and ODS ;

```
** SAS will allow you to move data and results into
   other formats fairly easily.  We have already been
   sending output to the 'LIST' window but you
   can export the data into another formats with
```

```
   several options ;

** Transfer SAS data sets to another format using proc export ;
* PC SAS can also write data in various kinds of raw data
  such as EXCEL (s9 pp260-275). ;
* See File -> Export Data for a wizard to step you through this process.
  The wizard will generate SAS code which can be save and re-used without
  the wizard any time.;
* Here is an example of the code generated by the export wizard in
  writing an EXCEL worksheet called HTWT.xls.;

PROC export DATA= WORK.htwt
            OUTFILE= "c:\Temp\htwt.xls"
            DBMS=EXCEL2000 REPLACE;
RUN;


** Transfer SAS procedure output using ODS ;
** ODS or Output Delivery System is a wonderful tool for exporting
   output from most procedures in various formats.  This includes
   other datasets as well as other file formats.  There are
   many file formats including html, rtf, pdf, xml, etc...
   (LSB s9.6 pp 272-273, s5 pp 148-175)
** The notop and nobot options leave out the HTML header and
   footer information - this leaves off the stylesheet
   information and reduces the file size ;

ods html file='c:\Temp\htwt_freq.html'(nobot notop)  ;

proc freq data=htwt;
   tables agegroup agegroup * sex  /list missing;
   format agegroup $agelbl.; /* add labels to the values of the new variables */
   title1 'The height/weight data set';
   title2 'Check new age group variable against original age variable';
run;

ods html close ;

** Specific portions of output can also be identified within ODS
   and sent to a dataset or selected for output to another format;
** Running the program once with the 'trace on' option will allow
   you to identify the specific ODS table or pathname of interest
ods trace on / listing ;        ** print 'ODS' names to the list file above the table ;
ods output CrossTabFreqs=freqout ; ** output first table to sas data freqout ;

proc freq data=htwt;
   tables agegroup agegroup * sex  / missing;
   format agegroup $agelbl. sex $sexL. ; /* add labels to the values of the new variables
*/
   title1 'The height/weight data set';
   title2 'Check new age group variable against original age variable';
run;

ods output close ;  *** Turn everything back to the way it was ;
ods trace off ;

title1 'Frequency Cross Tables from HTWT' ;
```

```
title2 'ODS Frequency Output Dataset' ;
proc print data=freqout ;
   run;

title ;

*** Run a regression model and ouptut
    the parameters, estimates, and R-sq values
    to a single data file ;
title1 'Regression with the Height/Weight datset' ;
title2 'Does weight depend on age and height' ;

*** Run once with 'Trace on' to get the ODS objects to place into SAS datasets ;
ods trace on /listing  ;
*** Using the ODS names output the statistics and estimates into a data files ;
ods output fitstatistics=fitstat
           parameterEstimates=paramest ;

*** Run the regresion requesting the basic parameters in an output data file.
    Probabilities and Rsq values need to be pulled using ODS ;
proc reg data=htwt outest=param_out ;
   model weight=age height  ;
   quit;   *** quit is used here since proc reg can be run interactively running each
statement immediately

*** Turn off ODS trace and ODS output ;
ods output off ;
ods trace off ;

*** Parameter estimates from the regression ;
proc print data=param_out ;
  title2 'Parameter Estimates from regression' ;
  run ;

*** build a data file from ODS ouput for R square values ;
data rsquare(keep=rsqr adj_rsq) ;
    set fitstat(where=(label2='R-Square') rename=(nValue2=rsqr));
       set fitstat(where=(label2='Adj R-Sq') rename=(nValue2=adj_rsq)) ;
proc print data=rsquare ;
  title2 'R-Square Values from regression' ;
  run;

*** Build a data file that contains probabilities from ODS output ;
data prob(keep=intercept_p age_p height_p) ;
    set paramest(where=(Variable='Intercept') rename=(probt=intercept_p)) ;
    set paramest(where=(Variable='age') rename=(probt=age_p)) ;
       set paramest(where=(Variable='height') rename=(probt=height_p)) ;
       run;
proc print data=prob ;
  title2 'Probabilities from regression' ;
   run;

*** Combine all of the data files together into a single file.
    Since they are all one record a merge is fine to do in this case
    also consider using if _n_=1 or multiple set statements ;
data param ;
   merge param_out rsquare prob ;
```

```
   run;
proc print data=param ;
  title2 'Combined Estimates, Probabilities and R-Square Values from regression' ;
   run;
```

Example 3

```
* f=htwt_example3.sas                                                  *
* Part I. SAS Options (Printing)                                       *
* Part II. Sorting Data with PROC SORT                                  *
* Part III. Using SET to concatenate multiple SAS data sets              *
* Part IV.  Using MERGE to add variables to a SAS data set              *
* Part V.   Using PROC FORMAT and the PUT function to create new variables *
* Part VI.  Type conversions with put/input                              *
************************************************************************;


                * Part I: SAS Options (printing);
** The SAS options statement can be used to change the
   way SAS works (LSB s1.14 pp28-29) ;
options pageno=1;

** Printing - linesize/page size options.
   1. Set the Page Setup (landscape/portrait and margins)
   2. Set the Print Setup (including the font)
      Check the linesize/pageszie in the print setup.
   3. Set the line and page size options to match print setup.;
options ps=50 ls=130 ;

/** Common SAS Options
Dataset Options                        System Options
Used in parentheses after DS Name      Used with options statement
e.g. Course.htwt(obs=5) ;              e.g. options obs=100 ;
drop=                                  obs=
keep=                                  ps=
obs=                                   ls=
in=                                    fmterror/nofmterr
where=                                 mergnoby=
compress=                              source/nosource
**/

            * Part II: Sorting Data with Proc Sort;
* PROC SORT is used to sort a data set on specified variables
  (LSB s4.3 pp108-109).;

*******************************************************
* This program sorts the data by name and creates a    *
* listing of the values of 3 variables (name being     *
* placed in the first column) for the first 10 records.*
* The resulting output is displayed in alphabetical    *
* order by name.                                       *
*******************************************************;
libname course 'X:\course\data';

data htwt;
   set course.htwt;
run;

proc sort data=htwt;
  by name ;
```

```
run;
*** Use ID statement to label printed observations in place of the
    observation number;
proc print data=htwt (obs=10);
  id name;
  var sex age;
  title1 'PROC PRINT: Example 3';
  title2 'Where the data set is sorted by name';
run;
```

* Part III: Setting or Concatenation of Data ;

```
*1) Adding Observations to a SAS dataset using SET statement (LSB s6.2 pp180-183);
* (From SAS Language Manual, Version 6 Page 486) If more than one data set
  name appears in the SET statement, the resulting output data set is a
  concatenation of all the data sets listed. The SAS System reads all
  observations from the first data set, then all from the second data set,
  and so on until all observations from all listed data sets are read;

* Concatenate the two datasets together in a DATA Step using the set statement;
* Note: IN= creates an automatic variable that indicates whether the data set
  contributed data to the current observation (LSB s6.12 pp200-201).  ;
* In the example below, M1 =1 if the observation comes from the MALE dataset.
  M1=0 if the observation does not come from the MALE dataset.;
* Note that the values of IN= variables are available for use in programming
  in the DATA step in which they are created.  IN= variables are not added to
  the data set being created unless they are explicitly assigned to a variable
  in the DATA step.;

data concat;
   set course.male_htwt (in=m1)
       course.female_htwt (in=m2);
   * explicitly assign the IN= variables to new variables so that they are
       permanently added to the data set concat.  Permanently adding the
       variables gives you the opportunity to use the
     variables in other data steps or procedures.;
   * You DO NOT have to assign the IN= variables to new variables if you
     just want to use them in the current data step.;
   inmale=m1;
   infem=m2;
   run;
proc sort data=concat;
   by age;
run;

proc print data=concat;
   title 'Data=Male and Data=Female Concatenated';
run;

* If you want to concatenate observations from two or more SAS datasets in
  a particular order, you can accomplish this using a SET statement
  with a BY statement.  This is called interleaving data sets.;
* Because this involves a by statement, the data sets must be sorted
  by the interleaving variable.;
```

```
* Interleave the MALE and FEMALE data sets BY age (LSB s6.3 pp182-183);

*** NOTE: data sets must be sorted first before they are interleaved.
    This has been done for the permanent data.;

proc sort data=course.male_htwt out=male_htwt;
by age;
run;

proc sort data=course.female_htwt out=female_htwt;
by age;
run;

data concat_inter ;
   set male_htwt
       female_htwt;
   by age;
run;

proc print data=concat_inter;
   title 'Data=Male and Data=Female Interleaved by Age';
run;

*** NOTE: If Tables only need to be concatenated without processing then proc append may
be a more appropriate way to combine data.
```

* Part IV. Merging or adding variables;

```
*2) Adding VARIABLES to a SAS dataset using MERGE - two datasets with a
   common merge key and different variables (LSB s6.4-6.5 pp184-187)
   Data sets are generally (though not necessarily) merged together using
   a merge key. A merge key is a variable that is common to both data sets - i.e. the
merge key
   must have the same name and length on both data sets;
 * Both data sets must be sorted by the merge key;
 * A one-to-one merge describes the case where both data sets have one
   observation for every value of the merge key;
 * A common error is forgetting to use a BY statement in the merge.
   SAS by default does not report an error in this case. Adding the
   MERGENOBY option will either provide a warning or an error.;
options mergenoby=warn ;

* Add the variable REGION to the HTWT data set;

data htwt;
   set course.htwt;
run;

data htwt_reg;
   set course.htwt_reg;
run;

proc sort data=htwt;
   by name;
run;
```

```
proc print data=htwt;
   title 'Merge Data Set #1: Data=HTWT';
run;

proc sort data=htwt_reg;
   by firstname;
run;

proc print data=htwt_reg;
   title 'Merge Data Set #2: Data=HTWT_REG';
run;

* In a merge, both data sets can contribute variables to the same observation;
* The IN= variables (m1 and m2) will indicate which data sets contributed
  to each observation. The variable FIRSTNAME must be renamed to NAME
  so that the two data sets have a common merge key;
data mer;
   merge htwt (in=m1)
         htwt_reg (in=m2 rename=(firstname=name));
   by name;
   *** explicitly assign in= variables to the variables in_one
       and in_two so they are available in data set mer even after
       the data step is complete;
   in_one=m1;
   in_two=m2;
run;

proc print data=mer;
   title 'Merged Data Set: data=MER';
run;

*3) Match merging - two datasets with a common merge key and different variables
   and different number of observations.  In the end we will see those
   individuals that are over 30 years old and live in Winnipeg.;

*** Subset the HTWT dataset using a WHERE statement ;
data htwt_ov30;
   set course.htwt;
   where age>30 ;
run;

** Subset the HTWT_REG dataset selecting only those who are from Winnipeg;
data htwt_wpg;
   set course.htwt_reg ;
   where region='Winnipeg' ;
run;

proc sort data=htwt_ov30;
   by name;
run;

proc print data=htwt_ov30;
   title 'Merge Data Set #1: Data=HTWT Where age>30';
run;

proc sort data=htwt_wpg;
```

```
   by firstname;
run;

proc print data=htwt_wpg;
   title 'Merge Data Set #2: Data=HTWT_REG Where Region=Winnipeg';
   title2 'Note Number of Observations';
run;

data mer;
   merge htwt_ov30 (in=m1)
         htwt_wpg (in=m2 rename=(firstname=name));
   by name;
   in_one=m1;
   in_two=m2;
run;

proc print data=mer;
   title 'Merged Data Set: data=MER  All Observations';
run;

** Limit data to just those over 30 and living in Winnipeg ;
data mer;
   merge htwt_ov30 (in=m1)
         htwt_wpg (in=m2 rename=(firstname=name));
   by name;
   if m1=1 & m2=1 ;  ** Subsetting if requires contribution from both data sets ;
run;

proc print data=mer;
   title 'Merged Data Set: data=MER Selecting Only Observation Present on Both Merged
Datasets';
run;

*4) One-to-many match merging (LSB s6.5 pp186-187) ;
* One-to-many merging refers to the case where one data set has one
  observation for each value of the merge key and the other data set
  has more than one observation for each value of the merge key.;

* Create a dataset with one observation per value of sex using Proc Means;
* Note:
  noprint option suppresses the printed output from Proc MEANS
  nway option limits the output to the highest level of
  interaction among CLASS variables;
proc means data=course.htwt noprint nway;
   class sex;
   var age;
   output out=mage mean=mean_age;  ** / autoname was not used in this example ;
run;

proc print data=mage;
   title 'Mean age by sex Produced by Proc Means';
run;

*** Note that the original data file is not sorted;
**** use out= option to name the sorted data set and not overwrite the original;
proc sort data=course.htwt out=htwt ;
   by sex;
```

```
run;

proc sort data=mage;
   by sex;
run;

data mer;
   merge htwt (in=m1)
         mage (in=m2 keep=sex mean_age);
   by sex;
   * create a variable that is equal to 1 if age is greater than the mean
     value of age (for each sex) and  0 otherwise.  This is often called
     an indicator variable.;

   if age > mean_age then hi_age=1;
   else if 0 < age <= mean_age then hi_age=0 ;
   else hi_age=.;
   label hi_age='Age Greater than Mean Value of Age for Each Sex';
run;

proc print data = mer;
   title 'Data = Mer - Adding Mean age by Sex';
run;

proc means data=mer n sum mean;
   title 'Proportion of Observations with Age Greater than Mean Age Value';
   class sex;
   var hi_age;
run;

/*
Set and Merge - to the tune of Deep and Wide.

Set and Merge
Set and Merge
There's a Data Step for
Set and Merge
<repeat>
   */
```

* Part V: Use of Put() with formats for creating variables;

```
* Creating a variable using a format statement;
* Previously we learned that formats can be used to label values of
  variables and to aggregate values of variables into groups.
  The example from last class used IF/THEN/ELSE statements to group
  age into 4 groups.;
* Though it is perfectly acceptable to use IF/THEN/ELSE, now we are
  going to show you how to use a fairly advanced technique to do the
  same thing.  ;

* This advanced technique uses formats along with the PUT Function
  to create a new grouping variable. This is mainly useful when you
  wish to group a large number of levels into a relatively small
  number of groups.  A good example would be grouping the 18,000+
```

```
  Winnipeg postal codes into the 12 Winnipeg areas. ;

* PUT and INPUT functions are discussed in general in the LSB, s10.8 (pp292-293).  The
use of these functions with user-defined formats is not discussed ;

* Example: Creating an Age Group Variable using a format and the PUT function;

* Recall that whenever we want to use a format, we must first create the
  format using PROC FORMAT;
proc format;
   * This format groups age into 4 groups;
   value agegrpf
      00-29 = '1'
          30-39 = '2'
          40-49 = '3'
          50-high = '4';
   * This format labels the age group variable;
   value $agegrpl
      '1' = '1: 0-29 years'
          '2' = '2: 30-39 years'
          '3' = '3: 40-49 years'
          '4' = '4: 50+ years';
run;

data htwt;
   set course.htwt;

   * You can create a grouping variable with a format by using the PUT function.;
   * The result of the PUT function is always a character variable.;
   * The put function puts the formatted value of Age into the new
     variable AGEGRP. The new variable AGEGRP takes on the values
     '1','2','3','4';
   agegrp = put (age,agegrpf.);
   label agegrp = 'Age Group';

   *** You can do this using if/then/else statements as well (see last class);
   if 0<=age<=29 then agegroup='1';
   else if 30<=age<=39 then agegroup='2';
   else if 40<=age<=49 then agegroup='3';
   else if age>49 then agegroup='4';
run;

proc freq data=htwt;
   title 'Using the PUT function and a FORMAT to create a new Variable (AGEGRP)';
   title2 'NOTE that AGEGRP has had the Labelling Format $AGEGRPL applied to it';

   tables agegrp*age/list ;
   * note that by applying the labeling format $AGEGRPL to the
     new variable AGEGRP we see the formatted values of AGEGRP
     instead of the underlying values of '1','2','3','4';
   format agegrp $agegrpl.;
run;

** Formatted values and class statements with output data (may be skipped).
* You may well ask why not just apply the grouping format AGEGRPF directly
  to AGE when analyzing it? Or, what is the advantage of using a
  grouping variable when a grouping format will do the same thing?
```

```
  The answer is somewhat complex.
  When the object is just to create a report, a grouping format applied
  directly to the variable for analysis will be adequate.
  When the object of the analysis is to produce an output SAS dataset by
  the grouped variable, you need to be concerned about the underlying
  value of the grouped variable when a grouping format is applied at the
  time of analysis.;

* Here is an example of applying the grouping format AGEGRPF directly to
  age for reporting and for creating a SAS output dataset;

   title 'Applying the Grouping Format AGEGRPF Directly to AGE at Analysis Time';
   title2 'NOTE That the Values 1-4 appear as the Formatted Values of Age';

proc means data=htwt  mean;
   where age ^=. ;
   class age;
   format age agegrpf.;
   var height;
   output out=mheight1 mean=mheight;
run;

proc print data=mheight1;
run;

*** Rerun the means procedure using the created agegrp variable
    The resulting output look identical to the proc means above ;
   title 'Using a created classification variable in proc means' ;
   title2 'NOTE The values for age group are 1-4' ;

proc means data=htwt  mean;
   where age ^=. ;
   class agegrp;
   var height;
   output out=mheight2 mean=mheight;
run;

proc print data=mheight2;
run;

proc print data=mheight1;
   title2 'Here are the Unformatted Underlying Values of Age on the Output SAS Dataset
from Proc Means';
   * note that this statement removes the format AGEGRPF from age and
     prints out the unformatted values of AGE;
    format age;
run;

* So this reveals that Proc MEANS places the lowest value of age for the
  group in the variable age in the summarized  output dataset.
  This may make it difficult to merge the summarized data back to the
  original data since the merge key AGE on the summarized data does not
  match all of the values of Age on the original data. Creating a grouping
  variable on the original data and using it to summarize your data solves
  this problem.;

********** Special TOPIC I ******************************
```

* Part VI: Type Conversions put/input ;

```
****  Type Conversions additional use of input/put functions

** SAS variables are either character or numeric.
If you use character variables in a numeric context
or vice versa, as users frequently do, the SAS system
automatically converts one of the following ways.
  - from numeric to character using the BEST12. format
  - from character to numeric using the $w informat
          (w is the length of the character variable)
When automatic conversion takes place a NOTE is written
to the SAS log. The desired result may not be what
SAS did leading to problematic or unexpected results.
Many users ignore these ubiquitous notes at the peril.

EXAMPLE LOG
   NOTE: Numeric values have been converted to character
   values at the places given by: (Line):(Column).
   52:8
   NOTE: Character values have been converted to numeric
   values at the places given by: (Line):(Column).
   55:9

Implicit conversions are very slow.
To ensure appropriate results when converting between character
and numeric data, use the PUT or INPUT function to control
type conversion.

Often to save disk space indicator variables have been coded
as character 0/1.  To use these variables in analysis such
as a logistic regression they will need to be converted.

INPUT:
Letters or strings that contain letters are set to missing and
and an 'Invalid argument' note is written to the log.

PUT
Missing numerics are written as a period '.' ;
;

*** Setup some data so we can see what the conversions look like.
data riw_test ;
   input @1 flag $1.
         @3 code 4.
         @8 riw $5. ;
   label riw='Resource Intensity'
        code='Coded Diagnostic Group'
           flag='Binary flag' ;
   datalines ;
1 0010 2.474
0 100  0.924
1 006 4.289
0 060 4.289
1 600 1.029
0 113 0.467
l 317 0613
```

```
;
   run;
*** Codes in the above code 006 (Amebiasis), 060 (yellow fever), 600 (Hyperplasia of
prostate)

data calc ;
   set riw_test ;

   *** Calculations on a character string
       returns a numeric but SAS does the
       conversion.  In the above data
       the last record was accidentally
       missing the period.;
   cost = riw * 2234.00 ;

   *** Character operations (concatination)
       returns a character string but not
       what is expected.  The input above
       caused problems as well. ;
   CDG = "CDG " || code ;
run;

proc print data=test ;
   run;

*** Running a proc means to get the proportion
    of the records with a true response does not
    work since the variable is character ;
proc means data=test ;
   var flag ;
   run;

*** Re do the conversions above using
    input/put functions;
data calc ;
   set riw_test ;

   *** input converts the riw to numeric.
       The 5.3 assumes that the field is 5
       characters long with 3 decimals.
   cost = input(riw,5.3) * 2234.00 ;
   CDG = "CDG " || put(code,z3.) ;
   nflag = input(flag,?? 1.) ; ** one value is a lc 'L' ;
       ** ?? supresses the error and value list with input functions ;
       ** ? suppresses the error but prints the value list ;
   run ;

proc print data=calc ;
run;

proc means data=calc mean ;
   var nflag ;
   run;

** In some cases variables will contain multiple 'bits' of
   information where a substring is used to extract the
   flag for an individual condition or switch.  If these
```

```
   variables are accidentally read as numeric the results
   can be non-sensical;
** In the example below a single variable with 1/0 values
   in each position identifies if a condition had occured
   in a particlar year out of ten.  Reading this data
   as numeric would cause have confusing results
   as the default numberic conversion is best12. format.
   With the exception of no-conditions being set the first
   year would always be flagged ;
data five_yr_flag ;
    input @1 flags 10.  ;  **** Missing a simple $ before the 10. ;
    yr1= substr(flags,1,1) ;
    yr2= substr(flags,2,1) ;
    yr3= substr(flags,3,1) ;
    yr4= substr(flags,4,1) ;
    yr5= substr(flags,5,1) ;
    yr10= substr(flags,10,1) ;

datalines ;
1000000000
0100000000
0010000000
0001000000
0000100000
0000000001
;

run;
proc print data=five_yr_flag ;
   run;
```

Example 4

```
* f=htwt_example4.sas                                *
*
* Session 4                                          *
* Part I. By Group Processing (First, Last, retain) *
* Part II. Groups of Variables & Array processing   *
* Session 5                                          *
* Part I. Date Time Processing                       *
* Part II. SQL                                       *
************************************;

** reset page number.  Set page size and line size for landscape printing ;
options pageno=1 ps=41 ls=127;

libname course 'X:\course\data';

%include 'X:\course\Formats\newfmts.sas' ;
```

```
 * Part I: By group processing for Longitudinal Data ;
```

```
* By-Group Processing in a DATA step (LSB s6.15 pp206-207)
---------------------------------- ;
* A BY-group is a group of one or more observations with the same value
  of the BY variable(s). For example, if you sort a data set by Name,
  then a BY-group is all of the observations with NAME='Deborah'.;
* A BY-group may also be designated by more than one BY variable.
  For example, if you sort a data set by NAME and AGEGRP, one of the
  BY-groups could be NAME='Deborah' and AGEGRP=00-19.;
* To process a data set using a BY-group, you must use a BY statement
  in a DATA step. SAS will expect the observations to be in order by
  the value of the variables specified in the BY statement.;
* When processing a data set using a BY-group, SAS generates two
  automatic temporary variables for each variable specified in the
  BY statement: FIRST.variable and LAST.variable.;
* These variables are available for programming in the DATA step, but
  are not permanently added to the data set unless they are explicitly
  assigned to a variable in the data step.;
* FIRST.variable =1 for the first observation in a BY-group and 0 otherwise;
* LAST.variable =1 for the last observation in a BY-group and 0 otherwise;
* If an observation is the first and last observation in a By-group
  (ie the By-group has only one observation in it) then
  FIRST.variable=1 and LAST.variable=1;

*** Create a new data set for height and weight over time (age) for
    two individuals ;
*** In this example we are using comma delimited data ;
data htwt_long ;
   infile datalines dlm=',' dsd ; ** The infile statement tells SAS where the raw
                                  data records are found.  This can be a
                                  separate file or inline using cards or datalines
                                  (LSB s2.4 pp38-39).
                                  In this case an infile is required because the
                                  data is in a delimited format.
                                  dlm - identifies the delimeter,
                                  dsd - tells SAS how to deal with multiple delimiters
```

```
                                    (LSB s2.15 pp60-61) ;
   informat name $10. ;    *** Informats define how the variable should be read.
                               This statement is generally used when the length
                               of individual variables may not be constant over
                               the whole file.  If the length is known the informat
                               can put on the input statement after the variable name
                               (LSB s2.7-2.8 pp44-45, s2.22 pp74).;
   input name age  height weight ;
   datalines ;
Deborah,35,66,125
Deborah,34,66,133
Deborah,33,66,131
Deborah,30,66,130
Deborah,31,66,129
Deborah,32,66,128
Carl,35,70,140
Carl,32,70,155
Carl,36,70,155
Carl,34,70,157
Carl,33,70,160
Carl,37,70,160
;
   run;

* In order to process a data set BY NAME, it must first be sorted by NAME;
* Usually another variable will need to be included to ensure that the order
  within each by group makes sense (e.g. date order) ;
proc sort data=htwt_long;
   by name age;
run;

proc print data=htwt_long ;
  run;

* SAS creates the temporary FIRST. and LAST. variables available to
  the DATA STEP when you indicate you want to process a dataset "by" some variable;
data htwt_long;
   set htwt_long;
   * BY statement indicates the BY-group;
   by name;
   * FIRST. and LAST. variables are NOT permanently added to the dataset, unless they
     are explicitly assigned to a variable in the data set.;
   first_name=first.name;
   last_name=last.name;
run;

proc print data=htwt_long;
   title 'Processing HTWT data by Name';
   var name first_name last_name age height weight;
run;

* SAS has two functions that allow for some basic longitudinal processing.  LAG()
function will return the value for a variable from the last record allowing comparisons
with earlier records. The DIF() function is closely related that it will return the
difference in a value between the current and a prior record.   Both of these functions
can identify more than just the prior record by using a number suffix (e.g. lag5()
returns the value from the fifth prior record.;
```

```
data lag ;
   set htwt_long ;
   by name ;
   lag_weight = lag(weight) ;
   weight_change = dif(weight) ;
run;

Proc print data=lag ;
   var name age height weight lag_weight weight_change ;
   run;

* When using LAG() and DIF() functions it is important that the first value in each by
group be re-set since it reflects the last value of the prior individual in the group.
NOTE: The LAG() and DIF() functions should not usually be defined within an an if/then
block ;
data lag ;
   set htwt_long ;
   by name ;
   lag_weight = lag(weight) ;
   weight_change = dif(weight) ;
   *** reset first values in each by group. ;
   if first.name then do ;
       lag_weight = . ;
       weight_change = . ;
       end ;
run;

Proc print data=lag ;
   var name age height weight lag_weight weight_change ;
   run;

* Using first. and last. processing and the retain statement (LSB s3.10 pp96-97, s6.15
  pp206-207). Use of retain with first/last processing is not covered specifically in
LSB. ;
* The RETAIN statement causes a variable to retain its value across iterations
  of the DATA step.;
* What is a DATA step iteration?
  SAS performs a DATA step iteration for each observation in a data set.
  Each iteration is made up of several steps:
    1) At the beginning of each DATA step, all variables are set to missing,
       including all new variables created in the DATA step.
    2) Observation # 1 is read in, replacing the missing values with the variable
       values
    3) Other calculations are performed such as calculating new variables
       and transforming old variables.
    4) Return to step 1. ;

* When a variable is retained, it is not reset to missing at the beginning of
  the DATA step.  Instead the value is retained until it is explicitly changed
  by programming statements.  DO NOT EVER retain variables that are present on
  the dataset being read in.  Only new variables created within the DATA step
  can be retained.;

*  In this example, the retain statement is used retain COUNT which is used to
   count the number of observations in each BY Group.  Also an index (first)
   weight is retained so that each value of weight can be compared to the index ;
```

```
*  Note the data is sorted by name and age.  This means the records are in ascending
   age order for each individual.  The index weight is the weight for the youngest
   time period. ;
proc sort data=htwt_long ;
   by name age ;
run;

data w_compare(keep=name age index_weight weight over count last_name);
   set htwt_long;
   by name ;
   retain count index_weight ;
   ** When the first record in the by group is encounted, the retained variables are
      assigned values;
   if first.name then do;
      count=0;                *** Why do you think this is set to 0? ;
       index_weight = weight ;  *** Assign INDEX_WEIGHT the value of weight on the first
                                    record in the by group;
   end;
   count=count+1;                    ** Counter for number of records for each ;
   over = (index_weight < weight) ;  ** indicator variable for increased weight ;
   last_name = last.name ;
run;

*** Print out data to see what it looks like ;
proc print data=w_compare ;
   var name age weight over index_weight last_name count ;
run;

*** Print the number of records for each individual ;
*** use SUM statement to print overall sum for variable count;
proc print data=w_compare ;
   where last_name = 1  ;  ** only use the last record in the procedure ;
   sum count ;
   var name count ;
   title 'Data=N Name, Retain Count';
run;

*** Calculate the proportion of measurements that the weight of the individual was
   over their index weight ;
proc means data=w_compare mean ;
   class name ;
   var over weight ;
   title 'Proportion of records where weight was over the index for each individual' ;
run;


** Can you think of another way to get the total number of records for each
   individual in a data set? ;
** If there are other methods to get counts, why do you think we would
   use first/last processing.? ;
** Using a datastep count is faster when there are many levels of the class or by
      variable (e.g. 5000 levels) ;



** First/Last processing can also be used for cumulating other kinds of variables
   in information across by groups.  In this example we will follow the same
```

```
   program as above but we can count the number of times each person is over
   their index weight ;

data w_compare(keep=name index_weight count over_counter percent_over );
   set htwt_long;
   by name ;
   retain count index_weight over_counter ;
   ** When the first record in the by group is encounted, the retained variables are
      assigned values;
   if first.name then do;
      count=0;                *** Why do you think this is set to 0? ;
        index_weight = weight ;  *** Assign INDEX_WEIGHT the value of weight on the first
                                 record in the by group;
     over_counter = 0 ;
   end;

   count=count+1;                    ** Counter for number of records for each ;
   over = (index_weight < weight) ;  ** indicator variable for increased weight ;
   over_counter = over_counter + over ;
   if last.name then do ;
       percent_over = (over_counter/count) * 100 ;
          output ;
          end ;
run;

*** Print out data to see what it looks like ;
proc print data=w_compare ;
   var name count over_counter percent_over index_weight  ;
run;
```

* Part II. Groups of Variables & Array processing;

```
*** Groups of Variables
------------------------

*** Using Groups of Variables with functions and arrays ;

proc contents data=course.htwt_wide;
run;

proc print data=course.htwt_wide ;
  run ;

* Many SAS functions can be used with groups of variables to get summary
  statistics and information (LSB s3.2 & s3.3, pp80-83.
    MIN(arg,arg) or MIN(of X1-Xn)
    MAX(arg,arg) or MAX(of X1-Xn)
    SUM(arg,arg) or SUM(of X1-Xn)
    MEAN(arg,arg) or MEAN(of X1-Xn)
  Unlike normal arathmetic opperations SAS funcitions do not return a missing
  value when calculations are attempted on a missing.  Missing values are
  skipped.
  ;

** Example: returning summary statistics from groups of similar variables;
```

```
data wide ;
    set course. htwt_wide ;

       *** Use various statistical functions for getting summary values
           of weight ;
       count = n(of age1-age6) ;
       sum_weight = sum(of weight1-weight6) ;
       mean_weight = mean(of weight1-weight6) ;
       min_weight = min(of weight1-weight6) ;
       max_weight = max(of weight1-weight6) ;
       run;

proc print data=wide ;
   title 'Summary Statistics using multiple variables and functions' ;
   var name count sum_weight mean_weight min_weight max_weight ;
run;


* Array processing  (LSB s3.10 pp94-97)
------------------------------------- ;
* Arrays allow you to group many variables together in order to
  apply the same processing to each variable.;

* Using an array to determine if an event happens ;
data event ;
   set course.htwt_wide ;

   * In the DATA step, you can put variables into a temporary group called an ARRAY
     using an ARRAY statement. The following statement groups the variables
     age1 through age6 into an array called ag.;
   * Note that SAS allows you to refer to several variables with the same
     prefix with a "-" instead of listing them;
  array ag{6} age1 age2 age3 age4 age5 age6 ;

   *** create a flag so so records with age 35+ can be identified. ;
   age_flag = 0 ;

   * To tell SAS to perform the same action several times, use an iterative DO loop.;
   * This statement iterates 6 times, once for each member of the array ag.;
   * 'i' is a new variable that is used as a counter for each iteration and
      allows SAS to select the corresponding location in the array ;
   do i = 1 to 6 ;
      if ag{i} >= 36 then age_flag=1 ;
     end ;
   run;
proc print data=event ;
    title 'Flag all records with an age over 35' ;
    var name age1-age6 age_flag ;
       run;

* Using an array and functions together ;
data event ;
   set course.htwt_wide ;
   *** Create an array with all of the array values ;
   array wt{6} weight1 weight2 weight3 weight4 weight5 weight6 ;
   *** the over{} array creates 6 new variables for testing results ;
   array over{6} over1 over2 over3 over4 over5 over6 ;
```

```
   *** Calculate the mean value of weight for selection procession ;
   mean_weight = mean(of weight1-weight6) ;

   *** Process all of the values in weight array and put the
       results into the new over array ;
   do i = 1 to 6 ;
      if wt{i} >= mean_weight then over{i}=1 ;
      end ;

   *** Total the number of times the individual was over their mean weight ;
   total_over = sum(of over1-over6) ;

   *** The variables in the over{} array were not initialized to zero (0) would
       This have any implications on the use of other statistical functions such
       As mean()?.   Initialize the array to zero in the do loop above using
          Over{i} = 0
       Or in the actual array statement using
          Array over{6} over1-over6 (0 0 0 0 0 0) ;
   run;

proc print data=event ;
    title 'Mean weight and Counter of weight over time - Array' ;
    var name mean_weight weight1-weight6 total_over ;
       run;

* Example: Find all records with any ICD10CA diabetes code. Count the number of
        times diabetes was coded on a single record.  Keep only those records
        with diabetes coded Using ICD10CA Diabetes is coded with multiple
        strings for different types and associated conditions.;

data diab;
   set course.hospital;

   * Define the array of diagnosis codes ;
   array dx(10) icd10_01-icd10_10;

   ** Initialize the diabetes flag and counter ;
   countdiab=0;  * Note that the values are set to 0 at the start of each data step
iteration ;
   finddiab=0;

   * finddiab=1 if there is 1 or more diabetes diagnosis code on the record;
   * countdiab counts the number of diabetes diagnosis codes present on the record;
   * The in() operator allows you to look for any one of the identified strings.
   * You can limit the number of times a do loop is processed using while or until ;
   do i=1 to 10 until(dx{i}='');
      if dx(i) in:('E10','E11','E12','E13','E14') then do;
         finddiab=1;
            countdiab=countdiab+1;
         end;
      end;
   if finddiab then output;

run;

*** count the number of records with diabeties and corresponding
```

```
    number of times a diabetes diagnosis was found in a single record ;
*** Can you think of a way to count the number of records with a diabetes
     code without using PROC FREQ?  Think back to the use of retain in an
     earlier example ;
proc freq data=diab;
   tables finddiab*countdiab/list missing;
run;

proc sort data=diab;
   by ident;
run;

proc print data=diab (obs=50);
   title 'Hospitalizations with Diabetes Diagnosis';
   var ident icd10_01-icd10_10 finddiab countdiab;
run;

Proc freq data=diab;
   title 'Number of Diabetes Diagnoses on a Hospital Record';
   tables countdiab;
run;

** If you want counts for the number of diabetes diagnoses try
   using a weight statement -  weight countdiab ;
```

* SESSION 5. ;

```
****************** SPECIAL TOPIC I: SAS DATES *****************;
```

* Part I: Date time processing ;

```
*** WORKING With SAS Dates (LSB s3.7 pp88-91)
* It can be difficult to work with character date and time variables: months have 31,
30 or 28 days, leap years, etc.;

* SAS has special numeric date variables called SAS Dates that allow you to add, subtract
and do other calculations without worrying about the number of days in a month or year.;

* SAS dates represent the number of days since (or before) January 1, 1960.  Below are
some examples of SAS dates:

Date                          SAS Date
January 1, 1960                  0
January 1, 1961                366
January 1, 1959               -365
March  31, 2007              17256
March  31, 2008              17622

* The difference between March 31, 2007 and March 31, 2008 = 17622-17256 = 366;
* SAS "knows" that 2008 is a leap year and includes that extra day in the calculation;
* http://support.sas.com/techsup/technote/ts668.html ;

A little side note: The earliest date that is valid in SAS software is January 1, 1582 --
SAS software uses the Gregorian calendar. That is the year that France, Italy,
Luxembourg, Portugal, and Spain replaced the Julian calendar with the Gregorian. (The
Gregorian calendar was first implemented so that the day after October 4, 1582 was
```

```
October 15, 1582. Nevertheless, SAS software recognizes 31 days in the month of October,
1582.) While the rest of Roman Catholic Europe switched shortly after 1582, the United
Kingdom and its colonies did not move to the Gregorian calendar until 1752. Many other
countries switched even later, including the Soviet Union in 1918 and Greece in 1923.
Some historic dates therefore might be handled in a misleading manner -- a problem which,
it should be noted, is true of any use of SAS dates in such instances.

data dates;
       infile 'X:\course\Raw Data\dates.txt' firstobs=2  ;
   input
     @1 ident $8.
     @11 sex $1.
     @13 sasdatedob yymmdd8.  /*** read data directly into SAS Date format ***/
     @23 admdate $8.
     @33 sepdate $8.
     ;
   *** create SAS date variables from character variables using INPUT functions
     (LSB s10.8 pp266-267)and SAS Date/Time INFORMATS (LSB s2.8 pp44-45).;
   *** INPUT functions are similar to PUT functions, except that INPUT returns
     a numeric value while PUT returns a character value.  Date values are often
     provided as character strings and must be converted to SAS dates either with
     an input statement (see below) or when reading the data with an input statement.;
   sasdateadm = input(admdate,yymmdd8.);
   sasdatesep = input(sepdate,yymmdd8.);
   label sasdateadm = 'Date of Hospital Admission, SAS Date';
   label sasdatesep = 'Date of Hospital Separation, SAS Date';
   format sasdateadm date9. sasdatesep yymmdd10. ;

   *** obtain the month of admission from the SAS Date variable using the MONTH function;
   month_adm = month(sasdateadm);
   month_sep = month(sasdatesep);
   label month_adm = 'Month of Hospital Admission';
   label month_sep = 'Month of Hospital Separation';
   *** obtain the Day of the week for admission from SAS dates using weekday function
       The SAS week starts with Sunday being 1 ;
   weekday = weekday(sasdateadm) ;

   *** Simple difference between two date variables is the number of days ;
   los  = sasdatesep - sasdateadm ;

   *** Intervals measurements are often useful for determining the passage of time
       e.g. the number of weeks (number of Sundays) or months (1 day of each month)
       between two dates.  Intervals are determined using the INTCK() function.
       Number of week intervals between the dates determined by Monday. ;
   weeks_passed = intck('week.2', sasdateadm, sasdatesep) ;

   *** often you may want to calculate the number of days between an event and a
     constant index date, where the event date is a variable in the data,
     but the index date is a fixed day. You can enter in any fixed date as a SAS
     date in the following  using: 'DDmonYYYY'd
     The 'd' trailing the quoted string indicates that the string is a SAS date;
   datediff = '01mar2004'd - sasdateadm;
   label datediff = 'Number of Days between Date of Admission and March 1, 2004';

   *** Calculation of actual age - this is often done by dividing by 365.25 ;
   *** Floor takes the integer value from the decimal value ;
   agesep = floor(yrdif(sasdatedob,sasdateadm,'ACT/ACT')) ;
```

```
   *** YRDIF function has been used but there are potential small inaccuracies
       http://support.sas.com/kb/36/977.html
       http://www.mofeel.net/1169-comp-soft-sys-sas/38953.aspx
   *** The SAS macro _age() has been provided for more accurate age calculation
       using the intck function.
       Age = %_age(sasdatedob,sasdateadm) ;
   label agesep='Age at Separation'  sasdatedob='Date of Birth, SAS Date' ;
   format sasdatedob yymmdd10.  ;
run;

*** SAS dates can be displayed many different ways using SAS Date/Time formats
    (LSB s4.6 pp110-111);
proc print data = dates (obs=20) label;
   var admdate sasdateadm sepdate sasdatesep datediff sasdatedob agesep weekday los
weeks_passed;
   title 'Character Dates and SAS Dates';
   *** comment the line below to see different SAS date formats;
   format sasdateadm  sasdatesep ;
run;

proc contents data=dates ;
  run;

proc univariate data = dates;
   var month_adm month_sep;
   histogram /normal midpoints = 1 to 12 by 1;
   title 'Distribution of Hospital Stays by Month';
run;

****************** SPECIAL TOPIC II SQL Processing**************;
```

* Part II: SQL Processing ;

```
* An alternative to some procedures and data step programming
   would be to use Proc SQL.  We will not be covering
   this procedure in depth during this workshop but those familiar with SQL should
   know that it is available.  Merges and sets can also be done with
   joins in Proc SQL but it is often more efficient do use base
   SAS data step processing.  (LSB Appendix F pp 302-305);

* SQL stands for Structured Query Language and was originally developed by
  IBM for extracting information from databases.  SQL works on processing
  columns (variables) rather than observations (in an implied loop).

* Procedure SQL commands              Base SAS equivalent ;
  /* Proc SQL ;
      create DATA as                  (Data statement)
         Select                       (Keep & proc print & proc means statistics options)
         From  <left/right join>       (Set/merge statement)
         Where (on)                    (Where statement & By statement in merge)
         Group by                        (class statement)
         Having                          (post processing datastep from proc means)
         Order by ;                      (proc sort)
         quit ;
*/

* Common problems:
```

```
      1. When listing multiple variables and datasets they must be separated by
         commas.
      2. An SQL command is one single statement.
      3. Use of an alias for a permanent SAS datasets can be confusing.  Since
         SQL uses a period ('.') to identify a table.field there needs to be
         a way for a permanent datasets (library.table) to be identified.
         In SAS SQL use the notation 'as' to identify an alias or short name
         to represent the permanent dataset.

* Top reasons for using SQ
        1. 'Fuzzy' merge
        2. Join tables (esp multiple database with different keys)
        3. Add summary data to groups/overall
        4. Save steps on basic processing
        5. Easier for other DB programmers to understand
        6. Selections (Where) can use wild characters.

* Where selections can include the comparison clauses:
     LIKE with wild characters represented by:
            an underscore (_) to represent a single character.
            a percent sign (%) to represent a string of characters.
     CONTAINS to search for a string within a string. ;

** Basic printed output ;
proc sql ;
   select name, sex, height
   from course.htwt ;
   quit ;

** Basic query to create a male only file ;
proc sql ;
   create table males as
   select alias.name, alias.age, alias.sex, alias.height, alias.weight
   from course.htwt as alias
   where sex='M';
   quit ;

** Adding overall mean to every record in a dataset (from above)
   doing a calculation with a newly created variable;
proc sql ;
   create table test as
   select alias.*, mean(weight) as meanwt,  weight-(calculated meanwt) as diff
   from course.htwt as alias ;
   quit ;

proc print data=test(obs=10) ;
   title 'Data table created with Average LOS on each record using SQL' ;
   var name sex weight meanwt diff ;
   run;

** Adding mean age for each sex to every record in a dataset (from example prog 3 ;
proc sql ;
   create table mage as
   select alias.*, mean(age) as mage,
      age>(calculated mage) as high_age label='Age Greater than Mean Value of Age for
Each Sex'
   from course.htwt as alias
```

```
   group by sex
   order by age ;
   quit ;
proc print data=mage ;
   title 'Data table created with Average AGE by sex using SQL' ;
   run;

** Joining two datasets together by key variables (from example prog 3)
   and printing results ;
title 'Data table created with a join by name/firstname using SQL' ;
proc sql ;
  create table merged as
    select htwt.*, htwt_reg.region
    from course.htwt as htwt,
       course.htwt_reg as htwt_reg
    where htwt.name = htwt_reg.firstname ;

  select *
      from merged ;
  quit ;

** Joining two datasets together by a key variable and a 'fuzzy' connection
   Keeping only the most recent hospitalization prior to death within 180 days ;
 proc format;
  value weekdnme
     1='1: Sunday'
     2='2: Monday'
     3='3: Tuesday'
     4='4: Wednesday'
     5='5: Thursday'
     6='6: Friday'
     7='7: Saturday' ;
   run ;

title 'Count of Deaths by Week Day' ;
proc sql ;
   create table death as
      select hosp.ident, hosp.admdate, hosp.sepdate, hosp.deathsep,
           reg.deathdate, deathdate-sepdate as diff,
           weekday(deathdate) as week_day_death format=weekdnme.
      from course.hospital as hosp,
         course.registry as reg
      where hosp.ident=reg.ident
          & 0<=deathdate-sepdate<=180
             & reg.deathdate^=.
      group by hosp.ident
      having diff=min(diff)
      order by hosp.ident, diff ;

   select week_day_death, count(week_day_death) as count
      from death
      group by week_day_death;

   title 'Count of Deaths at separation for hospital by Week Day' ;
   select week_day_death, count(week_day_death) as count
      from death
      where deathsep = 1
```

```
      group by week_day_death;

   ** Question should deathsep=1 be the same as diff=0? ;

quit ;

*** SPECIAL TOPIC III Attaching 1 calculated value to many records *** ;

** Sometimes we want to add a calculated value (example average los for Manitoba)
   to every record in a dataset.
   This can be done if you know the value by using retain or an explicit assignment.
   Sometimes the value comes from a calculation and we do not really want to type it
   in again. You now also know how to do this using SQL;

** Calculate the average hospital LOS for the whole dataset.  Output this information
to a SAS dataset.;
proc means data=course.hospital  ;
  var los ;
  output out=overall_los mean=avg_los ;
  run;

proc print data=overall_los ;
   title 'Average LOS for the Whole Dataset';
  run;

** Calculate the difference from the Average LOS for each individual hospitalization.;
data test ;
    set course.hospital(keep=ident los ) ;

    ** _N_ is an example of a SAS automatic variable that is always available
          to you in the data step.  _N_ indicates the number of times SAS has
          implicitly looped through the DATA step.  Usually this is the same
          as the observation number.  However it may be different if you have
          used a subsetting IF statement (LSB s6.14 pp196-197).;

    ** This statement gets the information in OVERALL_LOS (which contains
          the average los)when the first record in course.hospital is read.  The
          variables in OVERALL_LOS are implicitly retained across all the
          observations in COURSE.HOSPITAL.  This allows us to calculate the
          difference from the average for every hospitalization in COURSE.HOSPITAL. ;

    if _n_ = 1 then set overall_los (keep=avg_los);

    diff=los-avg_los;
    run;

proc print data=test(obs=50) ;
   run;


***************** SPECIAL TOPIC IV ******************************;
** We will do this example if we have time and interest;
*****************************************************************;

*** The following is a fairly advanced example but it gives you
   a more concrete example of where you might want to use first/last
   processing ;
```

```
*** We will be calculating the difference between an index separation date
   and follow-up admission dates.  The difference between each separation
   date and the following admission is also calculated.

   Exmaple
       ID  ADMIT   SEP  INDEX_SEP  DIFF_FROM_INDEX   LAST_SEP  DIFF_FROM_LAST
                          retain      (admin-index)    lag(sep) (admit-last_sep)
       1    1       2      2            .               .          .
       1    5       7      2            3               2          3
       1    10     14      2            8               7          3
       1    20     25      2           18              14          6
       2    3       5      5            .               .          .
       2    8      10      5            3               5          3
       2    15     24      5           10              10          5

*** In this example we use SAS data/time variables.  These variables are
   special to SAS in that they are numeric and represent the number of days
   since (before) January 1, 1960.  Unlike date strings these can be
   used in calculations (e.g. subtraction) to give a correct time between
   dates.
   The difference between '19990101' and '20010101' is  20000.  We really expect it
   to only be 365.  In a SAS date variable 19990101 is 14245 and
   20010101 is 14601.
*** Calculation of time to readmission from index separation event ;
*** Calculation of time from last separation ;

data test ;
   *set course.hospital ;
       infile 'X:\course\Raw Data\hospital07.txt' ;
   input
     @2 ident $8.
     @10 sex $1.
     @11 dob $8.
     @26 admdate $8.
     @34 sepdate $8.
     ;
   *** Convert date of admission/separation to SAS dates
       because of missing century on some dates ;
   *** A SAS date is an internal representation of
       a date that SAS uses.  It is a count of the
       number of days since January 1, 1960 ;
   admit = input(admdate,yymmdd8.) ;
   sep = input(sepdate,yymmdd8.) ;
run;

** Since I am interested in readmissions for an individual
   I will need to identify individuals (by group) and
   make sure the data is sorted in the appropriate
   order of admissions ;
proc sort data=test ;
   by ident admit sep ;
     *** SAS has many built in formats.  The following format statement
      uses one of these built in formats to show an understandable
      date ;
   * format admit sep date9. ;
run;
```

```
*** Read the test data by id so SAS knows about the
   groups of individuals ;
data test ;
   set test ;
   by ident ;

   *** We need to identify the index (or first) separation
       and hold onto that value for all of the other
       records for each individual ;

   retain index_sep ;

   *** Lag is a SAS function that will allow you to get
       the value of a variable from a prior data step iteration ;

   last_sep = lag(sep) ; *** get last value of sep ;

   *** The first time that we see and individual we need
       to keep the separation date.  This will allow us
       to count the days to readmission ;
   *** If it is not the first record for an individual then
       calculate the days between the current admission and
       the last or index separation ;

   if first.ident then do ;
      index_sep = sep ;
       last_sep = . ;  * since the last separation belongs to
                       someone else then explicitly make it missing ;
    end ;

   else do ;
     diff_from_index = admit - index_sep ;  ** Index admission ;
     diff_from_last = admit - last_sep ;    ** Last admission ;
   end ;
run;

*** Print the data to see if it is OK. ;
*** Are diff_from_index and diff_from_last the same on all records? ;
proc print data=test ;
  where diff_from_index^=diff_from_last ;
  id ident ;
  var admit sep index_sep diff_from_index diff_from_last ;
  format admit sep index_sep date9. ;
  run;
```

Graphic User Interface to SAS (point-and-click)

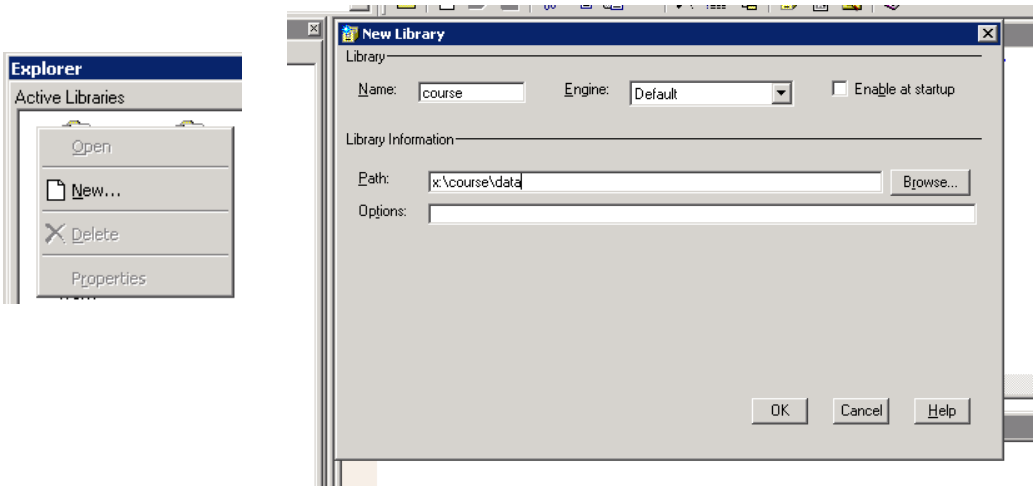
The following is intended to provide a brief introduction to parts of the SAS Graphical User Interface (GUI) for doing analytic tasks. SAS Analyst and Insight are no longer included in this section of the workshop as they will be discontinued after SAS version 9.2; they have been replaced with IML Studio and SAS Enterprise Guide. This portion of the workshop is only here to provide some insight into the graphic interfaces available in SAS it does not cover all of the possible options or capabilities of the different packages.

SAS Explorer and ViewTable using the SAS Display Manager

The SAS explorer is similar to the Windows explorer and provides file management and review capabilities including the definition of SAS libraries and moving or copying data files, and reviewing or setting file attributes. We have already seen the SAS explorer earlier in this workshops, it is part of the SAS programming environment.

Creating a New Library

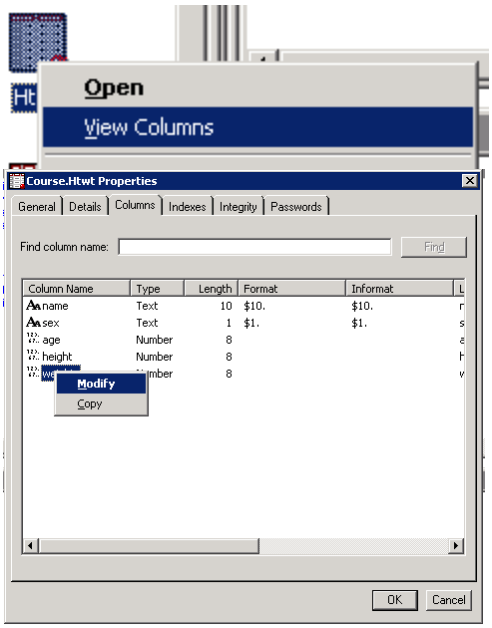
New libraries can be identified by right clicking in the explorer window and selecting 'New…'



The path name and the new library name must be completed. If you want the library to reappear every time you re-start SAS check the 'Enable at startup' check box. Various engines and options can also be select for the defined library.

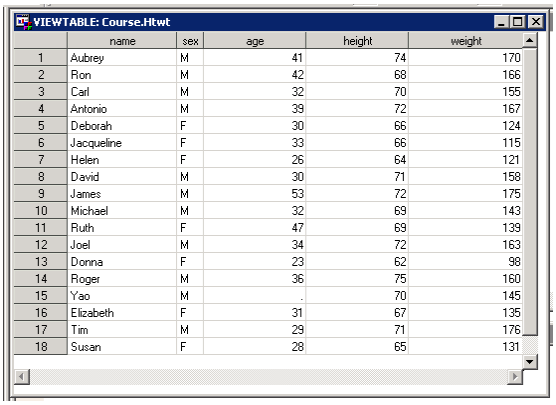
Contents of a Dataset

The contents of a SAS dataset can be reviewed from the explorer by right clicking on the dataset name and selecting 'View Columns…' This will show the variable names, formats, and associated labels. By right clicking on the variable name you can modify all of the associated attributes.

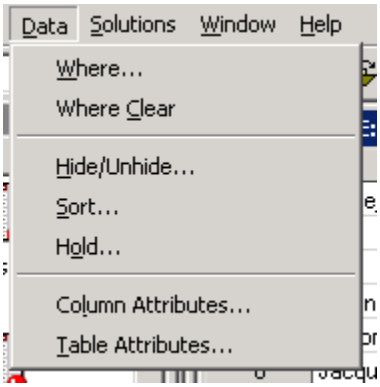


Open and preview a SAS Dataset

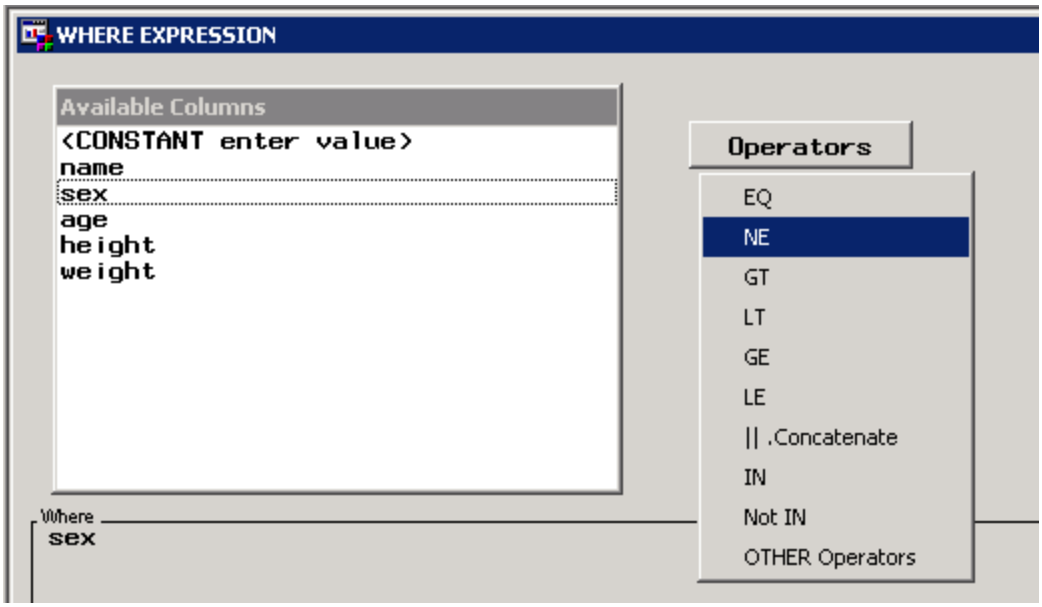
By double clicking on a SAS dataset in the explorer window the actual values and variables will be displayed in a ViewTable window. ViewTable can be used to preview variables and values in the dataset, temporarily select subsets of the data, hide/unhide variables (columns), sort the data and modify values and variable attributes.



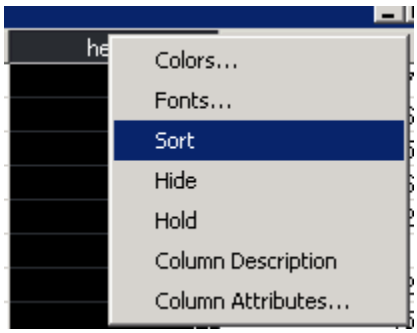
	name	sex	age	height	weight
1	Aubrey	M	41	74	170
2	Ron	M	42	68	166
3	Carl	M	32	70	155
4	Antonio	M	39	72	167
5	Deborah	F	30	66	124
6	Jacqueline	F	33	66	115
7	Helen	F	26	64	121
8	David	M	30	71	158
9	James	M	53	72	175
10	Michael	M	32	69	143
11	Ruth	F	47	69	139
12	Joel	M	34	72	163
13	Donna	F	23	62	98
14	Roger	M	36	75	160
15	Yao	M	.	70	145
16	Elizabeth	F	31	67	135
17	Tim	M	29	71	176
18	Susan	F	28	65	131



The 'Where…' screen will allow you to interactively define a where statement based on variables in the dataset and/or constant values. Once a variable is selected the appropriate operators are displayed for the next operation. Only the records that meet the defined criteria are displayed in the ViewTable. That way you can preview a specific set of records of interest, such as outliers or other problematic records.



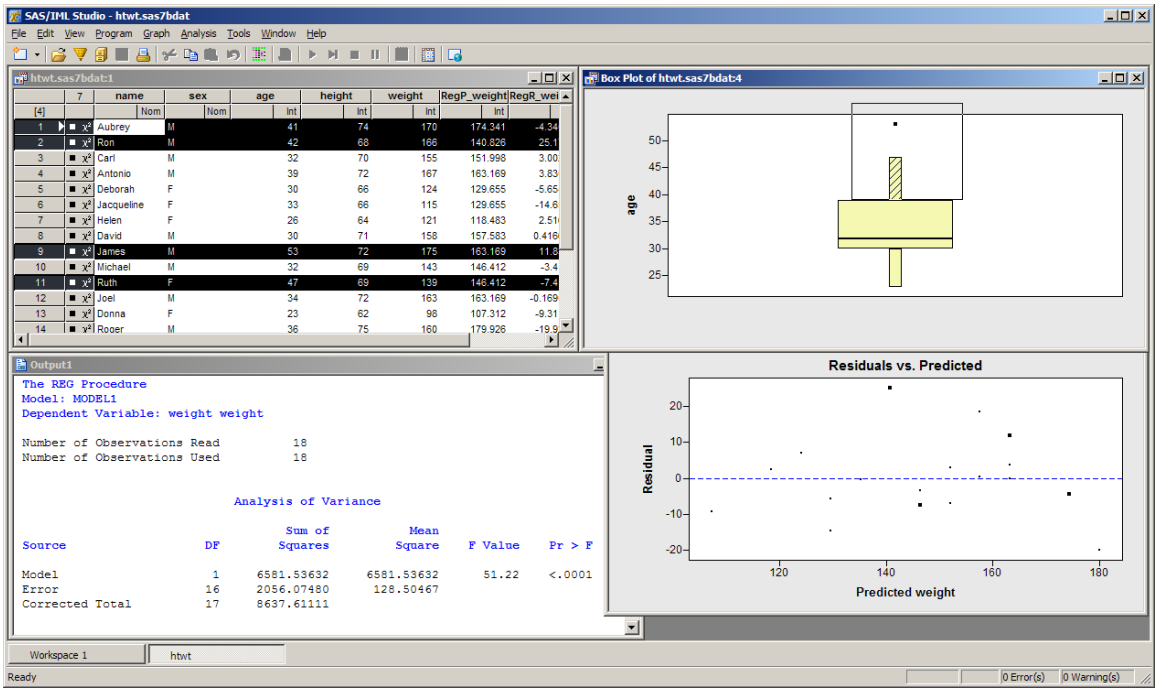
By right clicking on a variable name you can sort the data, hide the column or look at the variable attributes.



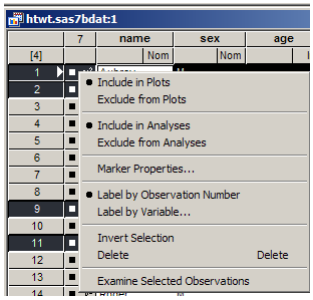
SAS IML Studio

SAS IML Studio (SAS® Stat Studio) is another separate application that allows for data exploration and analysis in the Windows environment – it is the successor to SAS Insight. It is similar to Insight in that it creates linked table and graphic output for data visualization and exploration. IM Studio allows for many more graphic and statistical routines along with an enhanced programming interface for those routines. If you have the 'R' statistical package installed you can also call 'R' routines from within the IML Studio environment.

When selecting records or ranges of records in one screen they will also be selected in the others. That way outliers identified through histograms, distributions, even regressions can be identified in the data table.



Records in the data table can be identified to include (default) or exclude in either calculations or graphics. By right clicking on one of left most column of the table you can exclude the selected records from further use. Because records can be identified, selected, through the graphic windows outliers can be excluded easily as a group – all records are treated the same way by changing one all the rest are changed.



More Information can be found online at:
http://support.sas.com/documentation/onlinedoc/imlstudio/index.html
Using R with SAS IML Studio:
http://support.sas.com/documentation/cdl/en/imlug/63541/HTML/default/viewer.htm#r_toc.htm

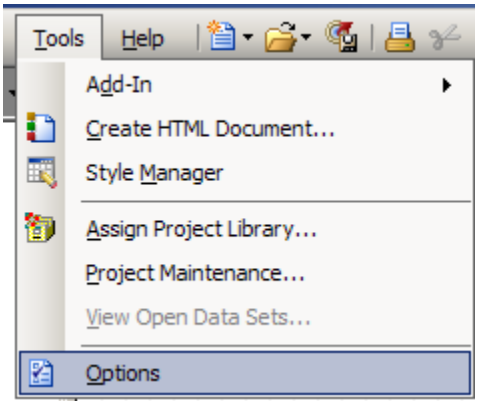
SAS Enterprise Guide

Starting with SAS 9.2 SAS Enterprise Guide is available under the University site licence. What is SAS EG you might ask? SAS Enterprise Guide is a separate SAS application that provides a graphic interface to SAS data manipulation and analysis – basically it writes SAS code for you using a visual programming environment, or Designer, where you just need to select data and tasks through menu items or dialog boxes. Tasks are displayed as interconnected icons in the *Designer* following a *Process Flow*. The tasks and programs in a process flow can all be saved in a *Project*. Projects then can be opened again and re-run as a whole unit, process branches, or even individual tasks. Each task can be opened and the actual code, log, and results previewed. Your own SAS code can be added allowing you to use both the pre-set tasks and user defined programs. The code from the GUI created tasks can be copied into your own code for modification if necessary. An existing SAS program can even be analyzed and converted into a process flow. Enterprise Guide is now the default environment that is opened under Windows when a SAS dataset or program is opened from Windows Explorer.

This introduction to EG is very brief additional documentation can be found from the SAS online documentation. There are a number of very helpful third party online references – because EG is changing rapidly you may be better off doing an internet. I have found The Little SAS Book for Enterprise Guide® by Susan Slaughter and Lora Delwiche a helpful introduction.

Enterprise Guide Environment

Like many Windows based programs today the Enterprise Guide environment can be highly modified with multiple docking windows and screens. If you have re-arranged the windows (on purpose or by accident) and want to return to the default settings just select 'Restore Window Layout' under the General tab under **Tools->Options** menu.



The work that you do in Enterprise Guide can be saved into projects where a Project is a collection of related tasks and contains all of the pointers to existing data (but not the data), tasks, code, results, and logs. Complex projects can be broken, or displayed, as

several process flows. Just like your regular SAS code the data is not actually stored as part of the project so it can be used in many places within the same or other projects.

Although projects can be saved as a separate file, and given to other people, remember that it does not contain the actual data or linked code and the final users must have the ability to create the same library or file access or the Project (and contained processes & tasks) will not run.

A Project contains a number of icons (nodes) that follow a specific process flow. The design of the process and associated tasks are done within the Project Designer window or Explorer. The Project Designer can have several types of items:

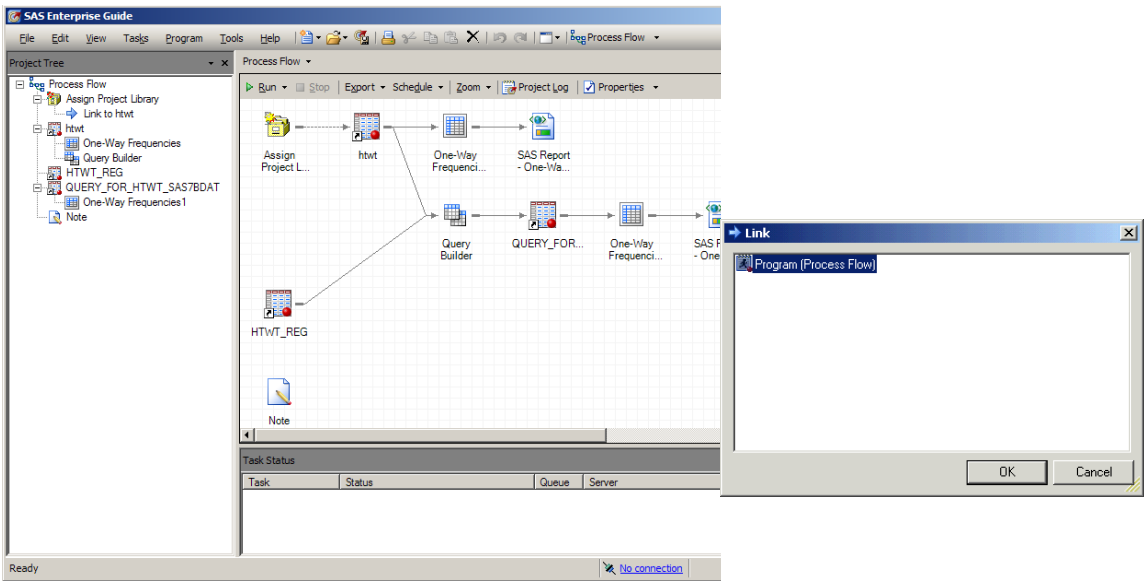
Data: Represent SAS datasets in either permanent or temporary libraries, raw data files or tables from other database applications (e.g. Excel or MS Access). These are just pointers to the external data files (note the little arrow on the bottom left).

Tasks: Specific data manipulation or analysis requests. This can be a simple query to a complex statistical analysis request or even a SAS program that you have written. Tasks, in particular program code, that is linked to an external file will contain a small arrow on the bottom left side of the task icon.

Most tasks are associated with one or more SAS procedures. SAS has provided a list of tasks and the corresponding procedure that is used/required:
http://support.sas.com/documentation/onlinedoc/guide/sastasksandprocs.htm

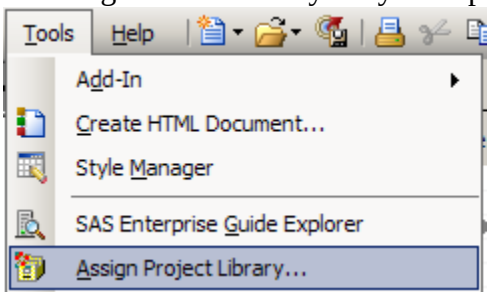
Results: Resulting tables, reports, or graphs or other output that are created by Tasks.

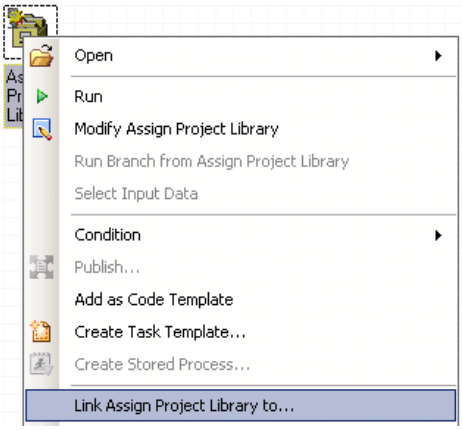
Notes: Generally these are used for documentation or commenting your project.



Define SAS Library

If you want to create your own library as part of the process select **Assign Project Library…** from under the tools menu. This step is not always necessary, but good practise, as Enterprise Guide will generate a library for you as part of the project.

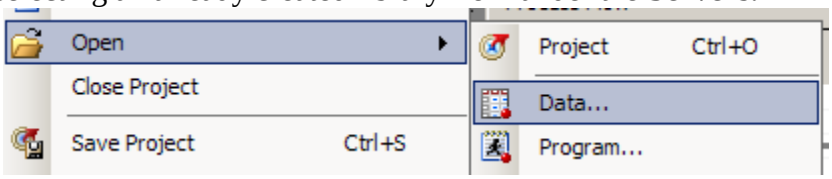




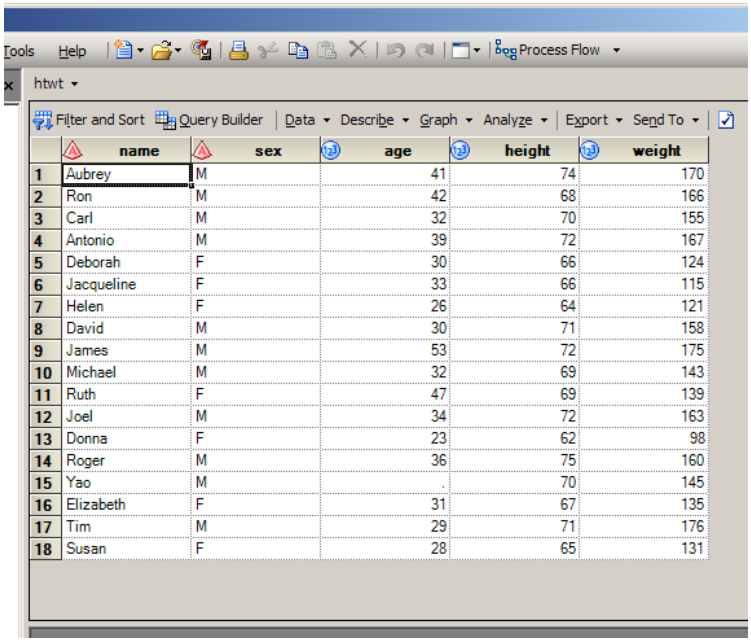
Once a library is generated you might want to include it as part of your process flow. Adding it to the process flow through a link will allow you to include it when re-running parts of your project.

Loading SAS Data

SAS data, as well as other types of data, can be loaded into a process flow by selecting **File->Open ->Data** and finding the data either directly on the computer through the file structure or selecting an already created library from under the **Servers.**

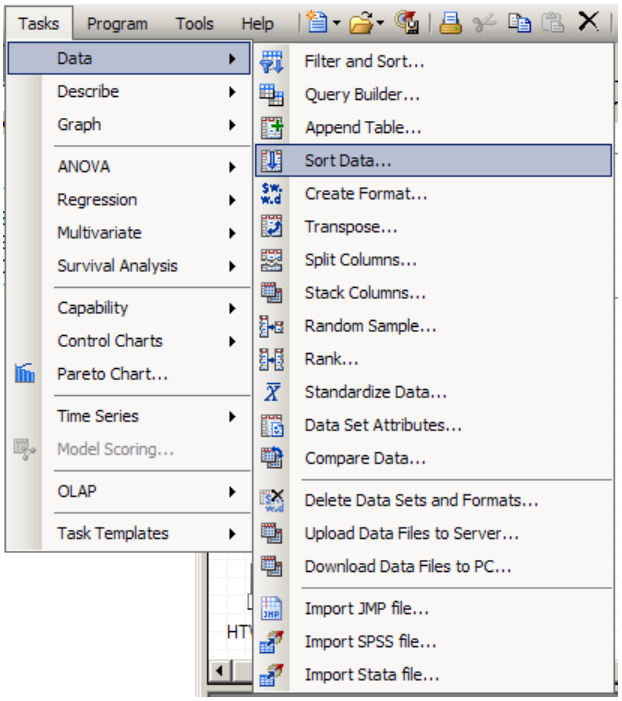


Once a dataset has been loaded an icon will appear in the Designer, by default the data set will also be opened in preview mode (this feature can be turned off when using large datasets using the option 'Automatically open data when added to project' under the **Data General** tab under **Tools->Options** menu). The dataset can be opened and previewed at any time by double clicking on the data icon or selecting **Open** from the context menu. The preview has similarities with ViewTable mentioned earlier but within the dataset preview you can also run a whole series of tasks (filters, descriptive analyses, graphics, exports, and statistics). Any selected analyses will be saved as part of the process flow in the project.



	name	sex	age	height	weight
1	Aubrey	M	41	74	170
2	Ron	M	42	68	166
3	Carl	M	32	70	155
4	Antonio	M	39	72	167
5	Deborah	F	30	66	124
6	Jacqueline	F	33	66	115
7	Helen	F	26	64	121
8	David	M	30	71	158
9	James	M	53	72	175
10	Michael	M	32	69	143
11	Ruth	F	47	69	139
12	Joel	M	34	72	163
13	Donna	F	23	62	98
14	Roger	M	36	75	160
15	Yao	M	.	70	145
16	Elizabeth	F	31	67	135
17	Tim	M	29	71	176
18	Susan	F	28	65	131

Data Manipulation – sort, merge, concatenation, formats



All of the basic data step and data manipulation processes can be done through the graphic interface using one of the options under **Tasks->Data->**. The Query Builder is probably the most powerful of these tools as it will allow you to graphically build SQL statements.

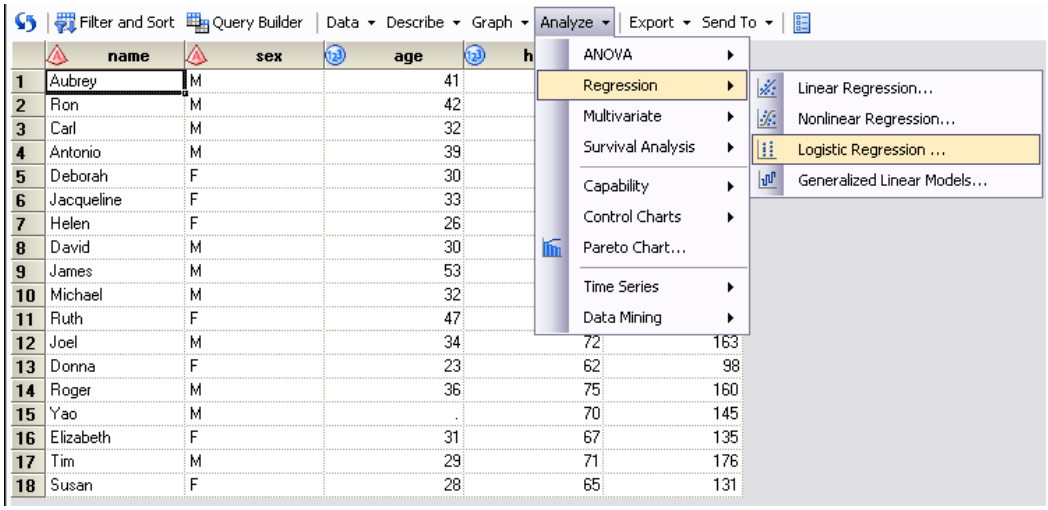
Once a data manipulation task has been selected an icon is added to the designer within the process flow.

Some data manipulation tasks are obvious others are a little more obscure for people already familiar with base SAS programming.

- Creating/calculating new variables is done through the **Query Builder**.
- Concatenating (setting) multiple datasets together is done with **Append**.
- Merging data is done with the **Query Builder** using a Join.
- Sub-setting data is done using **Filter and Sort** or **Query Builder**.

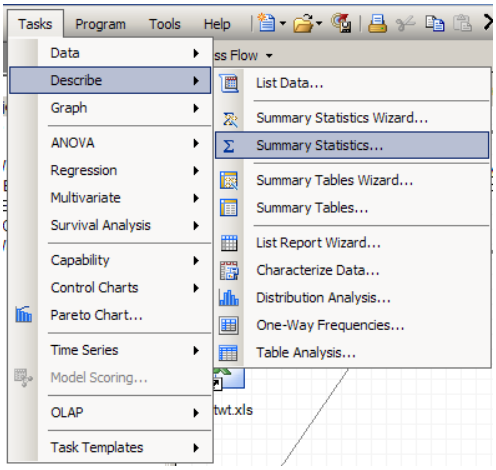
Data sets can be opened, viewed and edited directly in a 'Data Grid' by double clicking on a data item or selecting **Open** from the pop-up menu. The Data Grid view of data will give you access to most analytic and data tasks as well as allowing you to directly manipulate data values, columns and rows. By default data sets are "locked" in a protected mode so the underlying data can not accidentally be changed. If you wish to edit the data un-select the **Protect Data** option under the **Edit** menu.

Important Note
Editing data interactively in the Data Grid, including adding columns or rows, does not write any SAS code or generate log entries. This means that any changes made will not be replicated when the project or process flow is re-run.



	name	sex	age	h		
1	Aubrey	M	41			
2	Ron	M	42			
3	Carl	M	32			
4	Antonio	M	39			
5	Deborah	F	30			
6	Jacqueline	F	33			
7	Helen	F	26			
8	David	M	30			
9	James	M	53			
10	Michael	M	32			
11	Ruth	F	47			
12	Joel	M	34	72	163	
13	Donna	F	23	62	98	
14	Roger	M	36	75	160	
15	Yao	M	.	70	145	
16	Elizabeth	F	31	67	135	
17	Tim	M	29	71	176	
18	Susan	F	28	65	131	

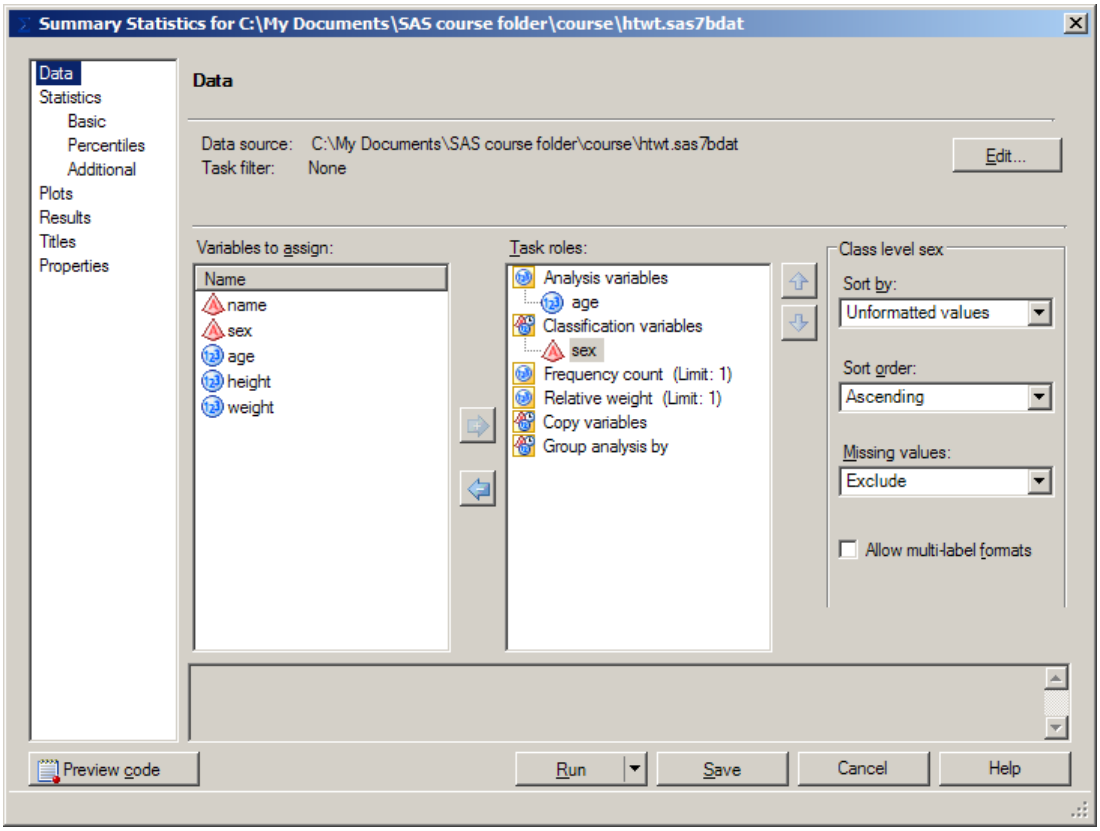
Analysis, Options, and SAS code



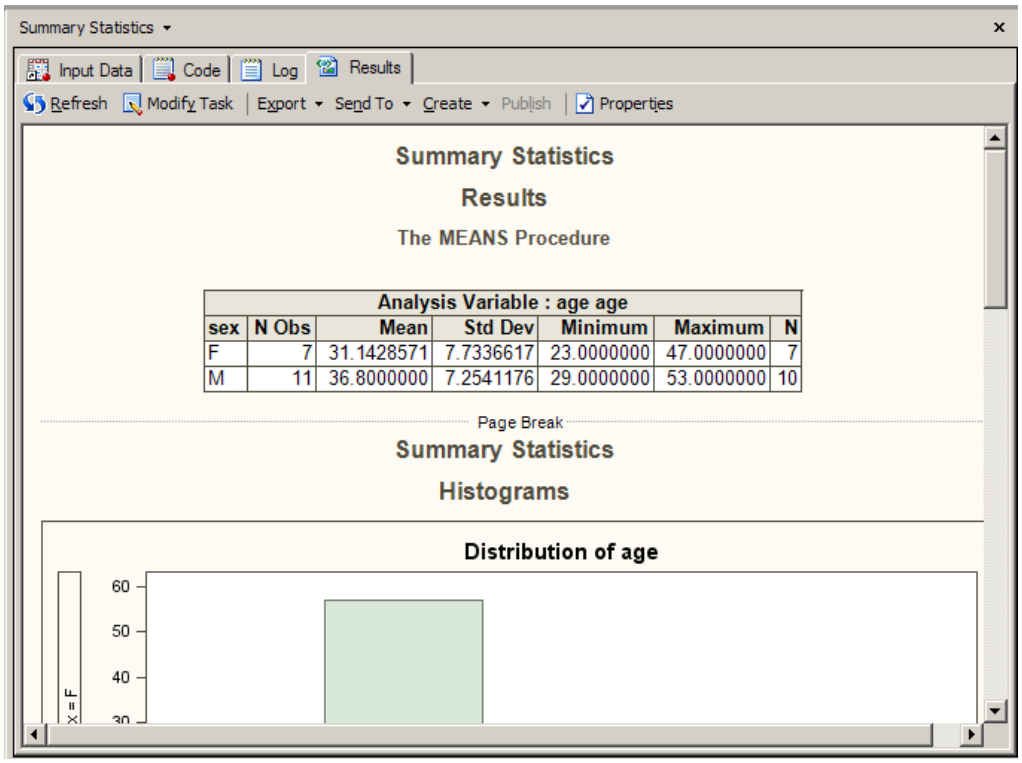
At any point you can select an analytic task to add to your project. The default data used is the currently active (selected) data in your process flow.

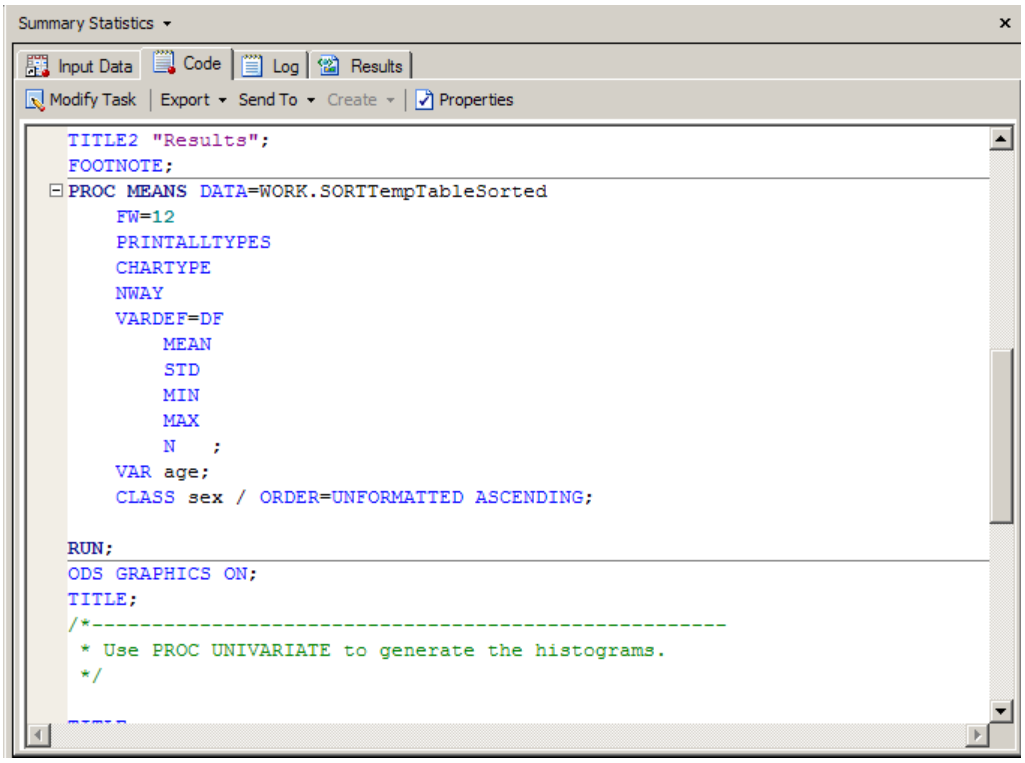
Each task that is select provides a series of options that are appropriate for that task. In this case the Summary Statistics task has been selected. Once you are finished selecting the options you are interested in using the task can be run immediately or it can be saved to the project for running later.

On the left side of the dialog box you can select the data to use, type of analysis, additional options. Depending on what is selected on the left different options will be displayed in the middle of the screen. When you are finished you can run the task (this also saves it in the process flow), save as part of the process, or preview the code (and copy if necessary).

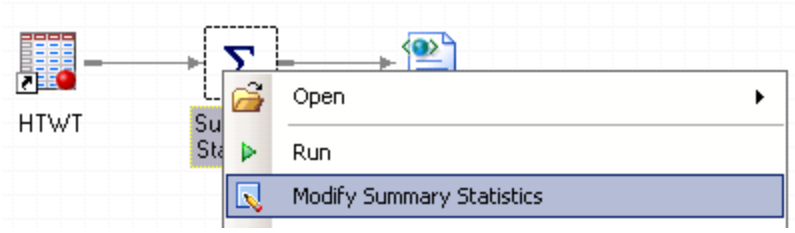


Once the task has been run the results are displayed including access to the SAS log, the code that Enterprise Guide created, Access to the original task and data, and options to save the output in various formats.

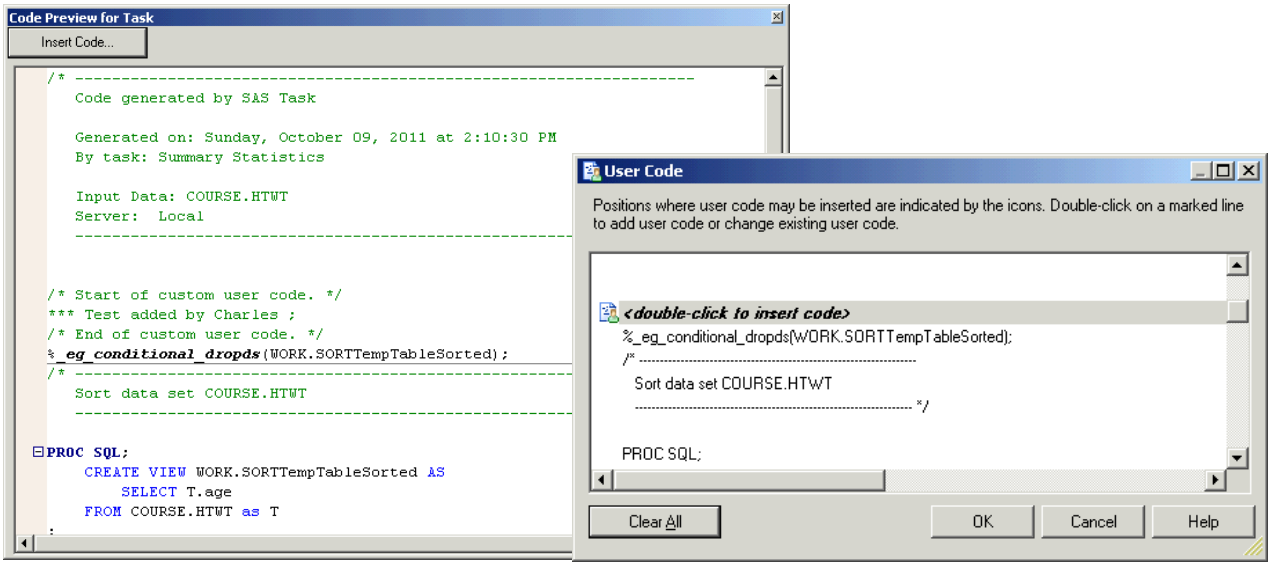




The code is not directly editable (except as mentioned below) but it can be copied and saved if necessary. If you want to modify or update a task select the 'Modify Task' tab or from the process flow.



When creating or modifying a task there is usually a 'Preview code' button at the bottom left of the task setting window. This will open a preview of the code – if you want to add or customize the code you can click on the 'Insert Code…' button which will open a window allowing you to insert or add a limited amount of code in very specific locations. This feature is pretty limited if you want more control over the code generated by a task see the Programming Task below and how to create a new programming template.

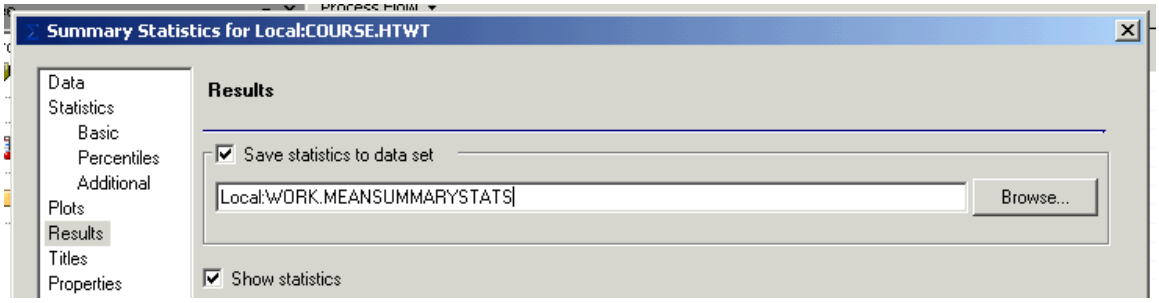


Log Files and Wrapper Code

Once you have run a task the log file for the code that was run can be reviewed as well. Unfortunately there is a lot of 'fluff' code that SAS adds to make sure the code runs and the results are displayed correctly. You can change an option to hide the fluff in your log. Select **Tools->Options** and go to "Results General" and change the checkbox option that says "Show generated wrapper code in SAS log"? If you clear that checkbox, the ODS sandwich (fluff) will be hidden from you when you run your programs.

Task Output

Many tasks, such as summary statistics, will allow you to output data files just as you would with many SAS procedures. Look for the results tab in the task settings – by default EG will try to save these files in the SASUSER library. This should be changed to another library or to the WORK. Since the SASUSER library is not 'cleaned' up the way the WORK file is when SAS shuts down temporary files will continue to be added to your system and eventually you might run into disk space issues.



The default can be changed by selecting WORK using the **Output Library** option under **Tools->Options**. This also changes the order that EG searches for files, that may have the same name, so you may need to be careful about the order, libraries and what is being saved into each library or you might get some unexpected output.

Customized result format and output

Using the Results options found under **Tasks->Options** you can change the format of the output from individuals tasks. These options can also be 'tweaked' within each task or program node individually by editing the Results property through the **Property** item on the task sensitive menu.

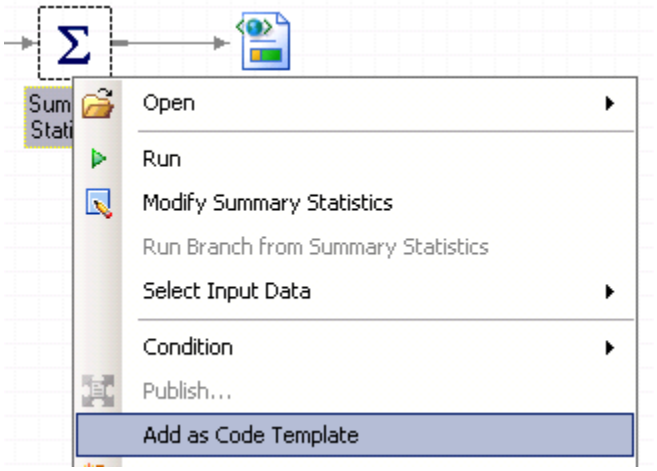
The output format can be saved as normal SAS reports (text that is) but also written into RTF, HTML, PDF format. If you have a particular viewer (e.g. MS Word) that you would like to use the viewer can be identified.

Using your Own Code

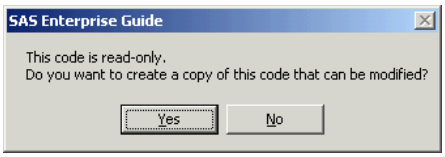
Access to some options, procedures, or complex data processing steps is not possible through the Enterprise Guide interface. In particular doing iterative (do loop or array) processing and by group processing is difficult in a graphic environment. Setting up formats is possible through the graphic interface but it can be slow for programmers familiar using PROC FORMAT. It is still possible to write SAS programming through program tasks or nodes allowing users to write and use more complex processing tasks.

To create a new program node select '**New Program'** from under the **File** or **Program** menu, or open an existing SAS program. In either case a program node, which can be renamed, will be added to your designer window and a SAS code editor will be opened. The Enterprise Guide program editor has the same functionality as the display manager editor but it also includes some additional capabilities. You can write and submit code as you normally would in SAS.

If you want to tweak code that has been created by a SAS EG task you can select '**Add code as Template** from the pop-up menu for any task in the designer. This will create a new program node with the code generated by EG. If you try to edit generated code within a task you will also be asked if you want to create an editable copy of the code.



or



When creating code this way the wrapper code (fluff) mentioned above is still copied over to the new program code. Along with the wrapper code in many tasks a lot of extra code is added (e.g. extra sort or data steps) that can be avoided if you are comfortable with writing your own code and controlling the flow of the data. This extra code is added by SAS to ensure your data is not destroyed and to make sure that the data is in the necessary format for the identified procedure (task).

Because EG sometimes uses unfamiliar library names, esptically if you load data from the file manager, it can be difficult to work out what library and dataset name to use in a programming task. By opening a program node and draging a database from the Project Tree into the editor SAS writes the database name, and library if necessary, as a comment in the code. This can be modified as necessary for set/merge statements or used in a data= option on a procedure.

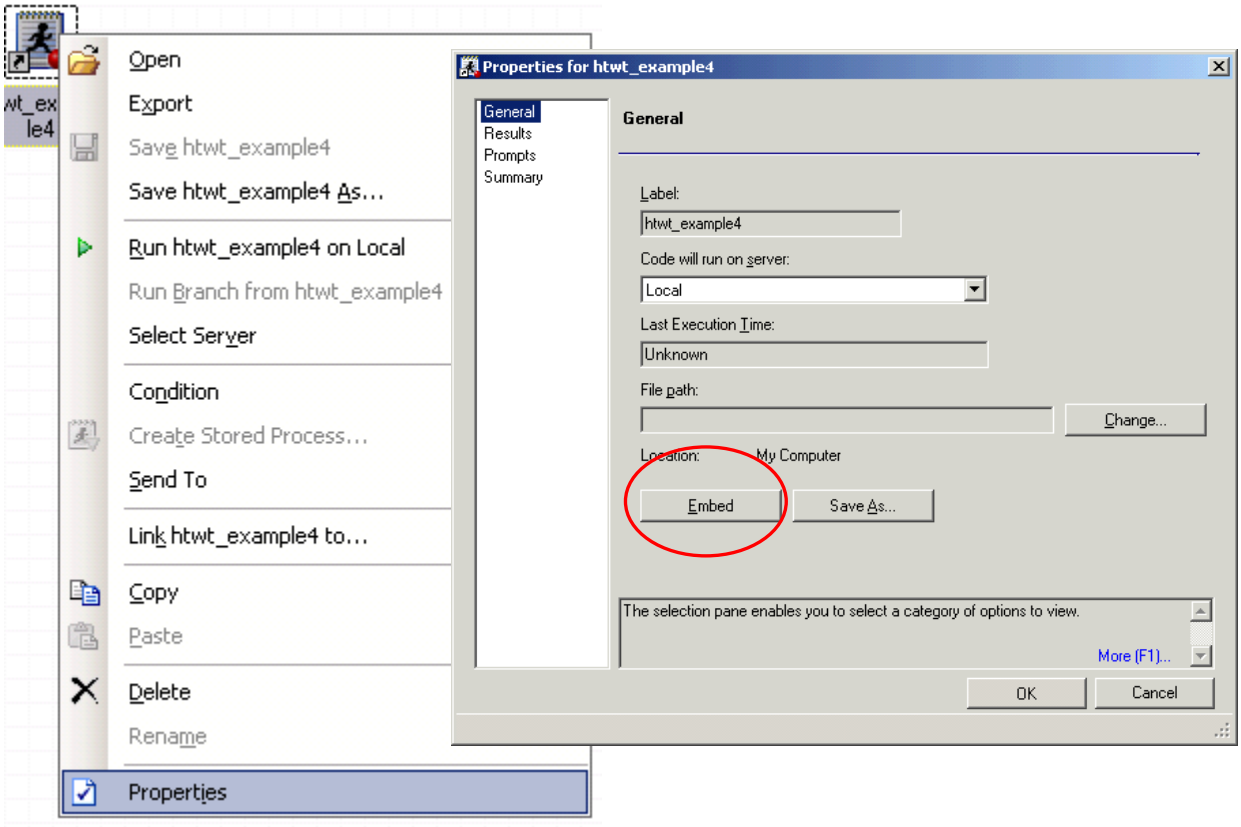
```
/*** Data dragged from Project Tree when opened from File Manage **/
LIBNAME ECLIB000 "X:\course\Data";

/*Data Source:  ECLIB000.htwt */


/*** Data dragged from Project Tree when opened from Library **/
/*Data Source:  WORK.TEST */
```

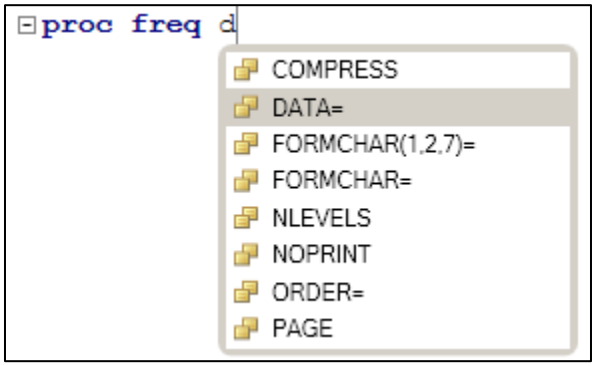
When the program is run any created data sets and results are shown as linked results or data items. Programs can be added into the process flow by selecting '**Link ___ to…**' from the pop-up menu.

If you open an external SAS program from the File or Program menu the code is linked back to the original and not actually stored as part of the project. If you want to include or embed the code right into the project (like a program task created in the project) open the program properties



Tool Tips and Interactive Help

The Starting with Enterprise Guide 4.3 (and SAS 9.3) the SAS editor has many interactive tools to assist the programmer. Although you still have to type out the code the new tools will make reduce the number of typographic and syntax errors.



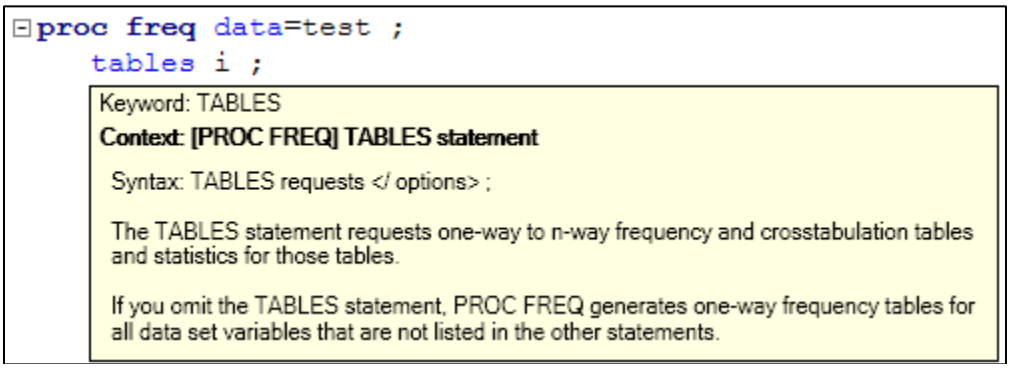
SAS will provide options to auto-complete words, options, datasets, procedures based on the locatoin of the cursor in the program and the first two letters typed of each word. This includes procedures, accepted options, and even available data sets or macro variables. This feature is turned on by default

but it can be controlled under the **Program Menu->Editor Options…** using the **Autocomplete** tab.

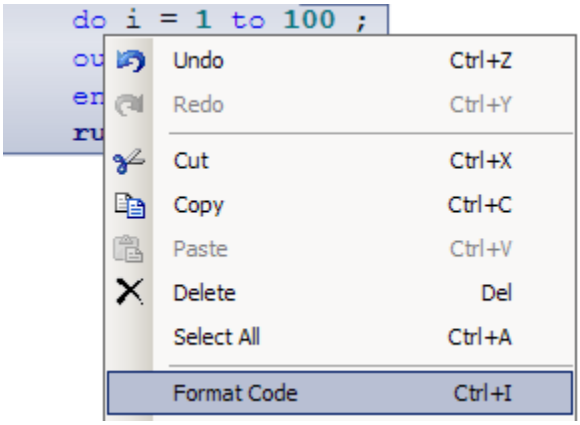
The program editor highlights matching parentheses pairs as you navigate – this helps ensure that all of your brackets/parenthises are balanced appropriately. You can also use the Ctrl+[(open bracket) key to move the cursor from one parenthesis to its match. If no match can be found the program editor just beeps.

```
test = (i+4)
```

By hovering over a SAS recognized word (blue or dark blue) in the program editor all of the syntax options and associated help are displayed in a pop-up window. This option is very helpful when trying to understand or determine the syntax required for a particular command or statement.



SAS can format your code in a consistent and structored fashion. Although it will not correct your code it will make it easier to read and find errors. In the program editor select **Format Code** under the a context (right click) menu or **Edit->Format Code**, or press Ctrl+I.



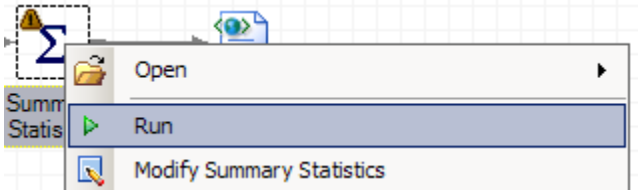
If the code can not be formatted for some reason SAS will return a message that indicates the problem (if it can be determined) and the location.

Formatting Error
Please check for an unmatched parenthesis on line 100

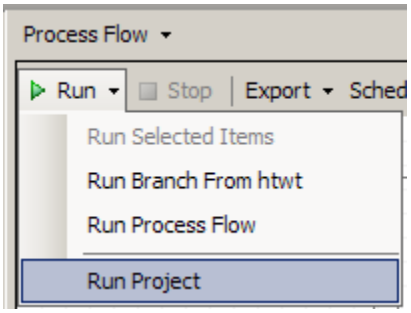
Within a project you can have a set of instructions (or process flow) run automatically by creating a *Process* Flow called *Autoexec*. Under **Tools->Options** make sure that the option 'Automatically run "Autoexec" process flow when project opens' is checked.

Running a Process Later

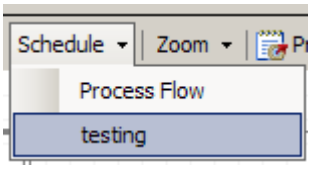
An individual item can be selected (right mouse click) and run again separately or re-opened to be modified or updated.

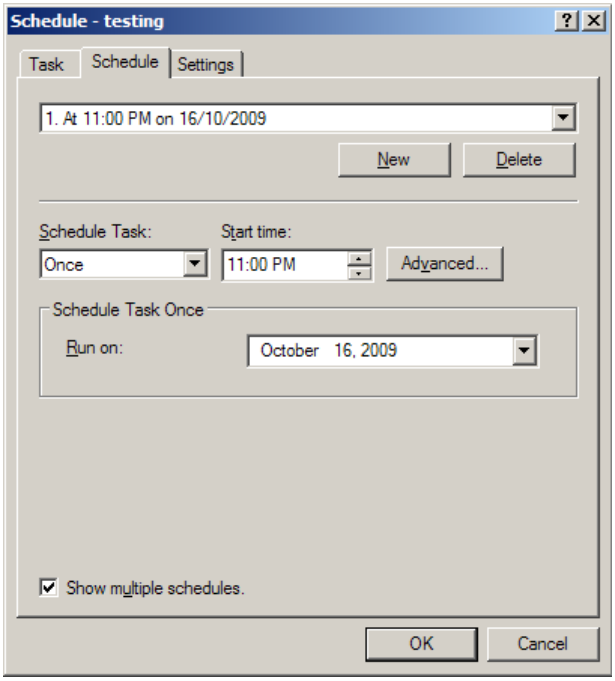


A project can be opened and re-run at a later point, let's say you needed to change some analysis or there was updated data. An individual branch, task (selected item), process flow, or whole project can be run using the various options from under the run menu. Because multiple branches, even process flows can be created within a project a whole series of tasks may be run at the same time or in parallel – on fast computers this allows a whole set of analysis to often run faster than the old sequential process of running submitted code.



Even more powerful for some users, especially in environments that have to share space or computing power projects or portions of projects can be run (scheduled) at a later time or even repeatedly over time.





More information on Enterprise Guide can be found online at:
http://support.sas.com/documentation/onlinedoc/guide/index.html

Practice Questions

SAS Workshop Practice Questions #1

In this set of questions you will review the hospital abstracts dataset using some basic SAS procedures. The datasets in this resource have been simulated using distributions of services within the Manitoba population which means that analysis for course should be representative of services and outcomes within Manitoba. NOTE: This data is not real and any correspondence to actual events, people or services are only coincidental. There is a basic data dictionary available at the end of this document (page 69).

Part 1: Viewing the Data (see Part I, page 14)

Using the SAS dataset called HOSPITAL, answer the following questions using the contents or print procedure. You might have to create a library to access the SAS data (e.g. libname course 'x:\course\data';)

1. How many observations are there in the dataset?
2. How many variables are there?
3. Are there any character variables?
4. Are there any numeric variables?
5. What is the label of the variable called age?
6. Print the first 50 observations.
7. Add an appropriate title and footnote.
8. Print out only the variables age of patient at admission, most responsible diagnosis and secondary diagnosis.
9. Using the SAS manual or SAS online help find out how to print the variable labels instead of the variable names.

Part 2: Exploring the Data (See Part II, page 15)

Using the SAS dataset HOSPITAL answer the following questions using the frequency or means procedures. If you have restarted SAS you might have to create a library to access the SAS data (e.g. libname course 'x:\course\data';)

1. Create frequency distribution of area.
2. See if you can figure out how to get the frequency distribution of a second variable (sex) in the same Proc Freq step.
3. See if you can figure out how to get a two-way frequency distribution (i.e. area by sex) using the SAS manual or the online documentation.
4. Run Proc Means on the variable age.
5. Add a second variable, (length of stay) to the Proc Means analysis.
6. Find out the number of missing values and the median value of age and length of stay.
7. Add a classification variable (sex) and find out the number of missing values, the mean and median value of age and length of stay by sex.

SAS Workshop Practice Questions #2

In this practice session you will import raw (ASCII) data and create new variables. If you have just started a new SAS session remember to define a SAS library.

Part 1: Reading Raw Data into a Temporary SAS dataset

A. Look at the format of the raw data file – `x:\course\Raw Data\hospital07.txt`. You can open this file in the SAS program editor or the Windows Notepad application.
   i. How is the data arranged?
   ii. Clear this file from the window by using pull-down menu Edit and clicking clear all.

B. Open up SAS program – `x:\course\Formats\newfmts.sas`. This file contains a list of formats that can be used with the HOSPITAL data.
   i. How does this set of proc format statements compare to what you learned on page 18?
   ii. Run newfmts.sas and look at the SAS log.
   iii. Clear this file from the window.
   iv. In the future you can include (or run) this program without opening it in the program editor using the following SAS statement:

```
%include 'x:\course\Formats\newfmts.sas';
```

C. In a data step, use an **infile** followed by an **input** statement to create a new SAS dataset from the raw ASCII hospital data.
   i. Use an 'infile' statement similar to the one on page 19 to access the data.

```
Infile 'x:\course\Raw Data\hospital07.txt';
```

   ii. The following table provides the location and labels for variables in the raw data. Use this information with an input statement to read the data. Remember that variable names should be a single word and short (e.g. the variable name for age at admission could be **ageadm**). Character variables are identified using a $ on the input statement.

Variable Name	Label	Type	Start Column	End Column	Format
Sex	Sex	Char	10	10	$sexL.
Ageadm	Age at admission	Num	19	22	
Los	Length of Stay (LOS)	Num	43	46	
Area	Region of Residence	Char	23	23	$areaL.

D. Create labels for each of the variables you were read into the dataset.
E. Format gender and region of residence with the correct format (provided in the file newfmts.sas).
F. Calculate the mean and median value of length of stay by sex (see page 15).

Part 2: Manipulating Data

In this example you will create new datasets and do some basic analysis using the SAS HOSPITAL data found in X:\course\data. (remember to use a SAS library to access SAS datasets).

A. Create two new temporary SAS datasets from `COURSE.HOSPITAL` in a single **data step** keeping only the variables age, sex, and length of stay. Create the new data in a datastep like that found on page 20.
   i. TEST1 data should contain observations from HOSPITAL with age less than 60.
   ii. TEST2 data should contain observations from HOSPTIAL with age greater than or equal to 60.
   iii. Calculate the mean length of stay for those aged less than 60 and those aged 60 or more using the two datasets. Remember to use titles to identify your output appropriately (page 15).

B. Using the dataset `COURSE.HOSPITAL`, calculate the frequency distribution of sex for those aged less than 60 and those aged 60 or more using a **where** statement (see page 21).

C. In a temporary (WORK) copy of the `HOSPITAL` dataset, create the following new variables:
   i. Create an **agegroup** variable which groups age into 4 categories (see page 22)

0-19, 20-39, 40-59, 60 or more

ii. Label the age group variable and create a format to label the values of the age group variable. Remember that a SAS format must be created in a separate step using **proc format** before it is used.

iii. Create a **short_stay** indicator variable that indicates the records where the length of stay is less than 3. Label this variable appropriately.

iv. Using the new variables calculate the proportion of hospital stays with length of stay less than 3 days by age group (see proc means page 23).

SAS Workshop Practice Questions #3

In this example you will use the simulated hospital abstract data to determine the number of cases in three geographic groups that stay longer than the average length of stay for that group.

A. Create a temporary copy of the permanent COURSE.`HOSPTIAL` dataset, to do the following. This can be done in a **data step** setting the hospital data from a defined **library**.
B. Create a variable which groups the **area** variable into 3 groups using a format or if/then conditional processing.

Group	Area
North	'A' North
	'B' Mid
South	'D' South West
	'E' South East
Urban	'C' South Central (Capital Region)

C. Calculate the average length of stay by area group and sex using proc means. Output the results into a temporary SAS (see page 31)
D. Merge the average length of stay variable to the temporary HOSPITAL dataset by the area group and sex (see page 31)
E. Create a new variable that indicates whether the length of stay for the case is greater than the group specific average length of stay. Label this variable appropriately (see high_age example page 32).
F. Report the number of cases and the proportion of cases that have a length of stay greater than the average length of stay by sex and area group using proc means..

SAS Workshop Practice Questions #4

A) In this example you will use the FIRST. and LAST. variables and the RETAIN statement to identify people with multiple hospitalizations. Count the number of hospitalizations for each individual and select all of these separations for the individuals that had more than one hospitalization.

1. Using a temporary version of the HOSPITAL dataset
    i. Sort the temporary dataset by the personal identification number (**ident**). Remember that this allows you to process the data set BY the personal identification number.
    ii. In a DATA STEP, set the sorted temporary data by the personal identification number (**ident**). You can use the same temporary dataset name if you want to.
    iii. In the same data step, create two new variables from the **first.ident** and **last.ident**. Remember the first and last variables are only temporary creating new variables will allow you to see the resulting codes for each set of records by **ident**.
2. Print out the first 50 observations of the dataset. Only print out the personal identification number and the two new variables you created.
3. Are there multiple records with the same personal identification number in the first 50 observations?
4. Can you think of a way to select individuals with multiple records (hint – use **first.ident** and **last.idnet**).
5. In another DATA STEP, set your sorted temporary HOSPITAL data by the personal identification number again and perform the following steps:
    i. Count the number of hospitalizations for each individual and output the last record for each individual using **last.ident** to a new dataset. Use a **retain** and **counter** variable for counting and **first.ident** to re-initialize the counter for each individual.
    ii. Keep only the personal identification number and your **counter** variable.
    iii. Get a frequency distribution of your **counter** variable.
6. Subset the above dataset containing only one record/person into a new dataset called COUNT2 keeping only the records with more than 1 hospitalization. Did you get the number of records the frequency table suggested you should?
7. If you are really keen and you want to practice merging, you can use the data you just created (COUNT2) to find the hospitalization records for people that have more than one hospitalization.
    i. Merge your sorted temporary HOSPITAL dataset to COUNT2 by the personal identification number.
    ii. Be sure to use the **in=** dataset option to find out if a record is present on one or both of the datasets you are merging.
    iii. Keep only the records that are present on both datasets.

iv. Print out the first 50 observations and use a var statement to print out the variables you are interested in (personal identification number for sure).
v. Are these multiple hospitalization records with the same personal identification number?

B) In this example, you will use an ARRAY statement and iterative DO loop to identify hospitalizations with a breast cancer diagnosis.

i. In a new DATA STEP and using the SAS data set COURSE.HOSPITAL, use an array statement to create an array with the ten diagnosis codes in it.
ii. Use a Do-Loop to find hospitalizations with a diagnosis of breast cancer (ICD 10 CA diagnosis code C50). Remember to use the colon modifier (=:) or the substr function to test the first 3 characters of the 5 character diagnosis code.
iii. Subset the data, keeping only those with a breast cancer diagnosis.
iv. Find the age and sex frequency distribution of hospitalizations for breast cancer.

C) Calculate the time until death and week day distribution of death for those individuals that died in hospital or within 180 days of separation from hospital using the variables DEATHDATE and SEPDATE.

i. Merge the SAS data sets HOSPITAL and REGSITRY by **ident** to get the death date.
ii. Create a new variable with the day of the week of death using the WEEKDAY function.
iii. Create frequency tables of the new variable for all of the individuals that died and just for those individuals that died in hospital (DEATHSEP=1).

SAS Workshop Practice Questions #5

Using the hospital and registry data calculate the crude rates of hospital separations, total days, and individuals by region.

Hint:

- You will need to summarize the registry by region by creating a temporary data set with a population variable.
- You will need to summarize the hospital data by region
- Merge this summarized data.

The result of a proc contents for the registry data set is listed below:

```
Character Dates and SAS Dates           11:56 Saturday, September 20, 2008

                          The CONTENTS Procedure

Data Set Name        COURSE.REGISTRY             Observations          5847
Member Type          DATA                        Variables             7
Engine               V9                          Indexes               0
Created              Monday, May 26,             Observation Length    48
Last Modified        Monday, May 26,             Deleted Observations  0
Protection                                       Compressed            NO
Data Set Type                                    Sorted                NO
Encoding             wlatin1  Western (Windows)


                    Engine/Host Dependent Information

       Data Set Page Size          4096
       Number of Data Set Pages    71
       First Data Page             1
       Max Obs per Page            84
       Obs in First Data Page      45
       Number of Data Set Repairs  0
       File Name                   X:\course\data\registry.sas7bdat
       Release Created             9.0101M2
       Host Created                XP_PRO


                Alphabetic List of Variables and Attributes

#  Variable   Type  Len  Format    Label

4  area       Char    2            Area of residence
6  deathdate  Num     8  YYMMDD8.  Date of Death (formatted SAS Date)
3  dob        Num     8  YYMMDD8.  Date of Birth (formatted SAS Date)
7  entrydate  Num     8  YYMMDD8.  Entry into Program (formatted SAS date)
1  ident      Char    8            Personal ID
2  sex        Char    1            Sex (Female/Male)
5  urban      Num     8            Urban (1)/Rural (0)
```

Data Dictionaries
MCHP Training and Research Resource

The administrative data that is used as part of this workshop represents utilization for roughly 0.5% of the Manitoba Population 2002/03-2003/04. Although the data is simulated it should provide a representative picture suitable for use in class room presentations.

Height/Weight Dictionary

The data represents 18 observations and 5 variables.

Name of Resource: HTWT

AGE Num 8 Age

HEIGHT Num 8 Height
The height in inches.

NAME Char 10 Name

SEX Char 1 Sex
The biological sex.

M	Male
F	Female

WEIGHT Num 8 Weight
The weight in pounds (lbs).

Hospital Dictionary

This dataset is part of the MCHP SAS Course database. Use of this data must be accompanied by the 'MCHP SAS Workshop Simulated Administrative Health Data Use Agreement'. The datasets in this resource have been simulated using distributions of services within the Manitoba population which means that analysis for course should be representative of services and outcomes within Manitoba.

NOTE: This data is <u>not</u> real and any correspondence to actual events, people or services are only coincidental.

The Hospital dataset represents inpatient services provided to individuals found the in the SAS course REGISTRY.

The data represents 1101 observations and 34 variables.

Name of resource: HOSPITAL

ADMDATE Num 8 Date of Admission
Date of admission to hospital.

AGE Num 8 Age at Admission
Range: 0-91

AREA Char 2 Area of Residence
Format: $AREAL

A	North
B	Mid
C	South Central (Capital Region)
D	South West
E	South East

CCI01-10 Char 8 CCI Intervention Code
The intervention code is an operative or non-operative intervention performed during the patient's hospital stay. The Intervention code is broken up into 6 fields that provide information on the type, location, and kind of intervention. The CCI does not provide a code to classify an intervention that did not occur. Full labels can be created using the ICD10L macro described at the end of this document.

• **Column**	**Field**
1	Section
2-3	Group Anatomy, Stage, Group, Functional, or Type. Depending on section
4-5	Intervention
6-7	Approach, Technique, Reason. Depending on section
8-9	Device, Agent, Method used
10	Tissue

CCI Rubric Formats

The following formats can be used to format the individual rubrics within each CCI.

Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
Section	Group Anatomy, Stage, Group, Functional, Type)	Intervention	Approach Technique, reason	Device, agent, method used	Tissue Used
1 digit	2 digit	2 digits	2 digits	2 digits	1 digit

	$CCISECL	$GrpS123l	$S1_Int	$Q1S1l	$Q2S1l	$Q3S1l
	$CCISECL	$GrpS123l	$S2_Int	$Q1S2l	$Q2S2l	
	$CCISECL	$GrpS123l	$S3_Int	$Q1S3l		
Format Name	$CCISECL	$GrpS5l	$S5_Int	$Q1S5l	$Q2S5l	
	$CCISECL	$GrpS6l	$S6_Int	$Q1S6l	$Q2S6l	
	$CCISECL	$GrpS7l	$S7_Int	$Q1S7l		
	$CCISECL	$GrpS8l	$S8_Int	$Q1S8l	$Q2S8l	$Q3S8l

DEATHSEP Num 3
Died at separation

DOB Num 8 Date of Birth (formatted SAS date)
Format: YYMMDD8.

ICD10_01-10 Char 8 ICD-10-CA Diagnosis code (most responsible)
ICD-10-CA codes are recorded to describe the diagnoses/conditions of the patients while in hospital. Full labels can be created using the ICD10L macro described at the end of this document. ICD10 Diagnosis codes can be found online through the WHO website: http://apps.who.int/classifications/apps/icd/icd10online/

IDENT Char 8 Personal ID

LOS Num 4 LENGTH OF STAY
Range: 1-888
This is calculated by subtracting admission date from separation date. For inpatients HAUM requires LOS = 1 if DATEADM = DATESEP (if stay is less than 24 hours). This rule means that true 24 hour stays, admitted on Monday, discharged on Tuesday, scores 1, as does admitted and discharged on Monday.

MDID Num 8 Physician ID
Range 1-1374

SEPDATE Num 8 Separation Date

SEX Char 1 Biological gender
Format: $SEXL

1 Male
2 Female

TEACHING Char 1 Teaching Hospital code
Format: $TEACHL
Teaching hospital records in the training database are identified with a '1'.

TRFROMF Char 1 Transfer from code

Format: $TRFL
This variable flags if there is a transfer from code (value='1') found on the original record. The hospital abstracts in the research repository indicate the hospital code where the transfer was from. These variables are modified from the original variables found in the research repository.

TRTOF Char 1 Transfer to code
Format: $TRTL
This variable flags if there is a transfer to code (value='1') found on the original record. The hospital abstracts in the research repository indicate the hospital code where the transfer was to. These variables are modified from the original variables found in the research repository.

URBAN Num 8
Format: $URBANL

1	Urban
0	Rural

Physician Dictionary

This dataset is part of the MCHP SAS Course database. Use of this data must be accompanied by the 'MCHP SAS Workshop Simulated Administrative Health Data Use Agreement'. The datasets in this resource have been simulated using distributions of services within the Manitoba population which means that analysis for course should be representative of services and outcomes within Manitoba.

NOTE: This data is not real and any correspondence to actual events, people or services are only coincidental.

The Physician Claims data contains visits to physicians by individuals found in the course REGISTRY file. In some cases claims are for services provided during an inpatient hospital stay.

The data represents 62467 observations and 14 variables.

Name of resource: PHYSICIAN

AGE Num 8 Age at Visit Date
Range: -1-92

AREA Char 2 Area of Residence
Format: $AREAL

A North
B Mid
C South Central (Capital Region)
D South West
E South East

DIAGNOSIS Char 4 Diagnosis Code (ICD-10)
Full labels can be created using the ICD10L macro described at the end of this document.
ICD10 Diagnosis codes can be found online through the WHO website:
http://apps.who.int/classifications/apps/icd/icd10online/

DOB Num 8 Date of Birth (formatted SAS code)

FEE Num 5 Fee for service
Range: $36.58-$855.31
This is the amount paid to the physician on behalf of the patient for the services rendered by the physician. For claims by physicians in salaried/no payment situations the fee is a flat-rate value not adjusted for the rules of application.

The fees are based on the then current fee schedule and associated rules of application.

GP Num 8 GP/FP Billing

IDENT Char 8 Personal ID

INHOSP Char 1 Inpatient hospital – service during inpatient stay

MDID Num 4 Physician ID
Range: 1-1882

SEX Char 1 Gender of patient
Format: $SEXF.

M Male
F Female

TARIFF Char 4 Tariff code – services rendered
Defines specific services for which a physician may bill Manitoba Health. All of these codes are based prefix='7' or physician visits.

TEACHING Char 1 Teaching Hospital code
Format: $TEACHL
Teaching hospital records in the training database are identified with a '1'.

URBAN Num 8

Format: $URBANL

2 Urban
0 Rural

VISITDATE Num 8 Date of Visit (formatted SAS date)

Tariff Dictionary

This data represents 587 observations and 9 variables.

Name of Resource: TARDESC

CANCDATE Num 8 Tariff Cancellation Date
This is the last date on which the tariff can be paid.

The tariff has not been cancelled = 99999999
If the tariff has been cancelled = YYYYMMDD format

The date must be numeric with YYYY being 4 numeric positions; MM must be 01-12; and DD must be 01 to the # of days in the month.

HISTCODE Char 4 History Code (internal MHSC)
MH code to identify a specific medical service. Refer to Manitoba Physical Manual for tariff codes and descriptions.

MAXSERV Num 8 Maximum Services Allowed

NGC Char 3 National Grouping Code
A federal code used to group similar types of medical services.

PATTERN Char 2 Pattern of Practice Code
Format: $PPRACL
This code is used to group types of medical services.

All tariffs are summarized into PATPRAC categories and the descriptions used for the MHSIP monthly random sampling for statement of benefits paid notifications to be mailed to recipients of medical services.

00 Complete History & Exam History & Physical
01 Regional History & Exam Office calls (initial)
02 Subsequent Visit
03 Special Call (special trip) House calls-routine

04 Hospital Calls
05 Consultation
06 Anaesthesia - surgical
07 Anaesthesia - obstetrical
08 x-ray - Head, Neck
09 x-ray - Chest
10 x-ray - Spine, Pelvis
11 x-ray - Upper Extremities
12 x-ray - Lower Extremities
13 x-ray - Abdomen
14 x-ray - Urological
15 x-ray - Obstetrical. & Gynaecological.
16 x-ray - Special
17 x-ray - Therapeutic
18 x-ray - Radium
19 Laboratory
20 Laboratory - short list tariffs
21 Heart Tracing "ECG"
22 Eye Test Refractions
23 Allergy Care
24 Immunization
25 Injection
26 Surgery Surgery >= $50.00
27 Diagnostic/therapeutic serv. Surgery <$50.00
28 Surgical assistance
29 Other Tests and exams
30 Laboratory Smear Cytological smears
31 Obstetrics Confinements
32 Caesarian
33 Obstetrics Abortions
34 Obstetrics Ectopic
35 Oral Surgery Dental surgery
36 Emergency Visit House visit- emergency
37 Hospital Misc. Elec. shock-therapy
38 Concomitant Care
39 Chiropractor - subsequent visit
40 Chiropractor - initial visit
41 Optometrist - eye test
42 Routine Visit/Chronic Care (PCH)

PREFIX Char 1 Tariff Prefix
Format: $TARPFL
This defines the circumstances or sub-component of a tariff classification which was applied to this claim when determining FEEPAID or grouping services into general categories for monthly reports produced by MHSIP.

Value MUST be one of:

0 Surgical assistance
1 Post-operative Fee
2 Surgery
3 Maternity
4 Anaesthetic
5 X-ray/radiology
6 Anaesthesia assistance
7 Calls, Special tests
8 Pathology/laboratory
9 undefined i.e. New procedure or procedure not covered by fee schedule.

SEXREST Char 1 Sex Restriction Code (M/F)
This code is used whenver there is a restriction for a specific tariff record.

M Patient's sex must be male
F Patient's sex must be female

TARDES Char 90 Tariff Description
A description of the service provided for under the tariff code.

TARIFF Char 4 Tariff Code – Services Rendered
Defines specific services for which a physician may bill Manitoba Health. Often requires prefix code, TARPREF, to determine the appropriate situation and type of service being claimed.

This is subject to annual review and redefinition of "covered" services. A specific code may have different meanings depending on the fiscal year of the claim. Some codes may split into two or more new codes, others may be combined into a single code.

May be "0000" - Local anaesthesia if TARPREF = 4 or 6.
May be "9999" - By report, new or special Services

Registry Dictionary

This dataset is part of the MCHP SAS Course database. Use of this data must be accompanied by the 'MCHP SAS Workshop Simulated Administrative Health Data Use Agreement'. The datasets in this resource have been simulated using distributions of services within the Manitoba population which means that analysis for course should be representative of services and outcomes within Manitoba.

NOTE: This data is not real and any correspondence to actual events, people or services are only coincidental.

This dataset represents one individual on each record with some corresponding demographic and coverage information.

The data represents 6042 observations and 7 variables.

Name of resource: REGISTRY

AREA Char 2 Area of residence
Format: $AREAL

A	North
B	Mid
C	South Central (Capital Region)
D	South West
E	South East

DEATHDATE Num 8 Date of Death (formatted SAS date)
Missing if individual has not died.

DOB Num 8 Date of Birth (formatted SAS date)

ENTRYDATE Num 8 Entry into Program (formatted SAS date)

IDENT Char 8 Personal ID

SEX Char 1 Biological Gender of patient
Format: $SEXF

M	Male
F	Female

URBAN Num 8
Format: $URBANL

1	Urban
0	Rural

Census Dictionary

This dataset is part of the MCHP SAS Course database. Use of this data must be accompanied by the 'MCHP SAS Workshop Simulated Administrative Health Data Use Agreement'. The datasets in this resource have been simulated using distributions of

services within the Manitoba population which means that analysis for course should be representative of services and outcomes within Manitoba.

The following document provides the variable names and some basic information on the census data associated with each individual found in the training resource REGISTRY database. The data is aggregated information for the area (usually DA) where the individual was living. The information includes variable type, general description, and the data values for each variable. The data represents 6042 observations and 13 variables.

Name of Resource: CENSUS

AGEDEP Num 8 Age Dependency Ratio
Range: 0-6
Neighbourhood based. The age dependency ratio is calculated as the population age 65 or greater divided by the population age 15-64. The populations come from the 2001 census.

IDENT Char 6 Personal ID Number (Mod)
Range: 00377485-00497617
This is a personal identifier that can be used in all of the training resource data. It is NOT related to PHIN or family registration number.

INC_AVEHHINC Num 8 Average Household Income ($)
Range: 0-$279,150
This refers to the average household income for the year prior to the census year (in this case 2000), measured in dollars.

LF_FEMPRATE15 Num 8 Female Labour Force Participation Rate
Range: 0-95.7
Neighbourhood based. This is the labour force participation rate for females aged 15 or over from the 2001 census. The labour force participation rate is defined as the total labour force in the week prior to census day divided by the population aged 15 years of age or older excluding institutional residents.

LF_UNEMRATE1524 Num 8 Unemployment Rate, 15-24
Range: 0-100
This refers to the unemployment rate for the labour force population aged 15-24 years.

LF_UNEMRATE2534 Num 8 Unemployment Rate, 25,34
Range: 0-100
This refers to the unemployment rate for the labour force population aged 25-34 years.

LF_UNEMRATE3544 Num 8 Unemployment Rate, 35-44
Range: 0-66.7
This refers to the unemployment rate for the labour force population aged 35-44 years.

LF_UNEMRATE4554 Num 8 Unemployment Rate, 45-54
Range: 0-100
This refers to the unemployment rate for the labour force population aged 45-54 years.

PFEMSPHH Num 8 Percent Female Single Parent Households
Range: 0-64.2857
Neighbourhood based. This is the percent of the total number of census families in private households with a female lone parent from the 2001 census.

PSPHH Num 8 Percent Single Parent Households
Range: 0-76.92
Neighbourhood based. This is the percent of the total number of census families in private households with a lone parent from the 2001 census.

PHS2534 Num 8 Percent of population aged 25-34 with a high school diploma.
Range: 0-100
Neighbourhood based. Based on the 2001 census, this is the percent of the population aged 25-34 with a high school diploma.

PHS3544 Num 8 Percent of population aged 35-44 with a high school diploma.
Range: 0-100
Neighbourhood based. Based on the 2001 census, this is the percent of the population aged 35-44 with a high school diploma.

PHS4554 Num 8 Percent of population aged 45-54 with a high school diploma.
Range: 0-100
Neighbourhood based. Based on the 2001 census, this is the percent of the population aged 45-54 with a high school diploma.

Prescription Dictionary

This dataset is part of the MCHP SAS Course database. Use of this data must be accompanied by the 'MCHP SAS Workshop Simulated Administrative Health Data Use Agreement'. The datasets in this resource have been simulated using distributions of services within the Manitoba population which means that analysis for course should be representative of services and outcomes within Manitoba.

NOTE: This data is not real and any correspondence to actual events, people or services are only coincidental.

This simulated data represents prescriptions filled at a retail pharmacy.

The data represents 70820 observations and 12 variables.

Name of resource: PRESCRIPTION

AGE Num 8 Age at RxDate
Range: 0-92

AREA Char 2 Area of residence
Format: $AREAL

A	North
B	Mid
C	South Central (Capital Region)
D	South West
E	South East

DAYSUPP Num 8 Days supply on Rx
Range: 0-400

DIN Char 8 Drug Identification Number this claim
This is an 8 digit number assigned by the Drugs Program (Health Canada) to each drug approved for use in Canada in accordance with the Food and Drug Regulation. Note that the same drug (e.g. Amoxicillin, 250 mg capsules) can have a number of different DINs associated with it (different manufacturers etc.).

DOB Num 8 Date of Birth (formatted SAS date)

IDENT Char 8 Personal ID

MDID Num 8 Physician ID
Range: 1-1772

QUANTITY Num 8 Metric Quantity claimed
Range: 0-40000

RXDATE Num 8 Prescription Filled date (formatted SAS date)

SEX Char 1 Biological gender of individual
Format: $SEXF

M	Male
F	Female

UNITCOST Num 8 Unit Price paid for drug this claim
Range: 0-$2475.41

ATC Codes Dictionary

This dataset is part of the MCHP SAS Course database. Use of this data must be accompanied by the 'MCHP SAS Workshop Simulated Administrative Health Data Use Agreement'. This data set may be merged with the Course Prescription dataset by DIN.

The data represents 5139 observations and 6 variables.

Name of Resource: ATC_CODES

ATC Char 7 Anatomical Therapeutic Chemical Drug Classification System
Format: $ATCL.
ATC is a system for classifying drugs that is widely used in European countries. It is becoming more commonly used in Canada and is managed by Health Canada. Drugs are divided into different groups according to the organ or system on which they act and their chemical, pharmacological and therapeutic properties. There are 5 different levels of groupings.

DDD Num 8 Defined Daily Dose
Range: 0.004-250
One of four measures of intensity of use, DDD is the assumed average maintenance dose per day for a drug product when used for its major indication in everyday practice. This is a technical unit of measurement and does not necessarily reflect he actual amount or dose used; it is also limited to solid drug forms only.

DIN Char 8 Drug Identification Number this claim
This is an 8 digit number assigned by the Drugs Program (Health Canada) to each drug approved for use in Canada in accordance with the Food and Drug Regulation. Note that the same drug (e.g. Amoxicillin, 250 mg capsules) can have a number of different DINs associated with it (different manufacturers etc.).

PRODE Char 35 Product description in English.

PRODG Char 30 Equivalent generic production name.

STR_NEW Num 8
Range: 0.001-500
This refers to the strength, without the unit attached, but in the units of the DDD (ie. DDDUNIT). This has been filled in for solid dosage forms, with 1 active ingredient (NAIS=1), for use in the DDD calculations.

Drug Cost Dictionary

This dataset is part of the MCHP SAS Course database. Use of this data must be accompanied by the 'MCHP SAS Workshop Simulated Administrative Health Data Use Agreement'. The datasets in this resource have been simulated using distributions of services within the Manitoba population which means that analysis for course should be representative of services and outcomes within Manitoba. This dataset may be merged with the Course Prescription dataset by DIN. Not every record in the prescription file contains an associated unit cost this data set will allow you to add an estimated unit cost value.

The data represents 4575 observations and 2 variables.

Name of resource: DRUG_COST

DIN Char 8 Drug Identification Number this claim
This is an 8 digit number assigned by the Drugs Program (Health Canada) to each drug approved for use in Canada in accordance with the Food and Drug Regulation. Note that the same drug (e.g. Amoxicillin, 250 mg capsules) can have a number of different DINs associated with it (different manufacturers etc.).

MEAN_UNITCOST Num 8 Mean Cost per Unit for DIN

Provided SAS Macro Code

The following SAS macros have been provided for use with MCHP workshop data. In most cases documentation for using the macro is either provided in a separate .docs file or at the top of the provided SAS code. Examples of the three most commonly used macros have been provided below.

Macro Names:

_age – Correctly calculate age using intck function instead of yrdif.
_charlsonicd10 – Generate Charlson Comorbidity Scores for hospital separations
_dumvar – Create Dummy variables based on values in a categorical variable.
_elixhausericd10 - Generate Elixhauser Scores for hospital separations
_extlog – Extract SAS code from a SAS log file
_icd10l – Create labels for ICD10 or CCI codes. This macro assumes that the data provided for the course is in a library called 'COURSE'. There is an option to use a different library name if necessary.
_lotus – Write out delimited text files
pop_rate.sas – Calculate age/sex direct or indirect adjusted rates
_random – Select random samples from a dataset
fixday – Correct invalid date strings (e.g. 20040229).

Examples:

Example for adding Charlson Comorbidity Score based on work by Hude Quan, 2005

```
libname course 'X:\course\Data' ;
*** Include macro code for calculating index ;
%include 'X:\course\macros\_charlsonicd10.sas' ;

data test ;
    set course.hospital ;
run ;
*** Add comorbidity information to a new output dataset called
cmb_out;
%_charlsonicd10(data=test, out=cmb_out, dx=icd10_01-icd10_10,
               type=off) ;
```

Quan H, Sundararajan V, Halfon P, Fong A, Burnand B, Luthi JC, Saunders LD, Beck CA, Feasby TE, Ghali WA. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005;43(11):1130-1139.

Example for adding ICD10CA or CCI Labels to your output.

```
*** Include macro code for creating labels;
%include 'X:\course\macros\_icd10l.sas' ;
*** Generate ICD10CA labels ;
%_icd10l(fmt=icd10,syear=2004) ;

proc freq data=test ;
      tables icd10_01 ;
      format icd10_01 $icd1004l. ;
      run ;

%_icd10l(fmt=cci,syear=2004) ;

proc freq data=test ;
    tables cci01 ;
      format cci01 $cci04l. ;
      run ;
```

Example for calculating age/sex direct adjusted rates.

```
libname course 'X:\course\Data' ;
*** Include macro code for creating labels;
%include 'X:\course\macros\pop_rate.sas' ;

*** Create format for grouping ages ;
proc format ;
     value agegF  low-24 = '01'
                  25-39 = '02'
                  40-64 = '03'
                  65-HIGH = '11' ;
    %include 'X:\course\Formats\newfmts.sas' ;
      run;

*** Create a population dataset containing age groups and sex ;
data pop(keep=ageg sex area) ;
   set course.registry ;
   *** Get population count for December 31 2004  ;
   if entrydate < '31dec2003'd & (deathdate >='31dec2003'd or deathdate=.) ;
   *** Calcualte age as of dec 31 2003 ;
   age = floor(yrdif(dob,'31dec2003'd,'ACT/ACT')) ;
   ageg = put(age,agegf.) ;
   format area $areal. sex $sexL. ;
   run;

proc freq data=pop ;
    title 'Verification of population groups 2003' ;
    tables ageg area sex ;
    run;

*** Create an event dataset containing age groups and sex ;
data separations(keep=ageg area sex separation los) ;
   set course.hospital ;
   *** Get all separations for 2004 ;
   if '01jan2003'd <= sepdate <= '31dec2003'd ;
   *** Create age groups at time of admission ;
   ageg = put(age,agegf.) ;
   *** Create a variable to count separations ;
   separation = 1 ;
   format area $areal. sex $sexL. ;
run;

proc freq data=separations ;
    title 'Verification of Hospital Separation groups 2003' ;
    tables ageg area sex ;
    run;

*** Call Rates Macro to calculate Separation rates - print only direct rate ;
pop_rate var=separation /** may use multiple variables var='separation los' **/
         numdata=separations
         popdata=pop
         area=area
         conf1='ageg sex'
         print=direct  /** may use all, indirect, or crude **/
         title='Direct Age/Sex adjusted Hospital Separations - 2003' ;
```

Common SAS Statements, Functions, Formats, & Procedures

SAS 9.2 Documentation
http://support.sas.com/documentation/
Base SAS:
http://support.sas.com/documentation/onlinedoc/base/index.html
SAS/STAT:
http://support.sas.com/documentation/onlinedoc/stat/index.html

STATEMENTS:
SAS programs are built from statements starting with a key word and ending with a semi-colon (;).

STANDALONE STATEMENTS (outside of a STEP)

```
Libname NAME ENGINE "path" ;
Title "title" ;
Footnote "footnote" ;
Options ps=XX ls=XX pagno=XX ;
Options mergenoby=warn;
%include "Filename" ;
ods TYPE <"path"> ;
       ods TYPE close ;
filename NAME "path" ;
```

COMMENTS

```
* comment statement ;
/*  COMMENT may appear anywhere **/
```

STEPS (PROC/DATA):
Analysis and Data manipulation processes are done in STEPS – groups of statements. Steps are bounded [start] by PROC or DATA and [end] with RUN; Steps are compiled and executed only when a step boundary is reached. Common syntax and statements to look for in steps include:

```
Proc PROCNAME data=DATANAME(options) OPTIONS ;
      where EXPRESSION ;
      class VAR; or by VAR;
      var VAR;  or tables VAR*VAR; or
           model  DEP=INDEP
      format VAR format.
      run;

Data DATANAME (options)
      set DATANAME(options) ; or
          merge DATANAME(options) ; or
          infile "path" options; input DEF;
      by VAR ; * required with merge ;
      <output> ; * implied if only 1 dataset
      ;
      format VAR format. ;
      label var="LABEL" ;
      run;
```

A Data Step requires one of 'set', 'merge', 'input' to populate the named dataset. An input statement should be associated with INFILE or DATALINES statement.

A MERGE statement should always be associated with a BY statement.

All variables in a WHERE expression must exist on the input dataset(s).

DATA SET OPTIONS found in parentheses () after dataset name

```
where=(EXPRESSION)
rename=(OLD=NEW)
in=Magic_VAR
obs=N
keep=VAR LIST/drop=VAR LIST
```

DATA STEP PROCESSING STATEMENTS

Create a new variable

```
newvar=EXPRESSION
```

Conditional Processing

```
if EXPRESSION then  <do> ;
else if EXPRESSION then <do>;
end ;
```

Carry value forward to next observation using retain.
VAR should not already exist in the set data.

```
retain VAR ;
```

By group processing. Often used with retain.

```
by VAR;
```

creates automatic variables

```
first.VAR last.VAR
```

Array processing

```
array NAME{i} VAR LIST ;
do x=i to X
       <until()> <where()>;
    NAME{i} ;  *reference array;
end ;
output DATA ;
```

FORMATS (system)

See PROC FORMAT for user defined formats

Date

```
DATEx.
YYMMDDx.
```

Numeric

```
X.Y (values in display)
Zx. (return leading 0s)
```

FUNCTIONS return a value.
e.g. Age = floor(yrdif(birth,today,'ACT/ACT')) ;

Date

```
YRDIF(sdate,edate,'ACT/ACT')
DATEPART(datetime_var)
QTR(datevar)
INTCK(interval,from,to)
MDY(month,day,year)
WEEKDAY(datevar)
YEAR(datevar)
MONTH(datevar)
```

Numeric/Stat

```
FLOOR(argument) & CEIL(argument)
ROUND(argument,unit)
MIN(arg,arg) or MIN(of X1-Xn)
MAX(arg,arg) or MAX(of X1-Xn)
MEAN(arg,arg) or MEAN(of X1-Xn)
SUM(arg,arg) or SUM(of X1-Xn)
ABS(argument)
LOG(argument)
EXP(argument)
MOD(argument1, argument2)
```

Random Numbers

```
CALL RANUNI(seed,var) or RANUNI(seed)
```

Character

```
COMPRESS(argument<,characters>)
UPCASE(argument) & LOWCASE(argument)
SUBSTR(argument,position, <n>)
SCAN(argument,n <,delim>)
See perl regular expressions
```

Variable Manipulation

```
LAG(var) & DIF(var)
PUT(var,<?|??>fmt.)
INPUT(var,<?|??>infmt.)
```

Array dimension

```
DIM(array_name)
```

COMPARISONS (operators)

```
=, ^=, <, >,<, >=, <=
EQ, NE, GT, LT, GE LE, IN()
: modifier is used for prefix
```

LOGICAL (Boolean) operators

```
&, |, ^
AND, OR, NOT
```

MISSING Values

```
numeric .
character ''  (null or space)
```

Have you tried the 'Get Of Out Jail Free' SAS code

```
*'; *"; */ ; *); %mend; quit; run;
proc datasets lib=work nolist kill; run; quit;
dm 'clear list ; clear log; wpgm ; zoom off' ;
```

SAS Dates (see also DATETIME variables)
SAS Dates represent days since (or before) January 1, 1960. Look for a numeric variable with a date format in proc contents.

COMMON PROCEDURES

ANALYTIC (BASE)

- **MEANS** - provides data summarization and descriptive statistics for variables across all observations and within groups of observations
- **FREQ** - produces one-way to n-way frequency and crosstabulation (contingency) tables. For two-way tables, PROC FREQ computes tests and measures of association. Listed under Base Statistical Procedures
- **UNIVARIATE** - descriptive statistics based on moments (including skewness and kurtosis), quantiles or percentiles (such as the median), frequency tables, and extreme values. Normal and other distribution tests. Listed under Base Statistical Procedures
- **TABULATE** - displays descriptive statistics in tabular format, using some or all of the variables in a data set. You can create a variety of tables ranging from simple to highly customized.

ANALYTIC (SAS/STAT)

- **REG** - a general-purpose procedure for regression. Other SAS regression procedures provide more specialized applications (LOGISTIC, GLM, GENMOD).
- **CORR** – computes Pearson product-moment correlation, Spearman rank-order correlation Kendall's tau-b coefficient, three nonparametric measures of association, and the probabilities associated with these statistics. Listed under Base Statistical Procedures
- **TTEST** - performs t tests for one sample, two samples, and paired observations.
- **ANOVA** - performs analysis of variance (ANOVA) for balanced data from a wide variety of experimental designs.
- **LOGISTIC** – regression model often used to investigate the relationship between discrete responses (usually binary) and a set of explanatory variables.
- **PHREG** - performs regression analysis of survival data based on the Cox proportional hazards model.
- **GLM** - uses the method of least squares to fit general linear models. Among the statistical methods available in PROC GLM are regression, analysis of variance, analysis of covariance, multivariate analysis of variance, and partial correlation.
- **GENMOD** - fits generalized linear models. The class of generalized linear models is an extension of traditional linear models that allows the mean of a population to depend on a linear predictor through a nonlinear link function and allows the response probability distribution to be any member of an exponential family of distributions. Many widely used statistical models are generalized linear models. These include classical linear models with normal errors, logistic and probit models for binary data, and log-linear models for multinomial data. Many other useful statistical models can be formulated as generalized linear models by the selection of an appropriate link function and response probability distribution. This procedure can fit models to correlated responses by the GEE method.

MANIPULATION, DOCUMENTATION

- **CONTENTS** - shows the contents of a SAS data set and prints the directory of the SAS data library.
- **FORMAT** - enables you to define your own informats and formats for variables.
- **SORT** - orders SAS data set observations by the values of one or more character or numeric variables.
- **TRANSPOSE** - creates an output data set by transposing selected variables into observations.
- **SQL** - implements Structured Query Language (SQL) for SAS. SQL is a standardized, widely used language that retrieves data from tables (datasets).

SQL QUERY & JOIN

```
proc sql ;
      create table NAME as
      select VAR, VAR
      from DATA,DATA
         left/right/full join DATA
      where/on EXPRESSION
      group by VAR,VAR
      having EXPRESSION
      order by VAR,VAR;
      quit ;
```

SQL SET or UNION

```
proc sql  ;
      select VAR,VAR
      from DATA
      where EXPRESSION
      union/intersect/outer
              union/except <corr>
      select VAR,VAR
      from  DATA
      where EXPRESSION
      quit ;
```

Commas are used between variables and datasets in SQL clauses: select, from, group by, order by.
When using left/right/full inner joins only two datasets can be defined.

YOUR NOTES: