Introduction to SAS

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Find a seat and log into your computer using your HawkID (or HealthCareID) and password.

Let one of the proctors know if you have not already saved course materials somewhere in your personal storage (e.g. on your "H:\" drive).

Make sure you know where you saved the materials

…”a software suite developed by SAS Institute for advanced analytics, multivariate analyses, business intelligence, data management, and predictive analytics.”

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Overview

- Day 1
  - Introduction to SAS
  - Data Management
- Day 2
  - Introduction to SAS Procedures
  - ODS Graphics Designer
  - Demonstration of SAS EG

Uses

- Access and manage data across multiple sources
- Generate reports and perform analyses

Interfaces

- SAS Windowing Environment  (SAS)
  - Provides a full programming interface
- SAS Enterprise Guide  (SAS EG)
  - Provides a point-and-click interface with menus and wizards to create code

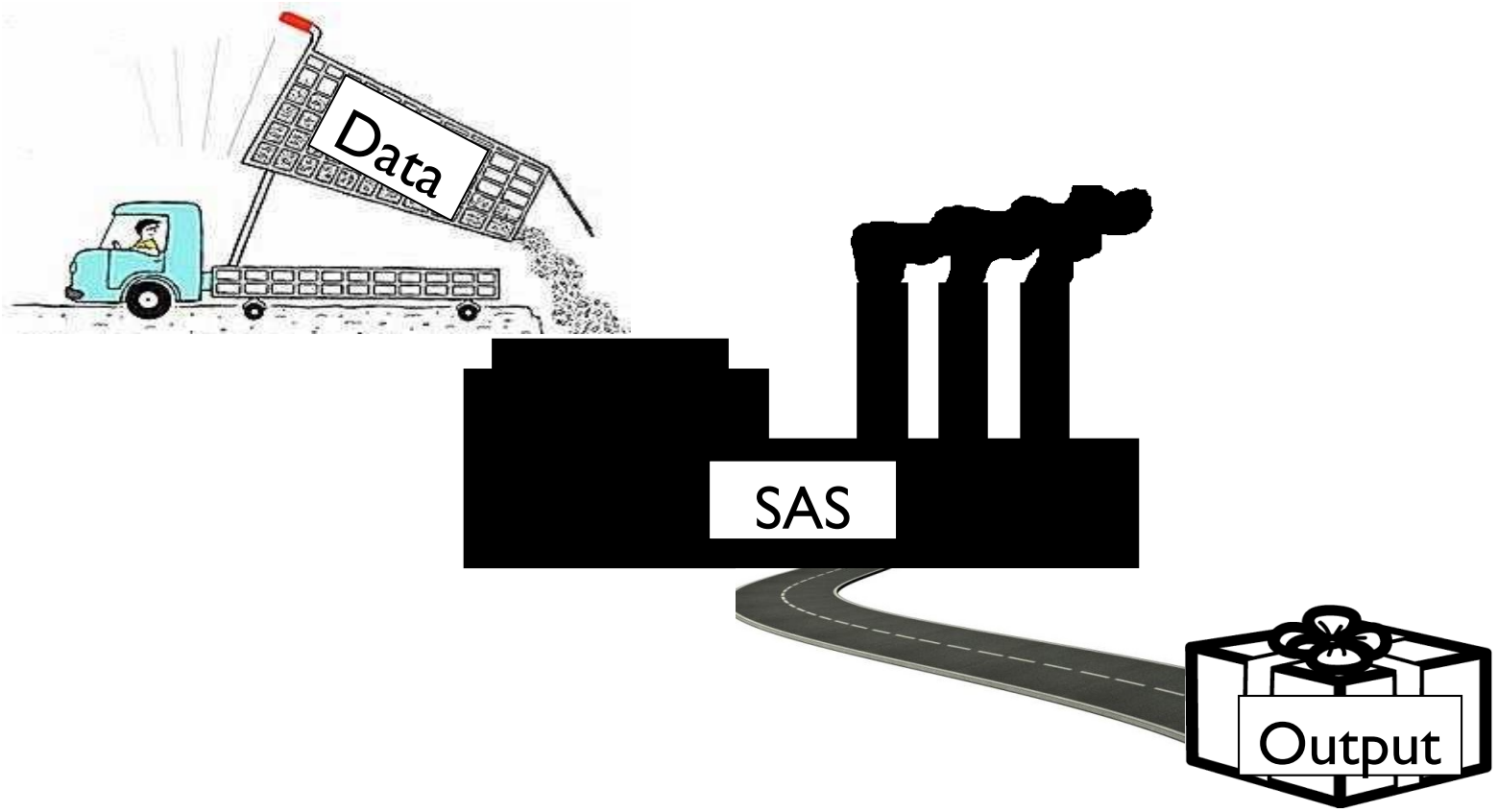
Access at UI

- PC Installation
  - SAS for training and Research at UI is “free”
    Contact your IT support people
    $272 for administrative use
- Virtual Desktop
  - Provides access to a variety of programs through web-based system
  - Used on or off campus
- Research Remote Desktop Service (RRDS)
    - Sign-up: https://workflow.uiowa.edu/form/rrdsrequest

Starting the SAS System

- Off campus
  - Virtual Desktop
    - http://virtualdesktop.uiowa.edu/
    - Requires installation of Citrix Receiver software
- PC installed or on campus
  - Start → All Programs → SAS → SAS 9.4
    or
  - Start button → “S” → SAS → SAS 9.4

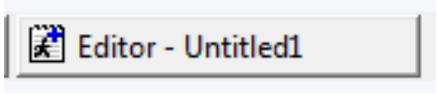
It’s not magic… it’s a tool



Interface Windows

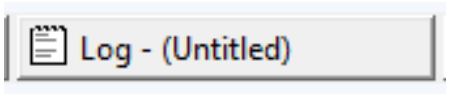
- Enhanced Editor
- Log
- Output or Results Viewer
- Explorer
- Results

Enhanced Editor



- Where you write your SAS programs
- A SAS program is a series of commands to:
  - Import and manipulate data
  - Generate reports and perform analyses
  - Output results

Log

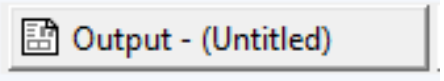


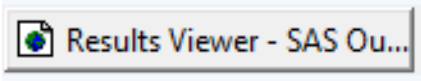
- Information pertaining to the program you've submitted is automatically displayed in the log
- Contains a list of:
  - Program commands and operations
  - Notes, warnings and errors

Output or Results Viewer

- When the SAS program executes without error, the results are displayed in the Output or Results Viewer
- The window the results will be displayed in will depend on the default setting

Output or Results Viewer





Output

The FREQ Procedure

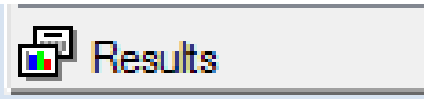
Status	Frequency	Percent
Alive	3218	61.78
Dead	1991	38.22

Results Viewer

The FREQ Procedure

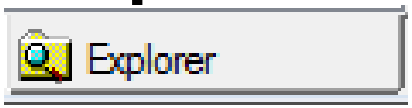
Status	Frequency	Percent
Alive	3218	61.78
Dead	1991	38.22

Results

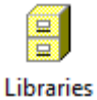


- Provides table of contents for output
- Lists each procedure in outline form
- Can be expanded to show each part

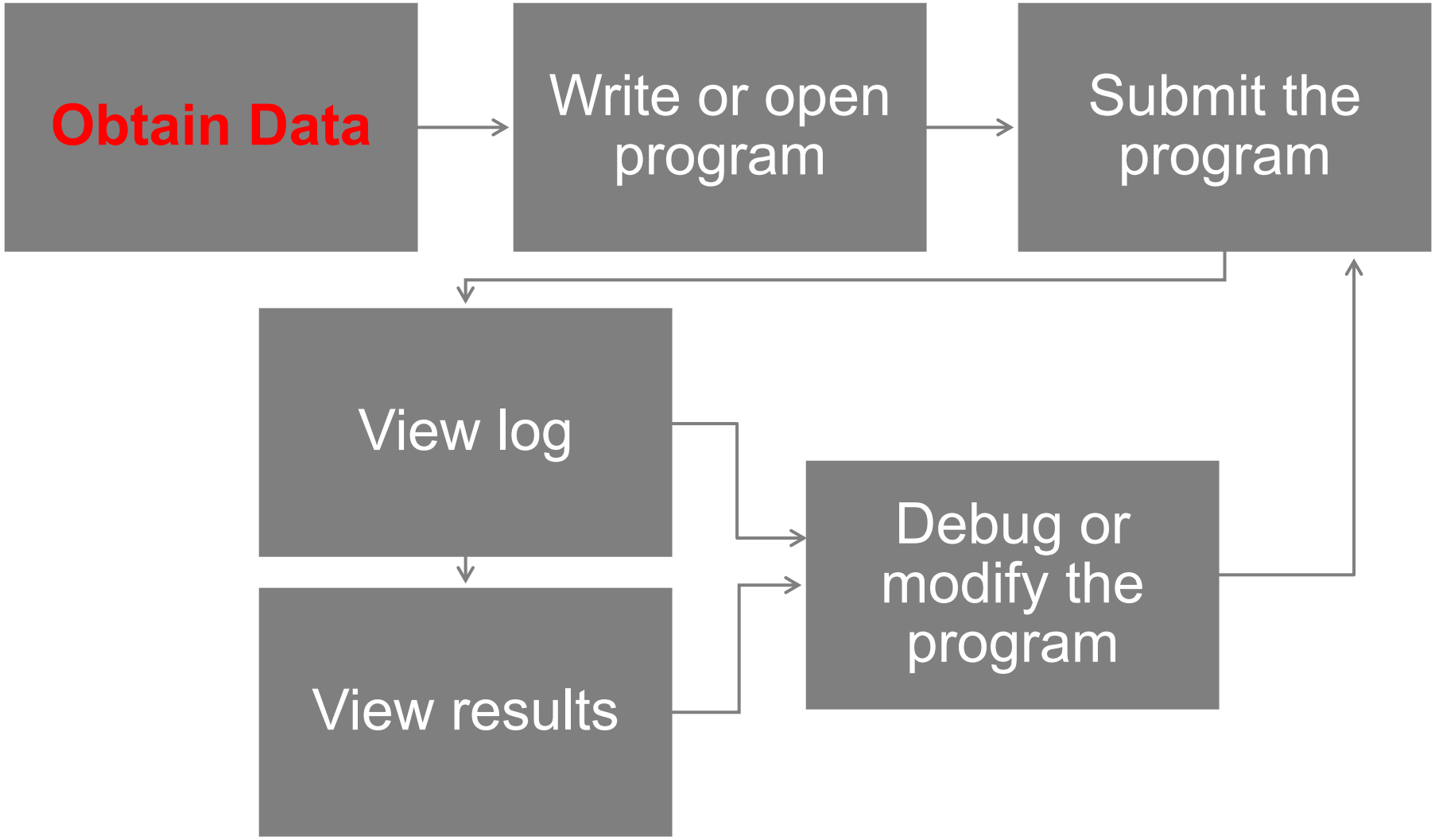
Explorer

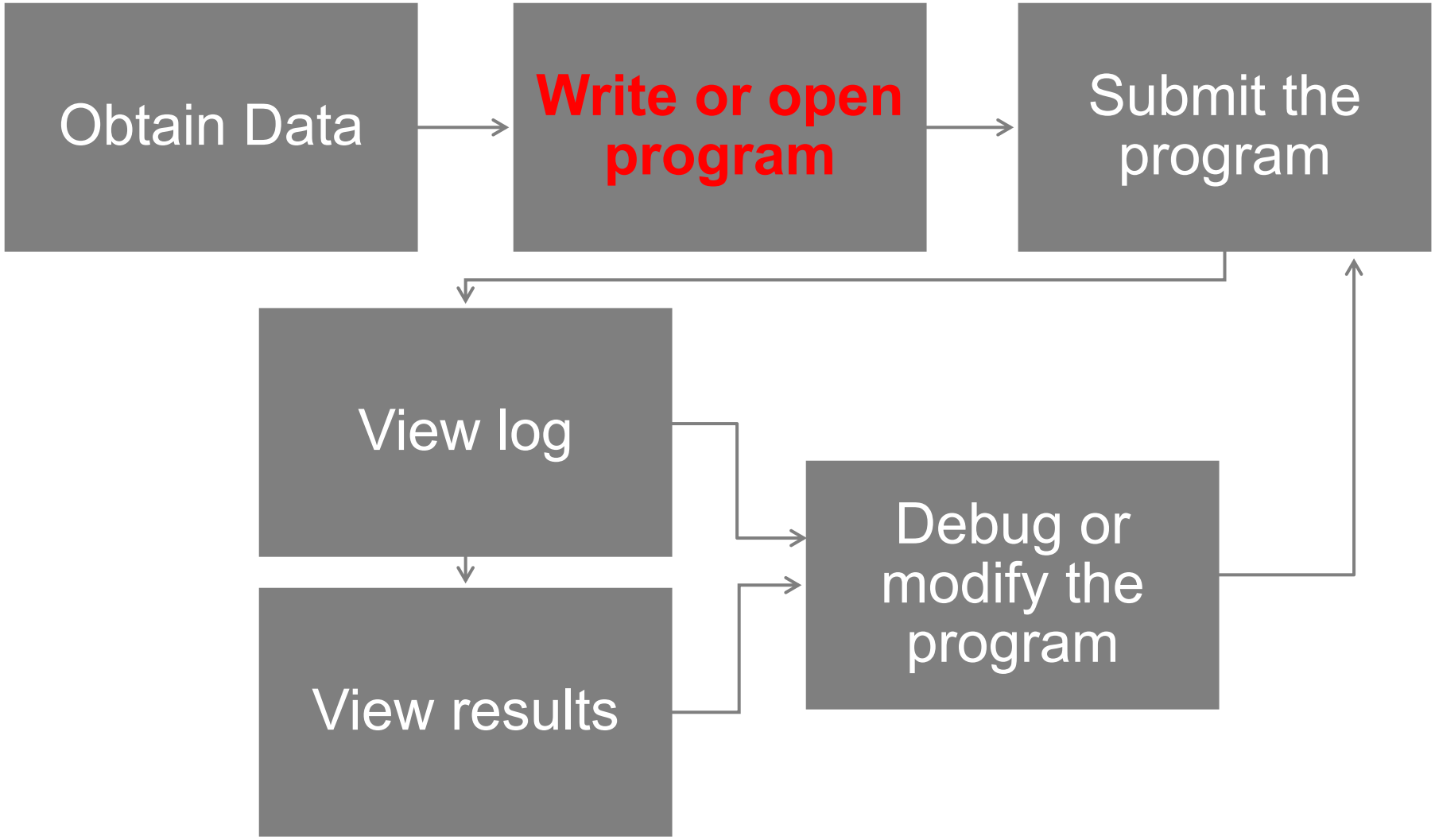


- Provides easy access to SAS files and data sets
- Computer 

provides access to all shared devices or drives
- Libraries 

contains all libraries currently defined

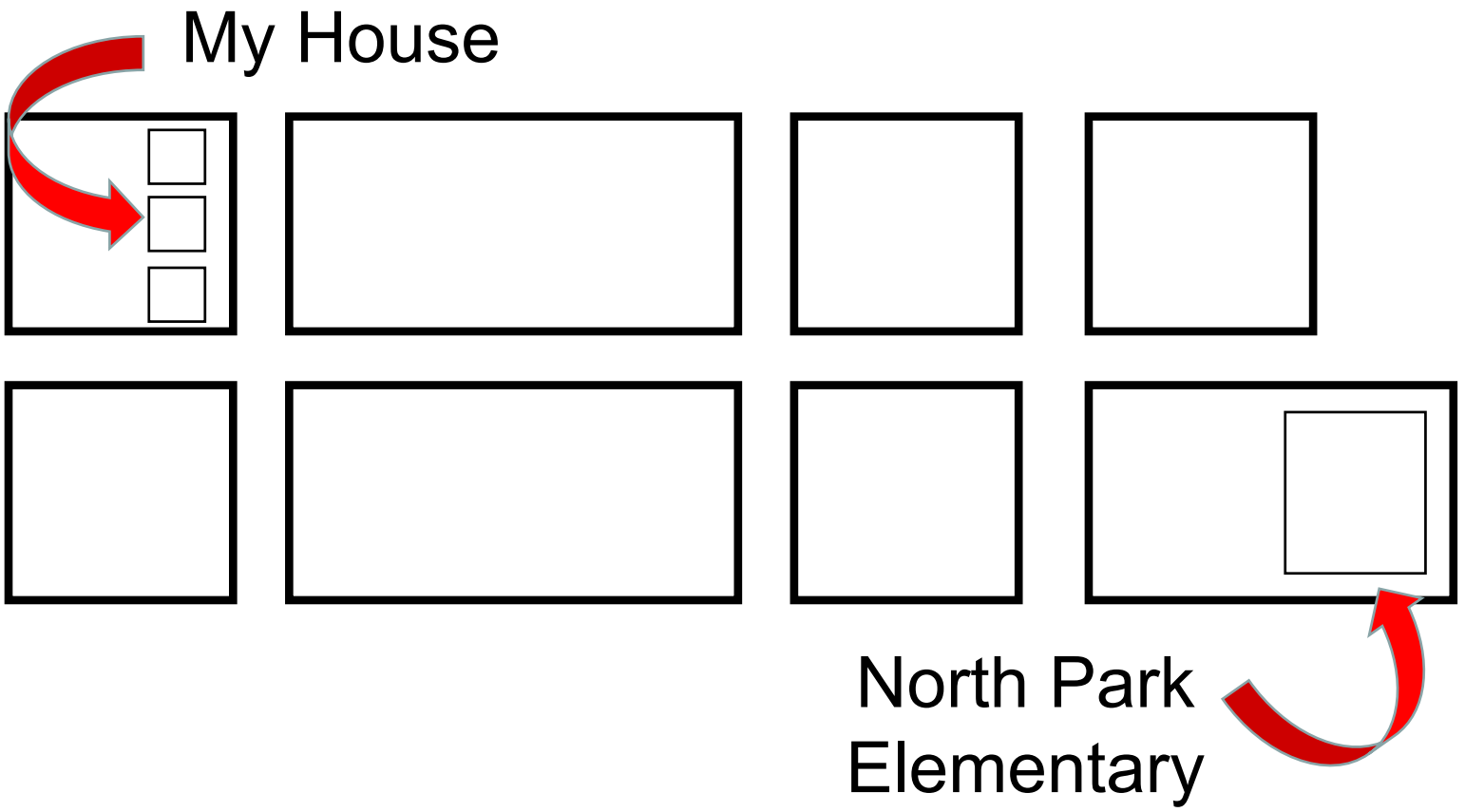

Obtain Data
Write or open program
Submit the program
View log
View results
Debug or modify the program


Obtain Data
Write or open program
Submit the program
View log
View results
Debug or modify the program

Becoming a SAS Programmer

- SAS is best as a “write code then run” program
- To be proficient, you must learn how to write a program
  - Simple if you understand what is required

My First Program

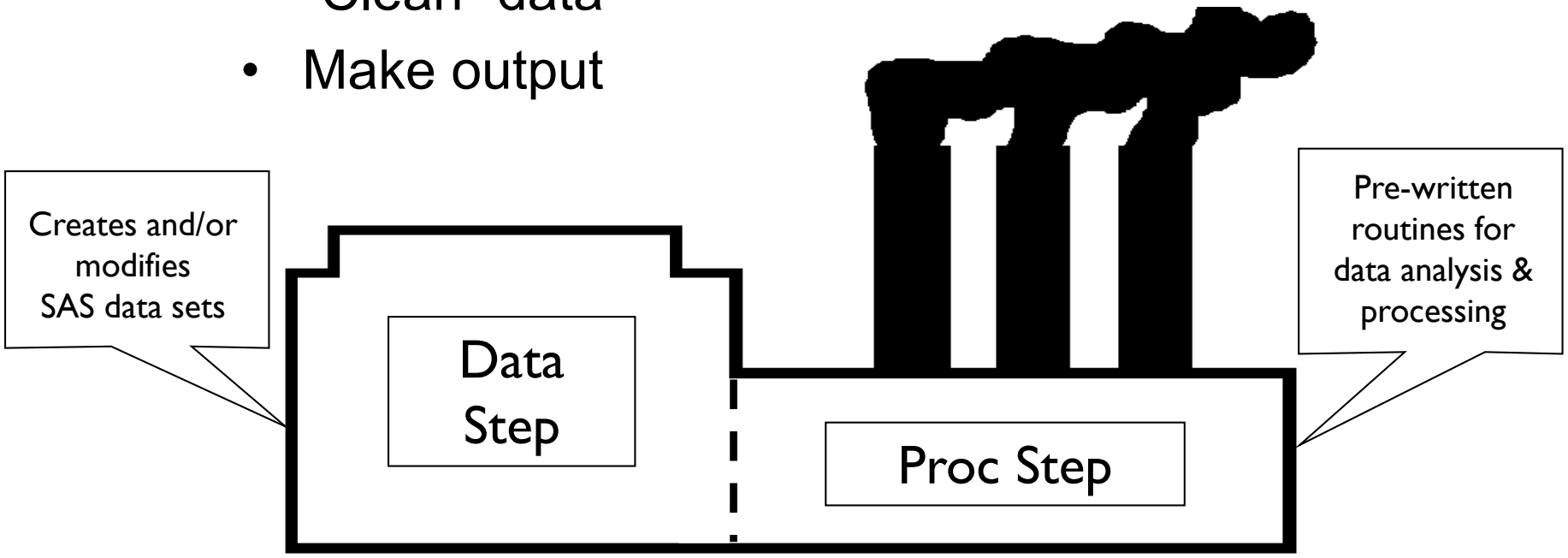


A Basic SAS Program

- Find data
- Read data → create a dataset
- “Clean” data
- Make output

A Basic SAS Program

- Find data
- Read data → create a dataset
- "Clean" data
- Make output



Data (1)

Layout

- Columns = Variables
- Rows = Observations

Bill	101	55	165.10
Tom	156	35	132.56
Sue	204	125	115.89
Ann	245	78	155.25
Jill	397	32	112.90
Bob	456	44	118.21
Tim	678	67	156.20
Matt	875	95	134.00
Kay	941	88	122.45

Data (2)

Variables need names

- 1-32 characters
- Must start with a character or underscore
  - Subsequent characters can be letters, numbers, or underscores
- No blanks or special characters
- Mixed-case OK
- Are not case sensitive

fname	id	days	wages
Bill	101	55	165.10
Tom	156	35	132.56
Sue	204	125	115.89
Ann	245	78	155.25
Jill	397	32	112.90
Bob	456	44	118.21
Tim	678	67	156.20
Matt	875	95	134.00
Kay	941	88	122.45

Data (3)

Data types

- Character
  - Can contain any character (letters, numbers, special characters, and blanks)
  - Length from 1-32,767 characters
- Numeric
  - Numbers (decimal point and minus sign)

fname	id	days	wages
Bill	101	55	165.10
Tom	156	35	132.56
Sue	204	125	115.89
Ann	245	78	155.25
Jill	397	32	112.90
Bob	456	44	118.21
Tim	678	67	156.20
Matt	875	95	134.00
Kay	941	88	122.45

Data (4)

Data sources

- Internal
  - Data embedded with a program
- External
  - "Local"
    - Excel, Access, delimited, text
  - "Remote"
    - Databases, servers, etc.

fname	id	days	wages
Bill	101	55	165.10
Tom	156	35	132.56
Sue	204	125	115.89
Ann	245	78	155.25
Jill	397	32	112.90
Bob	456	44	118.21
Tim	678	67	156.20
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Let's Write a Program!

Bill	101	55	165.10
Tom	156	35	132.56
Sue	204	125	115.89
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Jill	397	32	112.90
Bob	456	44	118.21
Tim	678	67	156.20
Matt	875	95	134.00
Kay	941	88	122.45

Let's Write a Program!

Use the "data" statement to tell SAS that you want to create a dataset and you want to name it "demo".

Datasets need names…

```
data demo;
```

Bill	101	55	165.10
Tom	156	35	132.56
Sue	204	125	115.89
Ann	245	78	155.25
Jill	397	32	112.90
Bob	456	44	118.21
Tim	678	67	156.20
Matt	875	95	134.00
Kay	941	88	122.45

Datasets

A “special” type of file that SAS creates and uses for its own purposes.

Datasets need names:

- 1-32 characters
- Must start with a character or underscore
  - Subsequent characters can be letters, numbers, or underscores
- No blanks or special characters
- Mixed-case OK
- Are not case sensitive

Let's Write a Program!

Use the "input" statement to tell SAS how to read in each line of the data file. This is where you provide variable names and where you tell SAS the type of each variable.

```
data demo;
input fname $ id days wages;

Bill    101   55   165.10
Tom     156   35   132.56
Sue     204  125   115.89
Ann     245   78   155.25
Jill    397   32   112.90
Bob     456   44   118.21
Tim     678   67   156.20
Matt    875   95   134.00
Kay     941   88   122.45
```

Let's Write a Program!

The "datalines" statement tells SAS that the next lines of the program actually contain data.

SAS will treat each line as a new observation until it encounters a semi-colon (;)

```
data demo;
input fname $ id days wages;
datalines;
Bill    101   55   165.10
Tom     156   35   132.56
Sue     204  125   115.89
Ann     245   78   155.25
Jill    397   32   112.90
Bob     456   44   118.21
Tim     678   67   156.20
Matt    875   95   134.00
Kay     941   88   122.45
;
```

Let's Write a Program!

The "run" statement isn't always necessary, but it's a good practice to tell SAS that this is the end of the DATA step or PROC step.

```
data demo;
input fname $ id days wages;
datalines;
Bill    101   55   165.10
Tom     156   35   132.56
Sue     204  125   115.89
Ann     245   78   155.25
Jill    397   32   112.90
Bob     456   44   118.21
Tim     678   67   156.20
Matt    875   95   134.00
Kay     941   88   122.45
;
run;
```

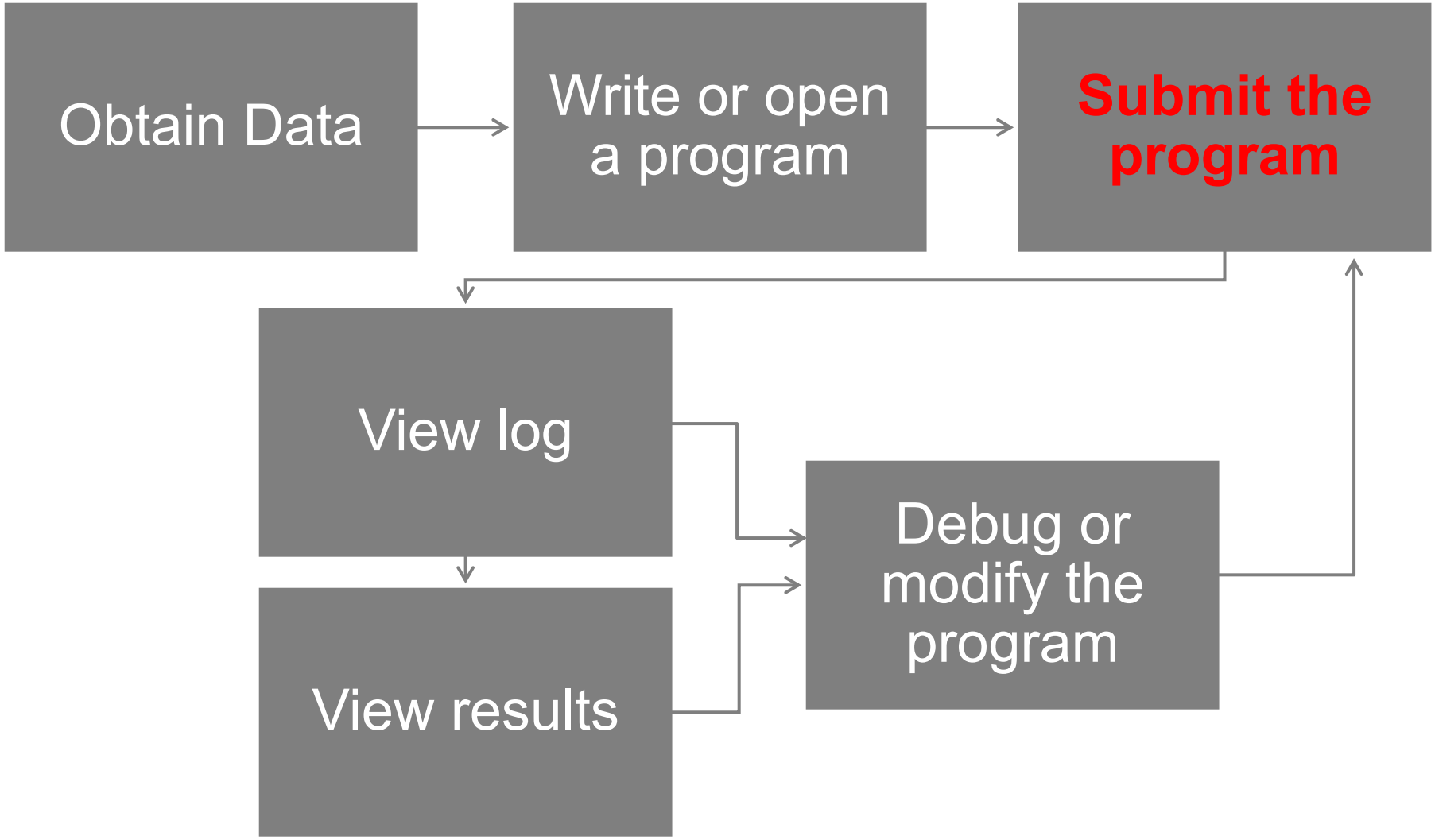
Let's Write a Program!

Now that our program has detailed how to get our data into a SAS dataset, we can ask SAS to run a simple PROC to see what the data looks like.

Again, the "run" statement isn't always necessary, but it's a good practice to tell SAS that this is the end of the DATA step or PROC step.

```
data demo;
input fname $ id days wages;
cards;
Bill    101   55   165.10
Tom     156   35   132.56
Sue     204  125   115.89
Ann     245   78   155.25
Jill    397   32   112.90
Bob     456   44   118.21
Tim     678   67   156.20
Matt    875   95   134.00
Kay     941   88   122.45
;
run;

proc print;
run;
```


Obtain Data
Write or open a program
Submit the program
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View results
Debug or modify the program

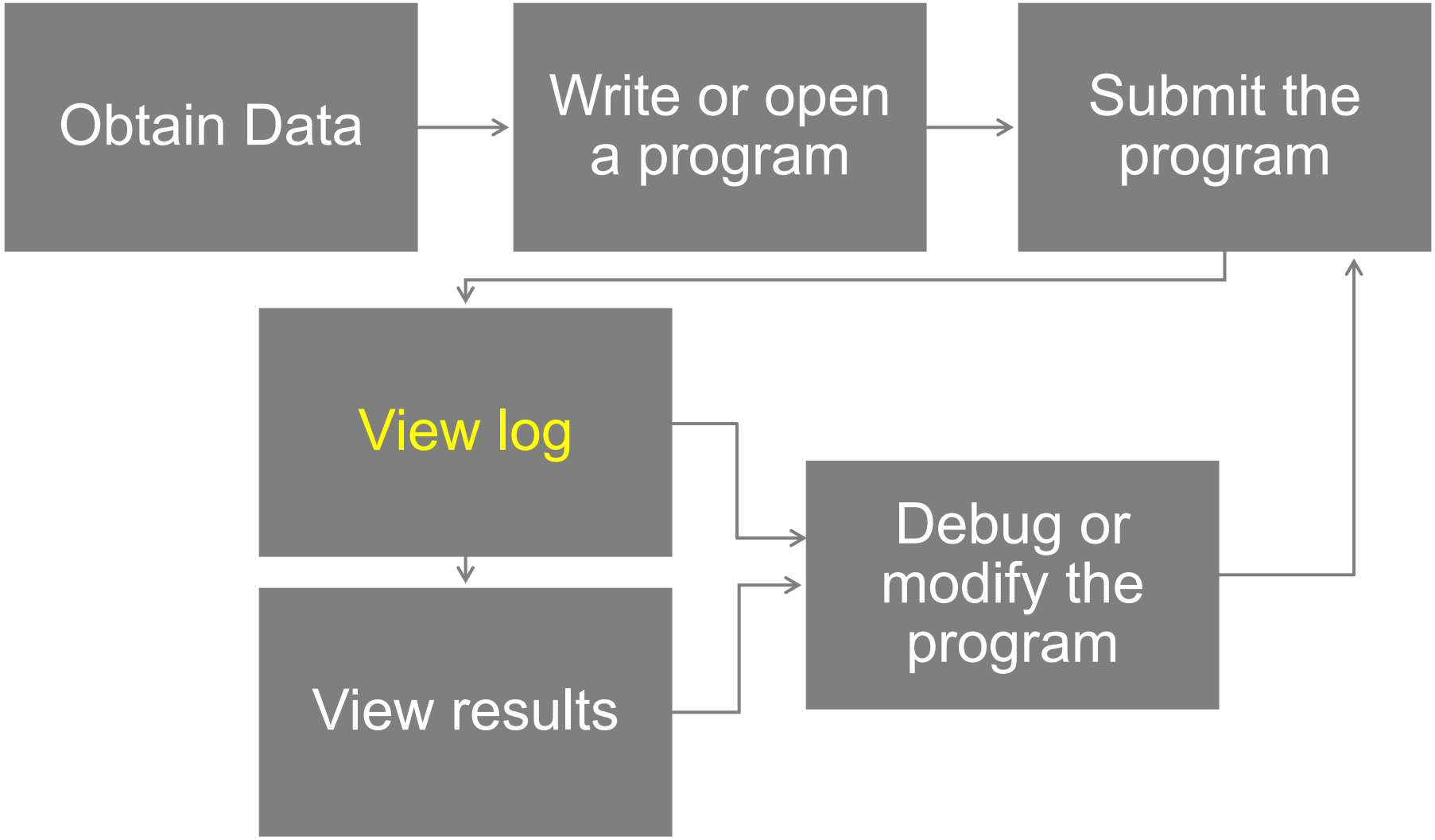
Submitting the Program

SAVE EARLY, SAVE OFTEN! 

- Can submit all or part of a program
- Click the “running man” 

Results!

Obs	fname	id	days	wages
1	Bill	101	55	165.10
2	Tom	156	35	132.56
3	Sue	204	125	115.89
4	Ann	245	78	155.25
5	Jill	397	32	112.90
6	Bob	456	44	118.21
7	Tim	678	67	156.20
8	Matt	875	95	134.00
9	Kay	941	88	122.45


Obtain Data
Write or open a program
Submit the program
View log
View results
Debug or modify the program

Log

```
NOTE: Copyright (c) 2002-2012 by SAS Institute Inc., Cary, NC, USA.
NOTE: SAS (r) Proprietary Software 9.4 (TS1M3)
      Licensed to UNIVERSITY OF IOWA - SFA T&R, Site 70086217.
NOTE: This session is executing on the X64_7PRO  platform.

NOTE: Additional host information:

 X64_7PRO WIN 6.1.7601 Service Pack 1 Workstation

NOTE: SAS initialization used:
      real time           0.65 seconds
      cpu time            0.49 seconds

1    data demo;
2    input fname $ id days wages;
3    datalines;

NOTE: The data set WORK.DEMO has 9 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds

13   ;
14   run;
15
16   proc print;
17   run;

NOTE: There were 9 observations read from the data set WORK.DEMO.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.42 seconds
      cpu time            0.14 seconds
```

Time to do some data fixing!

Assignment Statements

- Basic method for adding to or modifying a SAS data set
- Has the form

  Variable=expression;

  – Numeric value

    Year=2018;

  – Character value

    Study=“Heart”;

  – Copy a variable

    Newvariable=Oldvariable;

Arithmetic Calculations

Operation	Symbol	Example
Addition	+	CholestAdjust=Cholesterol+5;
Subtraction	-	SystAdjust=Systolic-10;
Multiplication	*	Heightm=Height*0.0254;
Division	/	BPRatio=SystAdjust/DiastAdjust
Exponentiation	**	Heightm2=Heightm**2

Let's re-Write a Program!

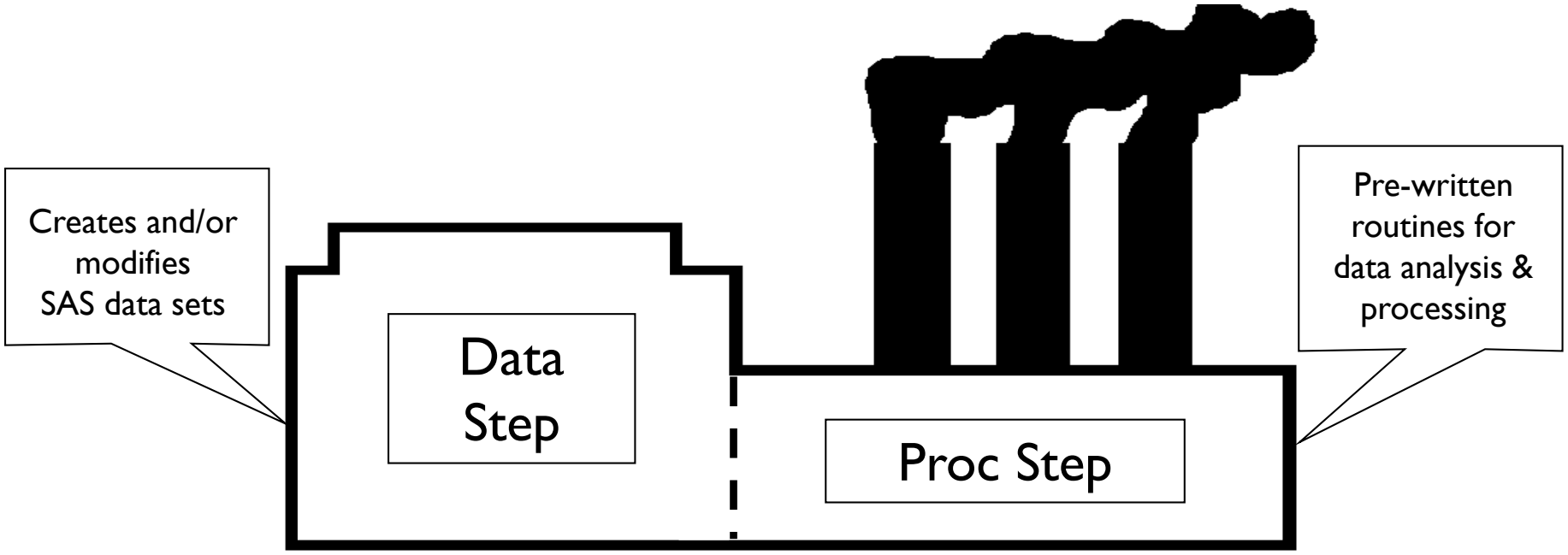
Create a new variable named "year" and give it a constant value of 2019.

Then create a new variable named "totwages" that is the product of wages and days.

```
data demo;
input fname $ id days wages;
year=2019;
totwages=wages*days;
datalines;
Bill    101   55   165.10
Tom     156   35   132.56
                ~
Matt    875   95   134.00
Kay     941   88   122.45
;
run;

proc print;
run;
```

BREAK

SAS Program Structural Components



Structural Components

- Every program typically has two parts:
  - DATA step
    - Reading data and variable manipulations
  - PROC step
    - Generates descriptive information and performs statistical analyses

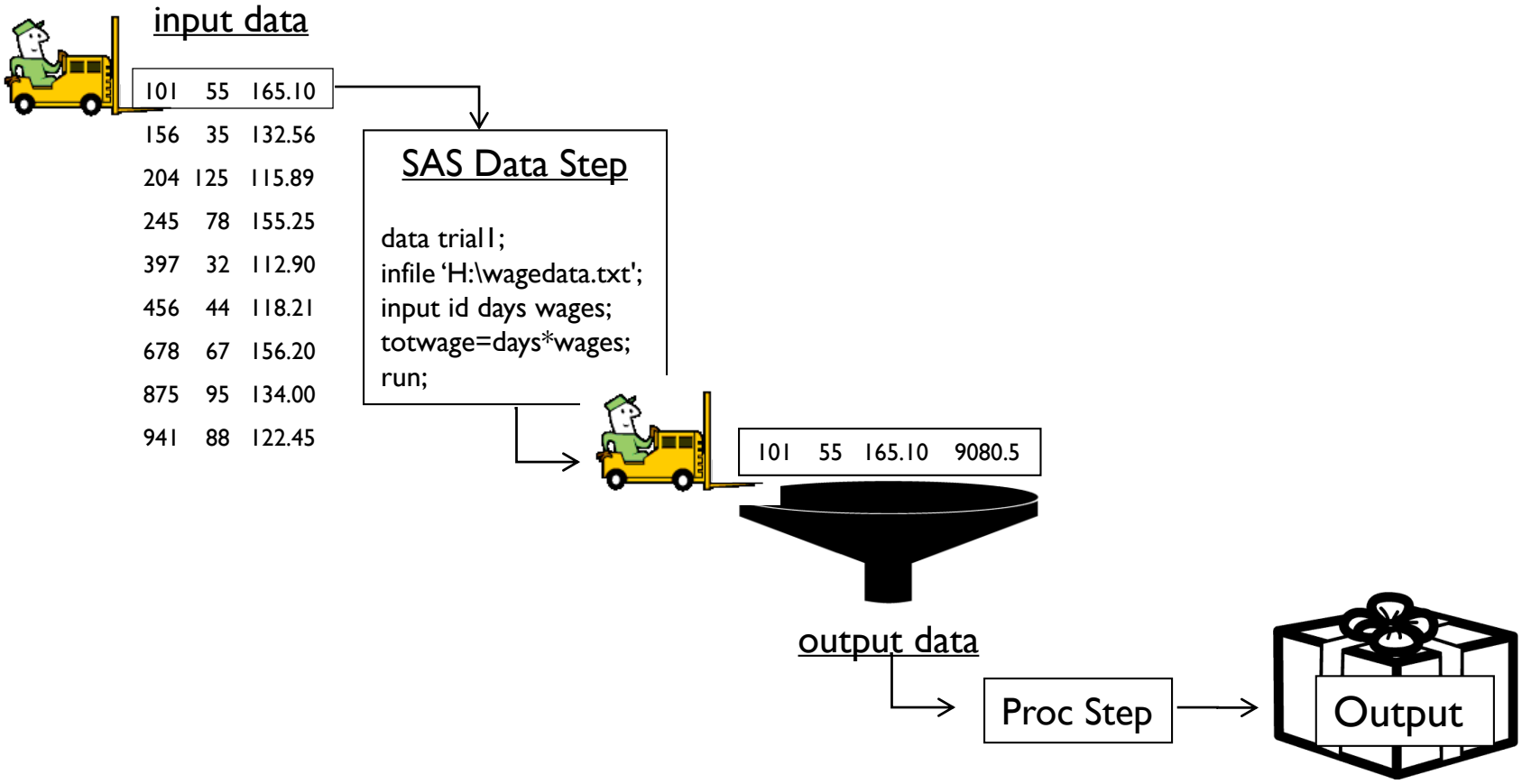
```
data demo;
input fname $ id days wages;
datalines;
Bill    101   55   165.10
Tom     156   35   132.56
Sue     204  125   115.89
Ann     245   78   155.25
Jill    397   32   112.90
Bob     456   44   118.21
Tim     678   67   156.20
Matt    875   95   134.00
Kay     941   88   122.45
;
run;

proc print;
run;
```

DATA Step

- Reads and modifies data
  - Calculations
  - Recoding variables
  - Combine data sets by concatenation or merging
- Data steps execute line by line and observation by observation

```
data demo;
input fname $ id days wages;
datalines;
Bill    101   55   165.10
Tom     156   35   132.56
Sue     204  125   115.89
Ann     245   78   155.25
Jill    397   32   112.90
Bob     456   44   118.21
Tim     678   67   156.20
Matt    875   95   134.00
Kay     941   88   122.45
;
run;

proc print;
run;
```

Structure Overview



PROC Step

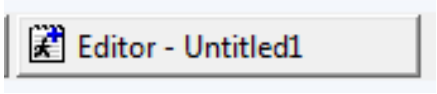
- Produces output
- Each procedure (PROC) has unique characteristics
- There are lots and lots of PROCs
- PROCs will be covered in more detail tomorrow.

```
data demo;
input fname $ id days wages;
datalines;
Bill    101   55   165.10
Tom     156   35   132.56
Sue     204  125   115.89
Ann     245   78   155.25
Jill    397   32   112.90
Bob     456   44   118.21
Tim     678   67   156.20
Matt    875   95   134.00
Kay     941   88   122.45
;
run;

proc print;
run;
```

Rules for SAS Statements

- Begin and end in any column
- Must end with a semicolon (;)
- May consist of more than one line
- Multiple statements may appear on a single line
- One or more blanks should be placed between items
- Unquoted items can be any case

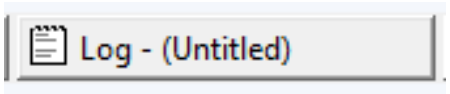
Enhanced Editor



- Color coded to help you detect errors

COLOR	COMMAND TYPE	EXAMPLE
BOLD BLUE	Major SAS commands	**DATA**
ROYAL BLUE	Sub commands, and recognized SAS words	INFILE STUDENT
PURPLE	Words within quotes such as filenames or titles.	'C:\My Documents\DATA.DAT'
BOLD GREEN	Numbers	**1-20**
GREEN	Commented out commands	*PLOT;
RED	Errors	TALBE
CALORIES	All user defined words such as variable names	CALORIES RESDAT1

Log



- Notes
  - Additional information; an indicator of a problem
- Warnings
  - Program still executes but possibly not the way you expected
- Errors
  - Usually the result of a syntax or spelling error

Don't Do This!

```
data demo;
input fname $ id days wages
datalines;
Bill     101   55   165.10
Tom      156   35   132.56
Sue      204  125   115.89
Ann      245   78   155.25
Jill     397   32   112.90
Bob      456   44   118.21
Tim      678   67   156.20
Matt     875   95   134.00
Kay      941   88   122.45
;
run;

proc print;
run;
```

I forgot the semi-colon (oops).

Consequences!

```
18   data demo;
19   input fname $ id days wages
20   datalines;
21   Bill    101    55   165.10
     ----
     180
ERROR 180-322: Statement is not valid or it is used out of proper order.

30   ;
31   run;

ERROR: No DATALINES or INFILE statement.
NOTE: The SAS System stopped processing this step because of errors.
WARNING: The data set WORK.DEMO may be incomplete.  When this step was stopped there were 0
         observations and 5 variables.
WARNING: Data set WORK.DEMO was not replaced because this step was stopped.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds

33   proc print;
34   run;

NOTE: There were 9 observations read from the data set WORK.DEMO.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

Correcting Errors Checklist

- Read the Log
- Test each part of the program
- Test program using small data sets
- Be observant of the colors in your program

Common Programming Errors

- No semicolon at the end of a statement
- Missing or mismatched quotation marks
- Misspellings
- Using the letter ‘o’ instead of number 0

Correcting DATA Errors

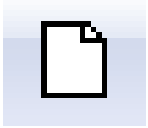
- Data entry errors
  - Descriptive summaries
  - Create flags to alert you of errors
- SAS coding errors
  - Spot check data

Let's Write another Program!

- Read in an "external" data file
  - H:\SASClass\bp.csv
  - Data on clinic and diastolic and systolic blood pressure at initial and follow-up visit.
- CSV: comma-separated values
  - Common data format
  - Easily imported/exported from Excel

```
C,84,138,93,143
D,89,150,91,140
 ,78,116,100,162
A,,,86,155
C,81,145,86,140
```

Let's Write another Program!

- Save your old program
- Start a new program 
- Close the old program?

Let's Write another Program!

Use the "data" statement to tell SAS that you want to create a dataset and you want to name it "bp".

```
data bp;
```

```
C,84,138,93,143
D,89,150,91,140
 ,78,116,100,162
A,,,86,155
C,81,145,86,140
```

Let's Write another Program!

Use the "infile" statement to tell SAS the name and location of the external data file (make sure you use YOUR location). Also tell SAS that the data values are delimited with a comma.

```
data bp;
infile 'h:\sasclass\bp.csv' dsd;
```

```
C,84,138,93,143
D,89,150,91,140
 ,78,116,100,162
A,,,86,155
C,81,145,86,140
```

Let's Write another Program!

Use the "input" statement to tell SAS how to read in each line of the data file. This is where you provide variable names and where you tell SAS the type of each variable.

```
data bp;
infile 'h:\sasclass\bp.csv' dsd;
input clinic $ dbp1 sbp1 dbp2 sbp2;
```

```
C,84,138,93,143
D,89,150,91,140
 ,78,116,100,162
A,,,86,155
C,81,145,86,140
```

Let's Write another Program!

Again, the "run" statement isn't always necessary, but it's a good practice to tell SAS that this is the end of the DATA step or PROC step.

Now that our data is in a SAS dataset, we can run a simple PROC to see what the data looks like.

```
data bp;
infile 'h:\sasclass\bp.csv' dsd;
input clinic $ dbp1 sbp1 dbp2 sbp2;
run;

proc print;
run;
```

```
C,84,138,93,143
D,89,150,91,140
 ,78,116,100,162
A,,,86,155
C,81,145,86,140
```

Programs and Outputs and Logs!

(oh my)

Missing Data

Obs	clinic	dbp1	sbp1	dbp2	sbp2
1	C	84	138	93	143
2	D	89	150	91	140
3		78	116	100	162
4	A	.	.	86	155

- Character variables “ ”
- Numeric variables .

Time to do some (more) data fixing!

Let's Write another Program!

"Fix" the record with the missing value for clinic – set it to "B"

Correct the record with the missing dbp2 variable.

```
data bp;
infile 'h:\sasclass\bp.csv' dsd;
input clinic $ dbp1 sbp1 dbp2 sbp2;
if clinic=' ' then clinic='B';
if dbp2=. Then dbp2=60;
run;

proc print;
run;
```

```
C,84,138,93,143
D,89,150,91,140
A,78,116,100,162
A,,,86,155
C,81,145,86,140
```

“Libraries” and the Libname Statement

- Must submit a libname statement to create a library reference
- Is a pointer to folder on your computer where the data files are stored
- Short hand way of telling SAS where to look for SAS data sets
  - General Format
    - `libname <name of library> "<folder location>";`
  - Example
    - `libname class "H:\SASUsersGroup\datasets\";`

Libname Rules

- 1-32 characters
- Must start with a letter
  - Subsequent characters can be letters, numbers or an underscore (no other 'special characters'
- No spaces

Let's Write more Program!

```
data bp;
infile 'h:\sasclass\bp.csv' dsd;
input clinic $ dbp1 sbp1 dbp2 sbp2;
if clinic=' ' then clinic='B';
if dbp2=. Then dbp2=60;
run;

proc print;
run;

libname ssd 'h:\sas\';

data ssd.bp;
  set bp;
run;
```

```
C,84,138,93,143
D,89,150,91,140
 ,78,116,100,162
A,,,86,155
C,81,145,86,140
```

Use the "libname" statement to create a library name and to tell SAS where to find that library

Let's Write more Program!

```
data bp;
infile 'h:\sasclass\bp.csv' dsd;
input clinic $ dbp1 sbp1 dbp2 sbp2;
if clinic=' ' then clinic='B';
if dbp2=. Then dbp2=60;
run;

proc print;
run;

libname ssd 'h:\sas\';

data ssd.bp;
  set bp;
run;
```

```
C,84,138,93,143
D,89,150,91,140
 ,78,116,100,162
A,,,86,155
C,81,145,86,140
```

Tell SAS what name you would like to give your "permanent" dataset. Note the two-part name (beginning with the library name).

Let's Write more Program!

```
data bp;
infile 'h:\sasclass\bp.csv' dsd;
input clinic $ dbp1 sbp1 dbp2 sbp2;
if clinic=' ' then clinic='B';
if dbp2=. Then dbp2=60;
run;

proc print;
run;

libname ssd 'h:\sas\';

data ssd.bp;
  set bp;
run;
```

```
C,84,138,93,143
D,89,150,91,140
 ,78,116,100,162
A,,,86,155
C,81,145,86,140
```

Tell SAS what dataset you would like to use for the source of your your "permanent" dataset.

Let's Write (yet) another Program!

- Read in a SAS Dataset
  - H:\SASclass\sample.sas7bdat
  - Data on patients and clinical characteristics.
  - It's already a SAS dataset – somebody has already done a lot of the work!

Let's Write (yet) another Program!

Use the "libname" statement to tell SAS to create a library name and to tell SAS where to find that library

```
libname ssd 'h:\sasclass\';
```

Let's Write (yet) another Program!

```
libname ssd 'h:\sasclass\';

proc print data=ssd.sample;
run;
```

"LOOK!" A SAS program that doesn't have a data step!

Use the "data=" option on the print proc to tell SAS which dataset you want to print.

Time to do some (yet more) data fixing!

Let's Write (yet) another Program!

```
libname ssd 'h:\sasclass\';

proc print data=ssd.sample;
run;
```

```
data stuff;
```

Tell SAS that you want to create a new dataset and name it "stuff". Note, the one-part name tells SAS that this is a temporary dataset.

Let's Write (yet) another Program!

```
libname ssd 'h:\sasclass\';

proc print data=ssd.sample;
run;
```

Use the "set" statement to tell SAS the name of the dataset that you want to use as a "source" for your new dataset.

```
data stuff;
 set ssd.sample;
```

Let's Write (yet) another Program!

```
libname ssd 'h:\sasclass\';

proc print data=ssd.sample;
run;


data stuff;
  set ssd.sample;
if cholesterol=999 then cholesterol=.;
```

Use an assignment statement to correct the wacko values for cholesterol.

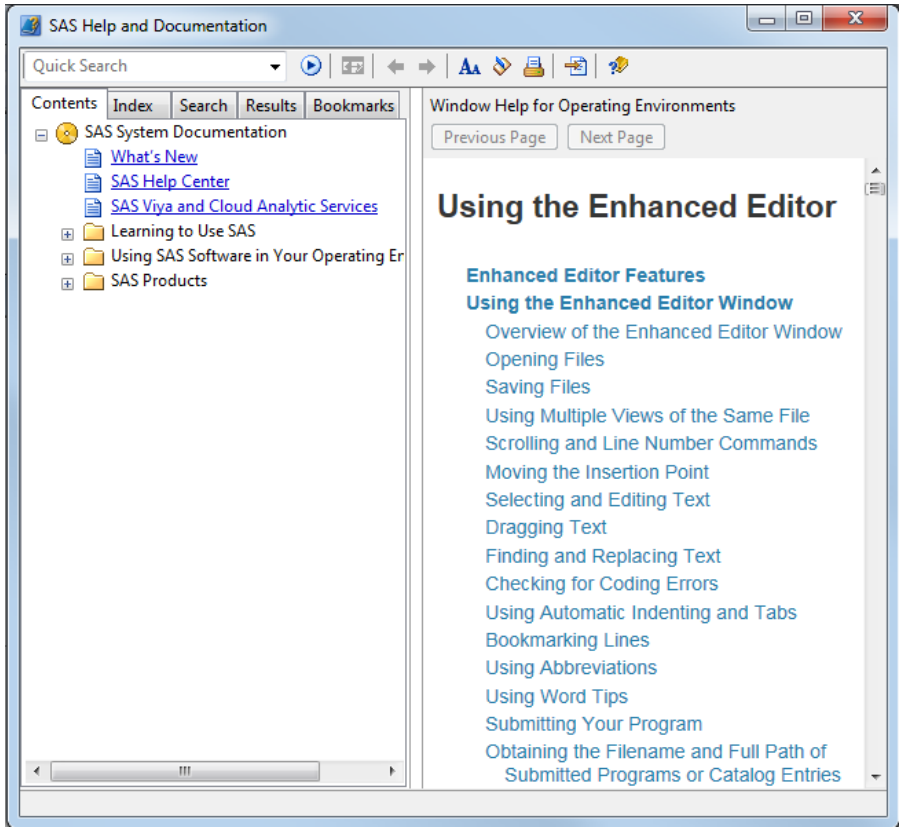
Let's Write (yet) another Program!

```
libname ssd 'h:\sasclass\';

proc print data=ssd.sample;
run;


data stuff;
  set ssd.sample;
if cholesterol=999 then cholesterol=.;
run;

proc print data=stuff;
run;
```

Use a "run" statement to finish the data step.

Look at the new dataset using a Proc Print.

I need help… who? how? where?



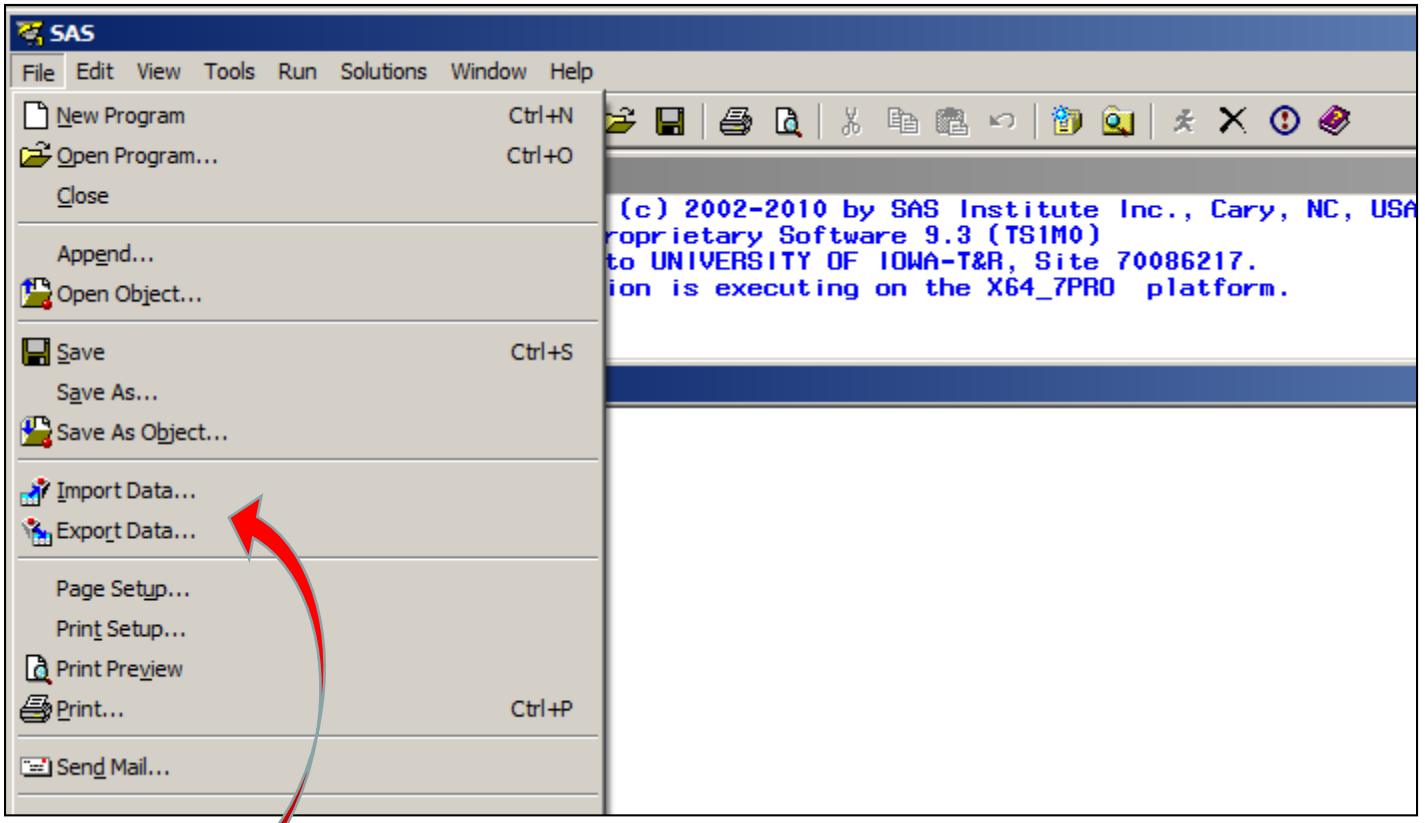
I need help… who? how? where?

- SAS®, Inc. Resource Center
  - https://www.sas.com/en_us/resource-center.html
- Technical support from SAS®, Inc.
  - https://support.sas.com
- The SAS® “community”
  - https://communities.sas.com/
- SAS Conference Proceedings
  - https://lexjansen.com/
- The non-® SAS “community”
  - https://sasCommunity.org
- Google
  - http://google.com

Import/Export Data

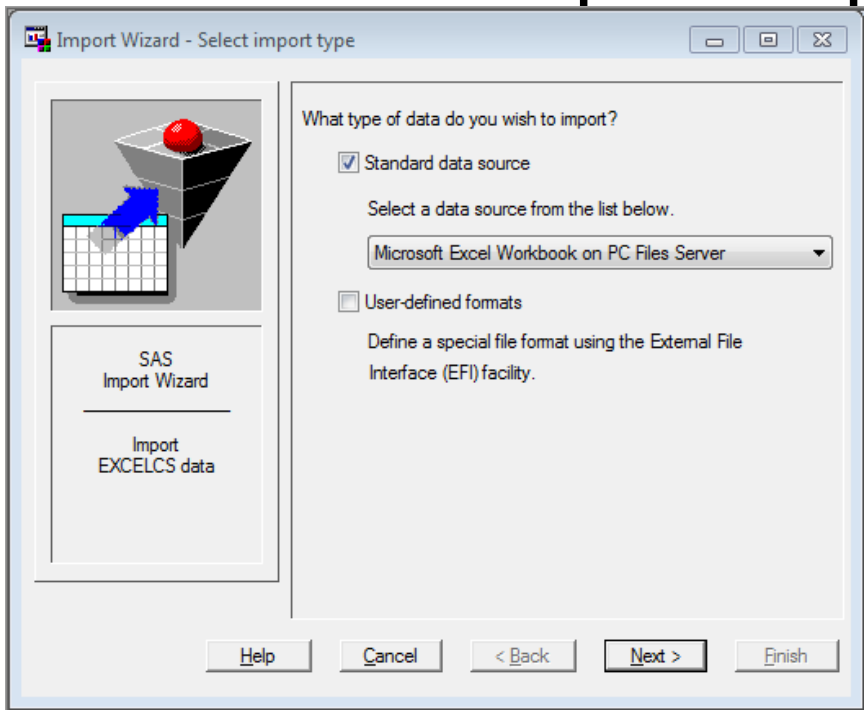
- SAS can import data from, and export data to, many different formats
  - MS-Excel
  - MS-Access
  - .csv
  - SPSS
  - Stata
  - many others
- A variety of methods for importing/exporting
- Best approach depends on variety of factors
  - Operating system (Linux, Windows, 32/64-bit)
  - SAS version (9.3, 9.4, 32/64-bit)
  - Originating/destination software (Excel, .csv, SPSS)
- Use the Wizard
  - Be careful, pay attention

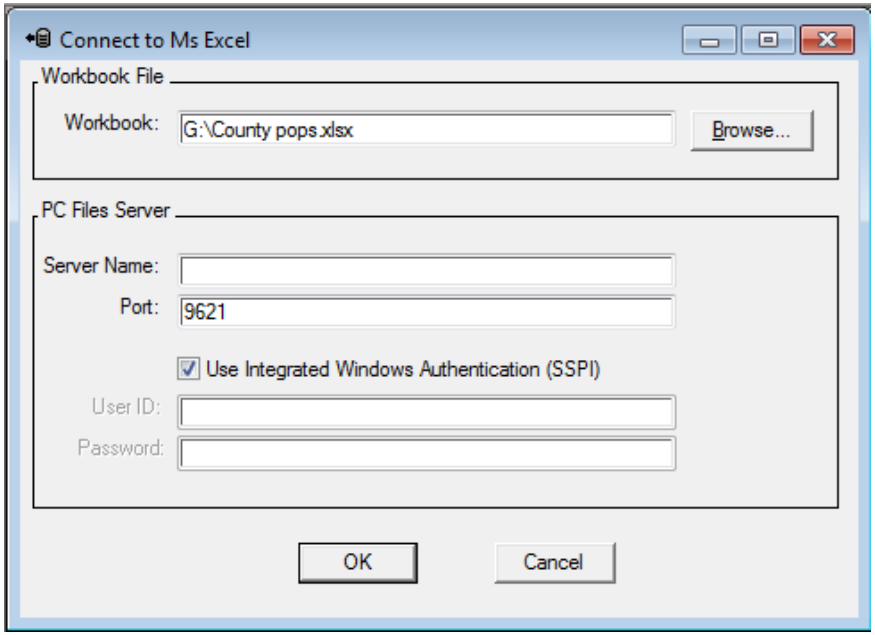
Import/Export Data (2)



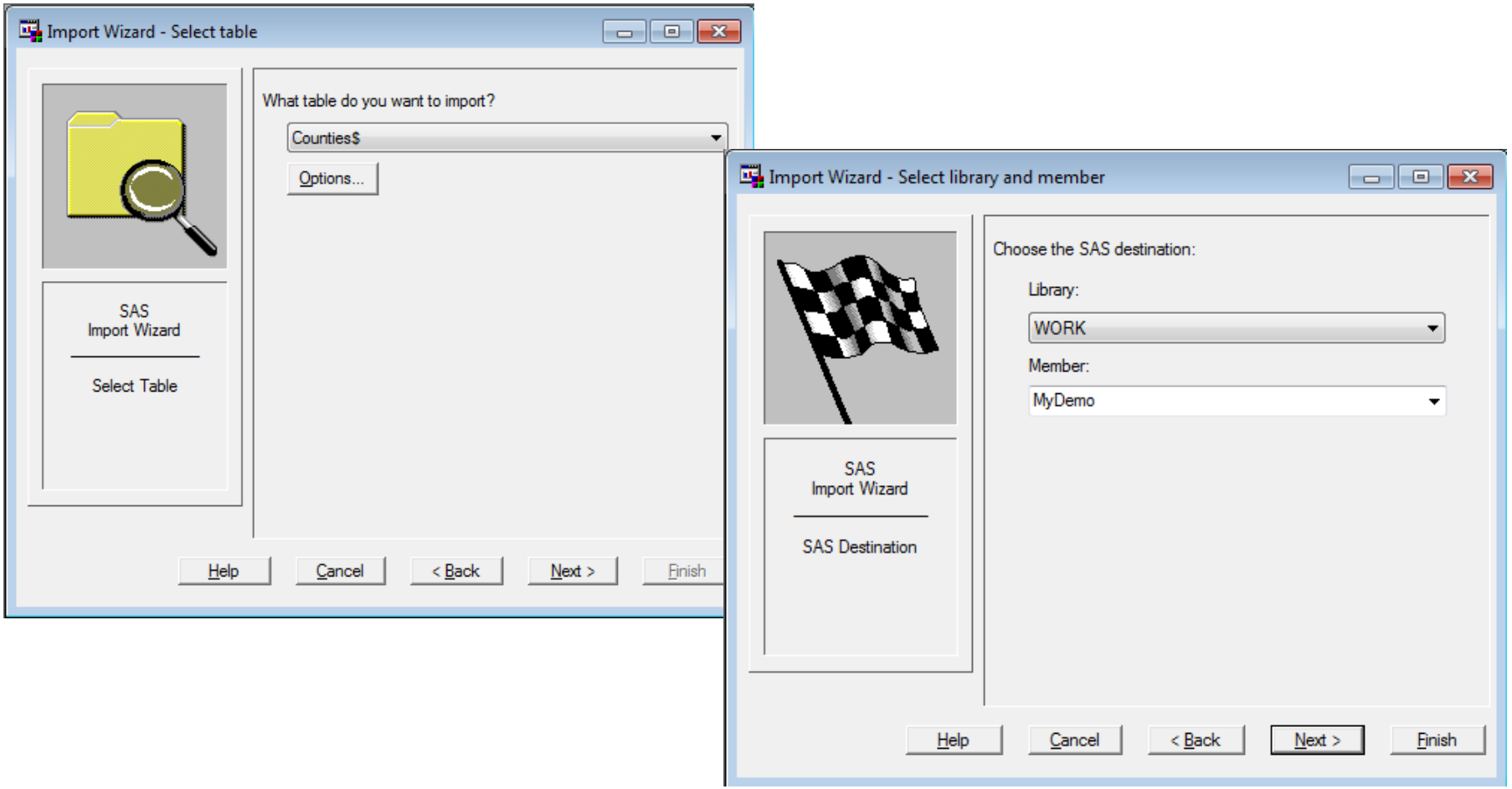
Wizards!

Import/Export Data (3)

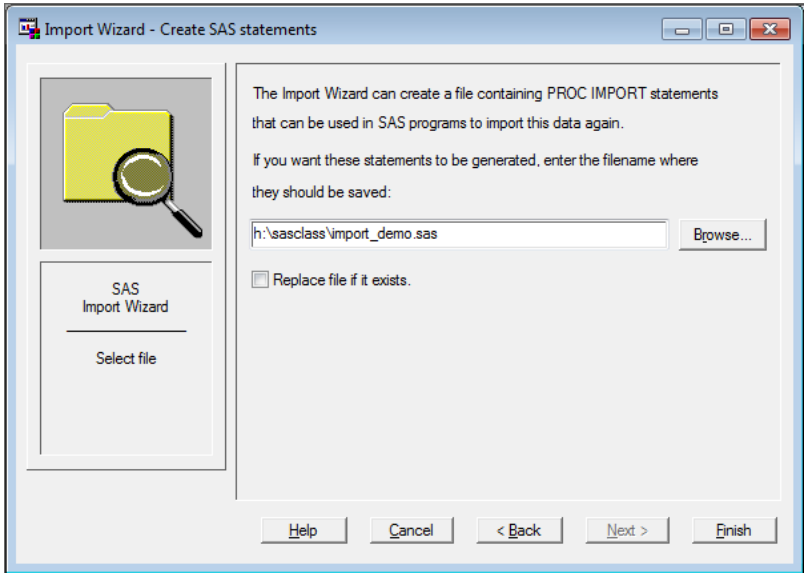




Import/Export Data (4)



Import/Export Data (5)

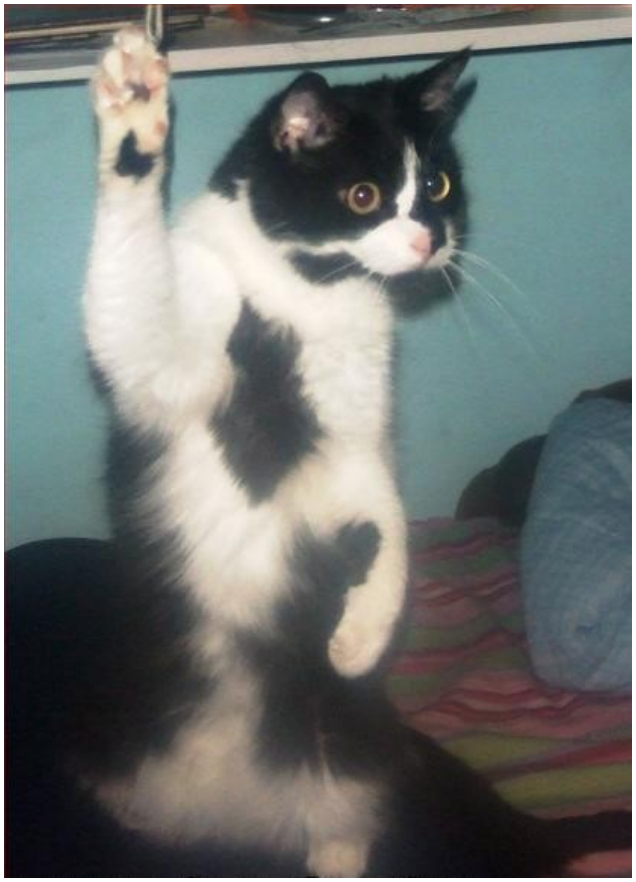



```
PROC IMPORT OUT= WORK.demo
    DATAFILE= "H:\My Documents\SAS\UI SAS bootcamp\2017\demos\patient.xlsx"
    DBMS=EXCELCS REPLACE;
  RANGE="Sheet1$";
  SCANTEXT=YES;
  USEDATE=YES;
  SCANTIME=YES;
RUN;
```

Parting Shots

- Univ. of Iowa SAS Users Group (UISUG)
  - https://uisug.org.uiowa.edu/
- UISUG Listserv
  - https://list.uiowa.edu/scripts/wa.exe?A0=SAS-USERS
    -or-
    https://list.uiowa.edu/scripts/wa.exe?HOME
    - Find the list name (SAS-USERS)
    - Click on the name
    - Click on Subscribe or Unsubscribe.
    - Enter your Name and Email Address.
- Care to join the UISUG steering committee:
  - eMail Sarah L Bell: sarah-mott@uiowa.edu

Questions?



Evaluate!


I have your evaluation ... great teamwork, great morale ... basically, you're a good dog