SAS®
Workshop

Manitoba Centre for Health Policy

University of Manitoba

Input and Development by:
Charles Burchill, Heather Prior, Wendy Au, Jen Bodnarchuk, Randy Walld
Shelley Derksen, Jill MacGregor, Ruth-Ann Soodeen, and Ruth Bond

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University of Manitoba | Rady Faculty of Health Sciences

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Outline

The MCHP SAS workshop will provide the necessary SAS skills to work with SAS, through SAS Studio, 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 tasks, procedures, and how to find options to use the procedures. Although SAS Studio tasks are reviewed the SAS programming language is stressed 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 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 and understanding PROC syntax

I. SAS Studio Environment
   a. Tasks
   b. Programmer
   c. Visual Programmer (Flow)

II. Viewing data

III. 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

Resource Books

Delwiche, Lora D., and Slaughter, Susan J. 'The Little SAS Book: A Primer, 5th edition, 2012.

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.

Cody, Ron. An Introduction to SAS University Edition, 1st Edition, 2015

SAS Online Documentation
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.

SAS University Edition

Starting in 2014 SAS is offering SAS University Edition. This is a freely available interface to SAS (including Base SAS and SAS/STAT) that will run on most computer operating systems (including the Mac). More information and downloads can be found from SAS (http://blogs.sas.com/content/sastraining/2014/06/18/free-sas-software-for-students/).
Downloads and installation: http://www.sas.com/en_us/software/university-edition/download-software.html
The minimum requirements are: 64bit Windows 7, minimum 1GB RAM, ~2GB disk; OS X 10.8, minimum 1GB ram, ~2GB disk space.

Full Version of SAS (UofM Students and Staff only)

If you need to license a copy of SAS for your own computer please contact the UofM ACN support desk (474-8600, support@cc.umanitoba.ca) to make arrangements. The annual license copy (2016) was $100.00.

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.

MCHP SAS Workshop

Data Use Agreement

The Manitoba Health, Healthy Living and Seniors (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: ______________________

Overview

What Is SAS

SAS is a suite of software products that allow end users to do basic to advanced analytics, multivariate analyses, data management, and predictive analytics. It was originally developed by Anthony Barr and Jim Goodnight in the late 1960s originally in agriculture but has since expanded into many different areas. It is heavily used in the health and health care industry. It provides the widest range of statistical and data management tools along with the ability to work with very large databases when compared to similar products. It has been reported to be the largest shareholder in the area of advanced analytics. According to SAS - SAS is the world's largest privately held software company. Unlike R, SAS software is proprietary and it is expensive to setup and use outside of the academic environment. Other products that are commonly used include S-Plus, SPSS, STATA – there is significant overlap between the capabilities of all of the products, each with gaps and strengths.

SAS Interface(s)

- **Display Manager (Stand Alone**) – old stand-alone interface with a program editor, list window, and log window. This is primarily programming environment although it does have some interactive features. Newer installations and enhancements of SAS focus on use of SAS/Studio and SAS Enterprise Guide.
- **SAS Studio (Client/Server, University Edition)** – Newer interface to SAS providing basic capabilities (depending on environment) through a web based interface. It provides a mixed programming/graphic environment.
- **SAS Enterprise Guide (Client/Server, stand-alone)** – Newer graphic interface, providing access to advanced capabilities, graphic programing environment.

SAS/Studio

SAS studio is a web based application that connects to a SAS compute server. In the case of University Edition the server is running in a Virtual Linux environment on your computer (through Oracle Virtual Box or VM Ware Player). SAS Studio passes instructions to the server for execution, the results are passed back to the web application.
Notes on Installation

- follow installation instructions: https://www.sas.com/en_ca/software/university-edition.html
- requires installation of Oracle Virtual Box, or VM Ware Player. This installs a LUNIX virtual machine on your computer that provides the server backend for SAS Studio to use.
- Prior to downloading University Edition you will be asked to create an account with SAS.
- SAS will expire in roughly a year – just download OVA file again, or updated license from the *SAS® University Edition: Information Center*. Depending on

your installation and network configuration the update might fail with the message "*Make sure you are connected to the internet and try again.*" – if you get this message just download the ova file again rather than trying to troubleshoot your network connection.

- Locations of files/directories will need to be defined in Virtual machine settings. Calling these locations within SAS studio uses a UNIX type path name structure. SAS recommends setting up the following directories SASUniversityEdition\myfolders\. These are used for storing defaults and other local files. I recommend also creating a separate directory for your actual data files – just makes moving files around easier.
- Virtual Box Settings you may want to check the following items:
    - Shared Folders – myfolders, as well as any custom locations. These will appear in SAS Studio as folder locations. Be sure to set the directories as auto-mounting.
    - If you are using large files or complex processing you may want to adjust the System setting for memory use to a larger setting. Remember to leave memory for your host computer.
        - In the Global Tools for the virtual machine the default disk space allocated is 12GB if you have a lot of data you might want to increase this amount as well.
- To connect to SAS Studio after launching the virtual environment connect your web-browser to URL: http://localhost:10080

- SAS Studio Recommended Preferences
    - Add the following to the Autoexec: `options mergenoby=warn nofmterr obs=max ;`
    - Preferences (there are lots, just use defaults, these are just a few):
        - Editor: Enable Hints, Enable Colour Coding, Enable Auto Save. If you are familiar with programming in SAS disable hints.
        - Results: Display warning if HTML results are larger than [3MB]. The results viewer is parsed as HTML and large output (more than a few pages) causes display to become very slow. This does is not associated

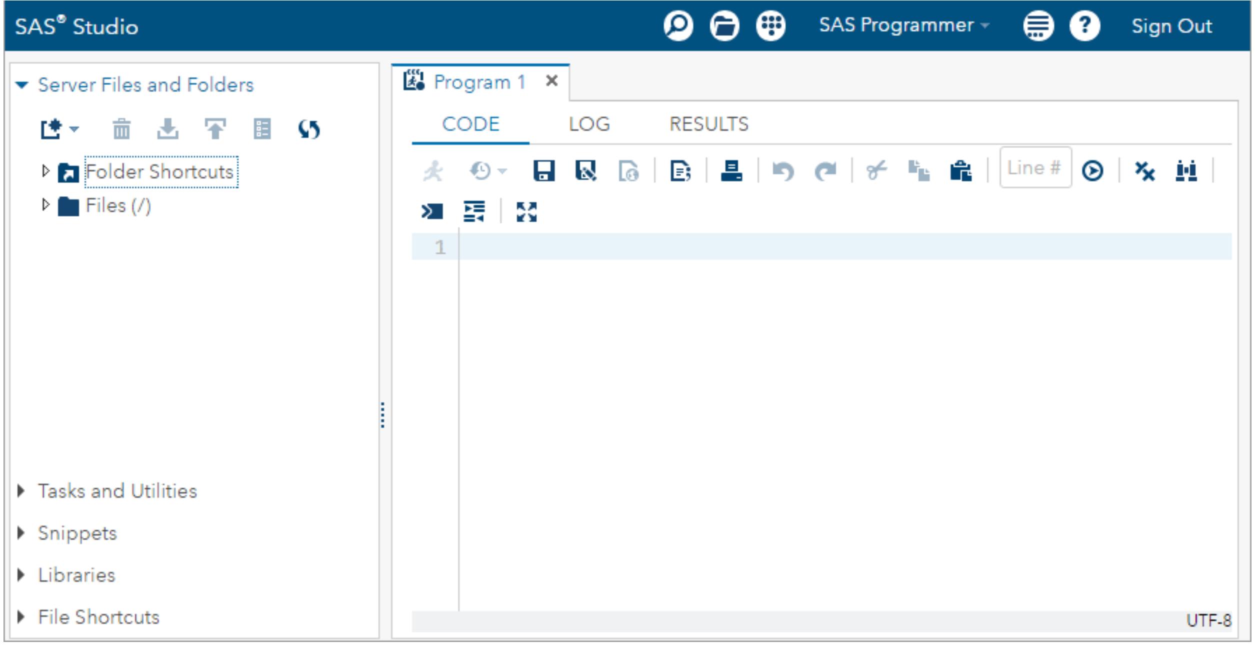
with the speed of SAS but the limitations on files sizes when viewing HTML through a browser.

- SAS Studio (3.7) Documentation: http://documentation.sas.com/?activeCdc=webeditorcdc&cdcId=sasstudiocdc&cdcVersion=3.7&docsetId=sasstudioov&docsetTarget=aboutthedoc.htm&locale=en

SAS Studio Environment

The arrangement of the SAS Studio window includes a Work Area on the right which provides a programming window, process flow sheet, or options for tasks. This is a tabbed window allowing multiple work area screens. On the left is a navigation pane allowing you to choose analytic or data options. The top of the screen includes search, open files, and new work area options (tabs). You can choose if you want to work in SAS Programmer mode or Visual process flow mode. The Options menu allows you to set defaults and preferences.

The Search will search the content of the active work area – this means that the search is context sensitive to the active navigation pane and work area tab.

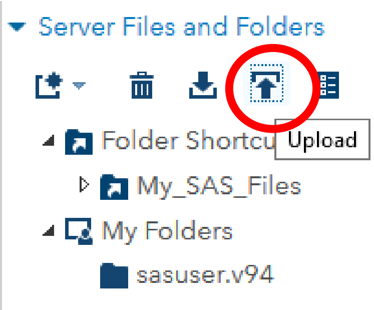


Navigation Pane

Server Files and Folders

Displays available folders and files. The list of folders available in SAS University Edition will only be those that were made available through the Virtual machine settings.

If you have external files that you want to upload into the Virtual environment (or download) you can use the upload/download utility in this section of the navigation pane. The size of the files that can be transferred this way is limited (by default) to 10MB, if you have larger files then create a Shared Folder location in the virtual machine.



Tasks/Utilities (point and click, but builds code, you can also create your own)

This is a set of common pre-configured tasks. Selecting a task will open a set of options in the work area to complete. Commonly used Tasks with completed options can be saved in *My Tasks* for future use. The tasks available may vary depending on the installation environment of SAS Studio. It is possible to create your own tasks, this is outside the scope of this workshop.

Utilities are similar to tasks but are more system or data oriented – e.g. importing, queries, or program editing. These utilities are also available the *New Options* menu at the top of the screen.

Snippets

This provides snippets or pieces of commonly used code examples. You can setup and save your own tasks or make copies under *My Snippets*.

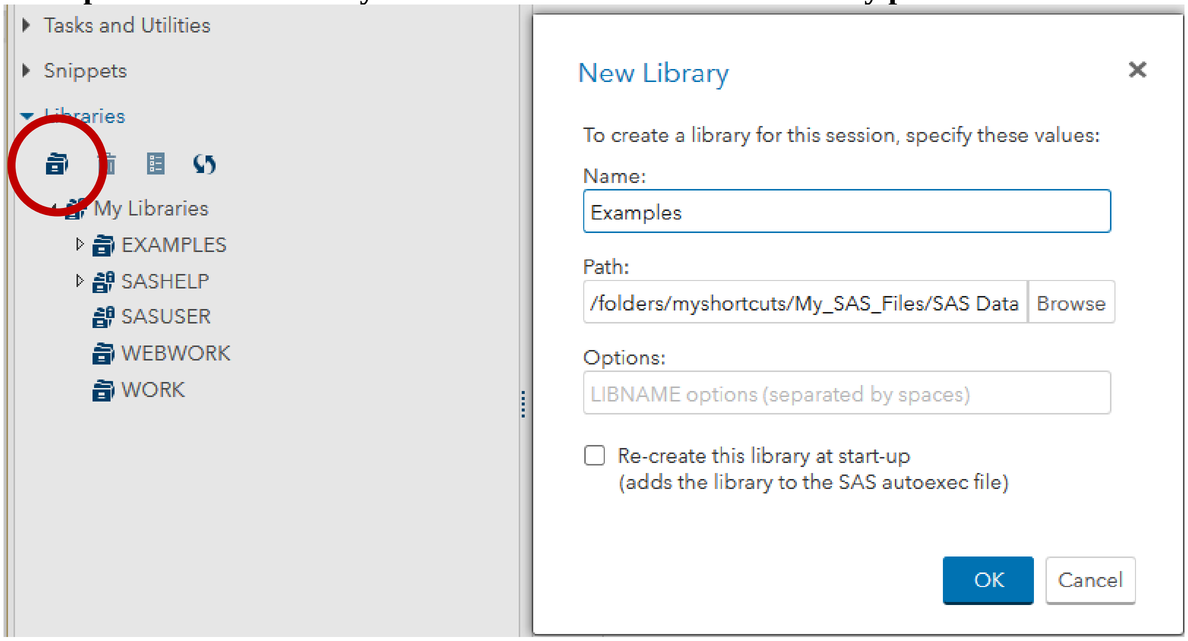
Libraries (Location of SAS Data)

Libraries are used by SAS to identify locations or sources of SAS datasets. When programming, a library reference provides a short cut name to data location. There are several pre-defined libraries but the only one that will be used is WORK. The WORK library is a 'scratch area' where temporary files can be held and used during a session.

Creating a new library means providing a short name (8 characters with now spaces or special characters) and a path name. In SAS University Edition only paths that have been identified in the Virtual machine will be available.

The installation instructions suggest only creating SASUniversityEdition\myfolders\ but having a secondary location for your course or thesis data is usually more convenient.

Example: Create a Library Reference to the SAS Data directory provided



New Library

To create a library for this session, specify these values:

Name: Examples

Path: /folders/myshortcuts/My_SAS_Files/SAS Data

Options: LIBNAME options (separated by spaces)

□ Re-create this library at start-up (adds the library to the SAS autoexec file)

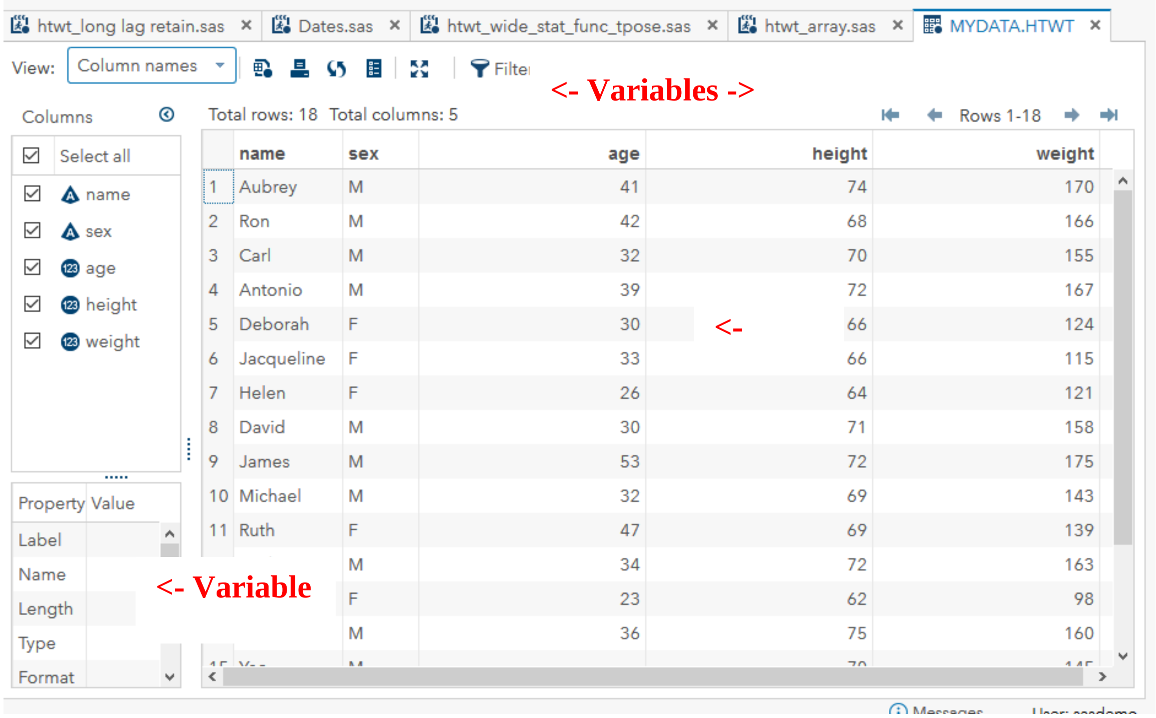
SAS Data Structure.

SAS uses its own particular terminology for describing the structure of a SAS dataset or file. Unfortunately SAS has also used different terms in various places in the program and associated documentation.

SAS Name and (common variants):

- SAS Dataset (table, file)
- Observations (records, rows)
- Variables (fields, columns)
- Values

Variables are either numeric or character, although you can set the length of variables, this is primarily for saving storage space. Unless you understand the effect of length on numeric variables you should use the default SAS value (of 8). Dates and Time variables are special cases of formatted numeric variables and should not be shortened. The length of Character variables is the number of characters the variable can store.



<- Variables ->

<- Variable

<-

<- Observations ->

Total rows: 18 Total columns: 5

Rows 1-18

	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
		M	34	72	163
		F	23	62	98
		M	36	75	160

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.

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;
```

Structured SAS Code Suggestions.

The following are some suggestions for SAS programming structure. Some alternatives have also been mentioned. Within SAS Studio selected text can be formatted automatically using the ‘Format Code’ (☰) option.

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 ;

Page intentionally left blank

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  and other procedures         *
******************************************;

* 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 s11.1 pp296-297).
  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, s2.21 pp70-71, s4.1 pp100-101):
  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, s1.10 pp20-21, s2.18, s2.19 pp64-67).
  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 s2.18 pp64-65).
  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 s2.19 pp66-67)

* SAS Studio University Edition uses a Linux virtual machine so there are
  no drive letters and the location of the data needs to be identified as
  a shared folder in the VM setup.  (e.g. /folders/myshortcuts/course/Data).
  An easy way to get the correct path is by coping from properties in the Server
  Files and Folders, Folder Shortcuts.;
libname course 'X:\course\data';

* Use title and footnote statements to give your output titles and
footnotes (LSB s4.1 p100-101).  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 s2.21 pp70-71).  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;

* Proc print prints out SAS datasets to the output window (LSB s4.5 pp108-109).
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/documentation/cdl/en/lrdict/64316/HTML/default/viewer.htm#a002295655.htm
     - 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 pp178-179);

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/documentation/cdl/en/proc/61895/HTML/default/viewer.htm#titlepage.htm
     - Base SAS, Base SAS Procedures Guide, Procedures
     - 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 p100-101).  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 s4.12 pp122-123, s9.6, s9.7 pp 264-267).;
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 s4.10 pp118-119, s9.3 258-259). ;
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/documentation/cdl/en/proc/61895/HTML/default/viewer.htm#a000146728.htm
    - Base SAS, Base SAS Procedures Guide, Procedures,
      The Means Procedure, Proc Means Statement
     (scroll down to statistic-keyword(s))
(LSB s4.10 p118-119, s9.3 p258-259);
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/documentation/cdl/en/proc/61895/HTML/default/viewer.htm#a002588796.htm
    - Base SAS, Base SAS Procedures Guide, Procedures,
      The Univariate Procedure
  (LSB s9.1, s9.2 pp254-257) ;
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/documentation/cdl/en/proc/61895/HTML/default/viewer.htm#a000146734.htm
    - Base SAS, Base SAS Procedures Guide, Procedures,
      The Means Procedure, OUTPUT Statement
```

```
(LSB s4.11 p120-121);
* 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;

* Simple regression (LSB s9.10 pp272-273) using PROC REG.
The REG procedure fits a linear regression using least-squares method.
There are other SAS procedures that will allow for different types of
regression and options (e.g. GLM, LOGISTIC, GENMOD) with a variety of distributions.
A variety of plots and output datasets can be created with various
options.  If ODS graphics is available a wide range of additional
graphic output can be created;

proc reg data=course.htwt  alpha=0.05  ;
    model weight = height ;
        output out=htwt_reg_out residual=resid predicted=pred l95m=lower u95m=upper ;
        plot weight*height  / pred   ;
        quit;

proc print data=htwt_reg_out ;
   run;

** Proc glm (general linear model) can be used for a variety of linear models
   including simple/multiple regression, ANOVA and others using the method
   of least-squares to fit the model.  String or categorical
   Classification variables may be used.  When using multiple independent variables
   contrast statements can be used to compare individual levels within specific
   variables.  Contrast statements are found in a number of regression procedures;
proc glm data=course.htwt ;
    class sex ;
        model weight = height age sex / alpha=0.05 ;
        contrast 'Compare Male vs Female' sex 1 -1 ;
        output out=htwt_glm_out residual=resid predicted=pred lclm=lower uclm=upper ;
        quit ;

proc print data=htwt_glm_out ;
   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 ;


* The easiest route to pulling data into SAS from an external source is using the Import Data
Utility in SAS Studio.  This uses PROC Import and SAS makes some assumptions about the data
Content so the data output and variable types should be reviewed.   The following provides an
examples of reading data through data step which provides more control over the import process.

libname course 'X:\course\data';

* read htwt data into a temporary SAS dataset from in-line data using
* a DATA STEP (LSB s2.4 pp36-37) Temporary data sets are stored in the WORK
* library (LSB s2.18 pp64-65). 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 pp40-41).;
  * This style of input is known as column input.  SAS can read in several
    styles of input including (LSB s2.1-2.7 pp30-43):
    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 */


* Use of formats to label or group displayed data ;
* Formats can be used to label the values of variables (LSB s4.6 pp110-111);
* You create formats to label values of variables using a SAS procedure
  called PROC FORMAT (LSB s4.8 pp114-115). 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;


* 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 pp36-37, s2.6 pp 40-41, s2.14 pp 56-57) ;
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 pp34-35, s2.17 pp62-63);
* 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;

* More information on reading external files from PC files can be found under the
SAS/ACCESS documentation Interface to PC files: Reference
http://support.sas.com/documentation/cdl/en/acpcref/63181/HTML/default/viewer.htm#titlepage.htm

You can access more recent and a broader range of PC files if the PC Files Access engine is
installed.  This PCFILES engine is not available in SAS University Edition. ;

libname test pcfiles path='X:\course\raw data\htwt.accdb' ;
libname t2 pcfiles path='X:\course\raw data\htwt.xls' ;
```

* 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 and associated
  An OUTPUT statements (LSB s3.6 pp84-85 s6.9 pp194-195);

* 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);

* Generating multiple output data sets needs to be done in several steps in
```

```
SAS Studio using either the query utility or filter task ;

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;


* Temporarily Subset the data in a PROC Step using the where statement
(LSB s4.2 pp102-103).   Within a SAS Studio task you can select data using Filter (usually
right below the DATA field).    Where statements can use SQL type queries for selection
that include like or contains operands. ;
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, pp 328);
* 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 *
* Within SAS studio new variables can be     *
* be created with transform, recode, or      *
* using the query utility.                   *
**********************************************;

data htwt;
   set course.htwt;

*-----------------------------------------------------*
* 1. Numeric Operations (LSB s3.1 pp74-75)            *
* 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.  ** takes the value to the
* power of the next number (e.g. **2 is squared      *
*-----------------------------------------------------*;

   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 ;

** SAS Follows basic Order of Operations (PEMDAS):
        P Parentheses first
        E Exponents (ie Powers and Square Roots, etc.)
        MD Multiplication and Division (left-to-right)
        AS Addition and Subtraction (left-to-right)

*-----------------------------------------------------------*
* 2. IF/THEN/ELSE statements (LSB s3.5 pp82-83)             *
* 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 pp76-81)                        *
* 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      *
*   EXP Returns the value of the exponential function.
*   ABS Returns the absolute value
*   MOD Returns the remainder from the division of the first
        argument by the second argument, fuzzed to avoid most
        unexpected floating-point results.
*   SQRT Returns the square root
*   RANUNI, RANNOR, RANPOI,,, all return random values
*
* Numeric functions typically ignore missing values 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                           *
*   COMPRESS Compresses characters or spaces out of a string
*   CAT, CATS, CATX Concatenate two or more variables
*   TRIM Removes trailing values, LEFT/RIGHT justify a string
*   LENGTH returns the length of a variable
*   SCAN scans a string variable for ‘words’
*----------------------------------------------------------------*;

   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 s10.6 pp 292-293, s5 pp 150-175)
** 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 s1.13 pp26-27) ;
options obs=1000; * options obs=max ;

/** 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 pp104-105).;

*******************************************************
* 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.                                       *
*
* Sorting can be done as a SAS Studio Sort Data task   *
*******************************************************;
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 pp180-181);
* (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.

* Unfortunately in SAS Studio there is no append or UNION query task so the
  next steps need to be done as code.  ;

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.

* Data can be joined using the SAS Studio Query utility.   The Query utility provides
  many more options than a simple SAS merge but it can be slower and more complicated
  to use than a simple merge.  The Query does not require sorting on the merge key.;
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, s6.6-6.7 pp188-191) ;
* 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, s11.8 (pp310-311).  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 particular 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 pp36-37).
                                   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 pp58-59) ;
   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 pp42-45, s2.21 pp70-71).;
   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 pp92-93, 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 encountered, 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, pp76-79.
    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;
** The following can be done in SAS Studio using the custom ‘transform’ task. ;
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;


** Transposing data (a side note since many people ask);
** Although SAS provides statistical functions for doing analysis over multiple
   related variables it is often easier in SAS to have a single variable and multiple
   records this is how most procedures 'expect' data to be formated. ;
** If necessary PROC Transpose or a datastep can be used to switch variables 'wise' data
to column 'wise' ;

** Proc Transpose example - transpose is done twice since there are two sets of variables
   that need to be transposed.  Once there are large number of records or fields using
   a datastep to transpose might be more efficient ;
proc transpose data=course.htwt_wide out=wt_long prefix=weight;
    by name ;
        var weight1-weight6 ;
        run;
proc transpose data=course.htwt_wide out=ag_long prefix=age;
    by name ;
        var age1-age6 ;
        run;
data htwt_long ;
     merge wt_long
           ag_long(drop=_name_) ;
         by name ;  *** SAS will write a note that MERGE has repeats of by values ;
         time = substr(_name_,7,1) ;  ** the _name_ variable contains the original
                            variable name - get suffix ;
         drop _name_ ;
         run;

** Data Step transpose - this uses a 'Do' loop with an output to create a new record for
   each variable in a dataset ;
data htwt_long(keep=name time weight age);
     set course.htwt_wide ;
         ** Define the groups of variables to transpose ;
         array wt{6} weight1-weight6 ;
         array ag{6} age1-age6 ;
         ** re-assign each variable to a new variable and output a new
            record for each array variable. ;
         do time = 1 to 6 ;
             weight = wt{time} ;
                 age = ag{time} ;
                 output ;
                 end ;
          run;
```

```
* Array processing (LSB s3.11 pp94-95)
--------------------------------------- ;
* 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 ;
        * else over{i} = 0 ;
      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)
           Note that this will do an implied retain so an else will be required;
   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(25) diag01-diag25;

   ** 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 id admdt;
run;

proc print data=diab (obs=50);
   title 'Hospitalizations with Diabetes Diagnosis';
   var id diag01-diag10 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 s3.8, s3.9 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 s11.8 pp310-311) 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,'AGE')) ;

   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 pp325-330, s6.3 pp182-183, s6.4 pp184-185);

* 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 ;
*/

* Statements in SQL need to go in the above order – it might be helpful to think of the saying:
Some French Waiters Grow Healthy Oranges.
There are many more capabilities and SQL commands available e.g. Unions (compare to SET).
* There is a nice online summery of generic SQL found online:
  https://www.w3schools.com/SQL/deFault.asp
  The examples provided here need to go between the Proc SQL and Quit statements.;

* 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 name, age, sex, height, weight
   from course.htwt
   where sex='M';
   quit ;

** Adding overall mean to every record in a dataset (from above)
   doing a calculation with a newly created variable,  An *
   is used to identify all of the existing fields in the table.;
proc sql ;
   create table test as
   select *, mean(weight) as meanwt,  weight-(calculated meanwt) as diff
   from course.htwt ;
   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 *, mean(age) as mage,
      age>(calculated mage) as high_age label='Age Greater than Mean Value of Age for Each Sex'
   from course.htwt
   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.  When using multiple from tables SQL needs a way to identify
   the table name and the corresponding fields.  In SQL a period in the select command
   is used to identify the table followed by the specific variable.   In SAS a period
   is used to distinguish a library (location) and then a table name.
```

```
    In the following example this problem is resolved by providing an
    Alternative name (short cut) using ‘as’ in the from line.


    Course.htwt_reg.region <- this is invalid SQL as the field identifier has two periods.
    This is resolved by identifying (course.htwt) as htwt_reg
    SQL will only ‘see’ htwt_reg.region because the course. Is replaced with
    The short alternative name.


    In practice the use of an alternative (alias) is only required if there are
    fields with the same name making a selection ambiguous.;
title 'Data table created with a join by name/firstname using SQL' ;
proc sql ;
  create table merged as
    select ahtwt.*, areg.region
    from course.htwt as ahtwt,
       course.htwt_reg as areg
    where ahtwt.name = areg.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.id, hosp.admdt, hosp.sepdt, hosp.sepdisp,
           reg.covenddate, covenddate-sepdt as diff,
           weekday(covenddate) as week_day_death format=weekdnme.
      from course.hospital as hosp,
         course.registry(where=(covcancode='2')) as reg
      where hosp.id=reg.id
          & 0<=covenddate-sepdt<=180
      group by hosp.id
      having diff=min(diff)
      order by hosp.id, 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 sepdisp = '07'
      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=ID 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 s6.15 pp206-207).;

    ** 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;
```

Practice Questions

SAS Workshop Practice Questions #1

In this set of questions you will review the hospital abstracts dataset using some basic SAS tasks 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 <u>not</u> 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.

Part 1: Viewing the Data

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 admdt?
6. Using the Print procedure or List Data task print the first 50 observations.

Part 2: Exploring the Data

Using the SAS dataset HOSPITAL answer the following questions using the frequency or means procedures or task. 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 RHA. These are the old RHAs (before May 2013)
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. RHA by sex) using the SAS manual or the online documentation.   Using a SAS Studio task you will need to do this as a 'Table Analysis'
4. Run Proc Means or Summary Statistics Task on the variable LOS for inpatients only (where transact='1'). Limiting the data as a task might have to be done with a Query utility first.
5. Find out the number of missing values and the median value of length of stay.
6. Add a classification variable (sex) and find out the number of missing values, the mean and median value of 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 2012.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 2012.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.

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). Using the HOSPITAL data in course uses a different set of formats - %include ‘x:\course\Formats\newfmts.sas’;

A. Create two new temporary SAS datasets (INPAT, DAYSURG) from `COURSE.HOSPITAL` in a single **data step** keeping only the variables sex, and length of stay

  i. INPAT data should contain observations from HOSPITAL with TRANSACT equal to1.

  ii. DAYSURG data should contain observations from HOSPTIAL with TRANSACT equal 3.

  iii. Calculate the mean length of stay (LOS) for INPAT and DAYSURG hospital separations. Remember to use titles to identify your output appropriately. Day Surgery records are recorded in hours.

B. Using the dataset `COURSE.HOSPITAL`, calculate the frequency distribution of sex for INPAT and DAYSURG using a **where** statement.

C. In a temporary (WORK) copy of the Inpatient `HOSPITAL` dataset, create the following new variables:

i. Create an AGE variable using the following calculation. We will cover SAS date values later in the course. AGE = floor((ADMDT-BIRTHDT)/365.25) ;

ii. Create an **agegroup** variable which groups age into 4 categories
    0-19, 20-39, 40-59, 60 or more

iii. 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.

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

v. Using the new variables calculate the proportion of hospital stays with length of stay less than 3 days by age.

SAS Workshop Practice Questions #3

In this example you will use the simulated hospital abstract data to determine the number of inpatient (TRANSACT=’1’) 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 **rha** variable into 3 groups using a format or if/then conditional processing.

Group	RHA
North	‘NO’ Northern
South	‘SO’ Southern
	‘IE’ Interlake-Eastern
	‘WE’ Prairie Mountain
Urban	‘WP’ Winnipeg

Include the formats for this data using

```
%include ‘X:\course\formats\newfmts.sas’ ;
```

C. Calculate the average length of stay by area group and sex using proc means. Output the results into a temporary SAS
D. Merge the average length of stay variable to the temporary HOSPITAL dataset by the area group and sex
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
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
    1. i. Sort the temporary dataset by the personal identification number (**ID**). Remember that this allows you to process the data set BY the personal identification number.
    2. ii. In a DATA STEP, set the sorted temporary data by the personal identification number (**ID**). You can use the same temporary dataset name if you want to.
    3. iii. In the same data step, create two new variables from the **first.id** and **last.id**. 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 **id**.
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.id** and **last.id**).
5. In another DATA STEP, set your sorted temporary HOSPITAL data by the personal identification number again and perform the following steps:
    1. i. Count the number of hospitalizations for each individual and output the last record for each individual using **last.id** to a new dataset. Use a **retain** and **counter** variable for counting and **first.id** to re-initialize the counter for each individual.
    2. ii. Keep only the personal identification number and your **counter** variable.
    3. 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 twenty five 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. Remember age can be calculated using:

    Age = floor(yrdif(birthdt,admdt,’AGE’)) ;

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 COVENDDATE when COVCANCODE=’2’ and SEPDT.

i. Merge the SAS data sets HOSPITAL and REGSITRY by **ID** 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 (SEPDISP=’07’).

SAS Workshop Practice Questions #5

Using the hospital and registry data calculate the crude rates for 2009 of inpatient 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. Select the registry data so there is only a single record/person (ID). The registry data includes individuals that may have been born or died during the time period. You may want to select a ‘census’ population for a particular time period (e.g. mid time period).
- You will need to summarize the hospital data by region. Remember the hospital data contains data for several years of data.
- Merge this summarized data.

Data Dictionaries

MCHP Training and Research Resource

The administrative data that is used as part of this workshop represents utilization for roughly 1% of the Manitoba Population 2005/06-2013/14. Although the data is simulated it should provide a representative picture suitable for use in class room presentations and workshops.

Height/Weight Dictionary

These data represent 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 (2005/06-2013/14)

NOTE: This data is not 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.

These data represent 19255 observations and 159 variables. It is important to note that the data includes both inpatient and day surgery records and some fields have different meanings (e.g. LOS). Inpatient records are identified with TRANSACT='1'.

Name of resource: HOSPITAL

ABSTRACTTYPE Char 1 ABSTRACT TYPE
Format: $ABSTL

1	Adult/Child
2	Paediatric
3	Obstetrical
4	Newborn & stillborn

ADMCATEGORY Char 1 Admit Category
Format: $ADMCL
This is the admission category for the patient record.

L	Elective
U	Urgent/emergent
N	Newborn
S	Stillborn
R	Cadaveric Donor

ADMDT NUM Date of admission to hospital
Range: 19951204-20100415
Date of admission to hospital. SAS date value (YYMMDD10.) .

ADMITSTATUS Char 1 ISB – Admit Status
Format: $ADSTL
This defines patient status at admission.

0	N/A
1	Emergent
2	Urgent
3	Elective
4	Day Surgery/Daycare
5	Stillborn
6	Brain Death
*	Missing

ALC_OFFDT1-3 Num 8 Date reassigned as Acute

ALC_ONDT1-3 Num 8 Date reassigned as ALC

ALCLOS NUM ALC Length of stay during hospitalization.
Alternate level of care coded during stay

ALC_REASON1-3 CHAR 2 ALC Reason Codes
Reason for alternate level of care coded during stay.

BIRTHDT Char 8 Birth Date (mod)
Date of birth from the training resource registry file. Birth date for the individual is a character string in the format yymmdd8. There are a number of birth dates that have 00 for the day and/or month. These should be corrected when using birth. This variable is modified from the original date of birth found in the research repository.

```
   age =floor(yrdif(birthdt,sepdt,'age'));
```

CMG Char 3 Case Mix Group No.
Formats: CMG03L, CMG07L
Case Mix groupers categorize patients into statistically and clinically homogeneous groups based on the collection of clinical and administrative data.

DIAG01-25 Char 7 ICD-10-CA Diagnosis Code

DPG4 Char 2 Day Procedure Group
Formats: $DPG03L, $DPG06L, $DPG07L
This is a national grouping methodology for ambulatory hospital patients mainly in the area of day surgery. Note that patients are assigned to categories according to the principal (most significant) procedure recorded on the patient abstract. Patients assigned to the same DPG category represent a homogeneous group with similar clinical episodes and requiring similar resources.

DPGRIW Num 8 Day Procedure Group Weight
Range: 0.015-4.4586
A relative resource allocation methodology for estimating a hospital's day procedure costs, based on the same scale as the inpatient RIW

HOSPRHA Char 2 RHA of Hospital
Format: $RHAL
This is the RHA location of the Hospital. See RHA for codes.

ID Char 6 Personal ID Number (Mod)
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. For more information on individuals, refer to CENSUS2001, REGISTRY, or REGISTRY_FAMILY.

INTCD01-20 Char 10 CCI Intervention Code
The intervention code is an operative or non-operative intervention performed during the patient's hospital stay. The CCI does not provide a code to classify an intervention that did not occur.

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

LOS Num 8 Length of Stay (derived)
Range: 1-3098
Calculated by subtracting admission date from separation date. For inpatients (TRANSACT=’1’) requires LOS = 1 if DATEADM = DATESEP (even 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. Day surgery cases (TRANSACT=’3’) LOS is the number of hours in the hospital.

NONALC_DAY1-2 Char 3 Non-ALC Days

NONALC_REASON1-2 Char 2 NAD Reason Code

NWB_APGAR1 Num 4 BIRTH APGAR SCORE @ 1 MINUTE
Range: 0-10, 99 (missing)

NWB_APGAR5 Num 4 BIRTH APGAR SCORE @ 5 MINS
Range: 0-10, 99 (missing)
APGAR score is based on physician assessment of five vital signs in newborn at 60 seconds and five minutes after birth.

Score ranges from 0 (stillborn) to 10.

NWB_GEST Num 8 Gestational Age (newborn record)

NWB_WT Num 4 BIRTH WEIGHT IN GRAMS
New born or still born weight in grams. Low and high birth weight babies have been limited to 1500 and 5000 grams. Completed if ABSTYPE=’4’

OBGESTAD Num 8 Gestational Age (mother’s record)

PROV_CODE1-8 Char 4 Attending Physician (baseno) (faked)

PROV_SERV1-8 Char 5 Most Responsible Provider Service
Format: $PSERVL
The provider service for a physician reflects the level of training or specialty of the physician. The service must always be accompanied by a provider number. They are considered a pair and it is incorrect to report a service without the corresponding provider number. The provider service for the non-physician provider reflects the level of specialty of the health care provider. The service must always accompany the provider type. The non-physician provider number is optional to record. The provider service may be completely different from the patient service recorded on the patient’s abstract.

Specialties recognized by the Royal College of Physicians and Surgeons of Canada	CIHI Provider Service Number
Family Practitioner/General Practitioner	00001
Community Medicine	00002
Emergency Medicine	00003
Internal Medicine	00010
Clinical Immunology and Allergy	00011
Cardiology	00012
Dermatology	00013
Endocrinology and Metabolism	00014
Gastroenterology	00015
Nephrology	00016
Neurology	00017
Respirology	00018

Rheumatology	00019	
Paediatrics		00020
Paediatric Immunology and Allergy		00021
Paediatric Cardiology		00022
Paediatric Dermatology	00023	
Paediatric Endocrinology and Metabolism	00024	
Paediatric Gastro-Enterology		00025
Paediatric Nephrology	00026	
Paediatric Neurology		00027
Paediatric Respirology	00028	
Paediatric Rheumatology	00029	
General Surgery	00030	
Cardiac Surgery	00031	
Neurosurgery		00032
Orthopedic Surgery		00034
Plastic Surgery	00035	
Thoracic Surgery		00036
Vascular Surgery		00037
Cardiothoracic Surgery	00038	
Urology	00039	
Paediatric General Surgery		00040
Paediatric Cardiac Surgery		00041
Paediatric Neurosurgery	00042	
Paediatric Orthopedic Surgery	00044	
Paediatric Plastic Surgery	00045	
Paediatric Thoracic Surgery		00046
Paediatric Vascular Surgery		00047
Paediatric Cardiothoracic Surgery	00048	
Paediatric Urology		00049
Obstetrics and Gynecology		00050
Gynecologic Reproductive Endocrinology and Infertility	00051	
Maternal-Fetal Medicine	00054	
Critical Care Medicine	00055	
Clinical Pharmacology	00056	
Anesthesia		00057
Paediatric Anesthesia		00058
Colorectal Surgery		00059
Otolaryngology	00060	
Paediatric Otolaryngology		00061
Ophthalmology	00062	
Paediatric Ophthalmology	00063	
Psychiatry		00064
Paediatric Psychiatry		00065
Hematology		00066
Paediatric Hematology	00067	
Physical Medicine and Rehabilitation	00070	
Geriatric Medicine		00072
General Surgical Oncology		00073
Medical Oncology		00074
Radiation Oncology		00075
Gynecologic Oncology	00076	
General Pathology		00077
Medical Microbiology	00078	
Diagnostic Radiology		00080
Medical Genetics		00082

Anatomical Pathology	00083	
Hematological Pathology	00085	
Neuropathology	00086	
Nuclear Medicine		00089
Medical Biochemistry	00090	
Pediatric Radiology		00092
Neuroradiology	00093	
Infectious Diseases		00096
Neonatal-Perinatal Medicine		00097

Non-Physician Services	CIHI Provider Service Number	
Dentistry Group	01000	
Dentist	01001	
Dental Surgeon	01002	
Oral Surgeon		01003
Orthodontist		01004
Paedodontist		01005
Periodontist		01006
Oral Pathologist	01007	
Endodontist		01008
Oral Radiologist	01009	
Dental Hygienist/Assistant		01010
Dental Mechanic	01011	
Paediatric Oral Surgeon	01012	
Paediatric Dentist		01013
Podiatry/Chiropody in General	02000	
Podiatrist		02001
Chiropodist		02002
Therapist Group	03000	
Radiotherapist	03001	
Physiotherapist	03002	
Occupational Therapist	03003	
Respiratory Therapist		03004
Massage Therapist		03005
Psychotherapist	03006	
Recreation Therapist		03007
Therapy Assistant		03008
Speech Language Pathologist	03009	
Kinesiologist		03011
Rehabilitation Counsellor	03012	
Physiotherapist Assistant	03013	
Occupational Therapist Assistant	03014	
Rehabilitation Therapist	03015	
Rehabilitation Engineer	03016	
Orthotist		03017
Prosthetist		03018
Vocational Rehabilitation Counsellor	03019	
Audiologist		04000
Chiropractor		05000
Dietitian		06000
Osteopath		07000
Optometrist		08000
Ophthalmologic technician		08001
Orthoptician/Prosthetician		09000

Naturopath		10000
Nursing Group	11000	
Registered Nurse	11001	
CAN / RNA / LPN / RPN	11002	
Nurse Practioner	11003	
Midwife		11004
Nurse Aide/Healthcare Aide		11005
Social Worker	12000	
Pharmacist		13000
Physicist in Medicine		14000
Psychologist		15000
Pastor/Clergy		16000
Technician Group		17000
X-ray Technician		17001
Lab Technician	17002	
Nuclear Medicine Technician	17003	
Alternative Healer		18000
Language Interpreter		19000
Home Support/Home Care Worker	20000	

PROV_TYPE1-8 Char 1 Provider Type

QUINT Char 2 Income Quintile
Neighbourhood income quintiles based. Income quintiles have been divided into Urban (Winnipeg & Brandon) and Rural Manitoba. The first character of the quintile indicates the location. A further division of NF is used to identify a large group of Manitoba individuals that can not be assigned a neighbourhood income. Most of these individuals are in institutions (PCH, Prison, LTC hospital) or covered by some form of social services. This value is assigned from the training resource registry.
U1 Urban lowest income quintile
U2
U3
U4
U5 Urban highest income quintile
R1 Rural lowest income quintile
R2
R3
R4 Rural highest income quintile
NF Not found or not assigned

RHA Char 2 Regional Health Authority
Format: $RHAL
This is the RHA that the individual was living in during the sample period. In the training resource individuals have been assigned a single RHA for the whole period. This is NOT the case in the actual research repository. The coding used at MCHP is not the same as Manitoba Health. RHAs are not found on the data found in the research repository but must be generated from postal code and municipal code. ArcView Shape files are available for mapping these areas.

MCHP	Name	
IE	IE Interlake Eastern	
		IE1 Interlake Eastern Selkirk Zone
		IE2 Interlake Eastern South Zone
		IE3 Interlake Eastern East Zone
		IE4 Interlake Eastern West Zone
		IE5 Interlake Eastern North Zone
		IE6 Interlake Eastern Remote Zone
NO	NO Northern	

NO1 Northern Direct Service Zone
NO2 Northern Non-Direct Service Zone
NO3 Northern Island Lake Zone

SO SO Southern Zone
SO1 Southern North Zone
SO2 Southern Mid Zone
SO3 Southern West Zone
SO4 Southern East Zone

WE WE Prairie Mountain
WE1 PMH North Zone
WE2 PMH Brandon Zone
WE3 PMH South Zone

WP WP Winnipeg
WP11 Winnipeg Urban
WP21 Winnipeg Churchill

SCU_ADMDT1-6 Num 8 Special Care Unit Admit Date

SCU_ADMTM1-6 Num 8 Special Care Unity Admit Time (24 hour)

SCU_DEATH Char 1 Special Care Unit Death Indicator

Y. Patient died
Missing Value. Patient did not die

SCU_GLASGOW Char 2 Glasgow Coma Scale

SCU_HOURS Char 4 Special Care Unit Total hours

SCU_HOURS1-6 Char 4 Special Care Unit Hours

SCU_SEPDT1-6 Num 8 Special Care Unit Discharge Date

SCU_SEPTM1-6 Num 8 Special Care Unit Discharge Time (24 hours)

SCU_UNIT1-6 Char 2 Special Care Unit Number

SEFI Num 8 SES Index Factor

SEPDISP Char 2 Discharge Disposition
Format: $SEPDISL
The discharge disposition is the status of the patient upon leaving the hospital

01 transferred to an acute care inpatient institution (includes other acute, sub-acute, acute psychiatric, acute rehabilitation, acute cancer centre, acute pediatric centre etc.)

02 transferred to continuing care (a facility that providescontinuing supervisory care by medical and allied medical staff)

03 transferred to other (includes ambulatory care, palliative care facility/hospice, addiction treatment centre, infants and children discharged/detained by social services)

04 discharged to home or a home setting with support services (senior’s lodge, attendant care, home care, meals on wheels, homemaking, supportive housing etc.) Example of dicharge to a home setting with support: a facility where supervisory care is not required on a continuing basis. A patient is discharged and is able to function independently within a group setting. Community services would be brought in to provide support, when necessary Example of discharge home with support services: A patient is discharge home with the support of home care who are providing daily dressing changes and wound care

05 discharged home (no support service required) (jail can be considered as home)

06 left against medical advice (with or without signout, AWOL)
07 died
08 cadaveric donor admitted for organ/tissue retrieval
09 stillbirth
10 newborn and pediatric discharged to Child and Family Services (Manitoba only)
11 private adoption of newborn (Manitoba only)
12 Patients who did not return from a pass

SEPDT NUM Separation Date
Range: 20040401-20140415
Date of separation from hospital. SAS date format yymmdd10.

SERV1-3 Char 2 Patient Service Transfer

SERVDAYS1-3 Char 5 Patient Service Transfer Days

SEX Char 1 Biological gender
Format: $SEXF

SUBSERV Char 1 Main Patient Sub-service
For further specification of the main patient service a one digit subservice code can be added. This optional code allows the client to further differentiate types of patients treated within a patient service.

SUBSERV1-3 Char 1 Patient Sub-service transfer
This one digit code may be defined by the client to further specify the patient service transfer.

TEACHING Char 1 Teaching Hospital code
Teaching hospital records in the training database are identified with a ‘1’.

TRANSACT Char 1 Transaction Code
Identify Inpatient (‘1’) and Day Surgery records (‘3’). Note LOS is measured in different units for Inpatient and Day Surgery records.

TRFROMF Char 1 Transfer from code
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
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.

WEIGHT Num 8 Newborn/Neonate Weight

WPG_CA Char 3 Winnipeg Community Areas
Format: $RHAL
These are Winnipeg subregions similar in size the non-Winnipeg RHAs. Note there are a small number of individuals with a Winnipeg RHA (K) that are not assigned to a Winnipeg Community area. Winnipeg areas are not found on the data found in the research repository but must be generated from postal code and municipal code. ArcView Shape files are available for mapping these areas.

W02	ASSINIBOINE SOUTH
W11	DOWNTOWN
W03	FORT GARRY
W09	INKSTER

W10	POINT DOUGLAS
W07	RIVER EAST
W12	RIVER HEIGHTS
W08	SEVEN OAKS
W04	ST. VITAL
W05	ST.BONIFACE
W01	ST.JAMES-ASSINIBOIA
W06	TRANSCONA

Physician Medical Services 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 from 2005/06-2013/14.

NOTE: This data is <u>not</u> 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.

These data represent 1578147 observations and 21 variables.

Name of resource: MEDICAL

AMBVIS Num 3 Ambulatory Visit Flag
This flag identifies ambulatory visits as used at MCHP (‘1’ – Ambulatory visit)

BIRTHDT Char 8 Birth Date (mod)
Date of birth from the training resource registry file. SAS date variable (YYMMDD10.)

```
age =floor(yrdif(birthdt,servdt,'age'));
```

SERVDT NUM 8 Date of service
Range: 19000116 - 21000104
This is the year-month-day format of patient’s visit or other service provided by billing physician.

DIAG Char 3 Diagnosis
This is the ICD-9-CM diagnosis codes provided on billing. Some DIAG fields are blank.

FEE Num 5 Fee for service
Range: -8-$8310.80
This is the fee that was billed for this service.

HOSPRHA Char 2 RHA of Hospital
This is the RHA location of the Hospital. See RHA for codes. Note in the research registry the hospital number will contain a provincial code for out of province services.

ID Char 6 Personal ID Number (Mod)
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. This number is assigned from the training resource registry.

IN_HOSP Num 3 In Hosp Confirmed Flag

MDBLOC Char 3 md bloc + subbloc
Format: $BLOCSBL
This is the field of practice that MDNO has registered with the Manitoba College of Physicians and Surgeons.

'01' = 'Internal Medicine'
'011'= 'Int.Med - Neurology'
'012'= 'Int.Med - Geriatrics'
'013'= 'Int.Med - Rheumatology'
‘014’= ‘Int. Med – Cardiology
‘015’= ‘Int. Med – Gastroenterology’
‘016’= ‘Int. Med – Nephrology’
‘017’= ‘Intmed – Allergy/Clinical Immunology’
'018'= 'Int.Med - Genetics'
'019'= 'Int.Med - OOP'
'02' = 'Pediatrics'
'029'= 'Pediatrics - OOP'
'03' = 'Psychiatry'
'039'= 'Psychiatry - OOP'
'04' = 'Surgery - unspecified'
'040'= 'Surgery - Oral'
'041'= 'Surgery - General'
'042'= 'Surgery - Thoracic & CV'
'043'= 'Surgery - Plastic'
'044'= 'Surgery - Urology'
'045'= 'Surgery - Orthopedic'
'046'= 'Surgery - Neurology'
'047'= 'Surgery - Dental'
'048'= 'Surgery - Peridontal'
'049'= 'Surgery - OOP'
'051'= 'ENT - Eye only'
'052'= 'ENT - Other than eye'
'053'= 'ENT - Optometry'
'059'= 'ENT - OOP'
'06' = 'Dermatology'
'069'= 'Dermatology - OOP'
'07' = 'Radiology'
'071'= 'Radiology - In-hospital'
'072'= 'Radiology - Professional'
‘073’= ‘Radiology – Nuclear Medicine Split’
‘074;= ‘Radiology – Nuclear Medicine Prof’
‘075’= ‘Radiology – Nuclear medicine Total
'076'= 'Radiology - Ultra Sound & MIR'
'079'= 'Radiology - OOP'
'08' = 'Pathology'
'081' ='Pathology - Anatomical'
'082' ='Pathology - Heamatological'
'083' ='Pathology - Medical Biochemistry'
'084' ='Pathology - Medical Microbiology'
'085' ='Pathology - Neuropathology'
'089'= 'Pathology - OOP'
'09' = 'Obstetrics & Gynecology'
'091'= 'Perinatal Medicine'

```
'099'= 'Obs&Gyne - OOP'
'10' = 'Anaesthesia'
'109'= 'Anaesthesia - OOP'
'11' = 'General Practice'
'111'= 'GP - Metro Wpg/Brandon'
'112'= 'GP - Rura; '
'113'= 'GP - Emergency Medicine'
'114'= 'Community Medicine (public health)'
'115'= 'Family Practice - Urban'
'116'= 'Family Practice - Rural'
'119'= 'GP - OOP'
'12' = 'Physical Medicine'
'121'= 'Phys. Med. - Chiropractic'
'129'= 'Phys. Med. - OOP'
'13' = 'Nurse Practitioners'
'130'= 'Int.Med - Career Medical Scientist'
'131' = Int.Med - Endocrinology'
'132' = Int.Med - Haematology'
'133' = Int.Med - Infectious Disease'
'134' = Int.Med - Respiratory'
'139'= 'Nurse Pract. - OOP'
'141'= 'Surgery - Vascular'
'142'= 'Surgery - Thoracic'
'143'= 'Paedeiatric Genera'
'15' = 'Malignant Disease Speccialist'
'150'= 'Oncology - Medical'
'151'= 'Oncology - Gynaecological'
'152'= 'Oncology - Urological'
'153'= 'Oncology - Paediatric'
'154'= 'Oncology - Community'
‘155’= ‘Oncology – General Surgery’
‘156’= ‘Oncology -  Otorhinolaryngology’
'158'= 'Oncology - Radiology'
‘159’= ‘Oncology – Out-of-Province Agreement’
'200'= 'Primary Care Nurse'
‘201’= ‘Mid Wife’
'99' = 'Unspecified or unknown';
```

MDNO Char 4 Physician number

This is not the original number found in the MCHP research registry but a randomized number for the base number of each physician.

0001-2899	Regular doctor "provider" numbers("BASE")
2900-2999	Nurse Practitioner
3000-3099	Radiologist
3100-3199	Laboratory
3200-3599	Alternate Numbers, salaried or sessional
3600-3699	Doctors in community clinics (salaried)
3700-3799	Chiropractors
3800-3899	Optometrists
3900-3999	
4000-4999	Out-of-province *** these are not in the training data ;
5000-5999	Dentists, oral surgeons, periodontists
6000-6199	Registered Laboratory Facilities - may agree on last 3 digits with 3000-3999 - a.k.a. "Technical Component"

6200-6299 = < not defined>
7000-7999 Teaching alternates for 2000-2999
8000-8999 Teaching alternates for 1000-999
9001-9998 Teaching alternates for 0001-0998

MGC Char 3 Manitoba Grouping Code

NGC Char 3 National Grouping Code

001	Consultation:	Major/initial	
002			Other
003	Office Visit:	Complete Exam-initial	
004			Complete Exam-other
005		Partial/minor/subsequent	
006			Psychotherapy(individual)
007			Special Eye exam
008			Well Baby care
009			Other office visits
010	Hospital Visits:	Complete exam	
011			Regular: 1st or 2nd week
012			3rd or 4th week
013			5th-13th week
014			after 13 weeks
015			Newborn/premature care
016			Other visits
017			Other hospital visits
018	Home Visits:	Routine	
019			Out-of-hours/emergency
021			other home visits
022	Major Surgery:	Integumentary - Mastectomy	
023			Integumentary - other
024		Musculo-skeletal - fractures	
025			Musculo-skeletal - other
026			Sub-mucous resection,etc
027			Respiratory other
028			Cardio - heart and pericardium
029			Cardiovascular varicose veins
030			Cardiovascular other
031			Appendectomy
032			Laparotomy
033			Cholecystectomy
034			Tonsillectomy - child
035			Tonsillectomy - adult
036			Inguinal/femoral hernia
037			Haemorrhoidectomy
038			Digestive system - other
039			Prostatectomy
040			Vasectomy
041			Urinary/male genital - other
042			Prolapse
043			Hysterectomy
044			Tubal ligation/Salpingectomy
045			Female genital- other
046			Cataract
047		Eye/ear - other	
050		other major surgery	
051	minor surgery:	Incision - abscess,etc	

052		Removal of foreign body
053		Benign tumor/cyst/wart/etc
054		Suture wounds
055		Excision of Nail
056		Chalaziln (?)
057		Circumcision - newborn
058		Mypingotomy
059		Fractures
060		Other minor surgery
061	Surg assistance:	Appendectomy
062		Cholecystectomy
063		Inguinal/femoral hernia
064		Prostatectomy
065		Hysterectomy
066		Caesarian Section
068		Other surgical assistance
069	Obstetric services:	Confinement - total care
070		Confinement - other
071		caesarian section
072		Therapeutic abortion
074		Other obstetric services
075	ANAESTHESIA:	Appendectomy
076		Cholecystectomy
077		Haemorrhoidectomy
078		Prostatectomy
079		hysterectomy
080		tonsillectomy - child
081		Tonsillectomy - adult
082		Confinement- caesarian section
083		Cystoscopy
084		D & C
085		Nerve Blocks
086		Other anaesthesia
087	Diagnostic Radiology:	Head & Neck
088		Spine and Pelvis
089		Extremities
090		Chest
091		G.I. Tract
092		G.U. Tract
093		
094		Other Diagnostic Radiology
095	Laboratory Services:	Haematology,automated
096		Haematology,manual
097		Hematology, unspecified
098		Biochemistry,automated
099		Biochemistry,manual
100		Biochemistry,unspecified
101		Radio-isotopes
102		ECG,EEG,BMR - technical
103		Other laboratory services
104	Other Diag/Therap. :	Hyposensitization/allergy
105		Injection/aspiration of joint
106		ECG - Prof. component included
107		Cystoscopy - diagnostic
108		Sigmoidoscopy
109		Other Endoscopy

110			Lumbar Myelogram
111			Other proc. for Diag. Radiology
112			D & C
113			Papanicolou smear
114			EEG. Prof. component included
115			Biopsies
116		Other Diagnostic/therapeutic services	
117		I.U.C.D.	
118	Miscellaneous serv.:	Detent. fees/group psychotherapy	
119	Other Identified		
120	Unidentified		

NSERV Num 3 number of services
Format: YYMMDD6.
Range: 1-99
Contains a count of the number of times the TARIFF service was provided to the patient on (or related to) the date of service. Negative values represent a ‘drawback’ of fees paid.

NOTE: for Psychotherapy tariffs / 8580, 8581, 8583, 8584, 8589, NSERV is the number of 15 minute units claimed for the service. Claim is a primary visit.

Detention with critically ill / 8573, 8574 represent 15 minute units claimed after a claim for tariff=8572.

Cardio-Respiratory Resuscitation / 2565 represents 15 minute units claimed after a claim for tariff=2556.

OPD Char 1 Outpatient Indicator
Format: $OPDI.
If 'O' - Outpatient services
If 'E' - Emergency Room services
Other - not Outpatient or Emergency room

Hospital number (HOSPRHA) should be non-zero.

Otherwise, OPDIND will be space, and location of service is either IN-HOSPITAL or Ambulatory Office/Facility visit.

QUINT Char 2 Income Quintile (pc)
Neighbourhood income quintiles based. Income quintiles have been divided into Urban (Winnipeg & Brandon) and Rural Manitoba. The first character of the quintile indicates the location. A further division of NF is used to identify a large group of Manitoba individuals that can not be assigned a neighbourhood income. Most of these individuals are in institutions (PCH, Prison, LTC hospital) or covered by some form of social services. This value is assigned from the training resource registry.

U1 Urban lowest income quintile
U2
U3
U4
U5 Urban highest income quintile
R1 Rural lowest income quintile
R2
R3
R4 Rural highest income quintile
NF Not found or not assigned

RHA Char 2 Regional Health Authority
Format: $RHAL

This is the RHA that the individual was living in during the sample period. In the training resource individuals have been assigned a single RHA for the whole period. This is NOT the case in the actual research repository. The coding used at MCHP is not the same as Manitoba Health. ArcView Shape files are available for mapping these areas.

MCHP	Name	
IE	IE Interlake Eastern	
		IE1 Interlake Eastern Selkirk Zone
		IE2 Interlake Eastern South Zone
		IE3 Interlake Eastern East Zone
		IE4 Interlake Eastern West Zone
		IE5 Interlake Eastern North Zone
		IE6 Interlake Eastern Remote Zone
NO	NO Northern	
		NO1 Northern Direct Service Zone
		NO2 Northern Non-Direct Service Zone
		NO3 Northern island Lake Zone
SO	SO Southern Zone	
		SO1 Southern North Zone
		SO2 Southern Mid Zone
		SO3 Southern West Zone
		SO4 Southern East Zone
WE	WE Prairie Mountain	
		WE1 PMH North Zone
		WE2 PMH Brandon Zone
		WE3 PMH South Zone
WP	WP Winnipeg	
		WP11 Winnipeg Urban
		WP21 Winnipeg Churchill

SEFI Num 8 SES Factor Index

SEX Char 1 Biological gender of individual
Format: $SEXF.

1	Male
2	Female

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

TEACHING Char 1 Teaching Hospital
This indicates if the hospital is a teaching hospital.

WPG_CA Char 3 Winnipeg Community Areas
Format: $RHAL

These are Winnipeg subregions similar in size the non-Winnipeg RHAs. Note there are a small number of individuals with a Winnipeg RHA (K) that are not assigned to a Winnipeg Community area. These values are assigned from the training registry. ArcView Shape files are available for mapping these areas.

W02	ASSINIBOINE SOUTH
W11	DOWNTOWN
W03	FORT GARRY
W09	INKSTER
W10	POINT DOUGLAS
W07	RIVER EAST
W12	RIVER HEIGHTS
W08	SEVEN OAKS
W04	ST. VITAL
W05	ST.BONIFACE
W01	ST.JAMES-ASSINIBOIA
W06	TRANSCONA

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 whenever 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 over the period 2005/06 – 2013/14. The data represents an approximate 1% of the actual population.

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

This dataset may contain multiple records for each individual if there are breaks or changes in coverage.

These data represent 15108 observations and 10 variables.

Name of resource: REGISTRY

BIRTHDT Char 8 Birth Date (mod)
This is the birth date for the individual as a character string in the format yymmdd8. There are a number of birth dates that have 00 for the day and/or month. These should be corrected when using birth. This variable is modified from the original date of birth found in the research repository.

```
age =floor(birth,covenddate,'act/act'));
```

COVCANCODE Char 1 Coverage Cancel Code or Cancel Reason
This is the reason for cancellation of coverage in the registry. There are only three codes in this database. This variable is modified from the original cancellation code in the research repository.

0 = Not canceled (still active and in province)
2 = Died (COVENDDATE) will be the date of death
Other= Other – loss to follow-up

COVENDDATE NUM 8 End of Coverage Date (mod)
Range: 19990403 - 20121122
This is the last date of coverage. Dates beyond 20100401 (April 1, 2010) indicate ongoing coverage for the purposes of this file.

COVSTARTDATE Char 8 Start of Coverage Date (mod)
Range: 19570629 - 20090330
This is the first date of coverage. In this registry individuals are considered living in Manitoba between the coverage start and coverage end dates. In the actual registry there may be gaps in coverage for individuals.

ID Char 6 Personal ID Number (Mod)
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.

QUINT Char 2 Income Quintile (pc)
Neighbourhood income quintiles based. Income quintiles have been divided into Urban (Winnipeg & Brandon) and Rural Manitoba. The first character of the quintile indicates the location. A further division of NF is used to identify a large group of Manitoba individuals that can not be assigned a neighbourhood income. Most of these individuals are in institutions (PCH, Prison, LTC hospital) or covered by some form of social services. Income groups are not found on the data found in the research repository but must be generated from postal code and municipal code.

U1 Urban lowest income quintile
U2
U3
U4
U5 Urban highest income quintile
R1 Rural lowest income quintile
R2
R3
R4
R5 Rural highest income quintile
NF Not found or not assigned

RHA Char 2 Regional Health Authority
Format: $RHAL
This is the RHA that the individual was living in during the sample period. In the training resource individuals have been assigned a single RHA for the whole period. This is NOT the case in the actual research repository. The coding used at MCHP is not the same as Manitoba Health. RHAs are not found on the data found in the research repository but must be generated from postal code and municipal code. ArcView Shape files are available for mapping these areas.

MCHP	Name	
IE	IE Interlake Eastern	
		IE1 Interlake Eastern Selkirk Zone
		IE2 Interlake Eastern South Zone
		IE3 Interlake Eastern East Zone
		IE4 Interlake Eastern West Zone
		IE5 Interlake Eastern North Zone
		IE6 Interlake Eastern Remote Zone
NO	NO Northern	
		NO1 Northern Direct Service Zone
		NO2 Northern Non-Direct Service Zone
		NO3 Northern island Lake Zone
SO	SO Southern Zone	
		SO1 Southern North Zone

		SO2 Southern Mid Zone
		SO3 Southern West Zone
		SO4 Southern East Zone
WE	WE Prairie Mountain	
		WE1 PMH North Zone
		WE2 PMH Brandon Zone
		WE3 PMH South Zone
WP	WP Winnipeg	
		WP11 Winnipeg Urban
		WP21 Winnipeg Churchill

SEFI Num 8 SES Factor Index

SEX Char 1 Biological gender of individual
Format: $SEXF

1 = Male
2 = Female

WPG_CA Char 3 Winnipeg Community Areas
Format: $RHAL
These are Winnipeg subregions similar in size the non-Winnipeg RHAs. Note there are a small number of individuals with a Winnipeg RHA (K) that are not assigned to a Winnipeg Community area. Winnipeg areas are not found on the data found in the research repository but must be generated from postal code and municipal code. ArcView Shape files are available for mapping these areas.

W02	ASSINIBOINE SOUTH
W11	DOWNTOWN
W03	FORT GARRY
W09	INKSTER
W10	POINT DOUGLAS
W07	RIVER EAST
W12	RIVER HEIGHTS
W08	SEVEN OAKS
W04	ST. VITAL
W05	ST.BONIFACE
W01	ST.JAMES-ASSINIBOIA
W06	TRANSCONA

Family Registry Dictionary

This dataset provides information on the family make up of each individual in the registry at different points in time. 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 over the period 2005/06 – 2013/14. The data represents an approximate 1% of the actual population.

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

This dataset may contain multiple records for each individual if there are breaks or changes in coverage.

These data represent 15966 observations and 7 variables.

Name of Resource: REGISTRY_FAMILY

BIRTHORD Num 8 Birth Order in Family

ENDDATE Char 8
Range: 19660101- 20121122
This is the end date of the combination of reltype, nsib, and birthord. Each id can have multiple records based on their changing family structure.

ID Char 6 Personal ID Number (Mod)
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. This number is assigned from the training resource registry.

MARST Char 1 Marital Status
This describes whether the individual is married or not. This can be used in conjunction with RELTYPE to determine if the individual is head of the household.

0	Not Married
1	Married
Blank	Dependent child

NSIB Num 8 Number of Siblings

RELTYPE Char 1 Type of Individual (family head/spouse/child)
Format: $RTYPE

1	Head of household
2	Spouse
5	Dependent child

STARTDATE Char 8
Range: 19570629- 20101130
This is the start date of the combination of reltype, nsib, and birthord. Each id can have multiple records based on their changing family structure.

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 15108 observations and 140 or 136 variables and covers two time periods (2006 and 2011).

Name of Resource: CENSUSXXXX (where XXXX is 2006 or 2011)

BIRTHDT Num 8 Birthdate (mod)

CC_F_AREA Num 8 Population & Dwelling – Total area
Only occurs in the 2006 data.

CC_F_POP Num 8 Population & Dwelling – Population count
Only occurs in 2006 data.

CC_F_POPDWELL Num 8 Population & Dwelling – Dwelling Count
Only occurs in 2006 data.

CC_F_DWELL Num 8 Population & Dwelling – Dwelling Count
Only occurs in 2011 data.

CC_F_LAND Num 8
Only occurs in 2011 data.

CD Char 2 Census Division Unique Identifier Code
Only occus in 2006 data.

CSD Char 3 Census Subdivision Unique Identifier Code
Only occurs in 2006 data.

CSDuid Char 7 Census subdivision unique identifier

DA Char 4 Dissemination Area Unique Identifier Code
Only occurs in 2006 data.

DAuid Char 8 Dissemination area unique identifier

EA Char 4 Enumeration Area Unique Identifier Code
Only occurs in 2006 data.

EDHS_HS65 Num 8 Total population 65 years and older with High School Graduation
Only occurs in 2006 data

EDHS_HS1524 Num 8 Total population 15-24 years with High School Graduation
Only occurs in 2006 data.

EDHS_HS2564 Num 8 Total population 25-64 years with High School Graduation
Only occurs in 2006 data.

EDHS_POP15 Num 8 Total population 15 years and over reporting Highest Level of Schooling
Only occurs in 2011 data.

EDHS_POP65 Num 8 Total population 65 years and older reporting highest level of schooling
Only occurs in 2006 data.

EDHS_POP1524 Num 8 Total population 15-24 reporting highest level of schooling
Only occurs in 2006 data.

EDHS_POP2564 Num 8 Total population reporting highest level of schooling
Only occurs in 2006 data.

EDHS_WOHS65 Num 8 Total population 65 years and older without High School Graduation
Only occurs in 2006 data.

EDHS_WOHS15 Num 8 Total population 65 years and older without High School Graduation
Only occurs in 2011 data.

EDHS_WOHS1524 Num 8 Total population 15-24 years without high school graduation

Only occurs in 2006 data.

EDHS_WOHS2564 Num 8 Total population 25064 years without high school graduation

FAMSTAT_FLPAR1-3 Num 8 Lone female parent with child(ren)

FAMSTAT_MLPAR1-3 Num 8 Lone male parent with child(ren)

FAMSTAT_TOTCENFAM Num 8 Number of Census families in private households

FAMSTAT_TOTFLPAR Num 8 Number of lone female parent families

FAMSTAT_TOTLPAR Num 8 Number of lone parent families

FAMSTAT_TOTMLPAR Num 8 Number of lone male parent families

FED Char 3 Federal Electoral District Unique Identifier Code
Only occurs in 2006 data.

GEO_ID Char 11 CD/CSD/Diss Area

GEO_NAME Char 60 Geographic area description

GEO_NAME_NR Char 66
Only occurs in 2011 data.

GEO_TYPE Char 3 Type of Record

Abbr	Description
CD	Census Division
CSD	Census Subdivision
PR	Province
EA	Enumeration Area
DA	Dissemination Area

GFEDDA Char 7 Dissemination Area Identification Number
Only occurs in 2006 data.

ID 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.

IN_CEN Num 8
Only occurs in 2011 data.

IN_NHS Num 8
Only occurs in 2011 data.

INC_ECO Num 8 Number of Census families reporting income

INC_ECO_AVEINC Num 8 Average income of census families reporting income

INC_FEM Num 8 Number of Females 15 years and older reporting income

INC_FEM_AVEINC Num 8 Average income of females 15 years and older reporting income

INC_MALE Num 8 Number of males 15 years and older reporting income

INC_MALE_AVEINC Num 8 Average income of males 15 years and older reporting income

INC_PHH Num 8 Number of provate households reporting income

INC_PHH_AVEINC Num 8 Average household income

INC_TOTPOP Num 8 Total population 15 years and older reporting income

INC_TOTPOP_AVEINC Num 8 Average income of total population 15 years and older reporting income

INCEN Num 8

INCENCSD Num 8

INPCCF Num 8

LF_EMP15 Num 8 Labour force population aged 15 years and older

LF_EMPRATE15 Num 8 Labour Force population rate aged 15 years and older

LF_FEMEMP15 Num 8 Female labour force population

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_FEMNOTLF15 Num 8 Female Non-Labour force 15 years and older

LF_FEMPOP15 Num 8 Female Labour force 15 years and older

LF_FEMPOPTOT15 Num 8 Females 15 years and older with labour force activity

LF_FEMRATE15 Num 8 Female labour force participation rate 15 years and older

LF_FEMUNEM15 Num 8 Unemployed female labour force 15 years and older

LF_FEMUNUMRATE15 Num 8 Unemployment rate female labour force 15 years and older

LF_NOTLF15 Num 8 Non-Labour force population aged 15 years and older

LF_POP15 Num 8 Labour force population 15 years and older

LF_POPTOT15 Num 8 Total population by labour force activity 15 years and older

LF_PRATE15 Num 8 Labour force rate for population 15 years and older

LF_UNEM15 Num 8 Unemployed labour force population 15 years and older

LF_UNEMRATE15 Num 8 Unemployment Rate, 15 years and older
Range: 0-100
This refers to the unemployment rate for the labour force population aged 15-24 years.

MOB1_EXTMIG, MOB5_EXTMIG Num 8 Number of 1 and 5-year external migrants

MOV1_INTERPROV, MOB5_INTERPROV Num 8 Number of 1 and 5-year Interprovincial migrants

MOB1_INTMIG, MOB5_INTMIG Num 8 Number of 1 and 5-year Internal migrants

MOB1_INTRAPROV, MOB5_INTRAPROV Num 8 Number of 1 and 5-year Intraprovincial migrants

MOB1_MIG, MOB5_MIG Num 8 Number of 1 and 5-year Migrants

MOB1_MOV, MOB5_MOV Num 8 Number of 1 and 5-year movers
Only occurs in 2006 data.

MOB1_MOVE, MOB5_MOVE Num 8 Number of 1 and 5-year movers
Only occurs in 2011 data.

MOB1_NONMIG, MOB5_NONMIG Num 8 Number of 1 and 5-year non-migrants

MOB1_NONMOV, MOB5_NONMOV Num 8 Number of 1 and 5-year non-movers

MOB1_TOTPOP1, MON5_TOTPOP5 Num 8 Total population by 1 and 5-year mobility status

MSTAT_DIV Num 8 Number of Divorced persons

MSTAT_MAR Num 8 Number of Legally Married Persons

MSTAT_SEP Num 8 Number of separated persons (still legally married)

MSTAT_SIN Num 8 Number of single persons

MSTAT_TOTPOP Num 8 Total population 15 years and older by legal marital status

MSTAT_WID Num 8 Number of Widowed Persons

NON_RESPONSE Num 8 NHS non_response rate
Only occurs in 2011 data.

PHH_TOTHH Num 8 Total number of private households

PHH_TOTPOP Num 8 Total number of persons in private households

PHHFAM_LIVALONE Num 8 Number of Non-family persons living alone
Only occurs in 2006 data.

PHHFAM_LIVREL Num 8 Number of non-family persons living with relatives
Only occurs in 2006 data.

PHHFAM_NONREL Num 8 Number of non-family persons living with non-relatives only
Only occurs in 2006 data.

PHHFAM_TOTPOP Num 8 Total number of family persons in private households

PHHNFAM_TOTPOP Num 8 Number of non-family persons in private households
Only occurs in 2006 data.

PHHNFAM_LIVALONE Num 8 Number of Non-family persons living alone
Only occurs in 2011 data.

PHHNFAM_LIVREL Num 8 Number of Non-Family persons living with relatives
Only occurs in 2011 data.

PHHNFAM_NONREL Num 8 Number of Non-Family persons living with non-relatives only
Only occurs in 2011 data.

POPFEM0004-POPFEM85 Num 8 Female population measured in 4 year intervals

POPFEM0004
POPFEM0509
POPFEM1014
POPFEM1419
POPFEM2024
POPFEM2529
POPFEM3034
POPFEM3539
POPFEM4044
POPFEM4549
POPFEM5054
POPFEM5559
POPFEM6064
POPFEM6569
POPFEM7074
POPFEM7579
POPFEM8084
POPFEM85

POPMALE0004-POPMALE85 Num 8 Male population measured in 4 year intervals
Due to an error, POPMALE3034 only occurs in 2006 data, while the corresponding variable in 2011 data is POPMALE3039.

POPMALE0004
POPMALE0509
POPMALE1014
POPMALE1519
POPMALE2024
POPMALE2529
POPMALE3034 or POPMALE3039
POPMALE3539
POPMALE4044
POPMALE4549
POPMALE5054
POPMALE5559
POPMALE6064
POPMALE6569
POPMALE7074
POPMALE7579
POPMALE8084
POPMALE85

POPTOT Num 8 Total population

POPTOT_FEM Num 8 Total female population

POPTOT_MALE Num 8 Total male population

POPTOT_ROUND Num 8 Total population (Rounded)
Only occurs in 2011 data.

QUALITY Char 5
Only occurs in 2011 data.

QUALITYN Num 8
Only occurs in 2011 data.

QUALITY_NHS Char 5
Only occurs in 2011 data.

QUALITY_NHSN Num 8
Only occurs in 2011 data.

QUINT Char 2 Income Quintile (pc)

RHA Char 2 Regional Health Authority

RP Char 2 Region / Province Unique Identifier Code
Only occurs in 2006 data.

SEFI Num 8 SES Factor Index

SEX Char 1 Biological sex

WPG_CA Char 3 Winnipeg Community Areas

Prescription Drug 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 over the period 2005/06 – 2013/14.

There are two supporting files that can be used with this data.
ATC_CODES – this is a list of ATC codes that can be matched by DIN.
DRUG_COST – this is a list of unit costs that can be matched by DIN.

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

This simulated data represents prescriptions filled at a retail pharmacy.

These data represent 1403467 observations and 17 variables.

Name of resource: DRUG

BIRTHDT NUM 8 Birth Date (mod)

Date of birth from the training resource registry file. This variable is modified from the original date of birth found in the research repository. SAS Date format variable (YYMMDD10.)

```
   age =floor(yrdif(birthdt,dateprvd,'age'));
```

DAYSUPP Num 8 Days Supply on Rx
Range: -1-999
This is the number of days that the prescription fill is expected to last.

Caution: This is a mandatory field. Because of this, some caution should be used. For the 1995/96 Pharmaceutical Use project it was felt that the 0 days supply and many of the 1 days supply did not reflect the true number of days supply. This variable most likely reflects the true days supply for scheduled medications such as antibiotics, but most likely does not for medications which are prescribed on a prn (as required) basis.

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.). For more information on ATC codes, refer to the concept dictionary. For more information on DIN, look at the UPMODE and UP_DINMST data files.

DRUGCOST Num 8 Drug cost claimed
Range $0.01-$9999.99
Note some values of this field will be missing and must be imputed from the UPMODE data. It is the amount in dollars and cents that the pharmacy is claiming for payment. However, it is not necessarily the amount PAID by government on the claim (incostpd).

ID Char 6 Personal ID Number (Mod)
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. This number is assigned from the training resource registry. For more information on the individual, refer to the CENSUS2001, REGISTRY, and REGISTRY_FAMILY data files.

INCOSTPD Num 8 16 Drug Cost paid – INGRED
Range: $0.01-$9998
This is the drug or ingredient cost approved and paid for by the program. It is used to assign ingredient cost in expenditure/cost calculations but may adjudicated 'downward' based on daysupp > 100 days and/or on a unit price (unitprc) that exceeds and expenditure validity check.

IQ Char 2 Income Quintile
Neighbourhood income quintiles based. Income quintiles have been divided into Urban (Winnipeg & Brandon) and Rural Manitoba. The first character of the quintile indicates the location. A further division of NF is used to identify a large group of Manitoba individuals that can not be assigned a neighbourhood income. Most of these individuals are in institutions (PCH, Prison, LTC hospital) or covered by some form of social services. This value is assigned from the training resource registry.

U1	Urban lowest income quintile
U2	
U3	
U4	
U5	Urban highest income quintile
R1	Rural lowest income quintile
R2	
R3	
R4	Rural highest income quintile
NF	Not found or not assigned

MQTYCLM Num 8 40 Metric Quantity claimed
Range: 0-90000
There may be a consistency problem with mqtyclm: Many drugs can be described using multiple metric quantity descriptions. For example, a 200 mL bottle of 250 mg/5 mL amoxicillin could be described as: 1 (bottle), 200 mL, 100 g or 10,000 mg. Also, mqtyclm is the variable to use for calculation of many of the pharmaceutical concepts as it will resemble most closely that quantity of drug actually dispensed to the person.

PRESMDCBLOC Char 3 MH Bloc of Specialty for prescriber

PROFEEPD Num 8 24 Professional fee paid
$0-$921.95
This is the dispensing or professional approved and paid for by the program. Note for C2, the current method of reimbursing pharmacies for providing the service is based on a capitated rate per bed exclusive for ingredient cost.

PRVDDT Num 8 Date Provided
Range: 19990401 - 2010415
This is the date that the prescription was filled. This is a character string in the format YYMMDD8. SAS Date format variable (YYMMDD10.)

RHA Char 2 73 Regional Health Authority
Format: $RHAL
This is the RHA that the individual was living in during the sample period. In the training resource individuals have been assigned a single RHA for the whole period. This is NOT the case in the actual research repository. The coding used at MCHP is not the same as Manitoba Health. ArcView Shape files are available for mapping these areas.

MCHP	Name	
IE	IE Interlake Eastern	
		IE1 Interlake Eastern Selkirk Zone
		IE2 Interlake Eastern South Zone
		IE3 Interlake Eastern East Zone
		IE4 Interlake Eastern West Zone
		IE5 Interlake Eastern North Zone
		IE6 Interlake Eastern Remote Zone
NO	NO Northern	
		NO1 Northern Direct Service Zone
		NO2 Northern Non-Direct Service Zone
		NO3 Northern island Lake Zone
SO	SO Southern Zone	
		SO1 Southern North Zone
		SO2 Southern Mid Zone
		SO3 Southern West Zone
		SO4 Southern East Zone
WE	WE Prairie Mountain	
		WE1 PMH North Zone
		WE2 PMH Brandon Zone
		WE3 PMH South Zone
WP	WP Winnipeg	
		WP11 Winnipeg Urban
		WP21 Winnipeg Churchill

SEX Char 1 64 Biological gender of individual
Format: $SEXF

1	Male
2	Female

UNITPRC Num 8 32 Unit price paid for drug this claim
Range: $0-9998
This is the price that is approved for payment on a per mqty basis. Unitprc is a field/variable used to validate the price of the claim.

WPG_CA Char 3 75 Winnipeg Community Areas
Format: $WPG_CAL
These are Winnipeg subregions similar in size the non-Winnipeg RHAs. Note there are a small number of individuals with a Winnipeg RHA (K) that are not assigned to a Winnipeg Community area. These values are assigned from the training registry. ArcView Shape files are available for mapping these areas.

W02	ASSINIBOINE SOUTH
W11	DOWNTOWN
W03	FORT GARRY
W09	INKSTER
W10	POINT DOUGLAS
W07	RIVER EAST
W12	RIVER HEIGHTS
W08	SEVEN OAKS
W04	ST. VITAL
W05	ST.BONIFACE
W01	ST.JAMES-ASSINIBOIA
W06	TRANSCONA

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 the 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 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 over the period 2005/06 – 2013/14.

The data represents 5451 observations and 14 variables.

Name of resource: UPMODE

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.).

P50 Num 8 the median, MQTYPAID

P75 Num 8 the upper quartile, MQTYPAID

P90 Num 8 the 90th percentile, MQTYPAID

P95 Num 8 the 95th percentile, MQTYPAID

QTYMODE Num 8 the most frequent value, MQTYPAID

QTYN Num 8 number of nonmissing values, MQTYPAID

UPMAX Num 8 the largest value, UNITPRC

UPMEAN Num 8 the mean, UNITPRC

UPMED Num 8 the median, UNITPRC

UPMIN Num 8 the smallest value, UNITPRC

UPMODE Num 8 the most frequent value, UNITPRC

UPN Num 8 number of nonmissing values, UNITPRC

UPSTD Num 8 the standard deviation, UNITPRC

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 ;
```

```
%_icd101(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,'AGE')) ;
   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,'AGE')) ;

Date

```
        YRDIF(sdate,edate,'AGE')
        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: