tutorialspoint

SIMPLY EASY LEARNING

www.tutorialspoint.com

https://www.facebook.com/tutorialspointindia https://twitter.com/tutorialspoint

About the Tutorial

SAS is a leader in business analytics. Through innovative analytics, it caters to business intelligence and data management software and services. SAS transforms data into insight which can give a fresh perspective to business.

Unlike other BI tools available in the market, SAS takes an extensive programming approach to data transformation and analysis rather than a drag-drop-connect approach. This makes it stand out from the crowd with enhanced control over data manipulation. SAS has a very large number of components customized for specific industries and data analysis tasks.

Audience

This tutorial is designed for all those readers who want to read and transform raw data to produce insights for business using SAS. Readers who aspire to become Data Analysts or Data Scientists can also draw benefits from this tutorial.

Prerequisites

Before proceeding with this tutorial, you should have a basic understanding of Computer Programming terminologies. A basic understanding of any of the programming languages will help you understand the SAS programming concepts. Familiarity with SQL will be an added benefit.

Disclaimer & Copyright

Table of Contents

1. SAS – Overview

SAS stands for **Statistical Analysis Software**. It was created in the year 1960 by the SAS Institute. From 1st January 1960, SAS was used for data management, business intelligence, Predictive Analysis, Descriptive and Prescriptive Analysis etc. Since then, many new statistical procedures and components were introduced in the software.

With the introduction of JMP (Jump) for statistics, SAS took advantage of the **graphical user interface** (GUI) which was introduced by the Macintosh. Jump is basically used for applications like Six Sigma, designs, quality control and engineering and scientific analysis.

SAS is platform independent which means you can run SAS on any operating system either Linux or Windows. SAS is driven by SAS programmers who use several sequences of operations on the SAS datasets to make proper reports for data analysis.

Over the years SAS has added numerous solutions to its product portfolio. It has solution for Data Governance, Data Quality, Big Data Analytics, Text Mining, Fraud management, Health science etc. We can say that SAS has a solution for every business domain.

To have a glance at the list of products available you can visit **SAS Components**.

Uses of SAS

SAS is basically worked on large datasets. With the help of SAS software, you can perform various operations on data. Some of the operations include:

- Data management
- Statistical analysis
- Report formation with perfect graphics
- Business planning
- Operations research and project management
- Quality improvement
- Application development
- Data extraction
- Data transformation
- Data updation and modification

If we talk about the components of SAS, then more than 200 components are available in SAS.

S.N.	SAS Component & their Usage
1	**Base SAS** It is a core component which contains data management facility and a programming language for data analysis. It is also the most widely used.
2	**SAS/GRAPH** Creates graphs, presentations for better understanding and showcases the result in a proper format.
3	**SAS/STAT** Perform Statistical analysis with the variance analysis, regression, multivariate analysis, survival analysis, and psychometric analysis, mixed model analysis.
4	**SAS/OR** Operations research.
5	**SAS/ETS** Econometrics and Time Series Analysis.
6	**SAS/IML** Interactive matrix language.
7	**SAS/AF** Applications facility.
8	**SAS/QC** Quality control.
9	**SAS/INSIGHT** Data mining.
10	**SAS/PH** Clinical trial analysis.
11	**SAS/Enterprise Miner** Data mining

Types of SAS Software

Let us now understand the different types of SAS software.

- Windows or PC SAS
- SAS EG (Enterprise Guide)
- SAS EM (Enterprise Miner i.e. for Predictive Analysis)
- SAS Means
- SAS Stats

We use Windows SAS in large organizations and also in training institutes. A few organizations also use Linux but there is no graphical user interface so you have to write code for every query. In Window SAS, there are a lot of utilities available that help the programmers and also reduce the time of writing the codes.

A SaS Window has 5 parts.

S.N.	SAS Window & their Usage
1	**Log Window** is like an execution window where we can check the execution of the SAS program. We can also check the errors here. It is very important to check the log window every time the program is run. This facilitates proper understanding about the execution of our program.
2	**Editor Window** is that part of SAS where we write all the codes. It is like a notepad. .
3	**Output Window** is the result window where we can see the output of our program.
4	**Result Window** is like an index to all the outputs. All the programs that we have run in one session of the SAS are listed here and you can open the output by clicking on the output result. But these are mentioned only in one session of the SAS. If we close the software and then open it, the Result Window will be empty.
5	**Explore Window** has all the libraries listed in it. You can also browse your system SAS supported files from here.

Libraries in SAS

Libraries are storage locations in SAS. You can create a library and save all the similar programs in that library. SAS provides you the facility to create multiple libraries. A SAS library is only 8 characters long.

There are two types of libraries available in SAS:

S.N.	SAS Window & their Usage
1	**Temporary or Work Library** This is the by default library of SAS. All the programs that we create are stored in this work library if we do not assign any other library to them. You can check this work library in the Explore Window. Suppose you create a SAS program and have not assigned any permanent library to it..... and if you end the session. The problem will be - when you start the software then this program will not be in the work library. This will only be there in Work library as long as the session is active.
2	**Permanent Library** These are the permanent libraries of SAS. We can create a new SAS library by using SAS utilities or by writing the codes in the editor window. When we create a program in SAS and save it in these permanent libraries, it will be available as long as we want it.

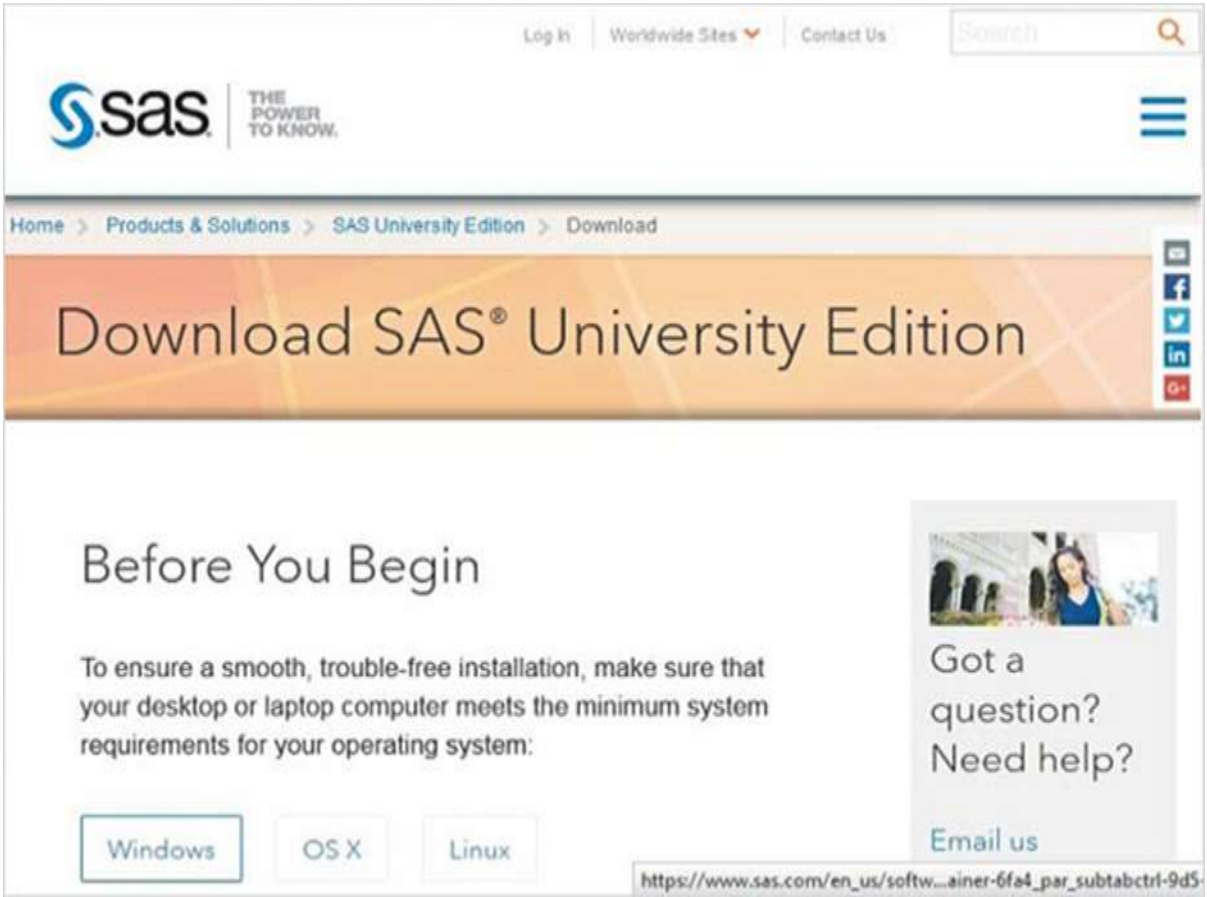
2. SAS – Environment

SAS Institute Inc. has released a free **SAS University Edition.** This provides a platform for learning SAS programming. It provides all the features that you need to learn in BASE SAS programming which in turn enables you to learn any other SAS component.

The process of downloading and installing SAS University Edition is very simple. It is available as a virtual machine which needs to be run on a virtual environment. You need to have virtualization software already installed in your PC before you can run the SAS software. In this tutorial, we will be using **VMware**. The following are the details of the steps to download, setup the SAS environment and verify the installation.

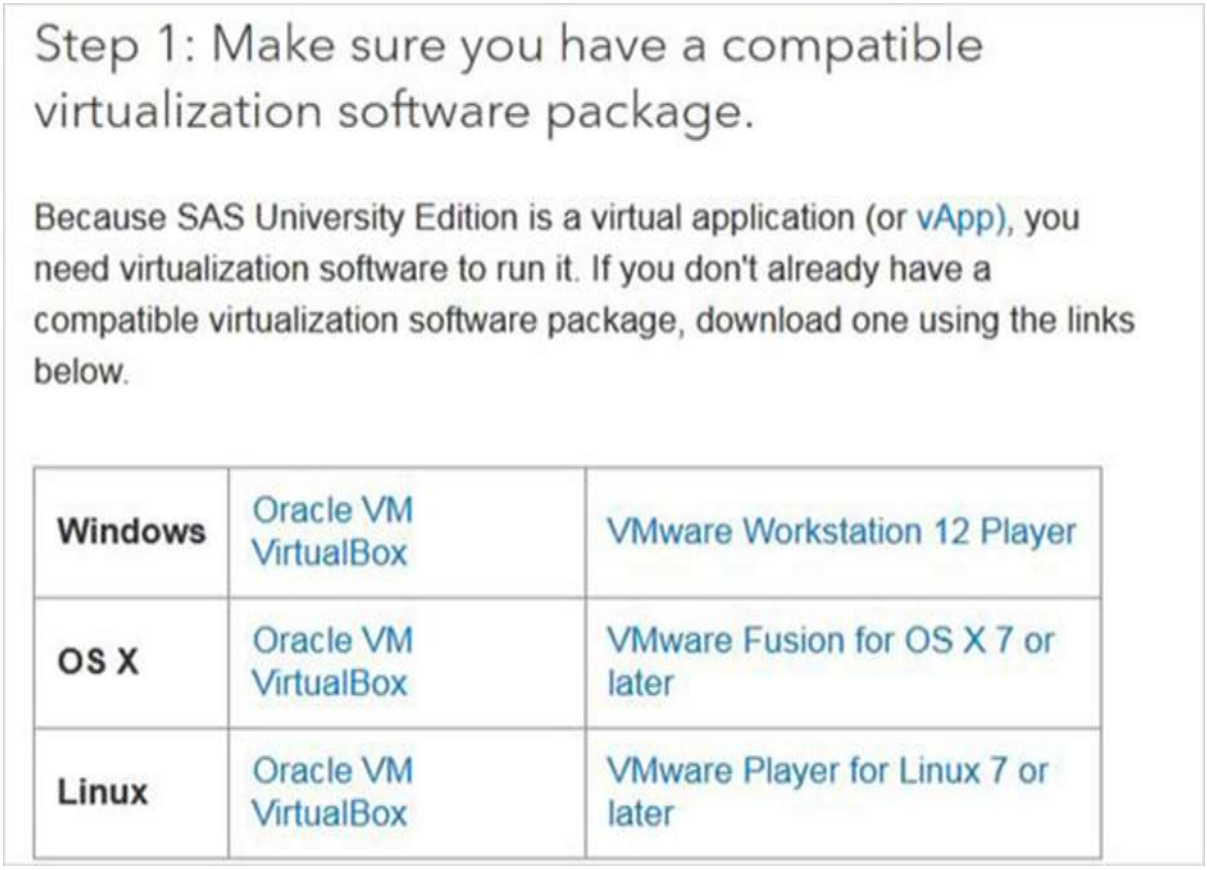
Download SAS University Edition

SAS University Edition is available for download at the URL SAS University Edition. Please scroll down to read the system requirements before you begin the download. The following screen appears on visiting this URL.



Setup virtualization software

Scroll down on the same page to locate the installation step 1. This step provides the links to get the suitable virtualization software. In case you already have any one of these software installed in your system, you can skip this step.



Step 1: Make sure you have a compatible virtualization software package.

Because SAS University Edition is a virtual application (or vApp), you need virtualization software to run it. If you don't already have a compatible virtualization software package, download one using the links below.

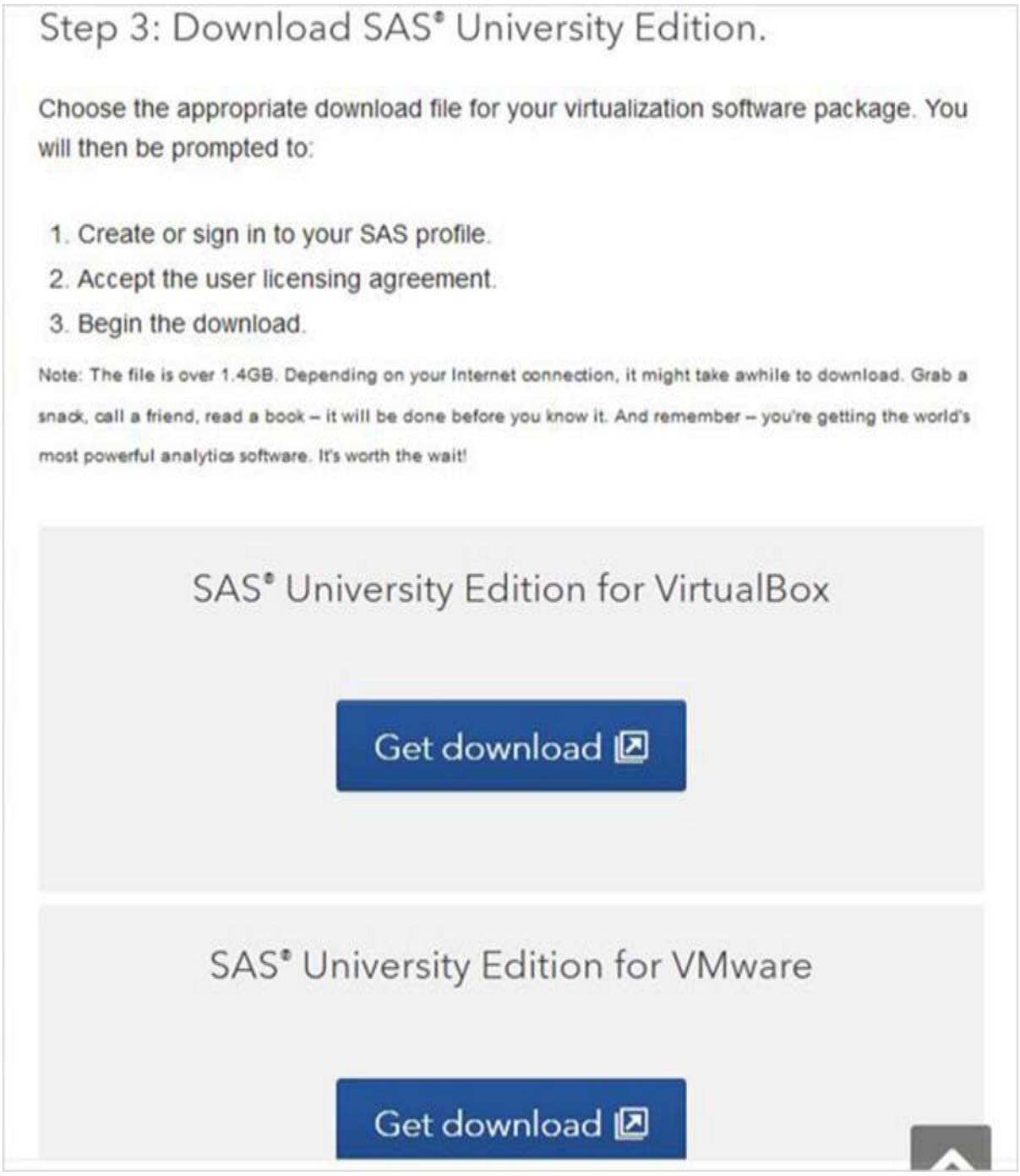
Windows	Oracle VM VirtualBox	VMware Workstation 12 Player
OS X	Oracle VM VirtualBox	VMware Fusion for OS X 7 or later
Linux	Oracle VM VirtualBox	VMware Player for Linux 7 or later

Quick start virtualization software

In case you are completely new to the virtualization environment, you can familiarize yourself with it by going through the following guides and videos available as step 2. You can skip this step in case you are already familiar.

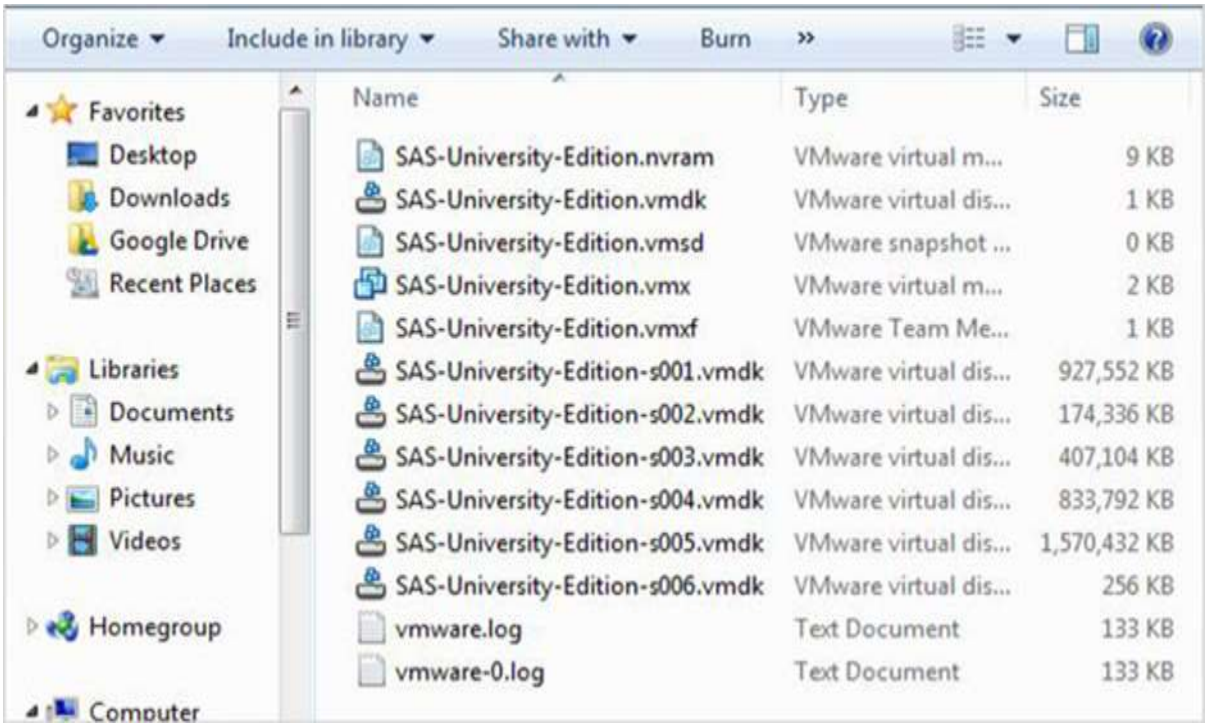
Download the Zip file

In step 3, you can choose the appropriate version of the SAS University Edition compatible with the virtualization environment you have. It downloads as a zip file with the name similar to unvbasicvapp__9411005__vmx__en__sp0__1.zip



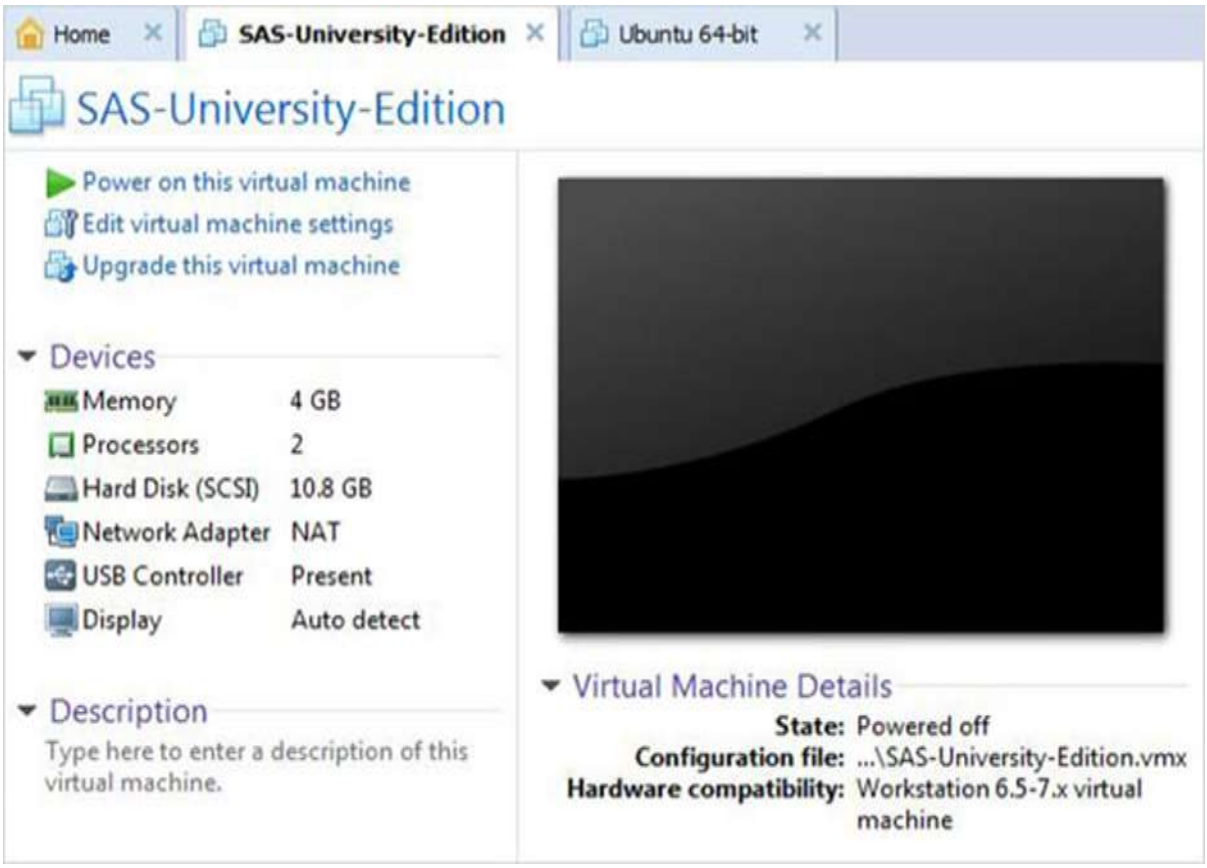
Unzip the Zip file

The zip file above needs to be unzipped and stored in an appropriate directory. In our case, we have chosen the VMware zip file which shows the following files after unzipping.



Loading the virtual machine

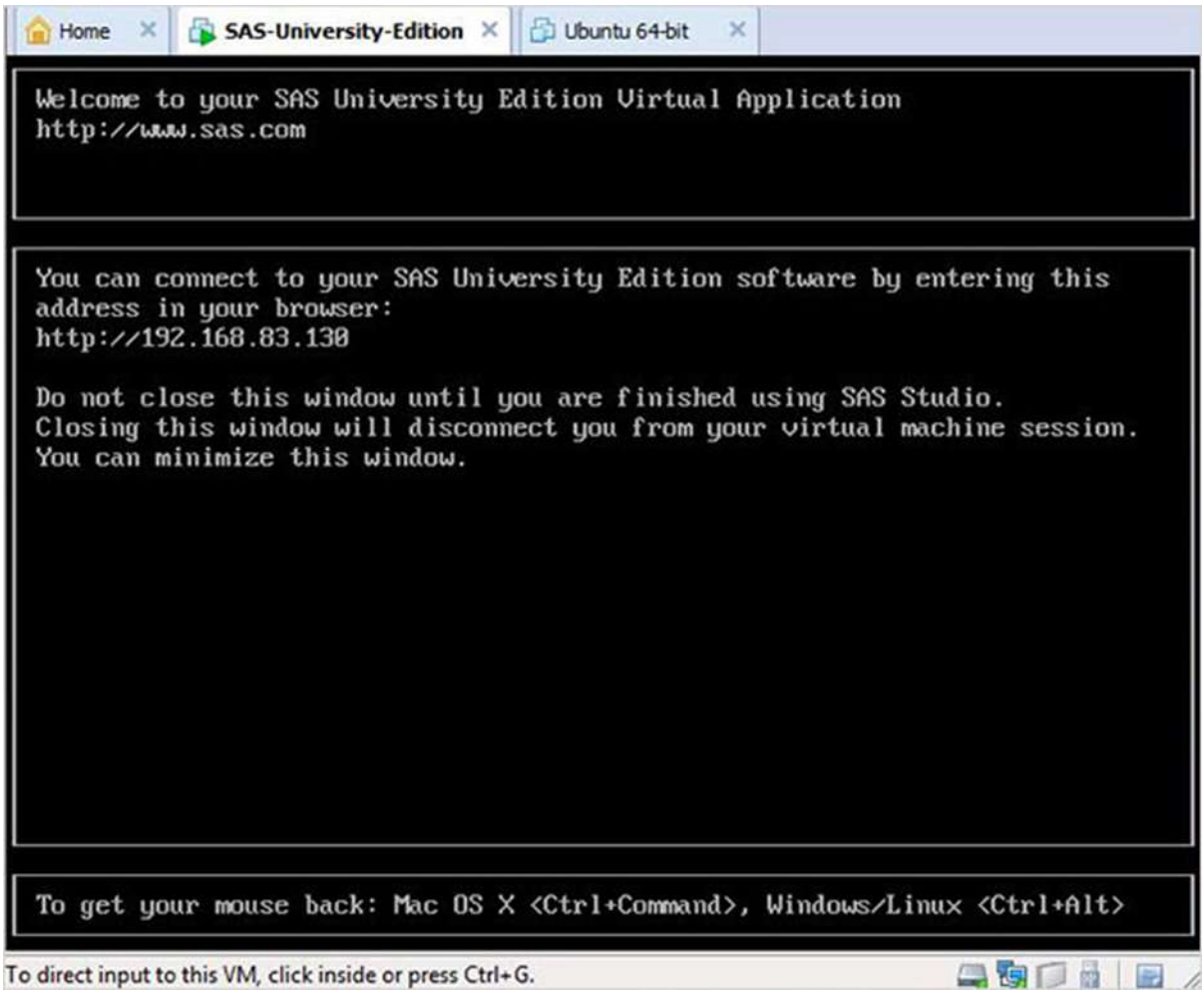
Start the VMware player (or workstation) and open the file which ends with an extension. vmx. The following screen appears. Please notice the basic settings like memory and hard disk space allocated to the vm.



Power on the virtual machine

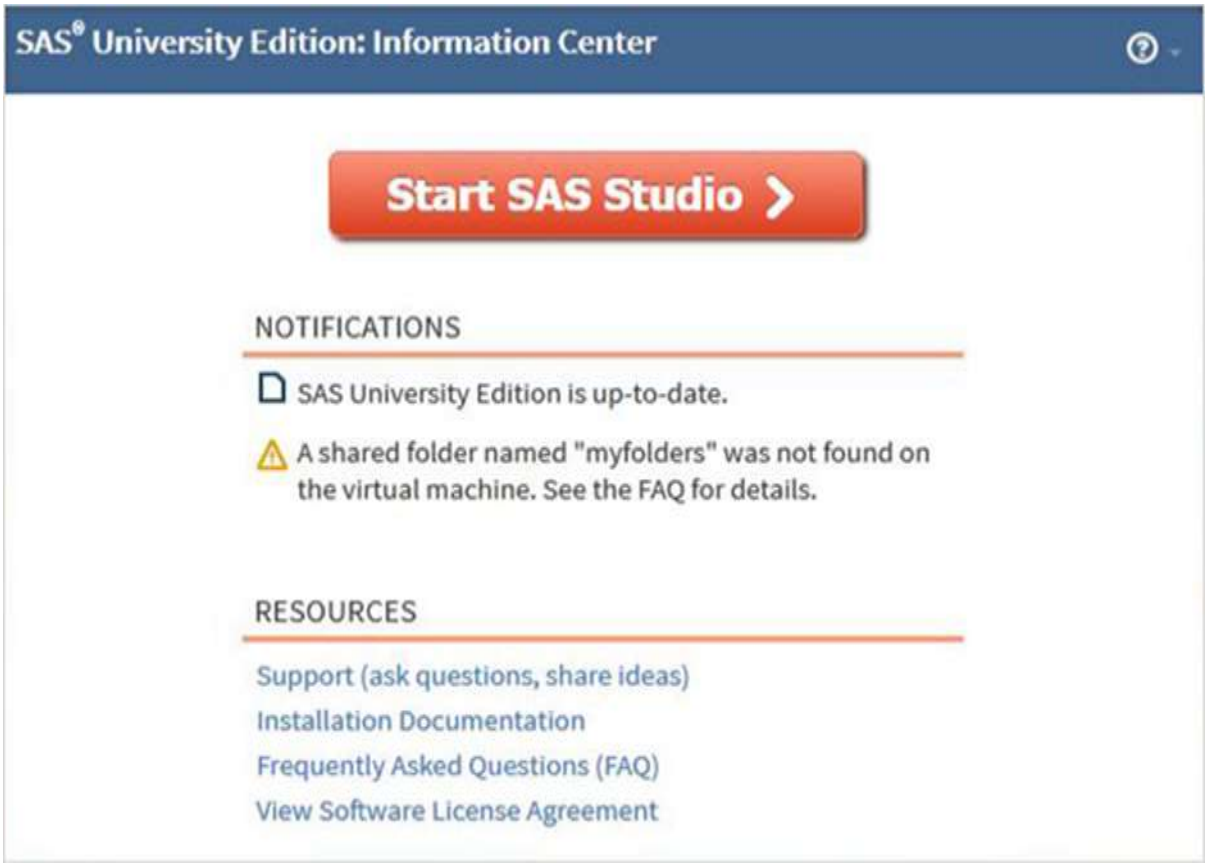
Click the **Power on this virtual machine** alongside the green arrow mark to start the virtual machine. The following screen appears.

The following screen appears when the SAS vm is in the state of loading after which the running vm gives a prompt to go to a URL location that will open the SAS environment.



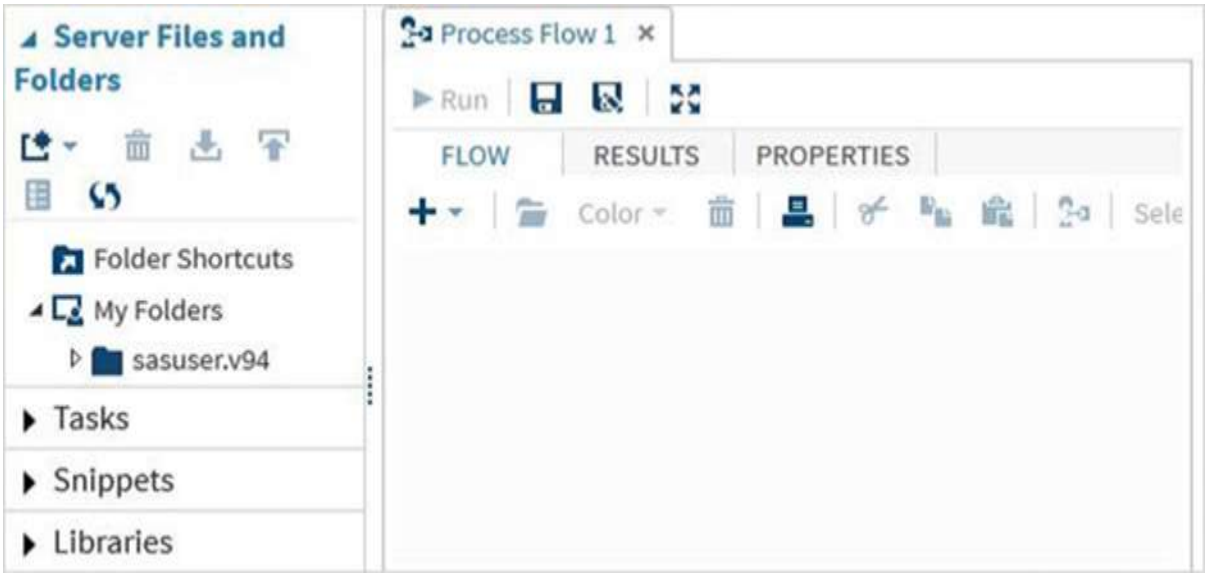
Starting SAS studio

Open a new browser tab and load the above URL (which differs from one PC to another). The following screen appears indicating the SAS environment is ready.

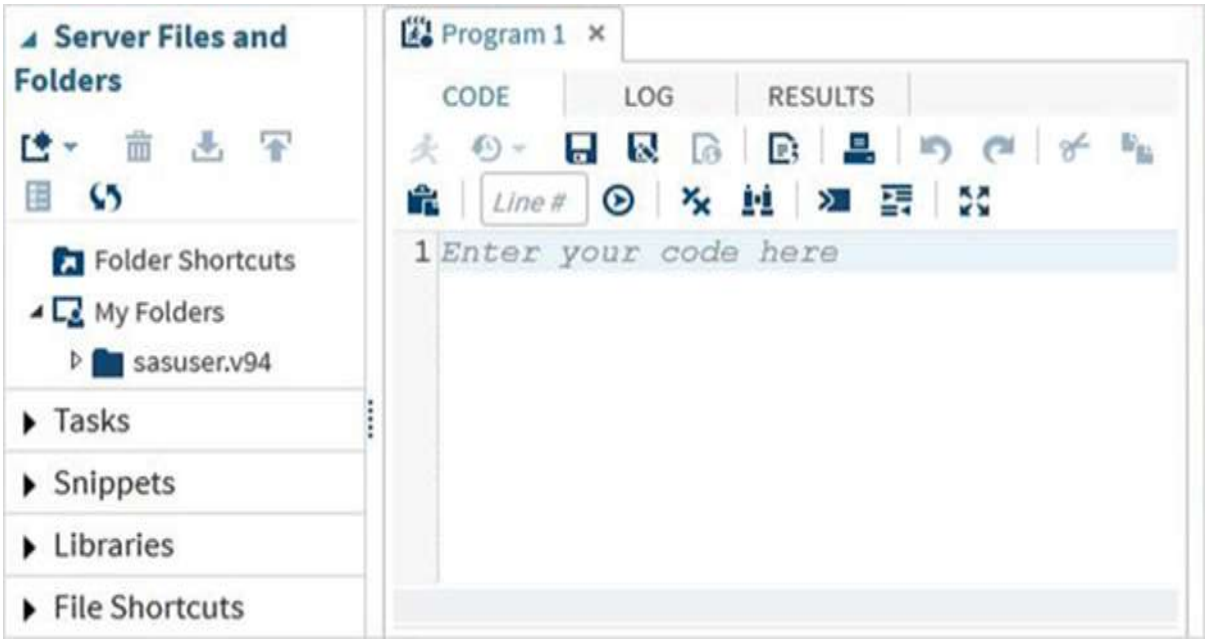


The SAS Environment

On clicking the **Start SAS Studio,** we get the SAS environment which by default opens in the visual programmer mode as shown in the following screenshot.



We can also change it to the SAS programmer mode by clicking on the dropdown.



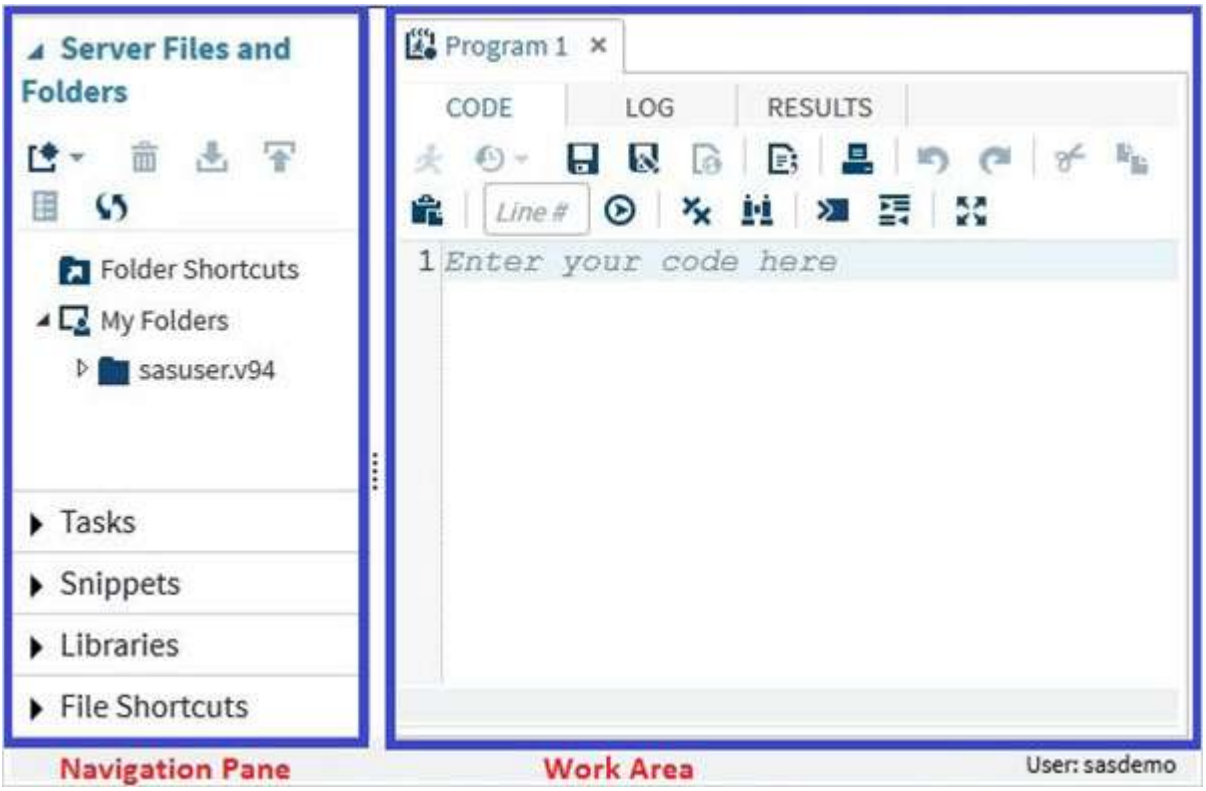
We are now ready to write the SAS Programs.

3. SAS – User Interface

SAS Programs are created using a user interface known as **SAS Studio**. In this chapter, we will discuss the various windows of SAS User Interface and their usage.

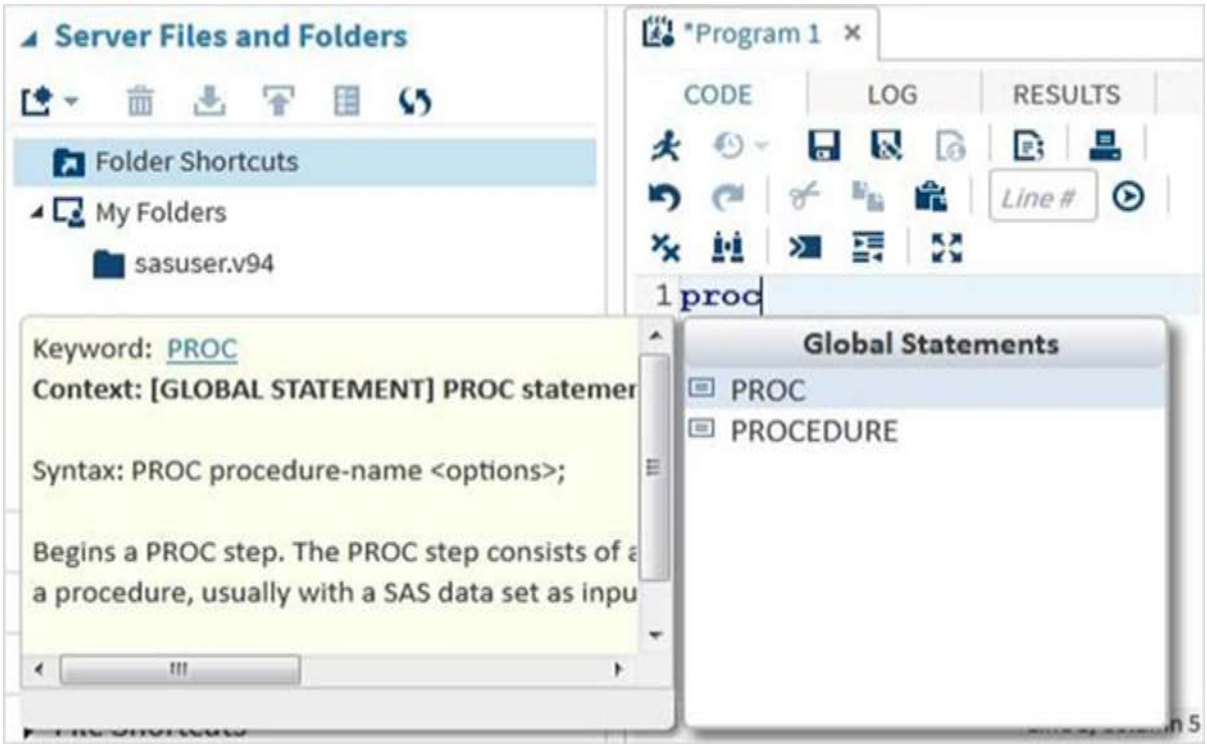
SAS Main Window

This is the window you see on entering the SAS environment. The **Navigation Pane** is to the left. It is used to navigate various programming features. The **Work Area** is to the right. It is used for writing the code and executing it.



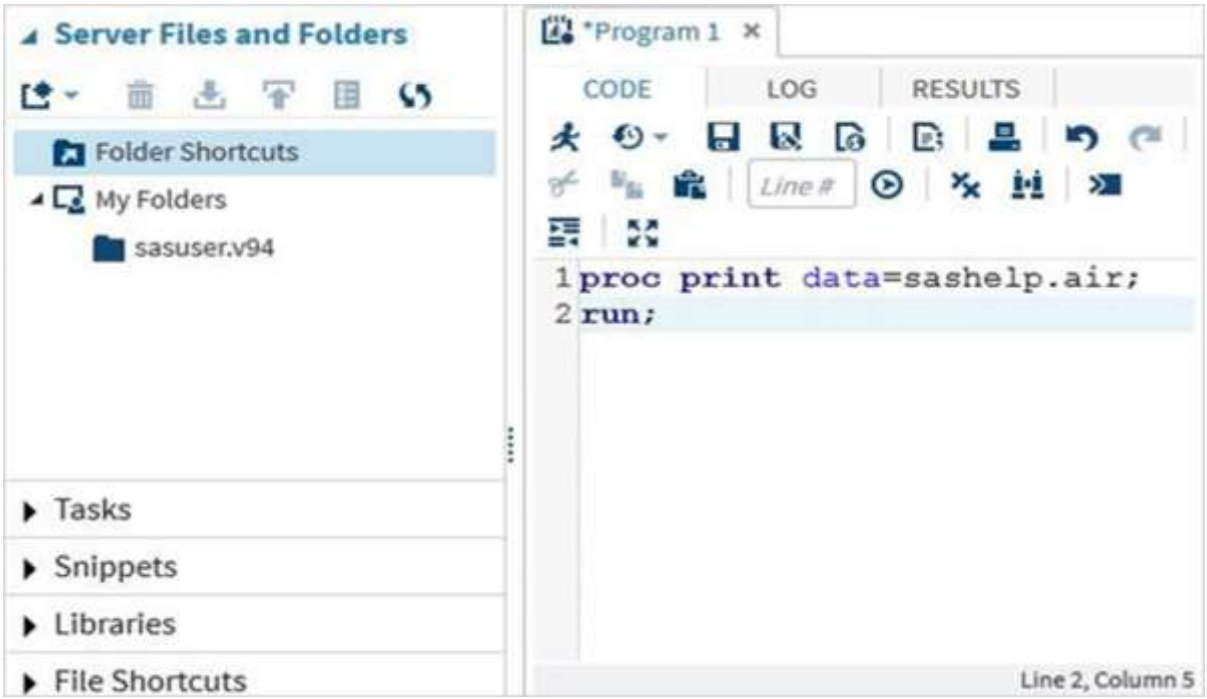
Code Autocomplete

This feature helps in getting the correct syntax of the SAS keywords and also provides link to the documentation for the keywords.



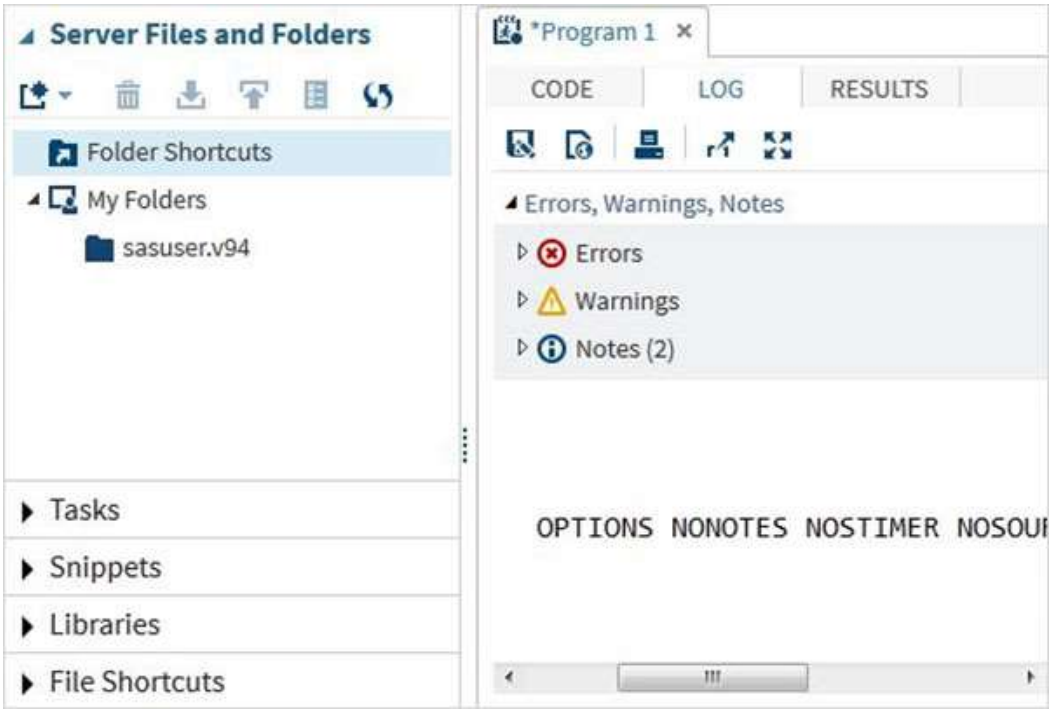
Program Execution

The execution of code is done by pressing the run icon, which is the first icon from left or the F3 button.



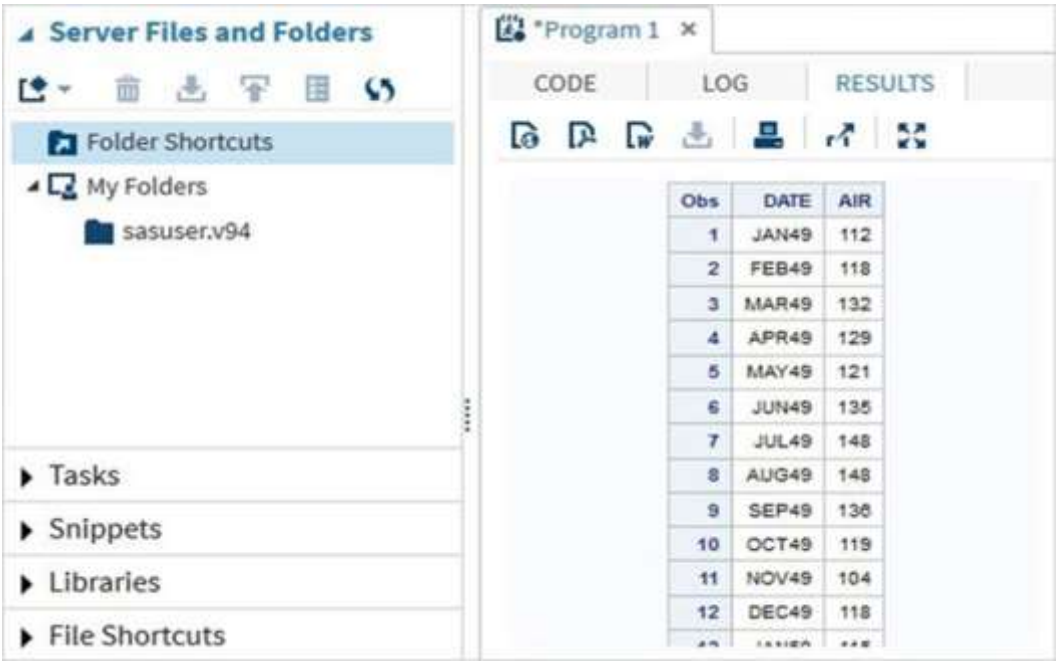
Program Log

The log of the executed code is available under the **Log** tab. It describes the errors, warnings or notes about the program's execution. This is the window where you get all the clues to troubleshoot your code.



Program Result

The result of the code execution is seen in the RESULTS tab. By default, they are formatted as html tables.

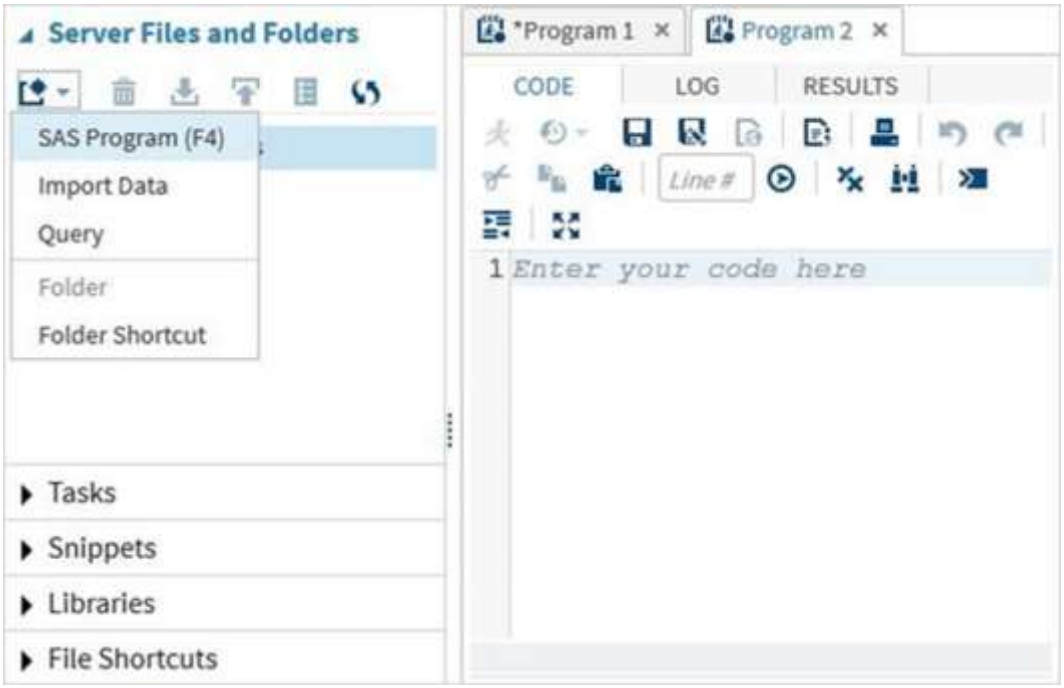


Program Tabs

The Navigation Area contains features to create and manage programs. It also provides the pre-built functionalities to be used with your program.

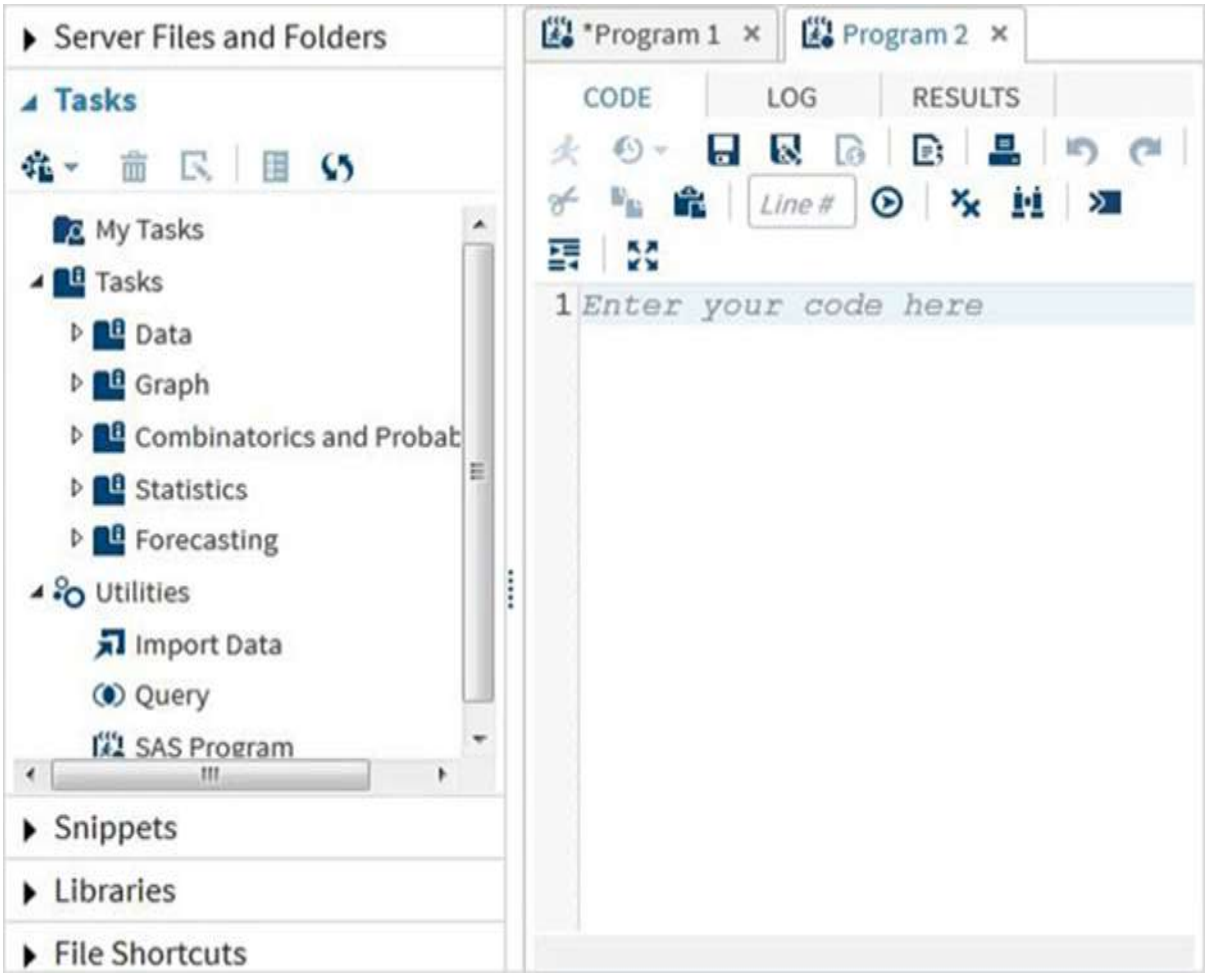
Server files and folders

Under this tab, we can create additional programs, import data to be analyzed and query the existing data. It can also be used to create folder shortcuts.



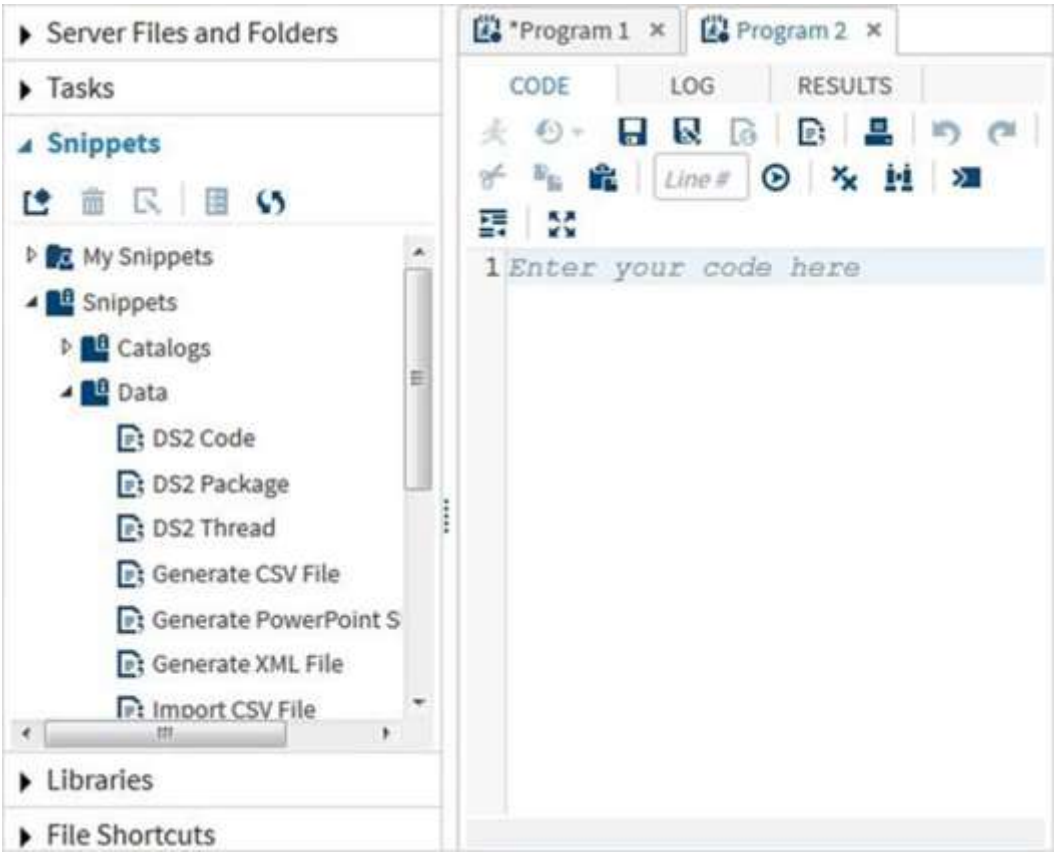
Tasks

The Tasks tab provides features to use in-built SAS programs by supplying only the input variables. For example, under the statistics folder you can find a SAS program to do linear regression by only supplying the SAS data set name and variable names.



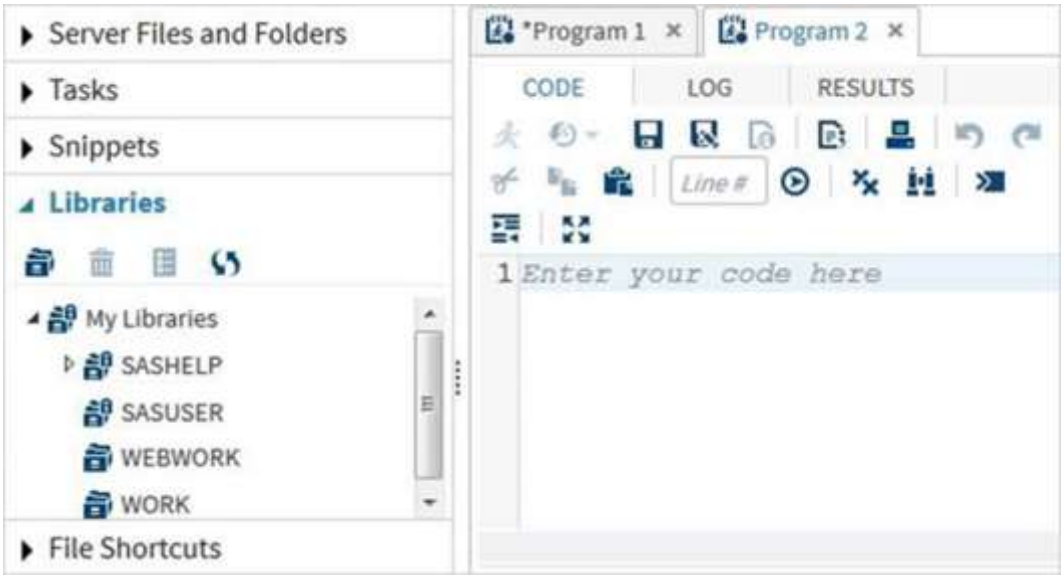
Snippets

The snippets tab provides features to write SAS Macro and generate files from the existing data set.



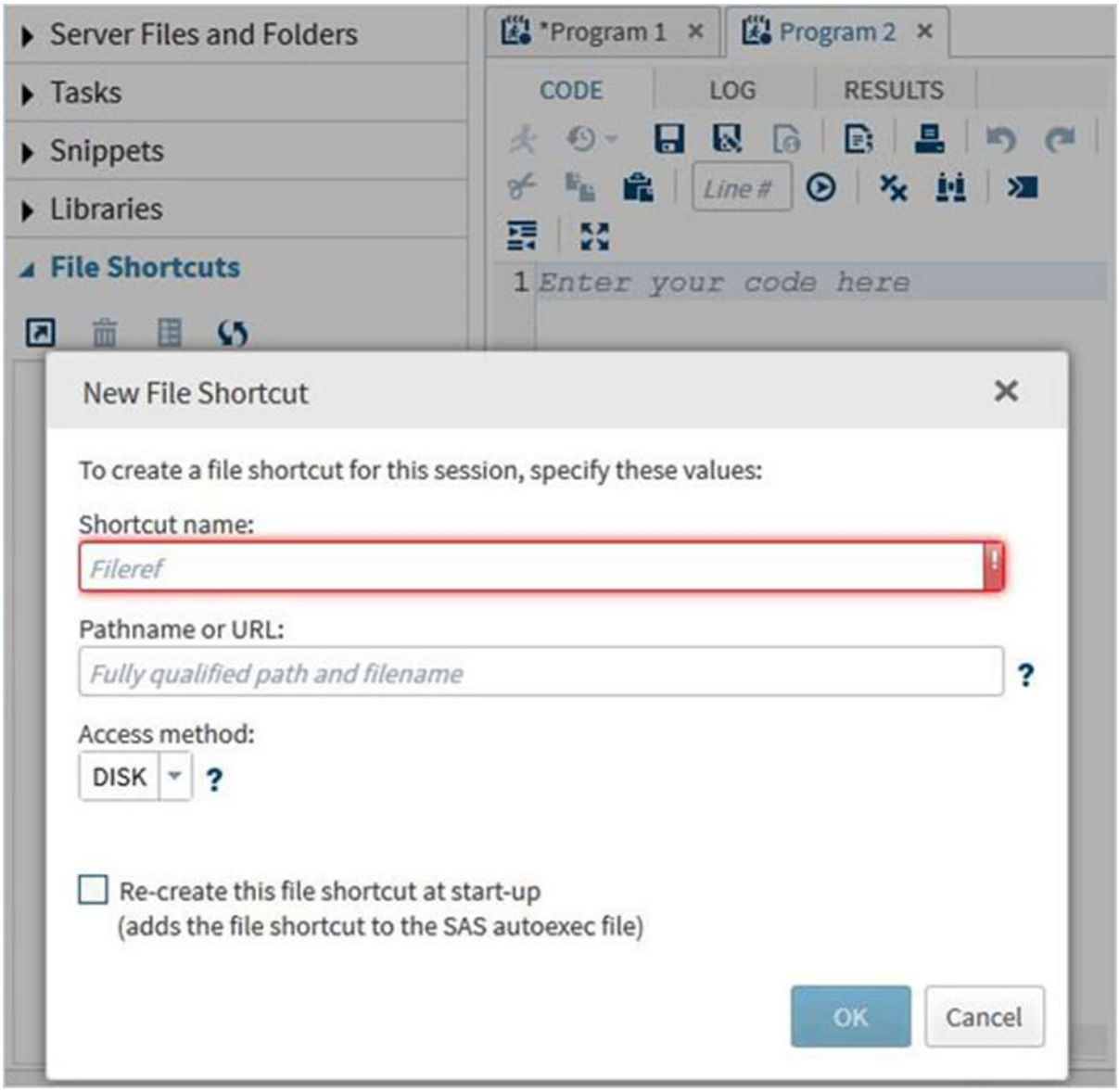
Program libraries

SAS stores the datasets in SAS libraries. The temporary library is available only for a single session and it is named as WORK. But the permanent libraries are available always.



File shortcuts

This tab is used to access files which are stored outside the SAS environment. The shortcuts to such files are stored under this tab.

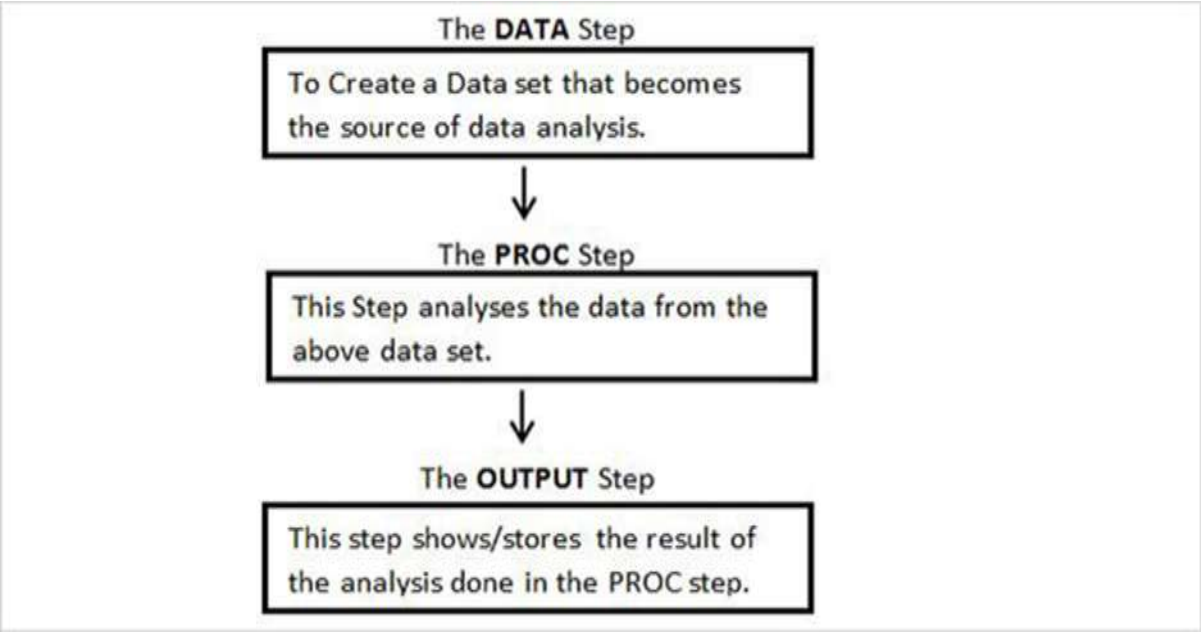


4. SAS – Program Structure

The SAS Programming involves first creating/reading the data sets into the memory and then doing analysis on the data. We need to understand the flow in which a program is written to achieve this.

SAS Program Structure

The following diagram shows the steps to be written in the given sequence to create a SAS Program.



Every SAS program must have all these steps to complete reading the input data, analyzing the data and giving the output of the analysis. Also the **RUN** statement at the end of each step. This is required to complete the execution of that step.

DATA Step

This step involves loading the required data set into SAS memory and identifying the variables (also called columns) of the data set. It also captures the records (also called observations or subjects). The following is the syntax for the DATA statement.

Syntax

```
DATA data_set_name;              #Name the data set.
INPUT var1,var2,var3;            #Define the variables in this data set.
NEW_VAR;                  #Create new variables.
LABEL;                           #Assign labels to variables.
```

```
DATALINES;              #Enter the data.
RUN;
```

Example

The following example shows a simple case of naming the data set, defining the variables, creating new variables and entering the data. Here the string variables have a $ at the end and numeric values are without it.

```
DATA TEMP;
INPUT ID $ NAME $ SALARY DEPARTMENT $;
comm = SALARY*0.25;
LABEL ID = 'Employee ID' comm = 'COMMISION';
DATALINES;
1 Rick 623.3 IT
2 Dan 515.2 Operations
3 Michelle 611 IT
4 Ryan 729 HR
5 Gary 843.25 Finance
6 Nina 578 IT
7 Simon 632.8 Operations
8 Guru 722.5 Finance
;
RUN;
```

PROC Step

This step involves invoking a SAS built-in procedure to analyze the data.

Syntax

```
PROC procedure_name options; #The name of the proc.
RUN;
```

Example

The following example shows how to use the **MEANS** procedure to print the mean values of the numeric variables in the data set.

```
PROC MEANS;
RUN;
```

The OUTPUT Step

The data from the data sets can be displayed with conditional output statements.

Syntax

```
PROC PRINT DATA = data_set;
OPTIONS;
RUN;
```

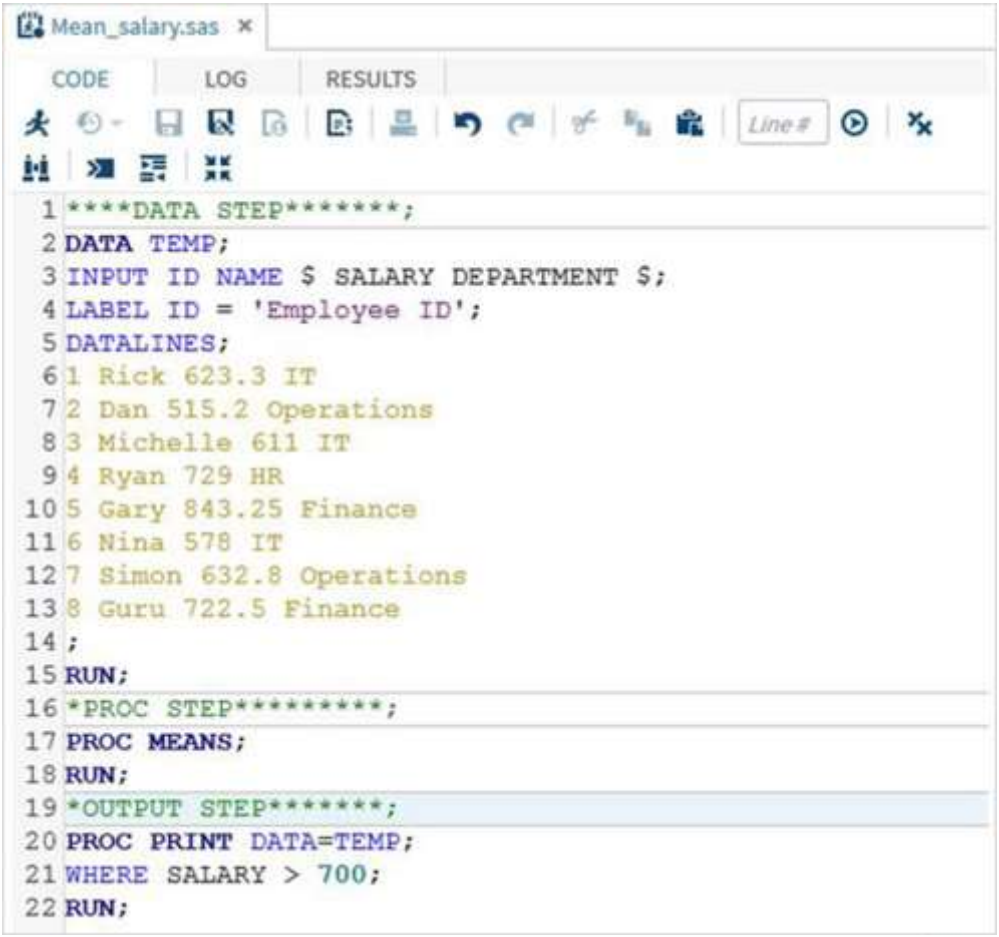
Example

The following example shows the use of the where clause in the output to produce only few records from the data set.

```
PROC PRINT DATA=TEMP;
WHERE SALARY > 700;
RUN;
```

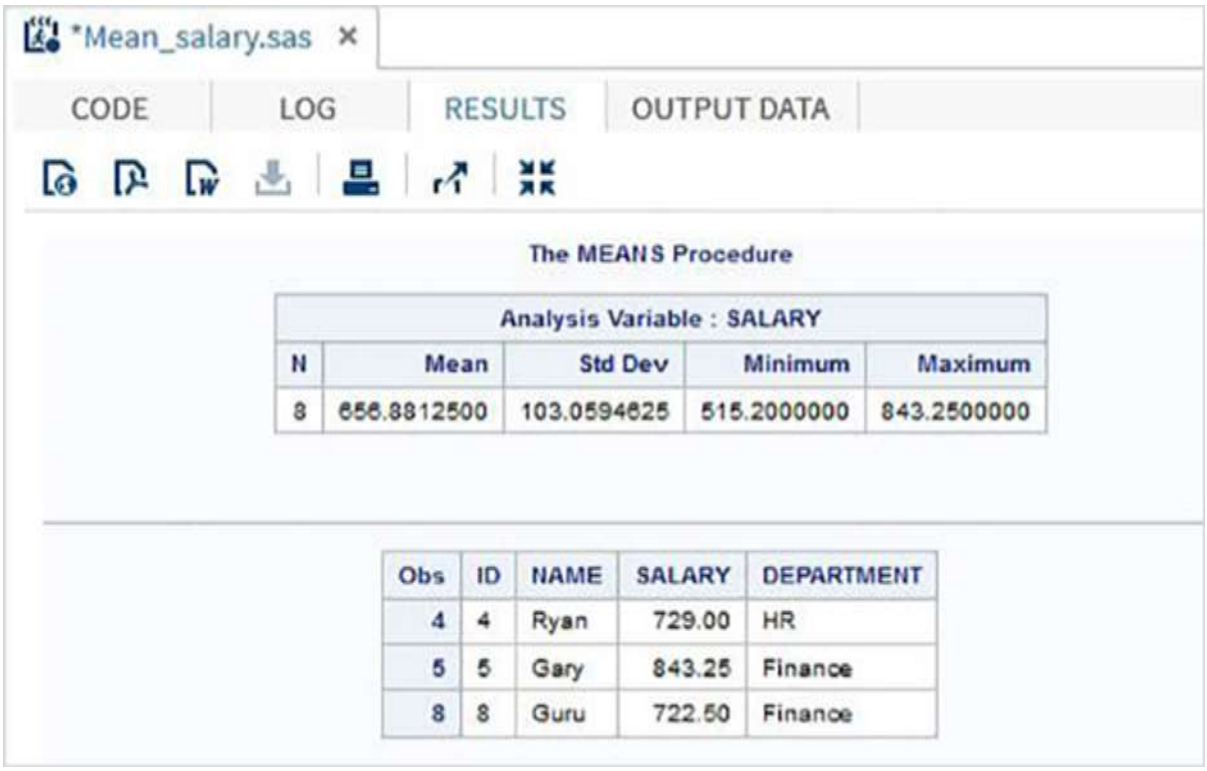
The Complete SAS Program

The following is the complete code for each of the above steps.



Program Output

The output from the above code is seen in the **RESULTS** tab.



5. SAS – Basic Syntax

Like any other programming language, the SAS language has its own rules of syntax to create the SAS programs. The three components of any SAS program — Statements, Variables and Data sets follow the rules on Syntax as mentioned below.

SAS Statements

Let us now discuss the SAS statements:

- Statements can start anywhere and end anywhere. A semicolon at the end of the last line marks the end of the statement.
- Many SAS statements can be on the same line, with each statement ending with a semicolon.
- Space can be used to separate the components in a SAS program statement.
- SAS keywords are not case sensitive.
- Every SAS program must end with a RUN statement.

SAS Variable Names

Variables in SAS represent a column in the SAS data set. The variable names follow these rules.

- It can be maximum 32 characters long.
- It cannot include blanks.
- It must start with the letters A through Z (not case sensitive) or an underscore (_).
- It can include numbers but not as the first character.
- Variable names are case insensitive.

Example

```
# Valid Variable Names
REVENUE_YEAR
MaxVal
_Length

# Invalid variable Names
Miles Per Liter    #contains Space.
RainfFall%      # contains apecial character other than underscore.
90_high           # Starts with a number.
```

SAS Data Set

The DATA statement marks the creation of a new SAS data set. The rules for DATA set creation are as below.

- A single word after the DATA statement indicates a temporary data set name. This means the data set gets erased at the end of the session.
- The data set name can be prefixed with a library name which makes it a permanent data set. This means that the data set persists after the session is over.
- If the SAS data set name is omitted then SAS creates a temporary data set with a name generated by SAS like - DATA1, DATA2 etc.

Example

```
# Temporary data sets.
DATA TempData;
DATA abc;
DATA newdat;

# Permanent data sets.
DATA LIBRARY1.DATA1
DATA MYLIB.newdat;
```

SAS File Extensions

The SAS programs, data files and the results of the programs are saved with various extensions in Windows.

- ***.sas -** It represents the SAS code file which can be edited using the SAS Editor or any text editor.
- ***.log -** It represents the SAS Log File that contains information such as errors, warnings, and data set details for a submitted SAS program.
- ***.mht / *.html -** It represents the SAS Results file.
- ***.sas7bdat -** It represents the SAS Data File that contains a SAS data set including variable names, labels, and the results of calculations.

Comments in SAS

Comments in SAS code are specified in the following two ways.

*message; type comment

A comment in the form of ***message;** cannot contain semicolons or unmatched quotation mark inside it. Also there should not be any reference to any macro statements inside such comments. It can span multiple lines and can be of any length. Following is a single line comment example:

```
* This is comment ;
```

Following is a multiline comment example:

```
* This is first line of the comment
* This is second line of the comment;
```

/*message*/ type comment

A comment in the form of **/*message*/** is used more frequently and it cannot be nested. But it can span multiple lines and can be of any length. Following is a single line comment example:

```
/* This is comment */
```

Following is a multiline comment example:

```
/* This is first line of the comment
* This is second line of the comment */
```

6. SAS – Data Sets

The data that is available to a SAS program for analysis is referred as a SAS Data Set. It is created using the DATA step. SAS can read a variety of files as its data sources like **CSV, Excel, Access, SPSS and also raw data**. It also has many in-built data sources available for use.

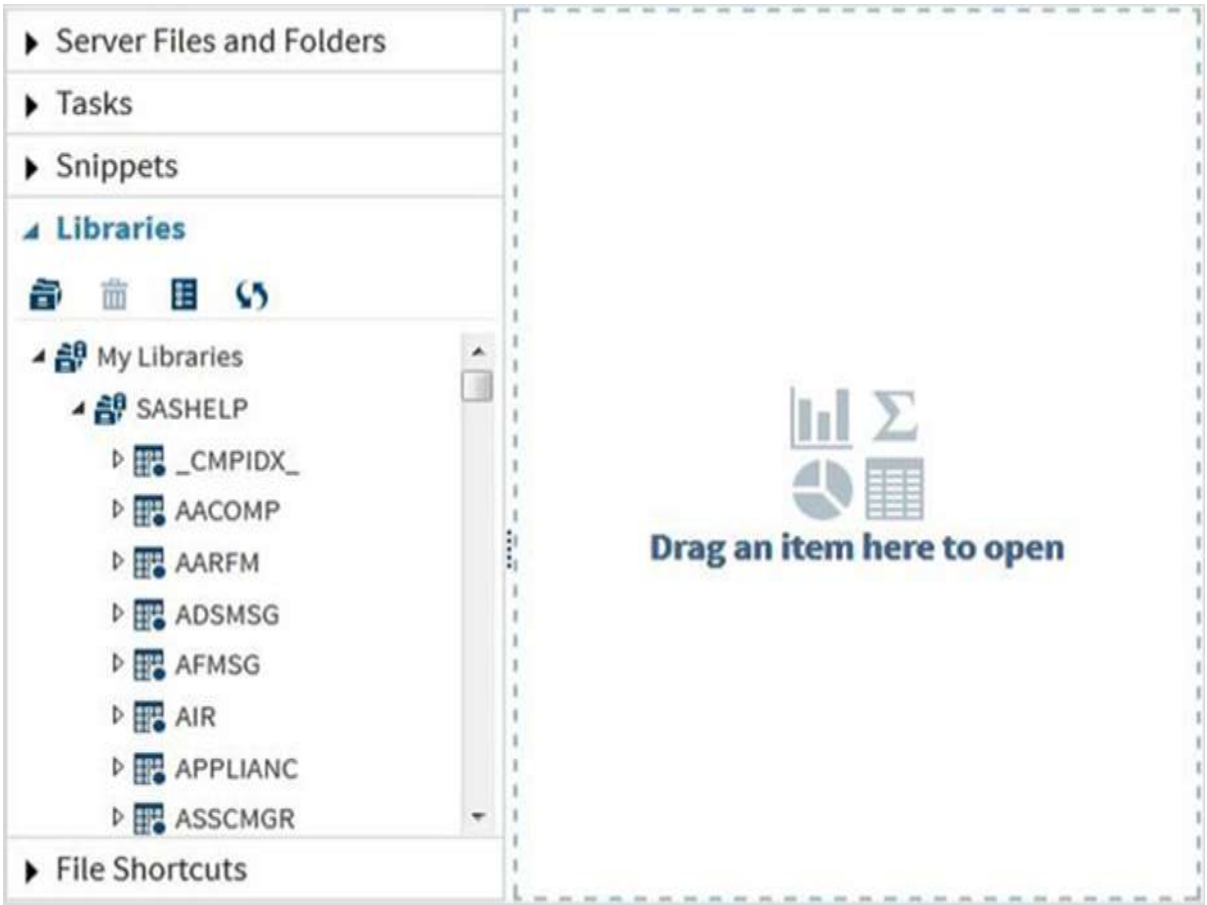
- The Data Sets are called **temporary Data Sets** if they are used by the SAS program and then discarded after the session is run.

- But if it is stored permanently for future use, then it is called a **permanent Data set**. All permanent Data Sets are stored in a specific library.

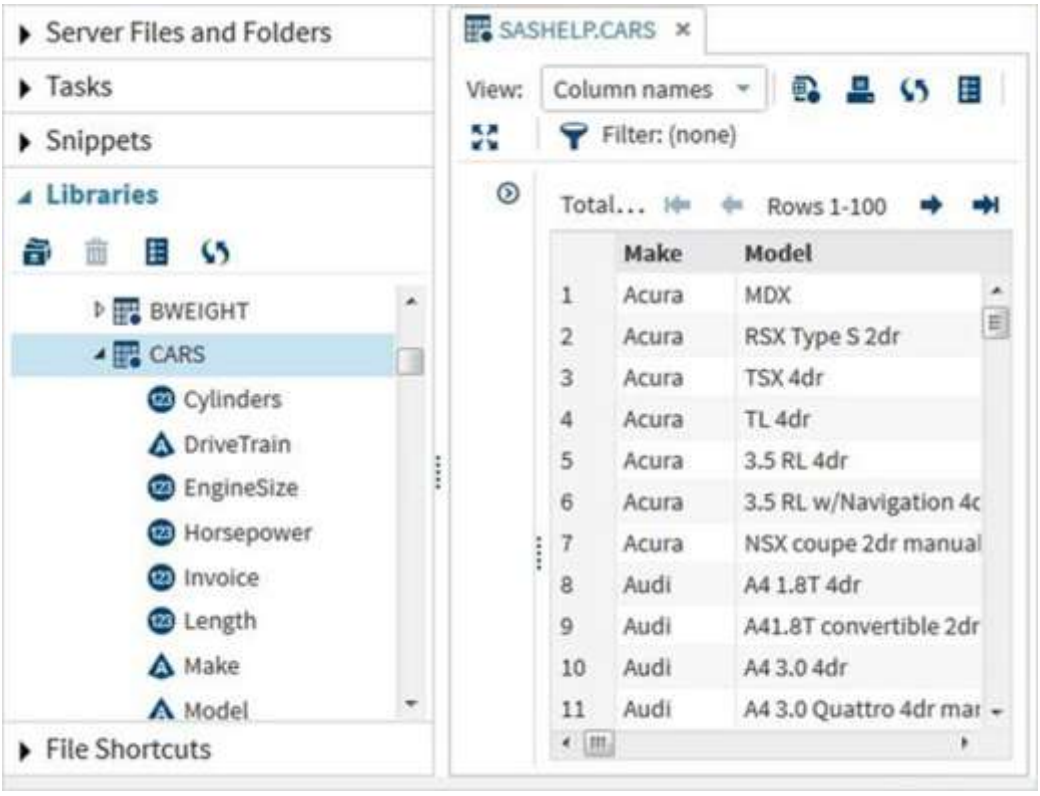
The SAS Data set is stored in the form of rows and columns. It is also referred as the SAS Data table. Following are the examples of permanent Data sets which are in-built as well as read from external sources.

SAS Built-In Data Sets

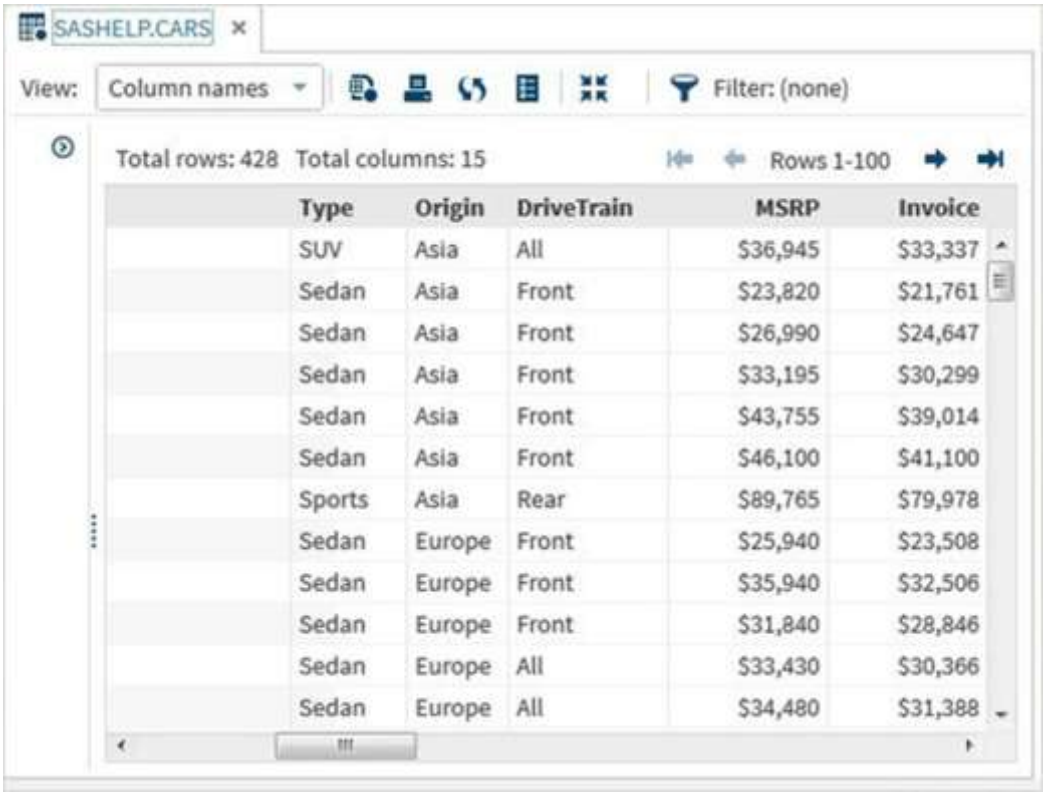
These Data Sets are already available in the installed SAS software. They can be explored and used in formulating sample expressions for data analysis. To explore these data sets, go to **Libraries -> My Libraries -> SASHELP**. On expanding it, we see the list of names of all the built-in Data Sets available.



Let us now scroll down to locate a Data Set named **CARS**. When you double-click on this Data Set, it opens in the right window pane where it can be explored further. We can also minimize the left pane by using the maximize view button under the right pane.

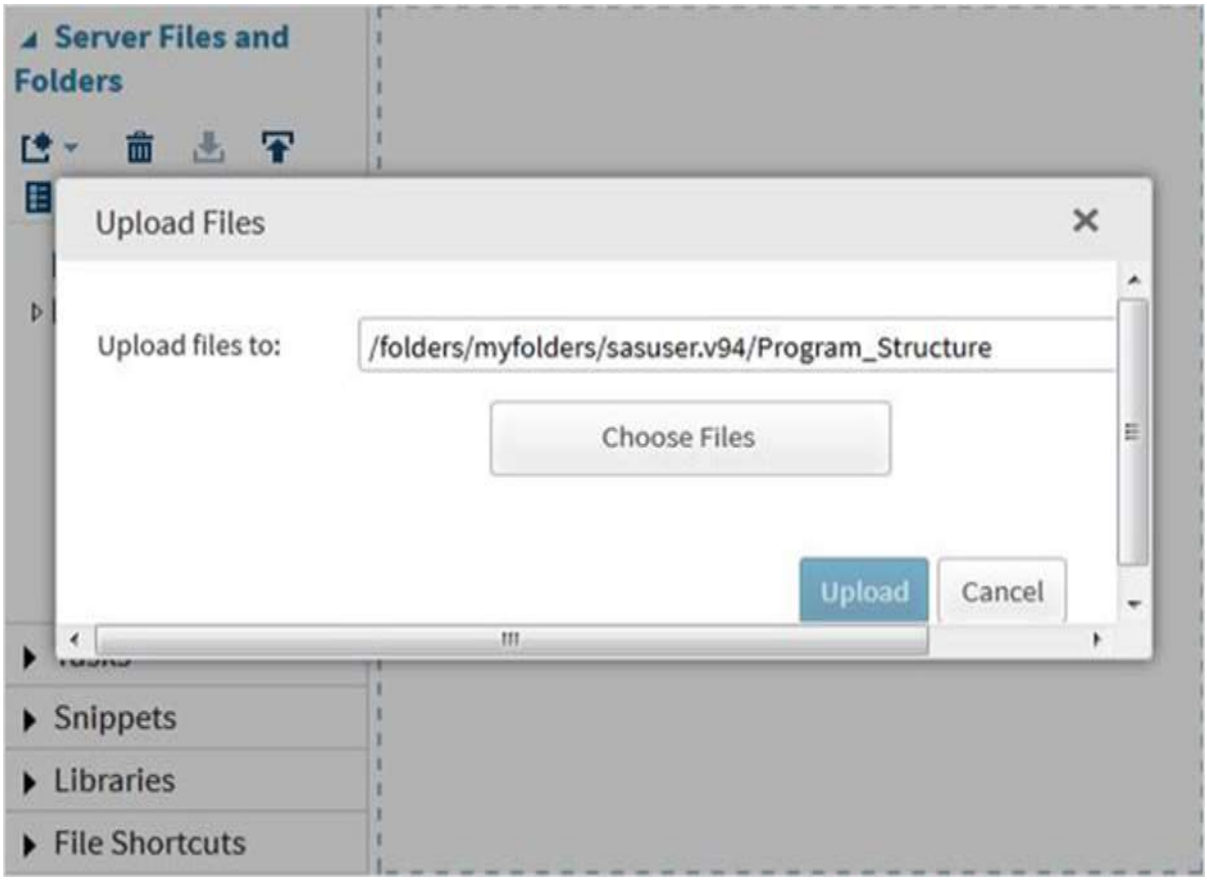


We can scroll to the right using the scroll bar in the bottom to explore all the columns and theirs values in the table.



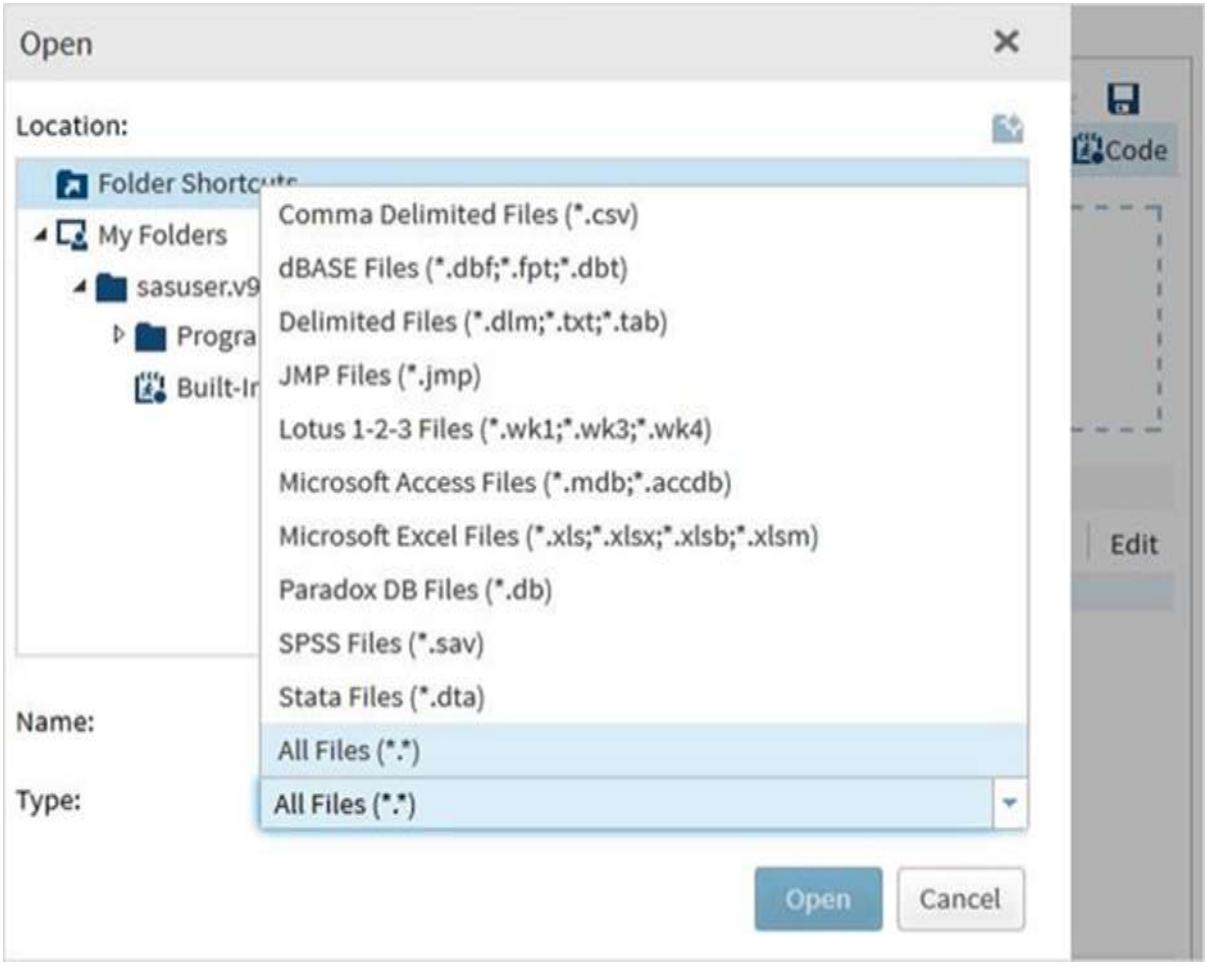
Importing External Data Sets

We can export our own files as Data sets by using the import feature available in the SAS Studio. But these files must be available in the SAS server folders. So we have to upload the source data files to SAS folder by using the upload option under the **Server Files and Folders**.

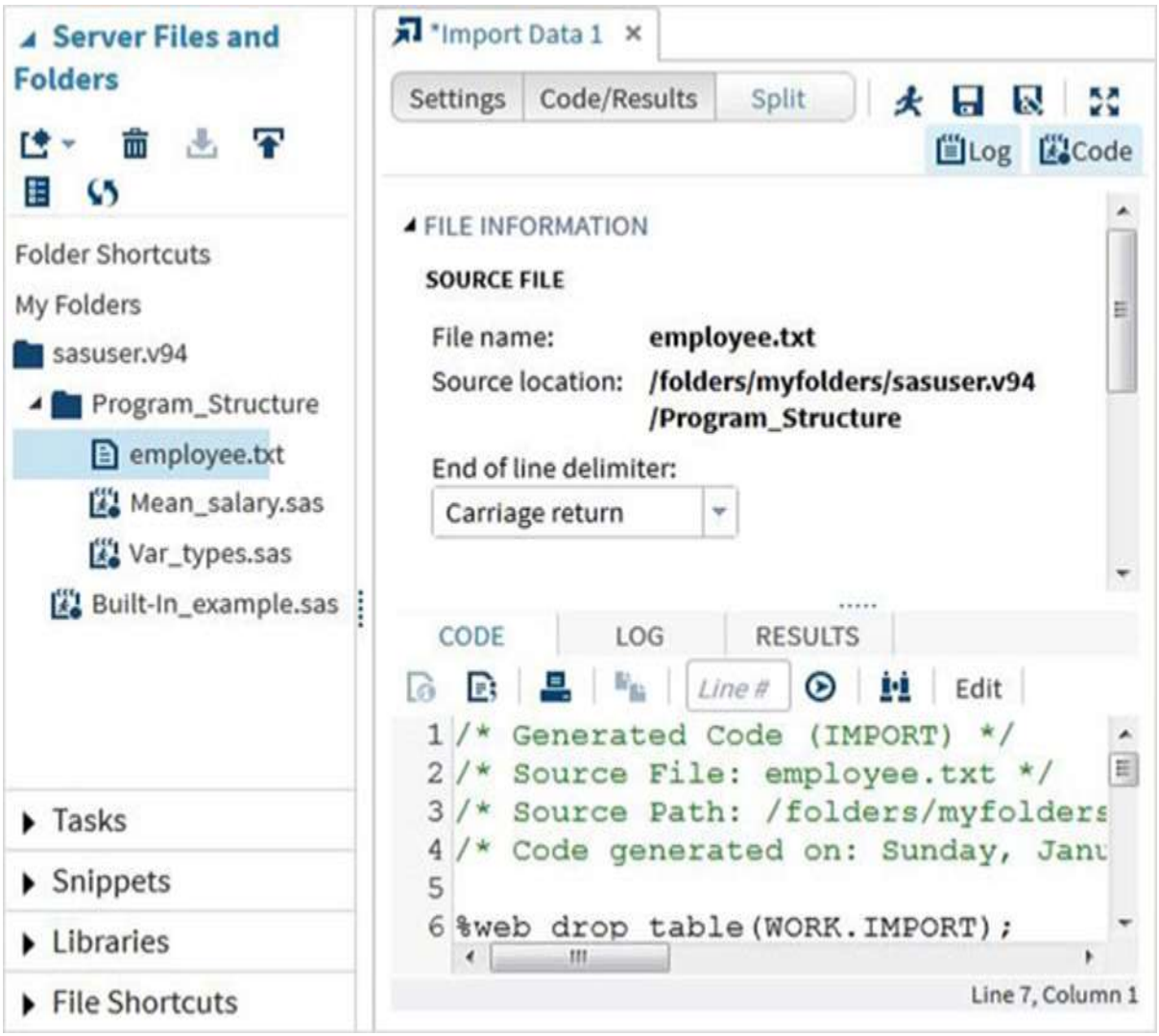


Next, we use the above file in a SAS program by importing it. To do this we use the option **Tasks -> Utilities -> Import data** as shown below. Double click the Import Data button which opens up the window in the right to choose the file for the Data Set.

Next, click on the **Select Files** button under the import data program in the right pane. The following is a list of the file types which can be imported.

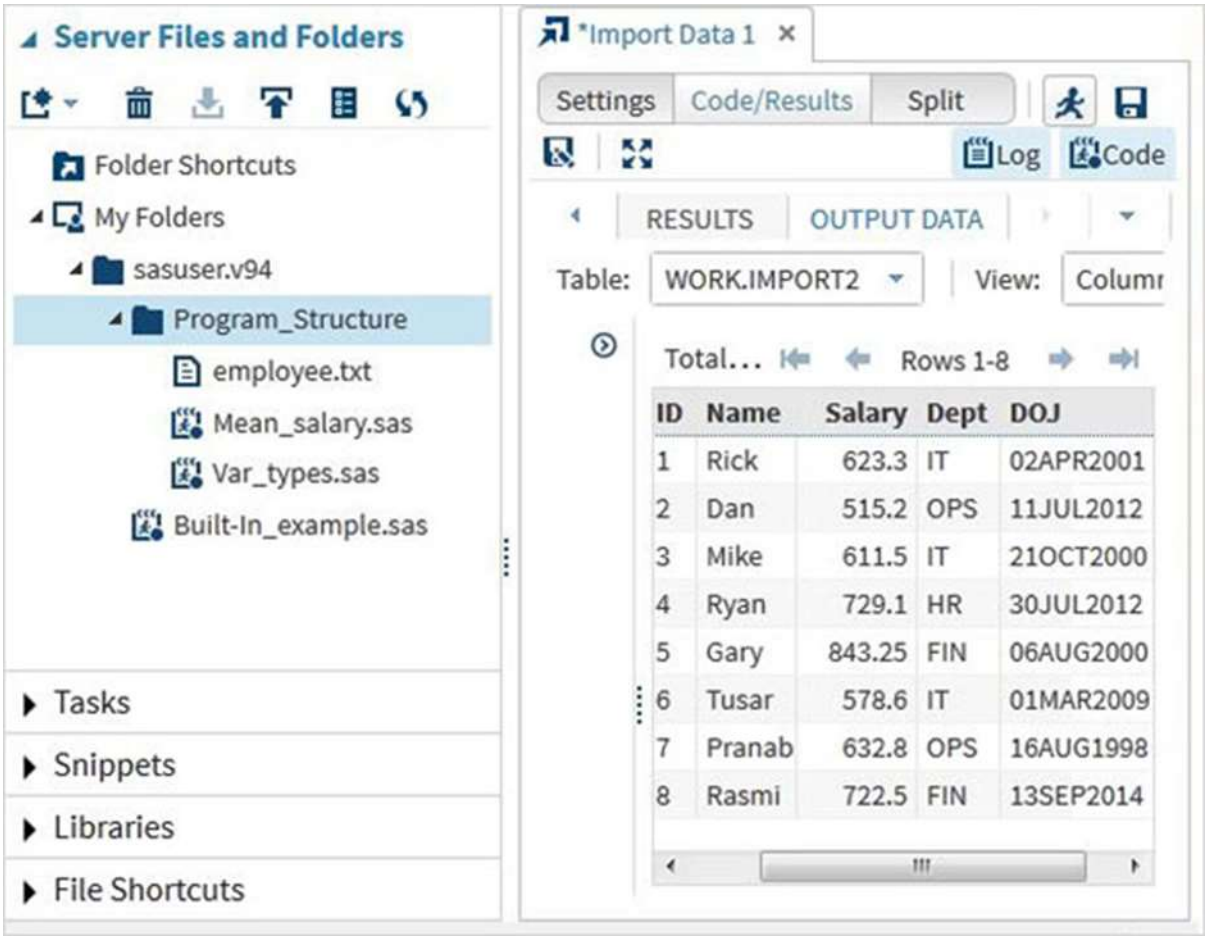


We choose the "employee.txt" file stored in the local system and get the file imported as shown below.



View the imported data

We can view the imported data by running the default import code generated using the Run option.



We can import any other file types using the same approach as above and use it in various SAS programs.

7. SAS – Variables

In this chapter, we will discuss SAS Variables. In general variables in SAS represent the column names of the data tables it is analyzing. Variables can also be used for other purpose like using it as a counter in a programming loop. We will now see the use of SAS variables as column names of SAS Data Set.

SAS Variable Types

SAS has three types of variables as below:

Numeric variables

This is the default variable type. These variables are used in mathematical expressions.

Syntax

```
INPUT VAR1 VAR2 VAR3;          #Define numeric variables in the data set.
```

In the above syntax, the INPUT statement shows the declaration of numeric variables.

Example

```
INPUT ID SALARY COMM_PERCENT;
```

Character variables

Character variables are used for values that are not used in mathematical expressions. They are treated as text or strings. A variable becomes a character variable by adding a $ sing with a space at the end of the variable name.

Syntax

```
INPUT VAR1 $ VAR2 $ VAR3 $;    #Define character variables in the data set.
```

In the above syntax, the INPUT statement shows the declaration of character variables.

Example

```
INPUT FNAME $ LNAME $ ADDRESS $;
```

Date variables

These variables are treated only as dates and they need to be in valid date formats. A variable becomes a date variable by adding a date format with a space at the end of the variable name.

Syntax

```
INPUT VAR1 DATE11. VAR2 MMDDYY10. ; #Define date variables in the data set.
```

In the above syntax, the INPUT statement shows the declaration of the date variables.

Example

```
INPUT DOB DATE11. START_DATE MMDDYY10. ;
```

Use of Variables in SAS Program

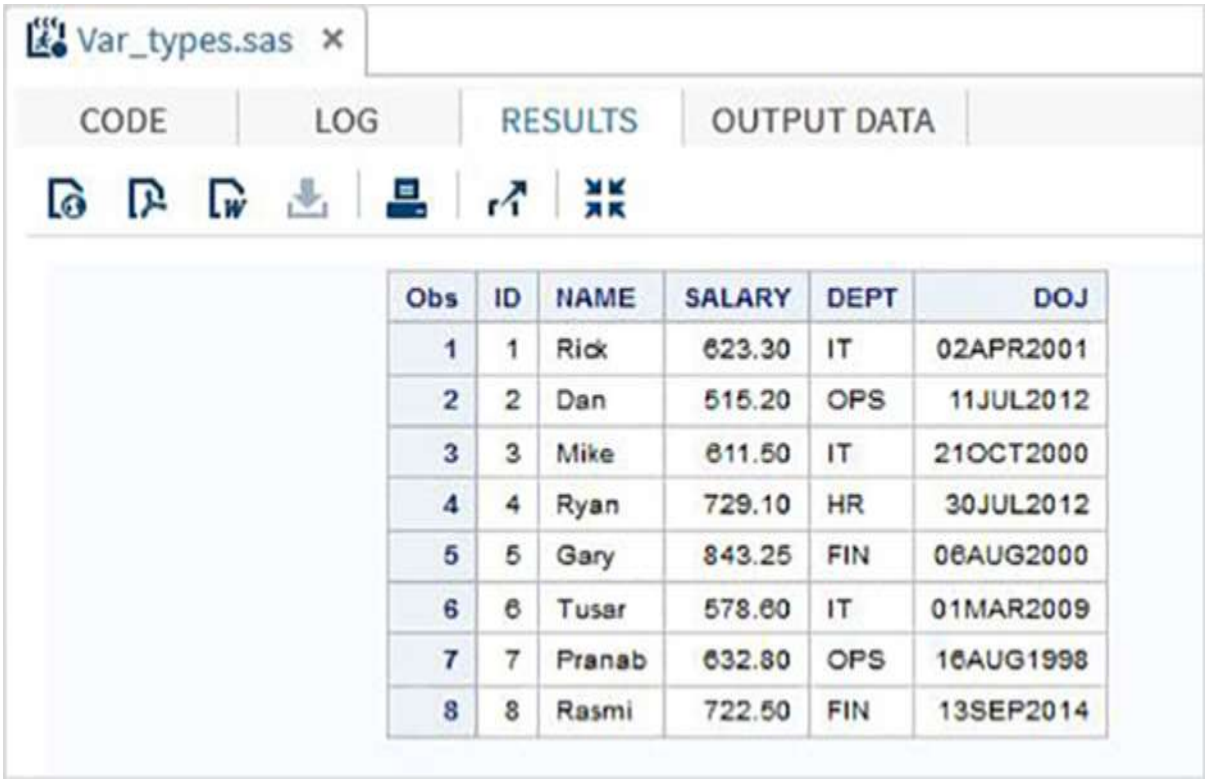
The above variables are used in SAS program as shown in the following examples.

Example

The following code shows how the three types of variables are declared and used in a SAS Program.

```
DATA TEMP;
INPUT ID NAME $ SALARY DEPT $ DOJ DATE9. ;
FORMAT DOJ DATE9. ;
DATALINES;
1 Rick 623.3 IT 02APR2001
2 Dan 515.2 OPS 11JUL2012
3 Michelle 611 IT 21OCT2000
4 Ryan 729 HR 30JUL2012
5 Gary 843.25 FIN 06AUG2000
6 Tusar 578 IT 01MAR2009
7 Pranab 632.8 OPS 16AUG1998
8 Rasmi 722.5 FIN 13SEP2014
;
PROC PRINT DATA=TEMP;
RUN;
```

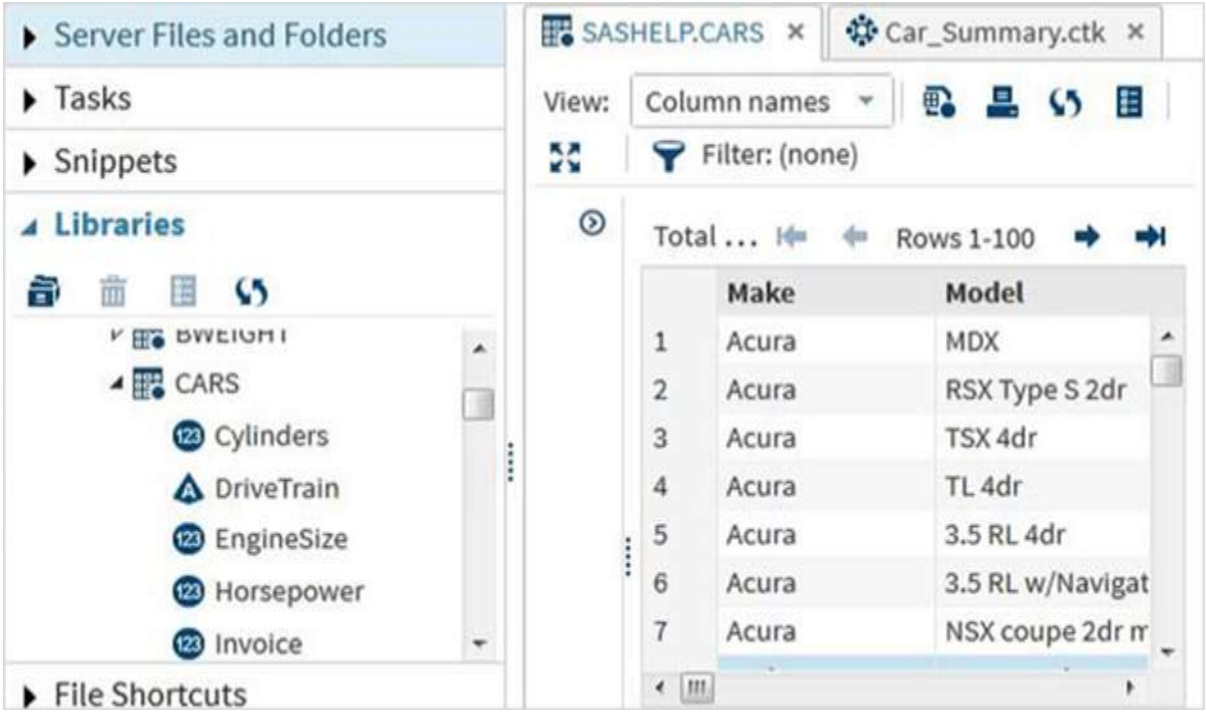
In the above example, all the character variables are declared followed by a $ sign and the date variables are declared followed by a date format. The following is the output of the above program.



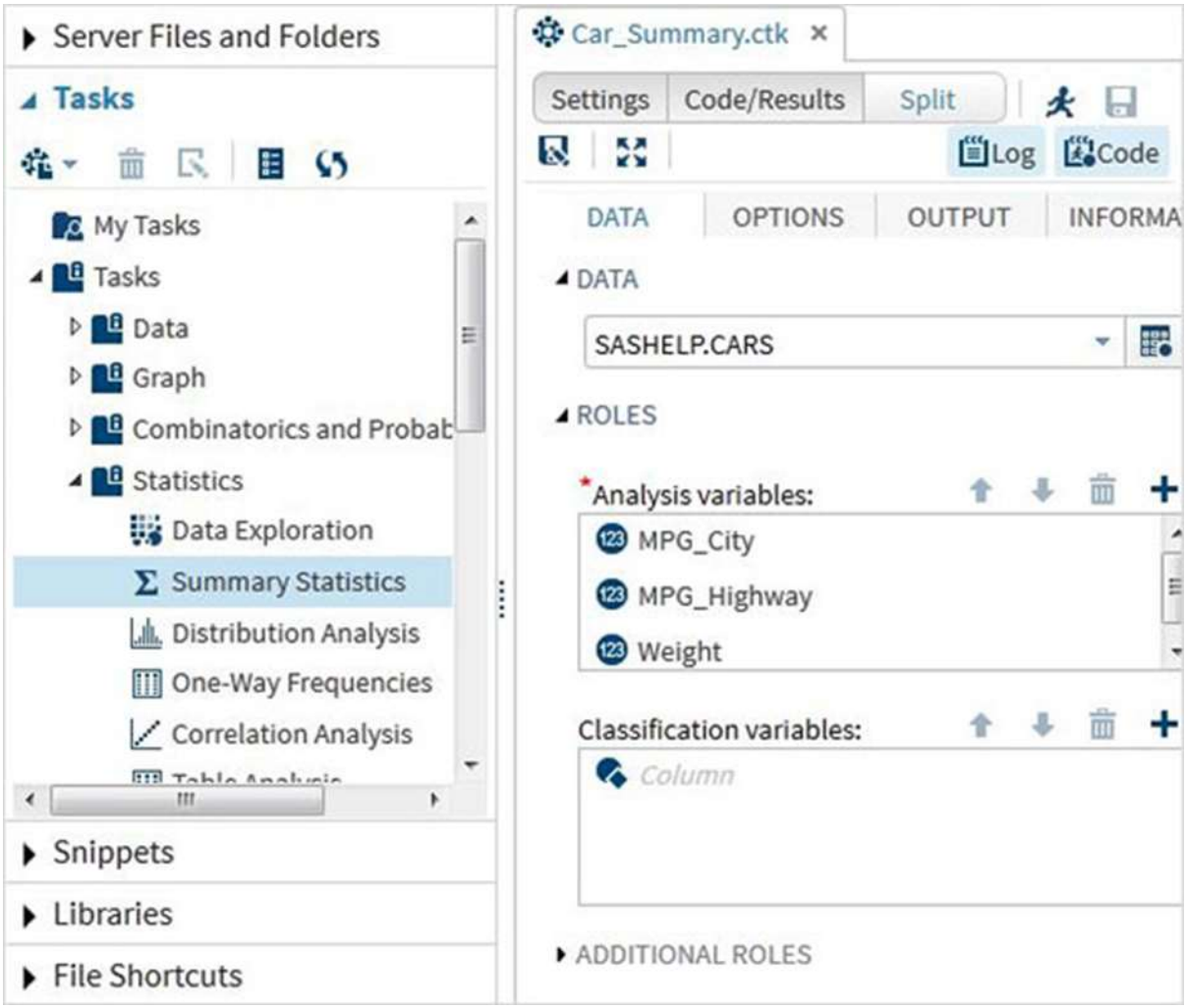
Obs	ID	NAME	SALARY	DEPT	DOJ
1	1	Rick	623.30	IT	02APR2001
2	2	Dan	515.20	OPS	11JUL2012
3	3	Mike	611.50	IT	21OCT2000
4	4	Ryan	729.10	HR	30JUL2012
5	5	Gary	843.25	FIN	06AUG2000
6	6	Tusar	578.60	IT	01MAR2009
7	7	Pranab	632.80	OPS	16AUG1998
8	8	Rasmi	722.50	FIN	13SEP2014

Using the Variables

The variables are very useful in analyzing the data. They are used in expressions in which the statistical analysis is applied. Let's see an example of analyzing the built-in Data Set named **CARS** which is present under **Libraries -> My Libraries -> SASHELP**. Double-click on it to explore the variables and their data types.



We can now produce summary statistics of some of these variables using the Tasks options in the SAS studio. Go to **Tasks -> Statistics -> Summary Statistics** and double-click it to open the window as shown below. Choose Data Set **SASHELP.CARS** and select the three variables - **MPG_CITY**, **MPG_Highway** and **Weight** under the Analysis Variables. Hold the Ctrl key while selecting the variables by clicking them. Once done, click run.



Click on the results tab after the above steps. It shows the statistical summary of the three variables chosen. The last column indicates the number of observations (records) used in the analysis.

Variable	Label	Mean	Std Dev	Minimum	Maximum	N
MPG_City	MPG (City)	20.0607477	5.2382176	10.0000000	60.0000000	428
MPG_Highway	MPG (Highway)	26.8434579	5.7412007	12.0000000	66.0000000	428
Weight	Weight (LBS)	3577.95	758.9832146	1850.00	7190.00	428

8. SAS – Strings

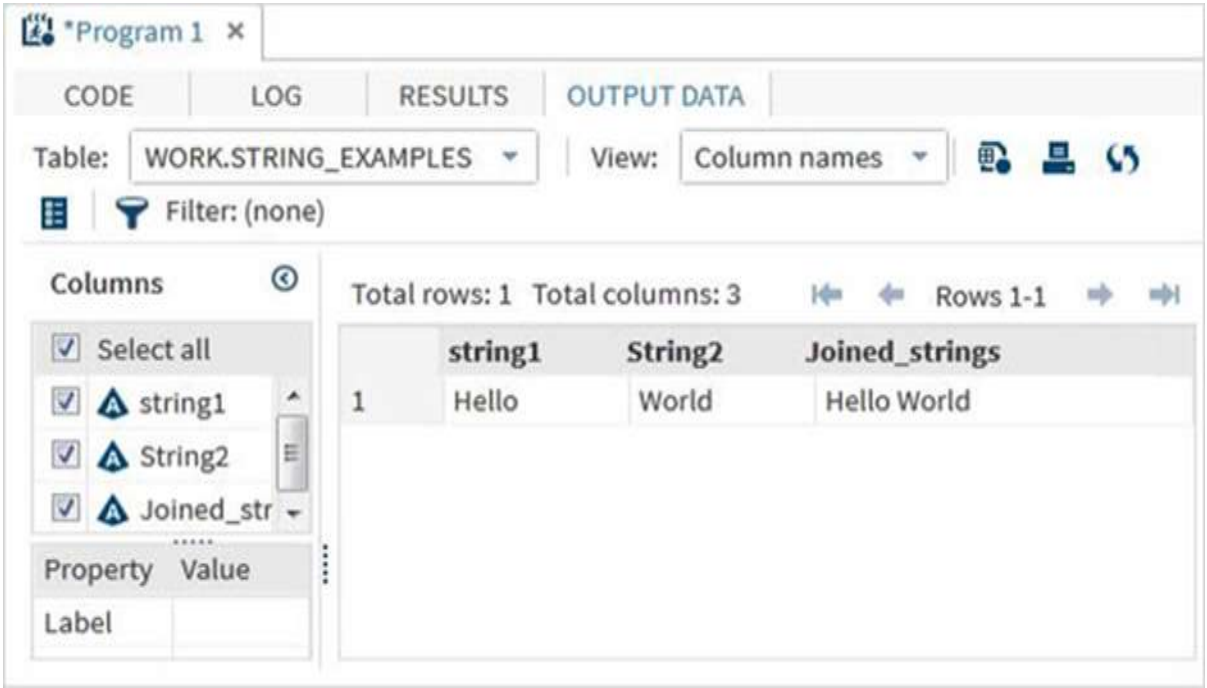
Strings in SAS are the values which are enclosed with in a pair of single quotes. Also the string variables are declared by adding a space and $ sign at the end of the variable declaration. SAS has many powerful functions to analyze and manipulate strings.

Declaring String Variables

We can declare the string variables and their values as shown below. In the code below, we declare two character variables of lengths 6 and 5. The LENGTH keyword is used for declaring variables without creating multiple observations.

```
data string_examples;
   LENGTH string1 $ 6 String2 $ 5;
   /*String variables of length 6 and 5 */
   String1 = 'Hello';
   String2 = 'World';
   Joined_strings =  String1 ||String2 ;
 run;
proc print data = string_examples noobs;
run;
```

On running the above code, we get the output which shows the variable names and their values.



String Functions

Following are the examples of some frequently used SAS functions.

SUBSTRN

This function extracts a substring using the start and end positions. In case the end position is not mentioned, it extracts all the characters till the end of the string.

Syntax

```
SUBSTRN('stringval',p1,p2)
```

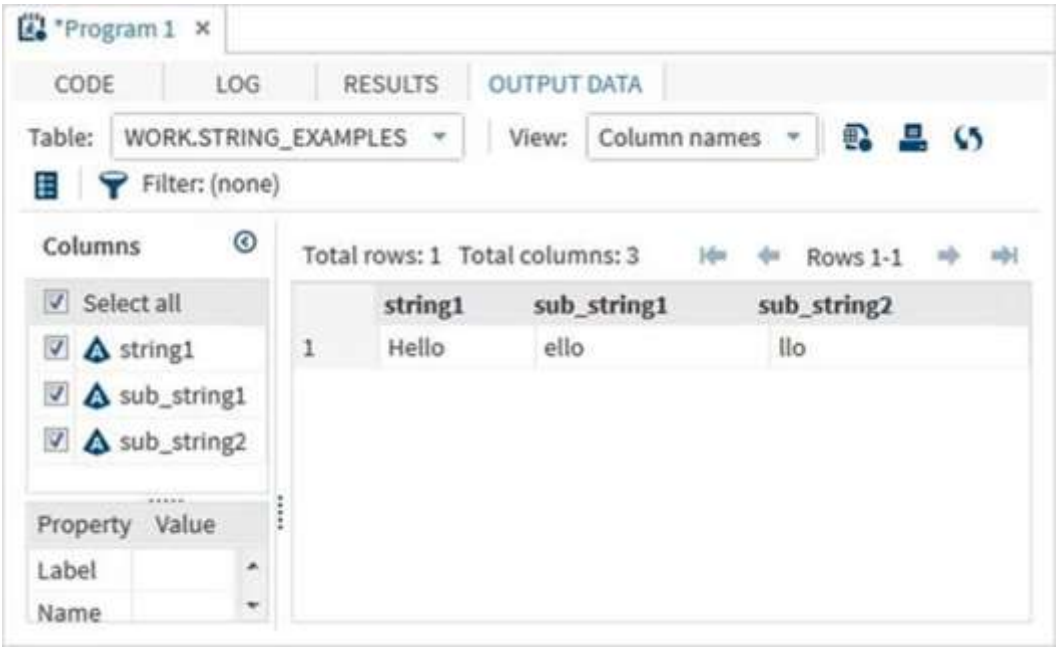
Following is the description of the parameters used:

- **stringval** is the value of the string variable.
- **p1** is the start position of extraction.
- **p2** is the final position of extraction.

Example

```
data string_examples;
   LENGTH string1 $ 6 ;
   String1 = 'Hello';
   sub_string1 = substrn(String1,2,4) ;
   /*Extract from position 2 to 4 */
   sub_string2 = substrn(String1,3) ;
   /*Extract from position 3 onwards */
run;
proc print data = string_examples noobs;
run;
```

On running the above code, we get the output which shows the result of **substrn** function.



TRIMN

This function removes the trailing space form a string.

Syntax

```
TRIMN('stringval')
```

Following is the description of the parameters used:

- **stringval** is the value of the string variable.

```
data string_examples;
   LENGTH string1 $ 7  ;
   String1='Hello  ';
   length_string1 = lengthc(String1);
   length_trimmed_string = lengthc(TRIMN(String1));
run;
proc print data = string_examples noobs;
run;
```

On running the above code, we get the output which shows the result of the **TRIMN** function.

string1	length_string1	length_trimmed_string
Hello	7	5

9. SAS – Arrays

Arrays in SAS are used to store and retrieve a series of values using an index value. The index represents the location in a reserved memory area.

Syntax

In SAS an array is declared by using the following syntax:

```
ARRAY ARRAY-NAME(SUBSCRIPT) ($) VARIABLE-LIST ARRAY-VALUES
```

In the above syntax:

- **ARRAY** is the SAS keyword to declare an array.
- **ARRAY-NAME** is the name of the array which follows the same rule as variable names.
- **SUBSCRIPT** is the number of values the array is going to store.
- **($)** is an optional parameter to be used only if the array is going to store character values.
- **VARIABLE-LIST** is the optional list of variables which are the place holders for array values.
- **ARRAY-VALUES** are the actual values that are stored in the array. They can be declared here or can be read from a file or data line.

Examples of Array Declaration

Arrays can be declared in many ways using the above syntax. Following are the examples.

```
# Declare an array of length 5 named AGE with values.
ARRAY AGE[5] (12 18 5 62 44);

# Declare an array of length 5 named COUNTRIES with values starting at index 0.
ARRAY COUNTRIES(0:8) A B C D E F G H I;

# Declare an array of length 5 named QUESTS which contain character values.
ARRAY QUESTS(1:5) $ Q1-Q5;

# Declare an array of required length as per the number of values supplied.
ARRAY ANSWER(*) A1-A100;
```

Accessing Array Values

The values stored in an array can be accessed by using the **print** procedure as shown below. After it is declared using one of the above methods, the data is supplied using the DATALINES statement.

```
DATA array_example;
INPUT a1 $ a2 $ a3 $ a4 $ a5 $;
ARRAY colours(5) $ a1-a5;
mix = a1||'+'||a2;
DATALINES;
yello pink orange green blue
;
RUN;
PROC PRINT DATA=array_example;
RUN;
```

When we execute the above code, it produces the following result:

Using the OF operator

The OF operator is used when analyzing the data from an Array to perform calculations on the entire row of an array. In the following example, we apply the Sum and the Mean of values in each row.

```
DATA array_example_OF;
      INPUT A1 A2 A3 A4;
      ARRAY A(4) A1-A4;
      A_SUM=SUM(OF A(*));
      A_MEAN=MEAN(OF A(*));
      A_MIN=MIN(OF A(*));
      DATALINES;
      21 4 52 11
      96 25 42 6
```

```
;
RUN;
PROC PRINT DATA=array_example_OF;
RUN;
```

When we execute the above code, it produces the following result:

Obs	A1	A2	A3	A4	A_SUM	A_MEAN	A_MIN
1	21	4	52	11	88	22.00	4
2	96	25	42	6	169	42.25	6

Using the IN operator

The value in an array can also be accessed using the **IN** operator which checks for the presence of a value in the row of the array. In the following example, we check for the availability of the colour "Yellow" in the data. This value is case sensitive.

```
DATA array_in_example;
     INPUT A1 $ A2 $ A3 $ A4 $;
     ARRAY COLOURS(4) A1-A4;
     IF 'yellow' IN COLOURS THEN available='Yes';ELSE available='No';
     DATALINES;
     Orange pink violet yellow
     ;
     RUN;
     PROC PRINT DATA=array_in_example;
     RUN;
```

When we execute the above code, it produces the following result:

10. SAS – Numeric Formats

SAS can handle a wide variety of numeric data formats. It uses these formats at the end of the variable names to apply a specific numeric format to the data. SAS uses two types of numeric formats. One for reading specific formats of the numeric data which is called the **informat** and another for displaying the numeric data in specific format called the **output format**.

Syntax

The Syntax for a **numeric informat** is:

```
Varname Formatnamew.d
```

Following is the description of the parameters used:

- **Varname** is the name of the variable.
- **Formatname** is the name of the name of the numeric format applied to the variable.
- **w** is the maximum number of data columns (including digits after decimal & the decimal point itself) allowed to be stored for the variable.
- **d** is the number of digits to the right of the decimal.

Reading Numeric formats

Following is a list of formats used for reading the data into SAS.

Input Numeric Formats

Format	Use
n.	Maximum "n" number of columns with no decimal point.
n.p	Maximum "n" number of columns with "p" decimal points.
COMMAn.p	Maximum "n" number of columns with "p" decimal places. This removes any comma or dollar signs.
COMMAn.p	Maximum "n" number of columns with "p" decimal places. This removes any comma or dollar sign.

Displaying Numeric formats

Similar to applying format while reading the data, following is a list of formats used for displaying the data in the output of a SAS program.

Output Numeric Formats

n.	Write maximum "n" number of digits with no decimal point.
n.p	Write maximum "n.p" number of columns with "p" decimal points.
DOLLARn.p	Write maximum "n" number of columns with p decimal places, leading dollar sign and a comma at the thousandth place.

Please Note:

- If the number of digits after the decimal point is less than the format specifier, then **zeros will be appended** at the end.
- If the number of digits after the decimal point is greater than the format specifier, then the last digit will be **rounded off**.

Examples

The following examples illustrate the above scenarios.

```
DATA MYDATA1;
input x 6.; /*maxiiuum width of the data*/
format x 6.3;
datalines;
8722
93.2
.1122
15.116
PROC PRINT DATA = MYDATA1;
RUN;

DATA MYDATA2;
input x 6.; /*maximum width of the data*/
format x 5.2;
datalines;
8722
93.2
.1122
15.116
PROC PRINT DATA=MYDATA2;
```

```
RUN;
DATA MYDATA3;
input x 6.; /*maximum width of the data*/

format x DOLLAR10.2;
datalines;
8722
93.2
.1122
15.116
PROC PRINT DATA=MYDATA3;
RUN;
```

When we execute the above code, it produces the following result:

```
# MYDATA1.
Obs   x
1     8722.0 # Display 6 columns with zero appended after decimal.
2     93.200 # Display 6 columns with zero appended after decimal.
3     0.112  # No integers before decimal, so display 3 available digits after
decimal.
4     15.116 # Display 6 columns with 3 available digits after decimal.

# MYDATA2
Obs   x
1     8722  # Display 5 columns. Only 4 are available.
2     93.20 # Display 5 columns with zero appended after decimal.
3     0.11  # Display 5 columns with 2 places after decimal.
4     15.12 # Display 5 columns with 2 places after decimal.

# MYDATA3
Obs   x
1     $8,722.00 # Display 10 columns with leading $ sign, comma at thousandth
place and zeros appended after decimal.
2     $93.20    # Only 2 integers available before decimal and one available
after the decimal.
3     $0.11    # No integers available before decimal and two available after
the decimal.
4     $15.12    # Only 2 integers available before decimal and two available
after the decimal.
```

11. SAS – Operators

An operator in SAS is a symbol which is used in a mathematical, logical or comparison expression. These symbols are in-built into the SAS language and many operators can be combined in a single expression to give a final output.

Following is a list of the SAS category of operators.

- Arithmetic Operators
- Logical Operators
- Comparison Operators
- Minimum/Maximum Operators
- Concatenation Operator

We will look at each of these operators. The operators are always used with variables that are part of the data that is being analyzed by the SAS program.

Arithmetic Operators

The following table describes the details of the arithmetic operators. Let's assume two data variables **V1** and **V2** with values **8** and **4** respectively.

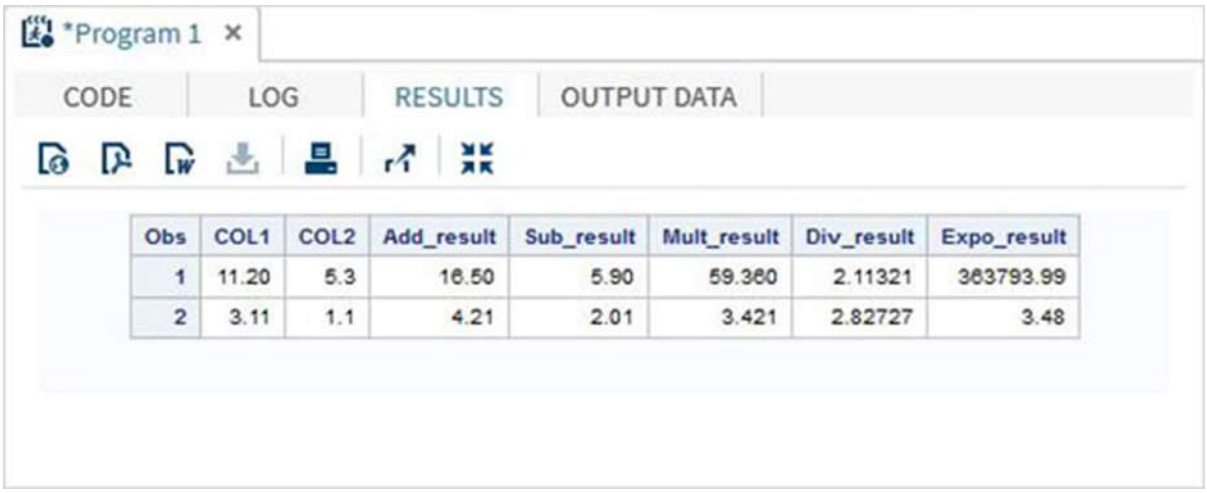
Operator	Description	Example
+	Addition	V1+V2=12
-	Subtraction	V1-V2=4
*	Multiplication	V1*V2=32
/	Division	V1/V2=2
**	Exponentiation	V1**V2=4096

Example

```
DATA MYDATA1;
input @1 COL1 4.2 @7 COL2 3.1;
Add_result = COL1+COL2;
Sub_result = COL1-COL2;
Mult_result = COL1*COL2;
Div_result = COL1/COL2;
Expo_result = COL1**COL2;
datalines;
11.21 5.3
```

```
3.11  11
;
PROC PRINT DATA=MYDATA1;
RUN;
```

On running the above code, we get the following output.



Obs	COL1	COL2	Add_result	Sub_result	Mult_result	Div_result	Expo_result
1	11.20	5.3	16.50	5.90	59.360	2.11321	363793.99
2	3.11	1.1	4.21	2.01	3.421	2.82727	3.48

Logical Operators

The following table describes the details of the logical operators. These operators evaluate the **Truth** value of an expression. So the result of logical operators is always a 1 or a 0. Let's assume two data variables **V1** and **V2** with values **8** and **4** respectively.

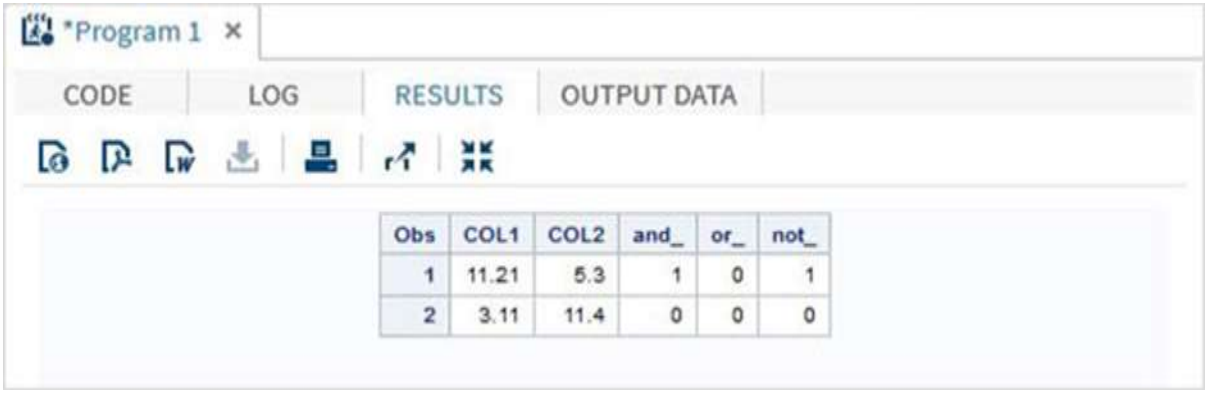
Operator	Description	Example
&	The **AND** Operator — If both data values evaluate to true then the result is 1 else it is 0.	(V1>2 & V2 > 3) gives 0.
|	The **OR** Operator — If any one of the data values evaluate to true then the result is 1 else it is 0.	(V1>9 & V2 > 3) is 1.
~	The **NOT** Operator — The result of the NOT operator in the form of an expression the value of which is FALSE or a missing value is 1 else it is 0.	NOT(V1 > 3) is 1.

Example

```
DATA MYDATA1;
input @1 COL1 5.2 @7 COL2 4.1;
and_=(COL1 > 10 & COL2 > 5 );
or_ = (COL1 > 12 | COL2 > 15 );
not_ = ~( COL2 > 7 );
datalines;
```

```
11.21 5.3
3.11  11.4
;
PROC PRINT DATA=MYDATA1;
RUN;
```

On running the above code, we get the following output.



Obs	COL1	COL2	and_	or_	not_
1	11.21	5.3	1	0	1
2	3.11	11.4	0	0	0

Comparison Operators

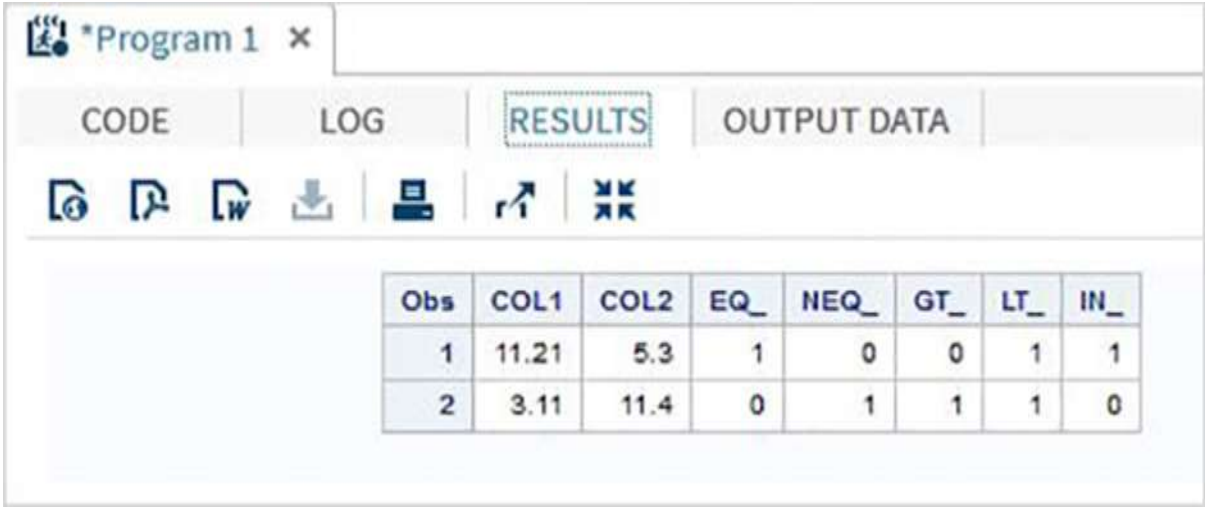
The following table describes the details of the comparison operators. These operators compare the values of the variables and the result is a truth value presented by 1 for TRUE and 0 for False. Let's assume two data variables **V1** and **V2** with values **8** and **4** respectively.

Operator	Description	Example
=	The EQUAL Operator — If both the data values are equal then the result is 1 else it is 0.	(V1 = 8) gives 1.
^=	The NOT EQUAL Operator — If both the data values are unequal then the result is 1 else it is 0.	(V1 ^= V2) gives 1.
<	The LESS THAN Operator.	(V2 < V2) gives 1.
<=	The LESS THAN or EQUAL TO Operator.	(V2 <= 4) gives 1.
>	The GREATER THAN Operator.	(V2 > V1) gives 1.
>=	The GREATER THAN or EQUAL TO Operator.	(V2 >= V1) gives 0.
IN	The IN Operator — If the value of the variable is equal to any one of the values in a given list of values, then it returns 1 else it returns 0.	V1 in (5,7,9,8) gives 1.

Example

```
DATA MYDATA1;
input @1 COL1 5.2 @7 COL2 4.1;
EQ_ = (COL1 = 11.21);
NEQ_= (COL1 ^= 11.21);
GT_ = (COL2 => 8);
LT_ = (COL2 <= 12);
IN_ = COL2 in( 6.2,5.3,12 );
datalines;
11.21 5.3
3.11  11.4
;
PROC PRINT DATA=MYDATA1;
RUN;
```

On running the above code, we get the following output.



Obs	COL1	COL2	EQ_	NEQ_	GT_	LT_	IN_
1	11.21	5.3	1	0	0	1	1
2	3.11	11.4	0	1	1	1	0

Minimum/Maximum Operators

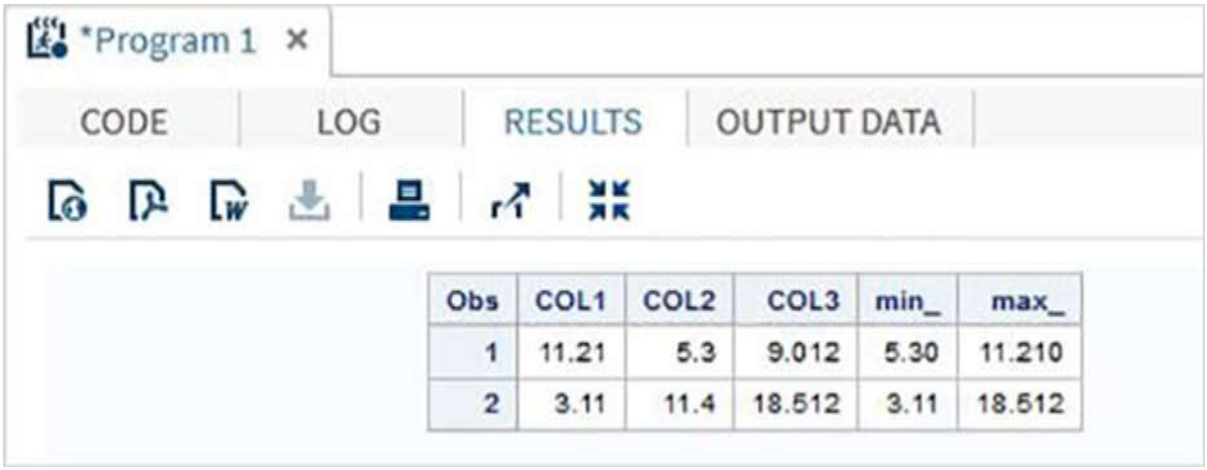
The following table describes the details of the Minimum/Maximum operators. These operators compare the values of the variables across a row and the minimum or maximum value from the list of values in the rows is returned.

Operator	Description	Example
MIN	The MIN Operator returns the minimum value form the list of values in the row.	MIN(45.2,11.6,15.41) gives 11.6
MAX	The MAX Operator returns the maximum value form the list of values in the row.	MAX(45.2,11.6,15.41) gives 45.2

Example

```
DATA MYDATA1;
input @1 COL1 5.2 @7 COL2 4.1 @12 COL3 6.3;
min_ = MIN(COL1 , COL2 , COL3);
max_ = MAX( COL1, COl2 , COL3);
datalines;
11.21 5.3 29.012
3.11  11.4 18.512
;
PROC PRINT DATA=MYDATA1;
RUN;
```

On running the above code, we get the following output.



Obs	COL1	COL2	COL3	min_	max_
1	11.21	5.3	9.012	5.30	11.210
2	3.11	11.4	18.512	3.11	18.512

Concatenation Operator

The following table describes the details of the Concatenation operator. This operator concatenates two or more string values. A single character value is returned.

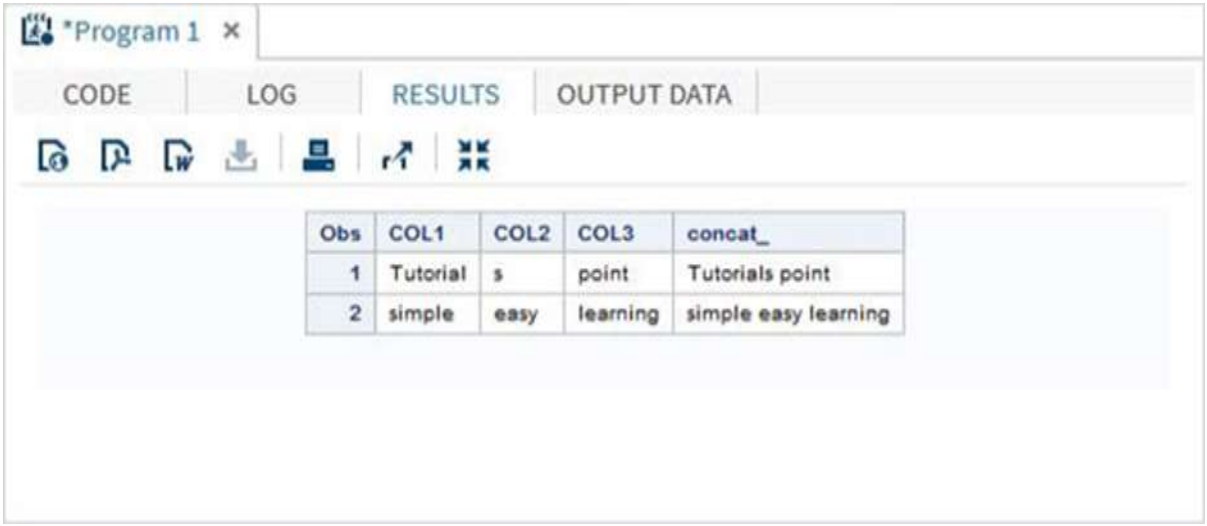
Operator	Description	Example
||	The Concatenate operator returns the concatenation of two or more values.	'Hello'||' World' gives Hello World

Example

```
DATA MYDATA1;
input  COL1 $     COL2 $  COL3 $;
concat_ = (COL1 || COL2 || COL3);
datalines;
Tutorial s point
```

```
simple easy learning
;
PROC PRINT DATA=MYDATA1;
RUN;
```

On running the above code, we get the following output.



Operators Precedence

The operator precedence indicates the order of evaluation of the multiple operators present in a complex expression. The following table describes the order of precedence within a group of operators.

Group	Order	Symbols
Group I	Right to Left	** + - NOT MIN MAX
Group II	Left to Right	* /
Group III	Left to Right	+ -
Group IV	Left to Right	||
Group V	Left to Right	< <= = >= >

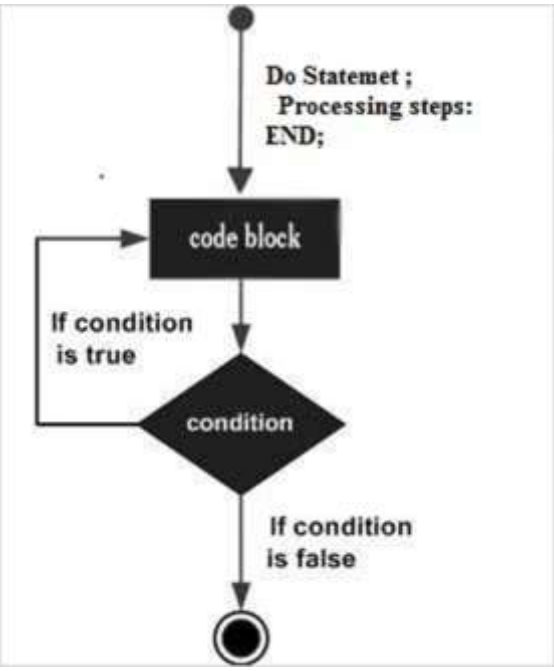
12. SAS – Loops

In this chapter, we will learn about SAS Loops. You may encounter situations, when a block of code needs to be executed several number of times. In general, statements are executed sequentially: The first statement in a function is executed first, followed by the second, and so on. But when you want the same set of statements to be executed again and again, we need the help of Loops.

In SAS, looping is done by using the DO statement. It is also called the **DO Loop**. Following is the general form of the DO loop statements in SAS.

Flow Diagram

Let us now understand the concept of the DO loop statements in SAS with the following Flow Diagram.



Following are the types of DO loops in SAS.

S.N.	Loop Type & Description
1.	DO Index The loop continues from the start value till the stop value of the index variable.
2.	DO WHILE The loop continues till the while condition becomes false.
3.	DO UNTIL The loop continues till the UNTIL condition becomes True.

SAS – DO Index Loop

This DO Index loop uses an index variable for its start and end value. The SAS statements are repeatedly executed until the final value of the index variable is reached.

Syntax

```
DO indexvariable= initialvalue to finalvalue ;
. . . SAS statements . . . ;
END;
```

Example

```
DATA MYDATA1;
SUM=0;
DO VAR=1 to 5;
   SUM=SUM+VAR;
END;

PROC PRINT DATA=MYDATA1;
RUN;
```

When the above code is executed, it produces the following result

SAS – DO WHILE Loop

The DO WHILE loop uses a WHILE condition. The SAS statements are repeatedly executed until the while condition becomes false.

Syntax

```
DO WHILE (variable  condition);
. . . SAS statements . . . ;
END;
```

Example

```
DATA MYDATA;
SUM=0;
VAR=1;
DO WHILE(VAR<6) ;
   SUM=SUM+VAR;
   VAR+1;
END;
   PROC PRINT;
   RUN;
```

When the above code is executed, it produces the following result.

SAS – DO UNTIL Loop

The DO UNTIL loop uses an UNTIL condition. The SAS statements are repeatedly executed till the UNTIL condition becomes TRUE.

Syntax

```
DO UNTIl (variable  condition);
. . . SAS statements . . . ;
END;
```

Example

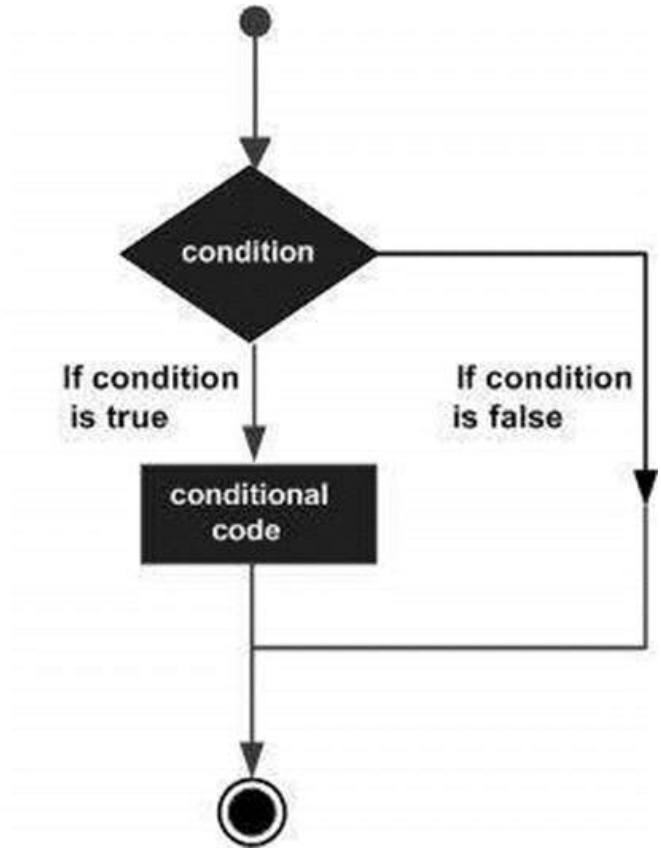
```
DATA MYDATA;
SUM=0;
VAR=1;
DO UNTIL(VAR>5) ;
   SUM=SUM+VAR;
   VAR+1;
END;
   PROC PRINT;
   RUN;
```

When the above code is executed, it produces the following result:

13. SAS – Decision Making

In this chapter, we will understand decision-making in SAS. Decision-making structures require the programmer to specify one or more conditions to be evaluated or tested by the program, along with a statement or statements to be executed if the condition is determined to be **true**, and optionally, other statements to be executed if the condition is determined to be **false**.

Following is the general form of a typical decision-making structure found in most of the programming languages:



SAS provides the following types of decision-making statements. Click the following links to check their detail.

S.N.	Statement Type & Description
1.	IF Statement An if statement consists of a condition. If the condition is true then the specific data is fetched.
2.	IF-THEN-ELSE Statement An if statement followed by else statement, which executes when the Boolean condition is false.

3.	IF-THEN-ELSE-IF Statement An if statement followed by else statement, which is again followed by another pair of IF-THEN Statement.
4.	IF-THEN-DELETE Statement An if statement consists of a condition, which when true deletes the specific data from the observations.

SAS – IF Statement

An **IF** statement consists of a Boolean expression followed by SAS statements.

Syntax

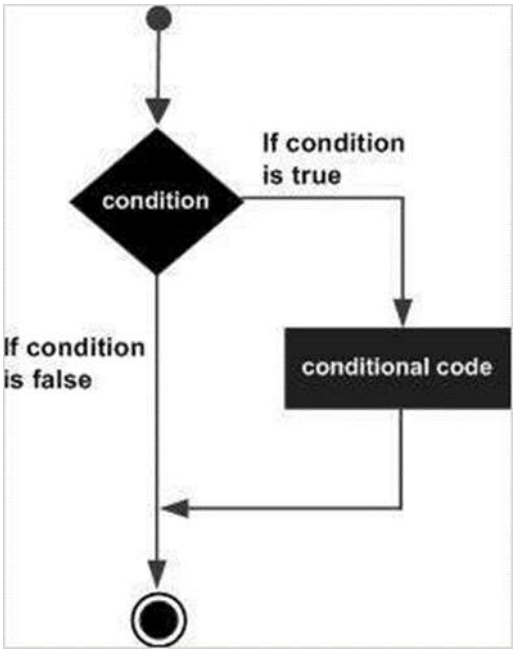
The basic syntax for creating an if statement in SAS is:

```
IF (condition );
```

If the condition evaluates to be **true**, then the respective observation is processed.

Flow Diagram

Let us understand the **SAS-IF** statement with the help of the following Flow diagram.



Example

```
DATA EMPDAT;
INPUT   EMPID ENAME $ SALARY DEPT $ DOJ DATE9.;
LABEL ID = 'Employee ID';
FORMAT DOJ DATE9.;
```

```
DATALINES;
1 Rick 623.3 IT 02APR2001

2 Dan 515.2 OPS 11JUL2012

3 Mike 611.5 IT 21OCT2000
4 Ryan 729.1 HR 30JUL2012
5 Gary 843.2 FIN 06AUG2000
6 Tusar 578.6 IT 01MAR2009
7 Pranab 632.8 OPS 16AUG1998
8 Rasmi 722.5 FIN 13SEP2014
;
Data EMPDAT1;
Set EMPDAT;
IF SALARY > 650;
PROC PRINT DATA=EMPDAT1;
run;
```

When the above code is executed, it produces the following result:

Obs	EMPID	ENAME	SALARY	DEPT	DOJ
1	4	Ryan	729.1	HR	30JUL2012
2	5	Gary	843.2	FIN	06AUG2000
3	8	Rasmi	722.5	FIN	13SEP2014

SAS – IF THEN ELSE Statement

An **IF-THEN-ELSE** statement consists of a Boolean expression with **THEN** statements. This is again followed by an ELSE Statement.

Syntax

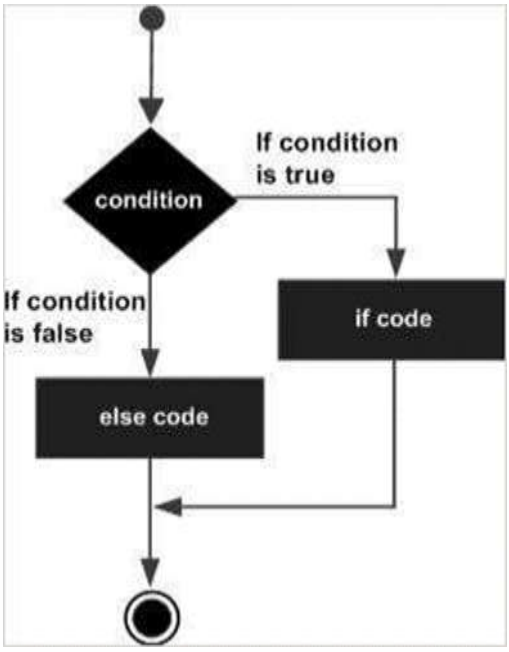
The basic syntax for creating an if statement in SAS is:

```
IF (condition ) THEN result1;
ELSE result2;
```

If the condition evaluates to be **true**, then the respective observation is processed.

Flow Diagram

Let us understand the **IF-THEN-ELSE** statement with the help of the following Flow diagram.

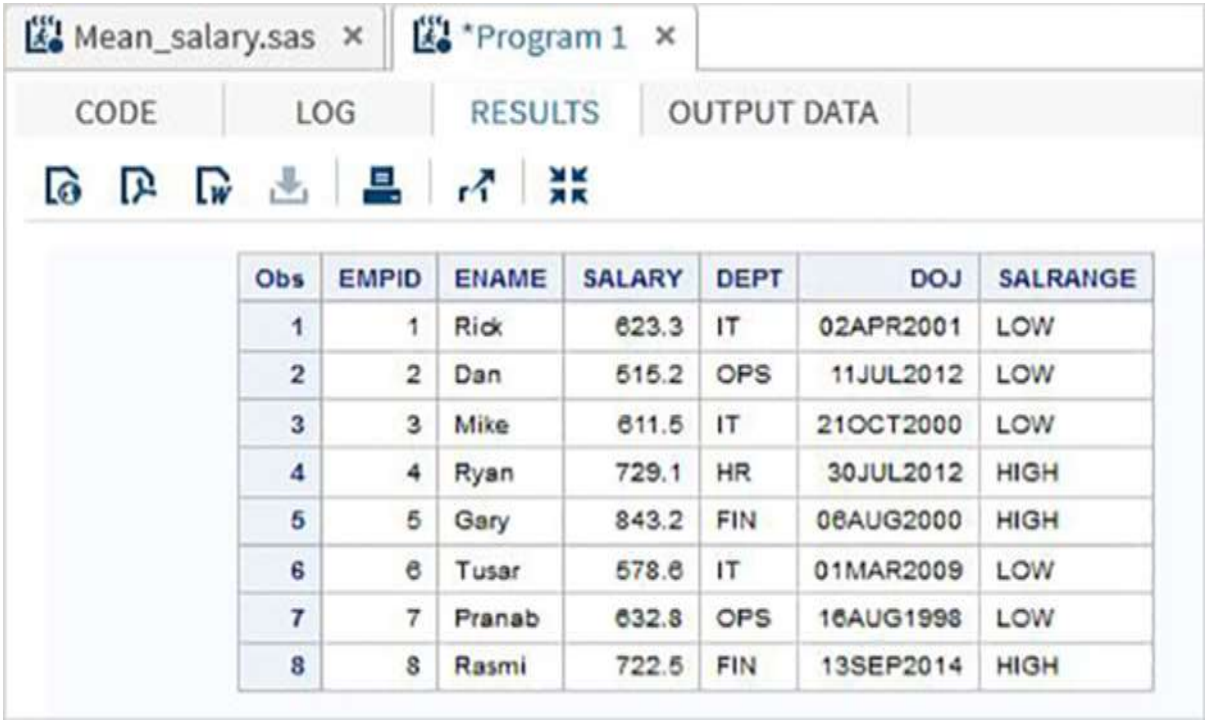


Example

```
DATA EMPDAT;
INPUT   EMPID ENAME $ SALARY DEPT $ DOJ DATE9.;
LABEL ID = 'Employee ID';
FORMAT DOJ DATE9.;
DATALINES;
1 Rick 623.3 IT 02APR2001
2 Dan 515.2 OPS 11JUL2012
3 Mike 611.5 IT 21OCT2000
4 Ryan 729.1 HR 30JUL2012
```

```
5 Gary 843.2 FIN 06AUG2000
6 Tusar 578.6 IT 01MAR2009
7 Pranab 632.8 OPS 16AUG1998
8 Rasmi 722.5 FIN 13SEP2014
;
Data EMPDAT1;
Set EMPDAT;
IF SALARY > 650 THEN SALRANGE ="HIGH";
ELSE SALRANGE="LOW";
PROC PRINT DATA=EMPDAT1;
run;
```

When the above code is executed, it produces the following result:



Obs	EMPID	ENAME	SALARY	DEPT	DOJ	SALRANGE
1	1	Rick	623.3	IT	02APR2001	LOW
2	2	Dan	515.2	OPS	11JUL2012	LOW
3	3	Mike	611.5	IT	21OCT2000	LOW
4	4	Ryan	729.1	HR	30JUL2012	HIGH
5	5	Gary	843.2	FIN	06AUG2000	HIGH
6	6	Tusar	578.6	IT	01MAR2009	LOW
7	7	Pranab	632.8	OPS	16AUG1998	LOW
8	8	Rasmi	722.5	FIN	13SEP2014	HIGH

SAS – IF THEN ELSE IF Statement

An **IF-THEN-ELSE-IF** statement consists of a Boolean expression with a THEN statements. This is again followed by an ELSE Statement.

Syntax

The basic syntax for creating an if statement in SAS is:

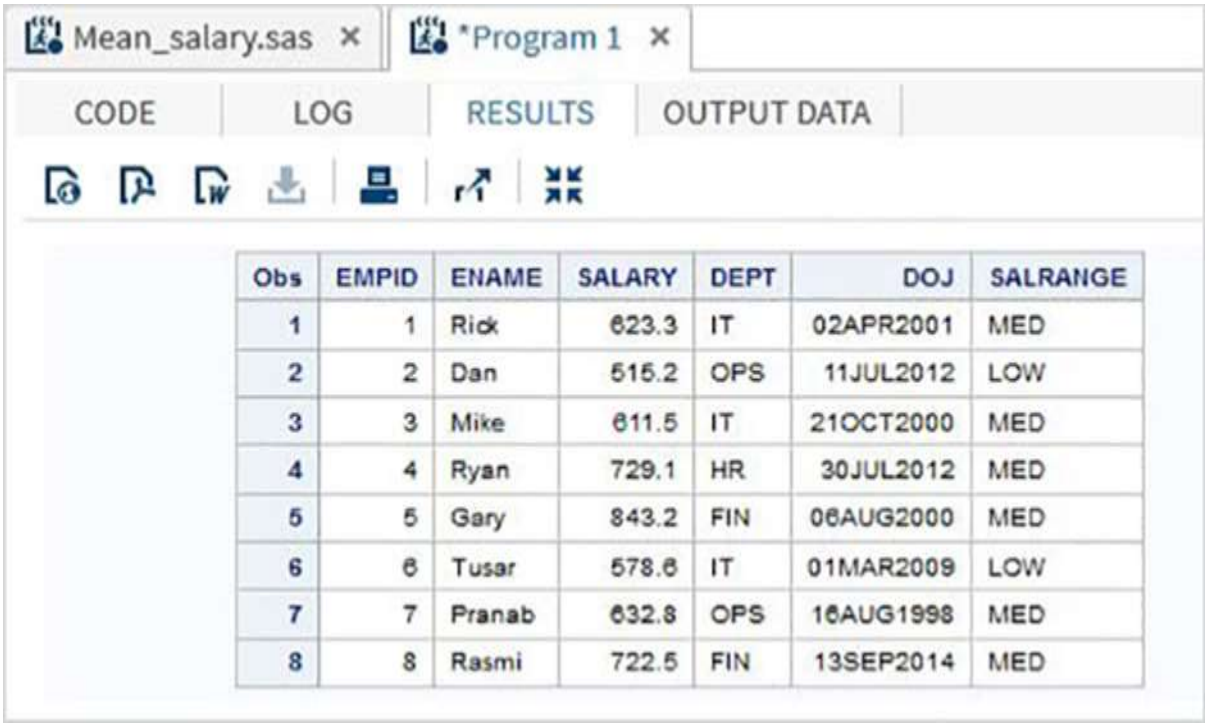
```
IF (condition1) THEN result1;
ELSE IF (condition2) THEN result2;
ELSE IF (condition3) THEN result3;
```

If the condition evaluates to be **true**, then the respective observation is processed.

Example

```
DATA EMPDAT;
INPUT   EMPID ENAME $ SALARY DEPT $ DOJ DATE9.;
LABEL ID = 'Employee ID';
FORMAT DOJ DATE9.;
DATALINES;
1 Rick 623.3 IT 02APR2001
2 Dan 515.2 OPS 11JUL2012
3 Mike 611.5 IT 21OCT2000
4 Ryan 729.1 HR 30JUL2012
5 Gary 843.2 FIN 06AUG2000
6 Tusar 578.6 IT 01MAR2009
7 Pranab 632.8 OPS 16AUG1998
8 Rasmi 722.5 FIN 13SEP2014
;
Data EMPDAT1;
Set EMPDAT;
IF SALARY < 600 THEN SALRANGE ="LOW";
ELSE IF 600 <= SALARY <= 700 THEN SALRANGE="MEDIUM";
ELSE IF 700 < SALARY THEN SALRANGE="MEDIUM";
PROC PRINT DATA=EMPDAT1;
run;
```

When the above code is executed, it produces the following result:



Obs	EMPID	ENAME	SALARY	DEPT	DOJ	SALRANGE
1	1	Rick	623.3	IT	02APR2001	MED
2	2	Dan	515.2	OPS	11JUL2012	LOW
3	3	Mike	611.5	IT	21OCT2000	MED
4	4	Ryan	729.1	HR	30JUL2012	MED
5	5	Gary	843.2	FIN	06AUG2000	MED
6	6	Tusar	578.6	IT	01MAR2009	LOW
7	7	Pranab	632.8	OPS	16AUG1998	MED
8	8	Rasmi	722.5	FIN	13SEP2014	MED

SAS – IF-THEN-DELETE Statement

An **IF-THEN-DELETE** statement consists of a Boolean expression followed by a **SAS THEN DELETE** statement.

Syntax

The basic syntax for creating an if statement in SAS is:

```
IF (condition ) THEN DELETE;
```

If the condition evaluates to be **true**, then the respective observation is processed.

Example

```
DATA EMPDAT;
INPUT   EMPID ENAME $ SALARY DEPT $ DOJ DATE9.;
LABEL ID = 'Employee ID';
FORMAT DOJ DATE9.;
DATALINES;
1 Rick 623.3 IT 02APR2001
2 Dan 515.2 OPS 11JUL2012
3 Mike 611.5 IT 21OCT2000
4 Ryan 729.1 HR 30JUL2012
5 Gary 843.2 FIN 06AUG2000
6 Tusar 578.6 IT 01MAR2009
```

```
7 Pranab 632.8 OPS 16AUG1998
8 Rasmi 722.5 FIN 13SEP2014
;
Data EMPDAT1;
Set EMPDAT;
IF SALARY > 700 THEN DELETE;
PROC PRINT DATA=EMPDAT1;
run;
```

When the above code is executed, it produces the following result:

Obs	EMPID	ENAME	SALARY	DEPT	DOJ
1	1	Rick	623.3	IT	02APR2001
2	2	Dan	515.2	OPS	11JUL2012
3	3	Mike	611.5	IT	21OCT2000
4	6	Tusar	578.6	IT	01MAR2009
5	7	Pranab	632.8	OPS	16AUG1998

14. SAS – Functions

SAS has a wide variety of in-built functions which help in analyzing and processing the data. These functions are used as part of the DATA statements. They take the data variables as arguments and return the result which is stored into another variable. Depending on the type of function, the number of arguments it takes can vary. Some functions accept zero arguments while some other accept fixed number of variables. Following is a list of types of functions SAS provides.

Syntax

The following is the general syntax for using a function in SAS.

```
FUNCTIONNAME(argument1, argument2...argumentn)
```

Here the argument can be a constant, variable, expression or another function.

Function Categories

Depending on their usage, the functions in SAS are categorized as follows.

- Mathematical
- Date and Time
- Character
- Truncation
- Miscellaneous

Mathematical Functions

These are the functions used to apply some mathematical calculations on the variable values.

Examples

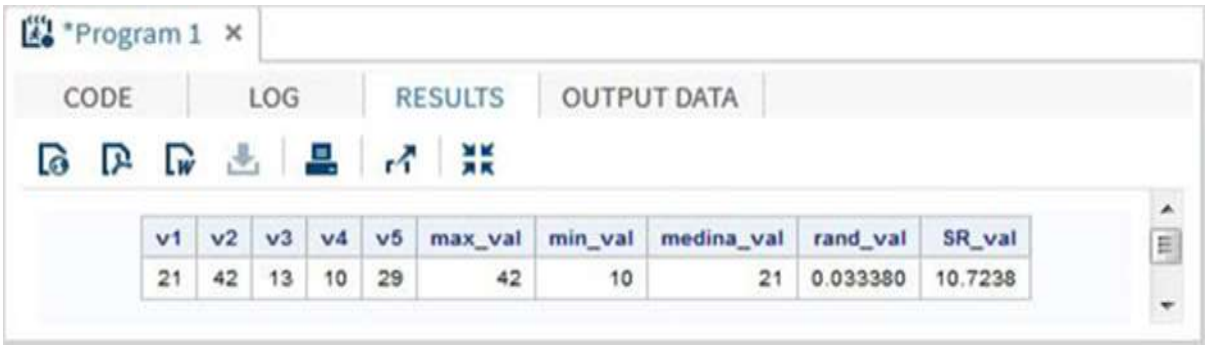
The following SAS program shows the use of some important mathematical functions.

data Math_functions;

```
v1=21; v2=42; v3=13; v4=10; v5=29;

/* Get Maximum value */
max_val = MAX(v1,v2,v3,v4,v5);

/* Get Minimum value */
```

```
min_val = MIN (v1,v2,v3,v4,v5);

/* Get Median value */
med_val = MEDIAN (v1,v2,v3,v4,v5);

/* Get a random number */
rand_val = RANUNI(0);

/* Get Square root of sum of the values */
SR_val= SQRT(sum(v1,v2,v3,v4,v5));

proc print data = Math_functions noobs;
run;
```

When the above code is run, we get the following output:



v1	v2	v3	v4	v5	max_val	min_val	medina_val	rand_val	SR_val
21	42	13	10	29	42	10	21	0.033380	10.7238

Date and Time Functions

These are the functions used to process date and time values.

Examples

The following SAS program shows the use of date and time functions.

```
data date_functions;
INPUT @1 date1 date9. @11 date2 date9.;
format date1 date9.  date2 date9.;

/* Get the interval between the dates in years*/
Years_ = INTCK('YEAR',date1,date2);

/* Get the interval between the dates in months*/
```

```
months_ = INTCK('MONTH',date1,date2);


/* Get the week day from the date*/
weekday_ =  WEEKDAY(date1);

/* Get Today's date in SAS date format */
today_ = TODAY();

/* Get current time in SAS time format */
time_ = time();
DATALINES;
21OCT2000 16AUG1998
01MAR2009 11JUL2012
;
proc print data = date_functions noobs;
run;
```

When the above code is run, we get the following output:

date1	date2	Years_	months_	weekday_	today_	time_
21OCT2000	16AUG1998	-2	-26	7	20468	73703.21
01MAR2009	11JUL2012	3	40	1	20468	73703.21

Character Functions

These are the functions used to process the character or the text values.

Examples

The below SAS program shows the use of character functions.

```
data character_functions;


/* Convert the string into lower case */
lowcse_ = LOWCASE('HELLO');
```

```
/* Convert the string into upper case */
upcase_ = UPCASE('hello');

/* Reverse the string */
reverse_ = REVERSE('Hello');

/* Return the nth word */
nth_letter_ = SCAN('Learn SAS Now',2);
run;

proc print data = character_functions noobs;
run;
```

When the above code is run, we get the following output:

Truncation Functions

These are the functions used to truncate numeric values.

Examples

The following SAS program shows the use of truncation functions.

```
data trunc_functions;

/* Nearest greatest integer */
ceil_ = CEIL(11.85);

/* Nearest greatest integer */
floor_ = FLOOR(11.85);

/* Integer portion of a number */
```

```
int_ = INT(32.41);

/* Round off to nearest value */
round_ = ROUND(5621.78);
run;

proc print data = trunc_functions noobs;
run;
```

When the above code is run, we get the following output:

ceil_	floor_	int_	round_
12	11	32	5622

Miscellaneous Functions

Let us now understand the miscellaneous functions of SAS with some examples.

Example

The following SAS program shows the use of Miscellaneous functions.

```
data misc_functions;

/* Nearest greatest integer */
state2=zipstate('01040');

/* Amortization calculation */
payment=mort(50000, . , .10/12,30*12);

proc print data = misc_functions noobs;
run;
```

When the above code is run, we get the following output:

15. SAS – Input Methods

The input methods are used to read the raw data. The raw data may be from an external source or from in stream data lines. The input statement creates a variable with the name that you assign to each field. So you have to create a variable in the Input Statement. The same variable will be shown in the output of SAS Dataset. Following are different input methods available in SAS.

- List Input Method
- Named Input Method
- Column Input Method
- Formatted Input Method

Let us now understand each input method in detail.

List Input Method

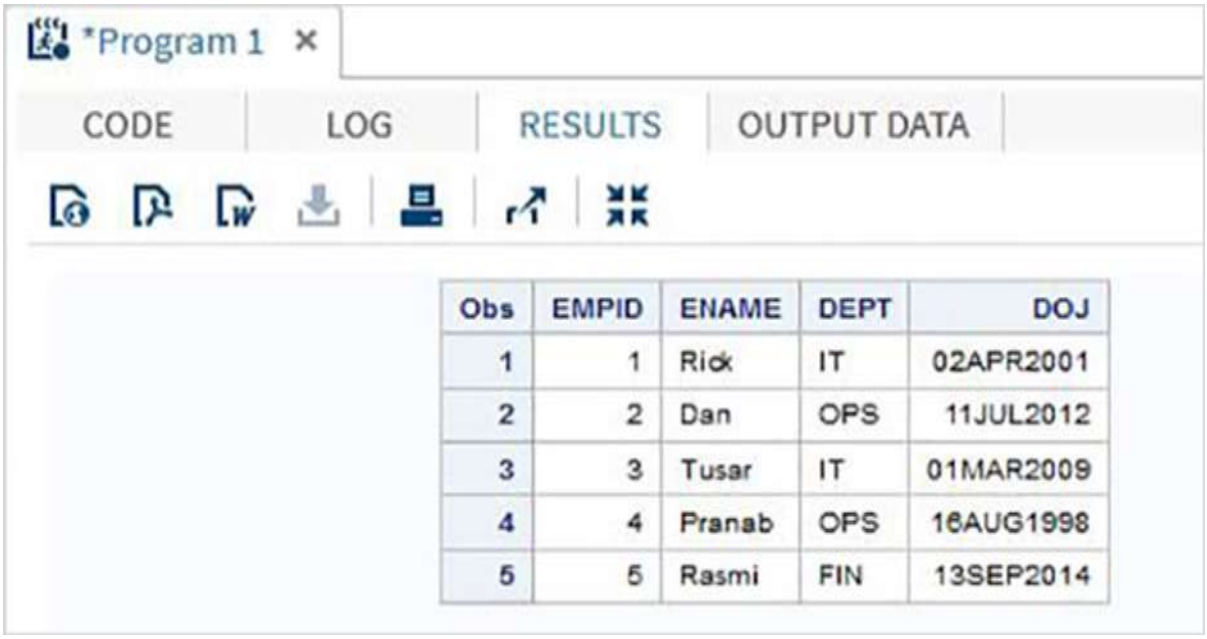
In this method, the variables are listed with the data types. The raw data is carefully analyzed so that the order of the variables declared matches the data. The delimiter (usually space) should be uniform between any pair of adjacent columns. Any missing data will cause problem in the output as the result will be wrong.

Example

The following code and the output shows the use of the list input method.

```
DATA TEMP;
INPUT   EMPID ENAME $ DEPT $ ;
DATALINES;
1 Rick  IT
2 Dan  OPS
3 Tusar  IT
4 Pranab  OPS
5 Rasmi  FIN
;
PROC PRINT DATA=TEMP;
RUN;
```

On running the above code, we get the following output.



Obs	EMPID	ENAME	DEPT	DOJ
1	1	Rick	IT	02APR2001
2	2	Dan	OPS	11JUL2012
3	3	Tusar	IT	01MAR2009
4	4	Pranab	OPS	16AUG1998
5	5	Rasmi	FIN	13SEP2014

Named Input Method

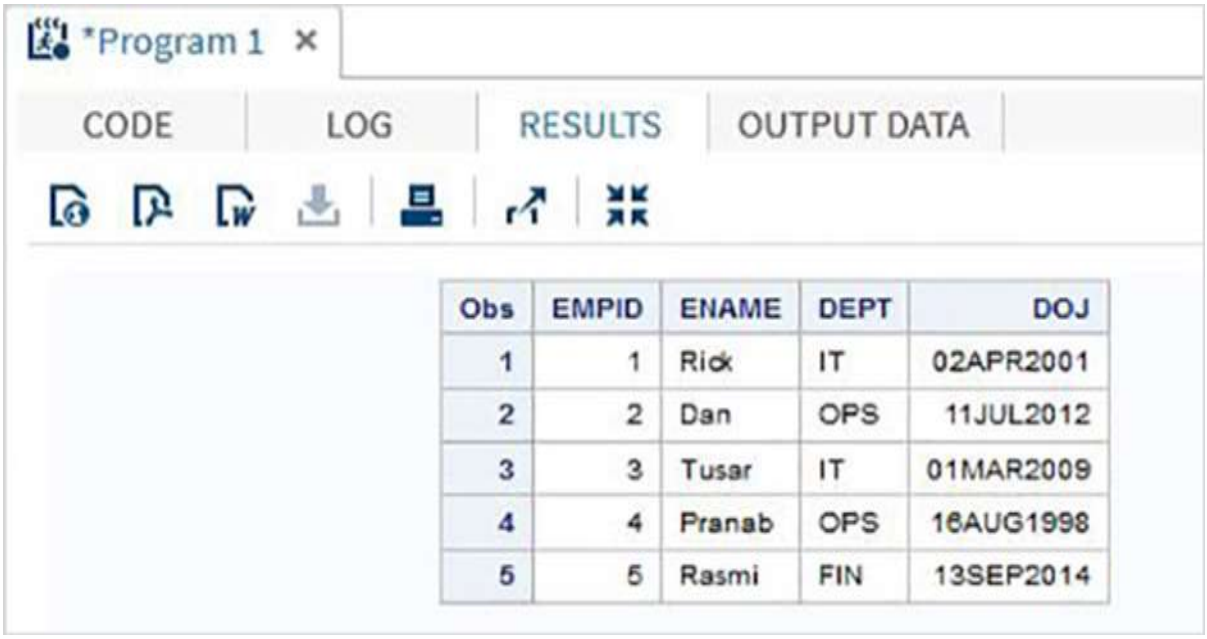
In this method, the variables are listed with the data types. The raw data is modified to have variable names declared in front of the matching data. The delimiter (usually space) should be uniform between any pair of adjacent columns.

Example

The following code and the output show the use of the Named Input Method.

```
DATA TEMP;
INPUT
EMPID= ENAME= $ DEPT= $ ;
DATALINES;
EMPID=1 ENAME= Rick  DEPT= IT
EMPID=2 ENAME= Dan  DEPT= OPS
EMPID=3 ENAME= Tusar  DEPT= IT
EMPID=4 ENAME= Pranab  DEPT= OPS
EMPID=5 ENAME= Rasmi  DEPT= FIN
;
PROC PRINT DATA=TEMP;
RUN;
```

On running the above code, we get the following output.



Obs	EMPID	ENAME	DEPT	DOJ
1	1	Rick	IT	02APR2001
2	2	Dan	OPS	11JUL2012
3	3	Tusar	IT	01MAR2009
4	4	Pranab	OPS	16AUG1998
5	5	Rasmi	FIN	13SEP2014

Column Input Method

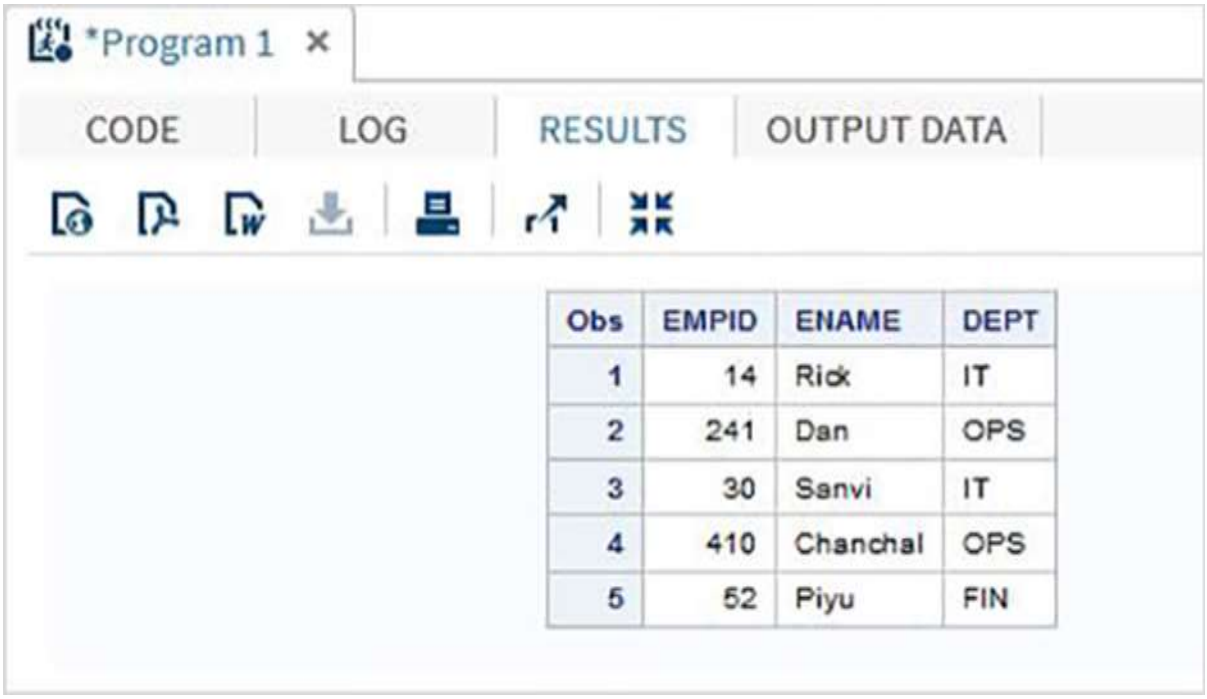
In this method, the variables are listed with the data types and width of the columns which specify the value of the single column of data. For example, if an employee name contains maximum 9 characters and each employee name starts at the 10th column, then the column width for the employee name variable will be 10-19.

Example

The following code shows the use of the Column Input Method.

```
DATA TEMP;
INPUT   EMPID 1-3 ENAME $ 4-12 DEPT $ 13-16;
DATALINES;
14 Rick     IT
241Dan      OPS
30 Sanvi    IT
410Chanchal OPS
52 Piyu     FIN
;
PROC PRINT DATA=TEMP;
RUN;
```

When we execute the above code, it produces the following result:



Obs	EMPID	ENAME	DEPT
1	14	Rick	IT
2	241	Dan	OPS
3	30	Sanvi	IT
4	410	Chanchal	OPS
5	52	Piyu	FIN

Formatted Input Method

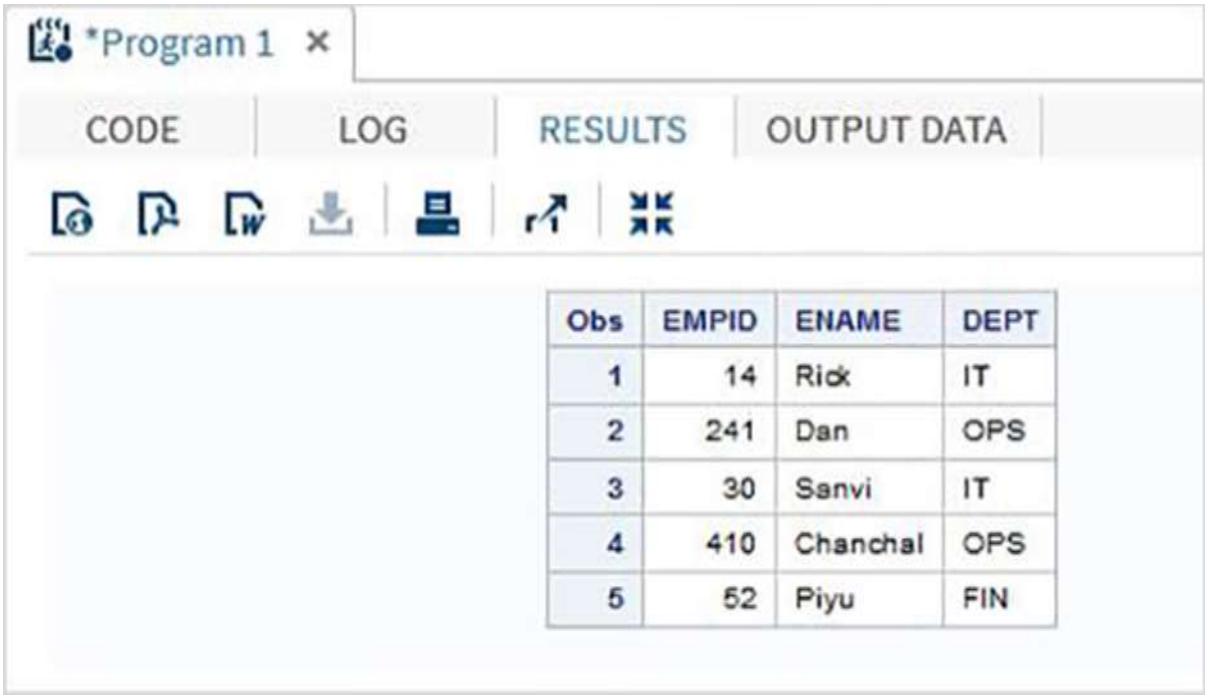
In this method, the variables are read from a fixed starting point until a space is encountered. As every variable has a fixed starting point, the number of columns between any pair of variables becomes the width of the first variable. The character '@n' is used to specify the starting column position of a variable as the nth column.

Example

The following code shows the use of the Formatted Input Method.

```
DATA TEMP;
INPUT   @1 EMPID $ @4 ENAME $ @13 DEPT $ ;
DATALINES;
14 Rick     IT
241 Dan      OPS
30 Sanvi    IT
410 Chanchal OPS
52 Piyu     FIN
;
PROC PRINT DATA=TEMP;
RUN;
```

When we execute the above code, it produces the following result:



Obs	EMPID	ENAME	DEPT
1	14	Rick	IT
2	241	Dan	OPS
3	30	Sanvi	IT
4	410	Chanchal	OPS
5	52	Piyu	FIN

16. SAS – Macros

SAS has a powerful programming feature called **Macros** which allows us to avoid repetitive sections of code and to use them again and again when needed. It also helps create dynamic variables within the code that can take different values for different run instances of the same code. Macros can also be declared for blocks of code which will be reused multiple times in a similar manner to macro variables. We will see both of these in the following examples.

Macro Variables

These are the variables which hold a value to be used again and again by a SAS program. They are declared at the beginning of a SAS program and called out later in the body of the program. They can be Global or Local in scope.

Global Macro variable

They are called global macro variables because they can be accessed by any SAS program available in the SAS environment. In general, they are the system assigned variables which are accessed by multiple programs. A general example is the system date.

Example

Following is an example of the SAS variable called SYSDATE. This represents the system date. Consider a scenario to print the system date in the title of the SAS report every day the report is generated. The title will show the current date and the day without we coding any values for them. We use the in-built SAS data set called CARS available in the SASHELP library.

```
proc print data = sashelp.cars;
where make = 'Audi' and type = 'Sports' ;
 TITLE "Sales as of &SYSDAY &SYSDATE";
run;
```

When the above code is run, we get the following output.

*Program 2

CODE | LOG | RESULTS

Department Sales as of Saturday 16JAN16

Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize	Cylinders	Hor
21	Audi	RS 6 4dr	Sports	Europe	Front	$84,600	$76,417	4.2	8	
22	Audi	TT 1.8 convertible 2dr (coupe)	Sports	Europe	Front	$35,940	$32,512	1.8	4	
23	Audi	TT 1.8 Quattro 2dr (convertible)	Sports	Europe	All	$37,390	$33,891	1.8	4	
24	Audi	TT 3.2 coupe 2dr (convertible)	Sports	Europe	All	$40,590	$36,739	3.2	6	

Local Macro Variable

These variables can be accessed by SAS programs in which they are declared as part of the program. They are typically used to supply different variables to the same SAS statements so that they can process different observations of a data set.

Syntax

The local variables are declared with the syntax shown below.

```
% LET (Macro Variable Name) = Value;
```

Here the Value field can take any numeric, text or date value as required by the program. The Macro variable name is any valid SAS variable.

Example

The variables are used by the SAS statements using the **&** character appended at the beginning of the variable name. The following program gets us all the observation of the make 'Audi' and type 'Sports'. In case we want the result of **different make**, we need to change the value of the variable **make_name** without changing any other part of the program. In case of bring programs, this variable can be referred again and again in any SAS statement.

```
%LET make_name = 'Audi';
%LET type_name = 'Sports';
proc print data = sashelp.cars;
where make = &make_name and type = &type_name ;
 TITLE "Sales as of &SYSDAY &SYSDATE";
run;
```

When the above code is run, we get the same output as for the previous program. But let's change the **type name** to **'Wagon'** and run the same program. We will get the following result.

Sales as of Saturday 16JAN16

Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize	Cylinders	Horsep
25	Audi	A6 3.0 Avant Quattro	Wagon	Europe	All	$40,840	$37,060	3.0	6	
26	Audi	S4 Avant Quattro	Wagon	Europe	All	$49,090	$44,446	4.2	8	

Macro Programs

Macro is a group of SAS statements that is referred by a name and to use it in program anywhere, using that name. It starts with a %MACRO statement and ends with %MEND statement.

Syntax

The local variables are declared with the syntax given below.

```
# Creating a Macro program.
%MACRO (Param1, Param2,….Paramn);

Macro Statements;
%MEND;
# Calling a Macro program.
%MacroName (Value1, Value2,…..Valuen);
```

Example

The following program declares a group of SAT statements under a macro named '**show_result**'; This macro is being called by other SAS statements.

```
%MACRO show_result(make_ , type_);
proc print data = sashelp.cars;
where make = "&make_" and type = "&type_" ;
TITLE "Sales as of &SYSDAY &SYSDATE";
run;
%MEND;

%show_result(BMW,SUV);
```

When the above code is run, we get the following output.

Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	Engine Size	Cylinders	Horsepov
27	BMW	X3 3.0i	SUV	Europe	All	$37,000	$33,873	3.0	6	2
28	BMW	X5 4.4i	SUV	Europe	All	$52,195	$47,720	4.4	8	3

Commonly Used Macros

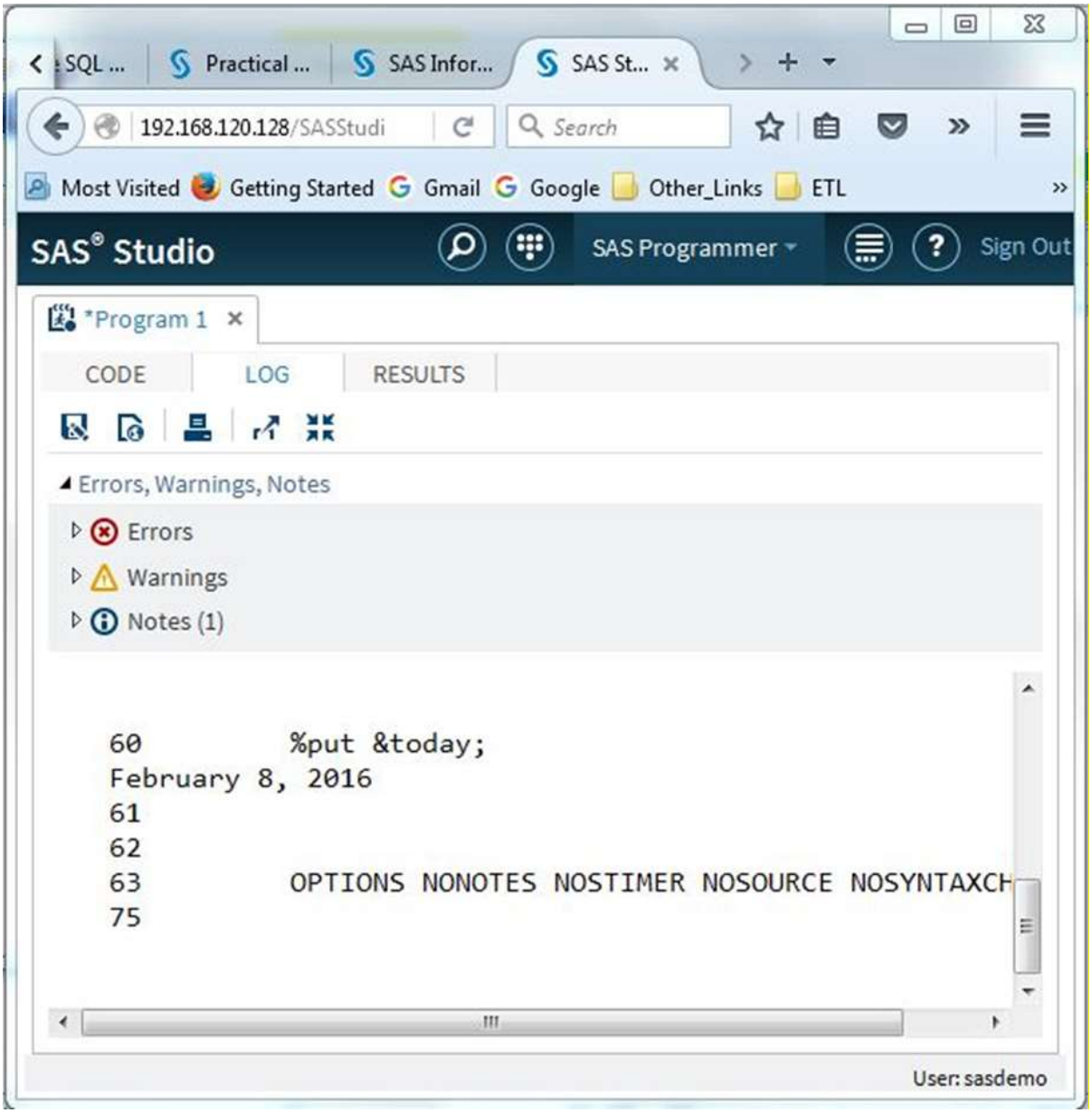
SAS has many MACRO statements which are in-built in the SAS programming language. They are used by other SAS programs without explicitly declaring them. Common examples are - terminating a program when some condition is met or capturing the runtime value of a variable in the program log. Below are some examples.

Macro %PUT

This macro statement writes text or macro variable information to the SAS log. In the below example the value of the variable 'today' is written to the program log.

```
data _null_;
CALL SYMPUT ('today',
TRIM(PUT("&sysdate"d,worddate22.)));
run;
%put &today;
```

When the above code is run, we get the following output.



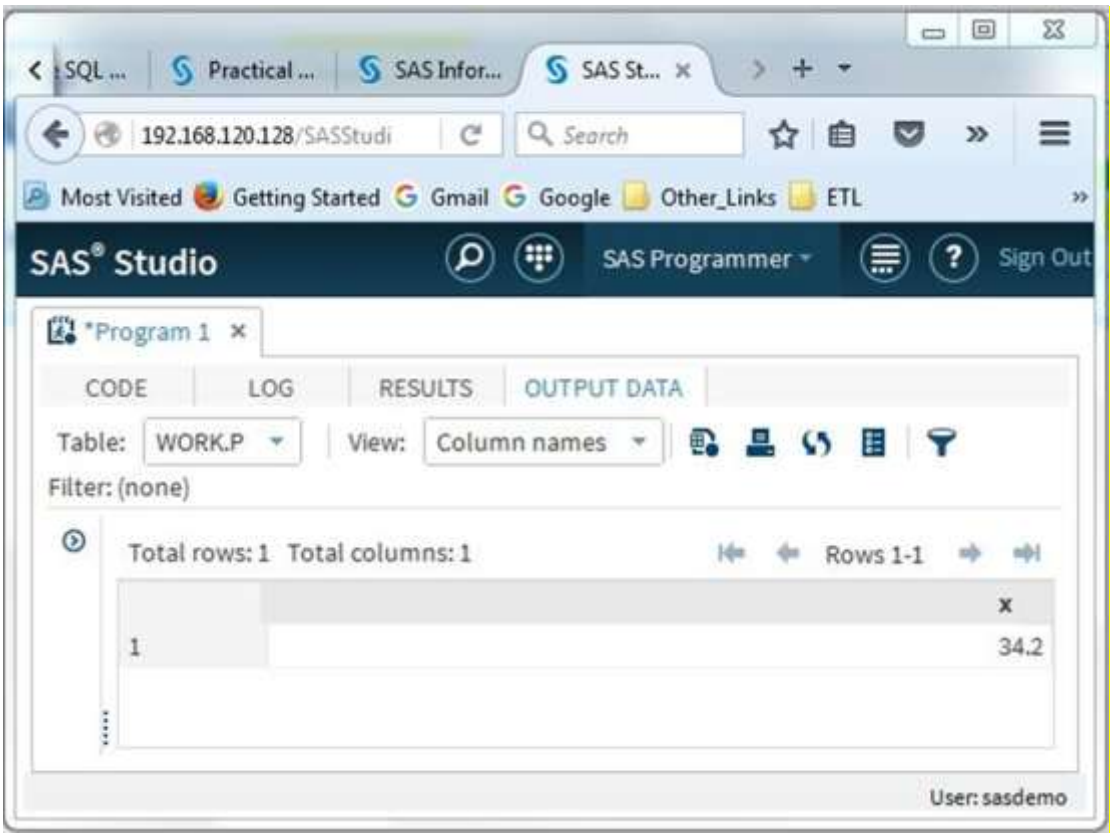
Macro %RETURN

Execution of this macro causes normal termination of the macro that is currently getting executed when certain condition evaluates to be true. In the following example, when the value of the variable "**val**" becomes 10, the macro terminates else it continues.

```
%macro check_condition(val);
   %if &val = 10 %then %return;

    data p;
       x=34.2;
    run;
```

```
%mend check_condition;

%check_condition(11)  ;
```

When the above code is run, we get the following output.

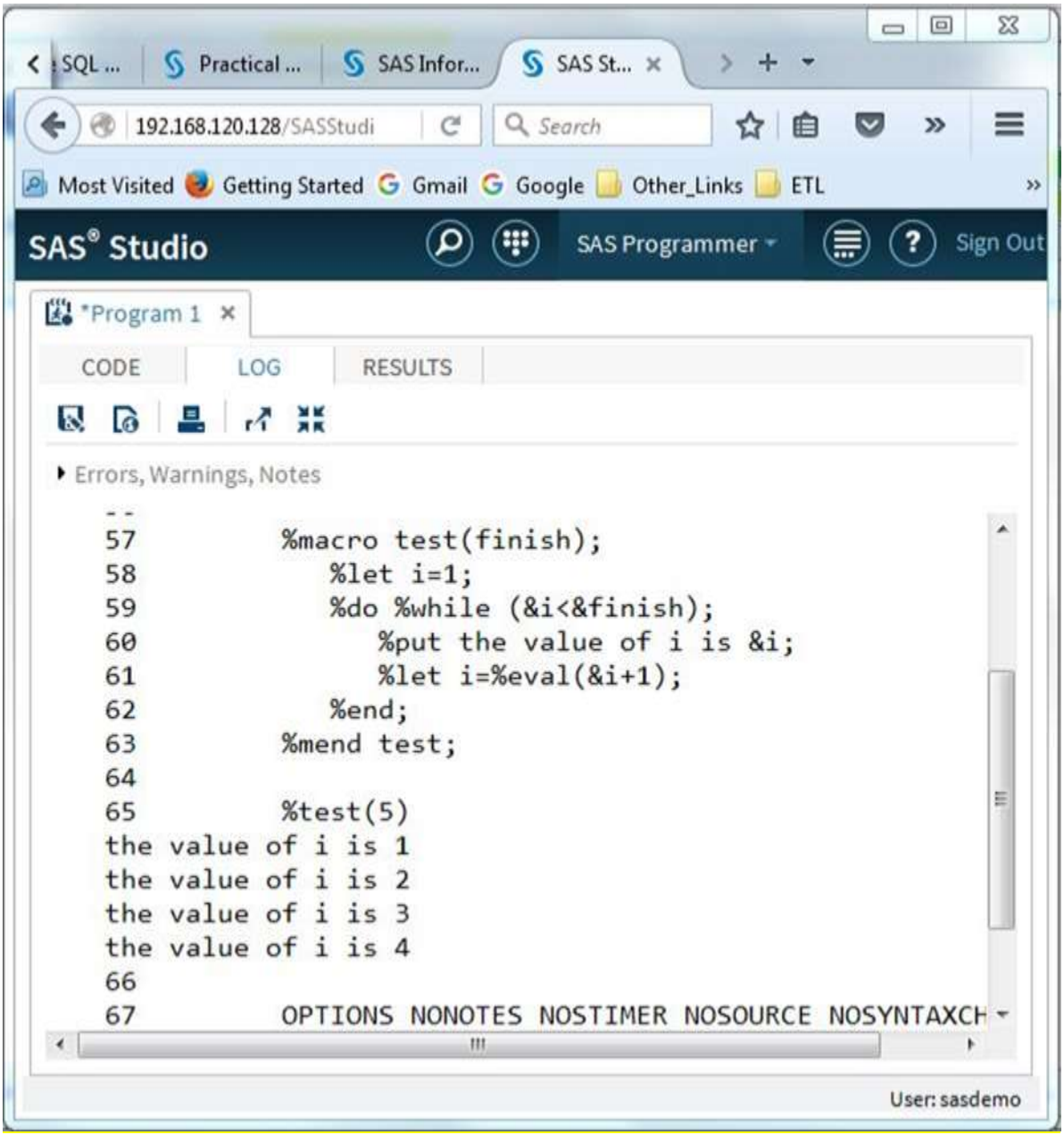


Macro %END

This macro definition contains a **%DO %WHILE** loop that ends, as required, with a %END statement. In the following example the macro named test takes a user input and runs the **DO** loop using this input value. The end of the DO loop is achieved through the %end statement while the end of the macro is achieved through the %mend statement.

```
%macro test(finish);
   %let i=1;
   %do %while (&i <&finish);
      %put the value of i is &i;
      %let i=%eval(&i+1);
   %end;
%mend test;
%test(5)
```

When the above code is run, we get the following output.



17. SAS – Date Times

In this chapter, we will discuss Date Times in SAS. Dates in SAS are a special case of numeric values. Each day is assigned a specific numeric value starting from 1st January 1960. This date is assigned the date value 0 and the next date has a date value of 1 and so on. The previous days to this date are represented by -1, -2 and so on. With this approach, SAS can represent any date in the future and any date in the past.

When SAS reads the data from a source, it converts the data read into a specific date format as specified in the date format. The variable to store the date value is declared with the proper **informat** required. The output date is shown by using the output data formats.

SAS Date Informat

The source data can be read properly by using specific date **informats** as shown below. The digit at the end of the informat indicates the minimum width of the date string to be read completely using the informat. A smaller width will give incorrect result. With SAS V9, there is a generic date format **anydtdte15.**which can process any date input.

Input Date	Date width	Informat
03/11/2014	10	mmddyy10.
03/11/14	8	mmddyy8.
December 11, 2012	20	worddate20.
14mar2011	9	date9.
14-mar-2011	11	date11.
14-mar-2011	15	anydtdte15.

Example

The following code shows the reading of different date formats. Please note the all the output values are just numbers as we have not applied any format statement to the output values.

```
DATA TEMP;
INPUT @1 Date1 date11. @12 Date2 anydtdte15. @23 Date3 mmddyy10.   ;
DATALINES;
02-mar-2012 3/02/2012 3/02/2012
;
PROC PRINT DATA=TEMP;
RUN;
```

When the above code is executed, we get the following output.

SAS Date output format

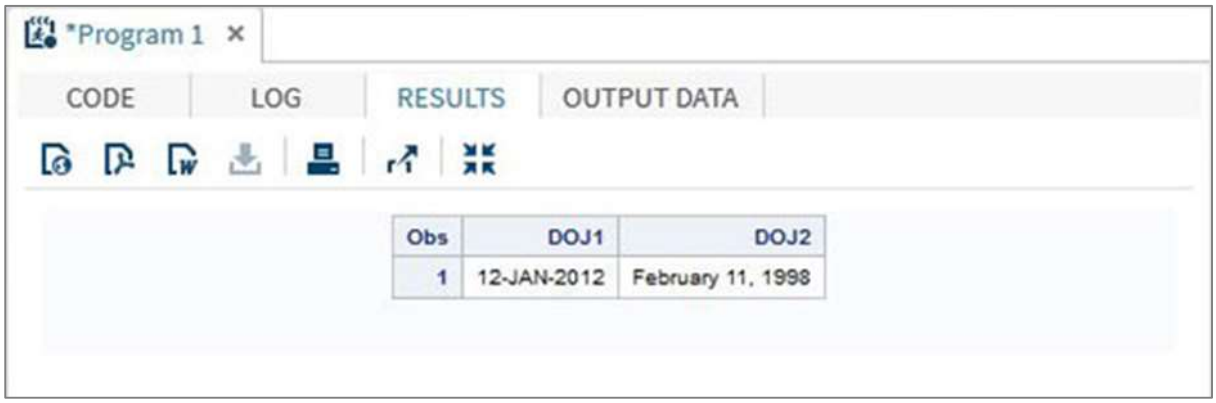
The dates after being read, can be converted to another format as required by the display. This is achieved using the format statement for the date types. They take the same formats as informats.

Example

In the following example, the date is read in one format but displayed in another format.

```
DATA TEMP;
INPUT  @1 DOJ1 mmddyy10. @12 DOJ2 mmddyy10. ;
format  DOJ1 date11.  DOJ2 worddate20. ;
DATALINES;
01/12/2012 02/11/1998
;
PROC PRINT DATA=TEMP;
RUN;
```

When the above code is executed, we get the following output.



SAS Data Set Operations

18. SAS – Read Raw Data

In this chapter, we will discuss how SAS reads raw data. SAS can read data from various sources which includes many file formats. The file formats used in SAS environment are discussed below.

- ASCII(Text) Data Set
- Delimited Data
- Excel Data
- Hierarchical Data

Reading ASCII (Text) Data Set

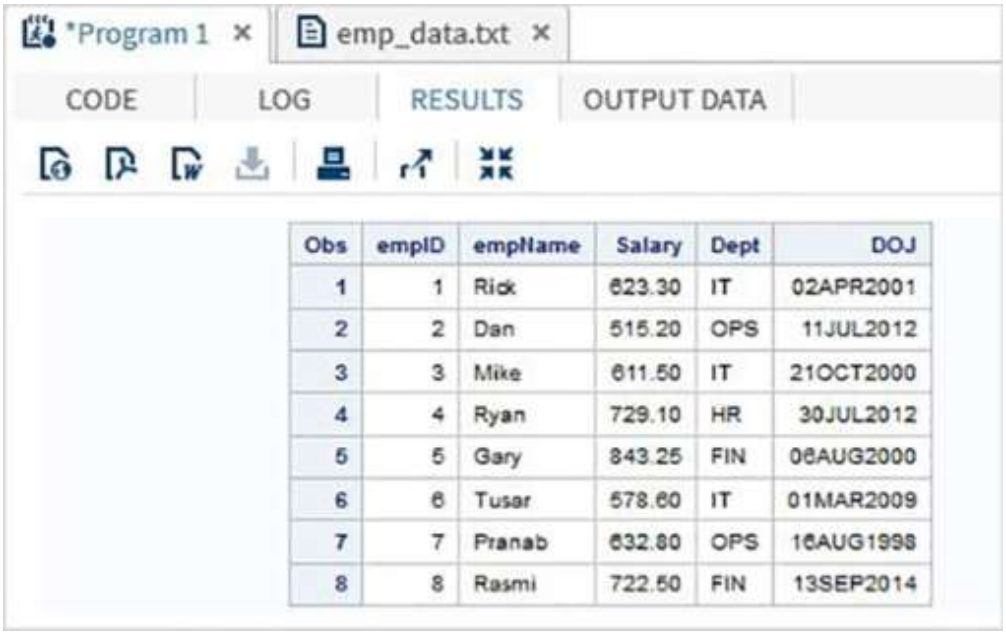
These are the files which contain the data on text format. The data is usually delimited by a space, but there can be different types of delimiters also which SAS can handle. Let's consider an ASCII file containing the employee data. We read this file using the **Infile** statement available in SAS.

Example

In the following example, we read the data file named **emp_data.txt** from the local environment.

```
data TEMP;
  infile
'/folders/myfolders/sasuser.v94/TutorialsPoint/emp_data.txt';
  input empID empName $ Salary Dept $ DOJ date9. ;
  format DOJ date9.;
 run;
 PROC PRINT DATA=TEMP;
RUN;
```

When the above code is executed, we get the following output.


*Program 1 × emp_data.txt ×

CODE LOG RESULTS OUTPUT DATA

Obs	empID	empName	Salary	Dept	DOJ
1	1	Rick	623.30	IT	02APR2001
2	2	Dan	515.20	OPS	11JUL2012
3	3	Mike	611.50	IT	21OCT2000
4	4	Ryan	729.10	HR	30JUL2012
5	5	Gary	843.25	FIN	06AUG2000
6	6	Tusar	578.60	IT	01MAR2009
7	7	Pranab	632.80	OPS	16AUG1998
8	8	Rasmi	722.50	FIN	13SEP2014

Reading Delimited Data

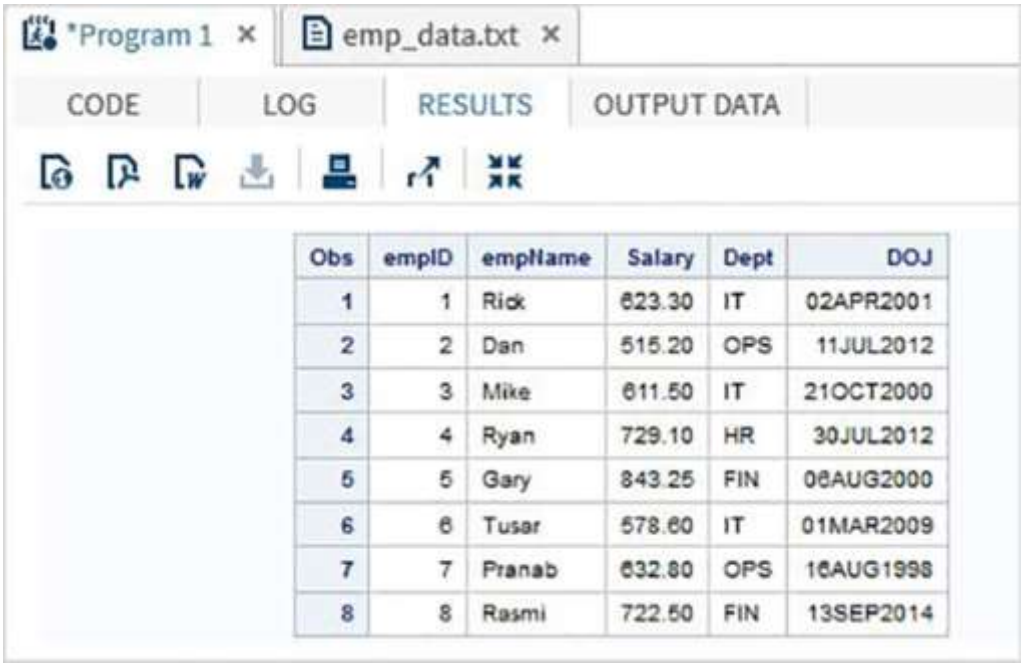
These are the data files in which the column values are separated by a delimiting character like a comma or pipeline etc. In this case, we use the **dlm** option in the **infile** statement.

Example

In the following example, we read the data file named emp.csv from the local environment.

```
data TEMP;
  infile
'/folders/myfolders/sasuser.v94/TutorialsPoint/emp.csv' dlm=",";
  input empID empName $ Salary Dept $ DOJ date9. ;
  format DOJ date9.;
 run;
 PROC PRINT DATA=TEMP;
RUN;
```

When the above code is executed, we get the following output.



Obs	empID	empName	Salary	Dept	DOJ
1	1	Rick	623.30	IT	02APR2001
2	2	Dan	515.20	OPS	11JUL2012
3	3	Mike	611.50	IT	21OCT2000
4	4	Ryan	729.10	HR	30JUL2012
5	5	Gary	843.25	FIN	06AUG2000
6	6	Tusar	578.60	IT	01MAR2009
7	7	Pranab	632.80	OPS	16AUG1998
8	8	Rasmi	722.50	FIN	13SEP2014

Reading Excel Data

SAS can directly read an excel file using the import facility. As seen in the chapter SAS data sets, it can handle a wide variety of file types including MS excel. Assuming the file emp.xls is available locally in the SAS environment.

Example

```
FILENAME REFFILE
"/folders/myfolders/TutorialsPoint/emp.xls"
TERMSTR=CR;

PROC IMPORT DATAFILE=REFFILE
DBMS=XLS
OUT=WORK.IMPORT;
GETNAMES=YES;
RUN;
PROC PRINT DATA=WORK.IMPORT RUN;
```

The above code reads the data from excel file and gives the same output as for the above two file types.

Reading Hierarchical Files

In these files, the data is present in hierarchical format. A given observation has a header record. Detail records are mentioned below it. The number of details records can vary from one observation to another. Following is an illustration of a hierarchical file.

In the following file, the details of each employee under each department is listed. The first record is the header record mentioning the department and the next few records starting with DTLS are the details record.

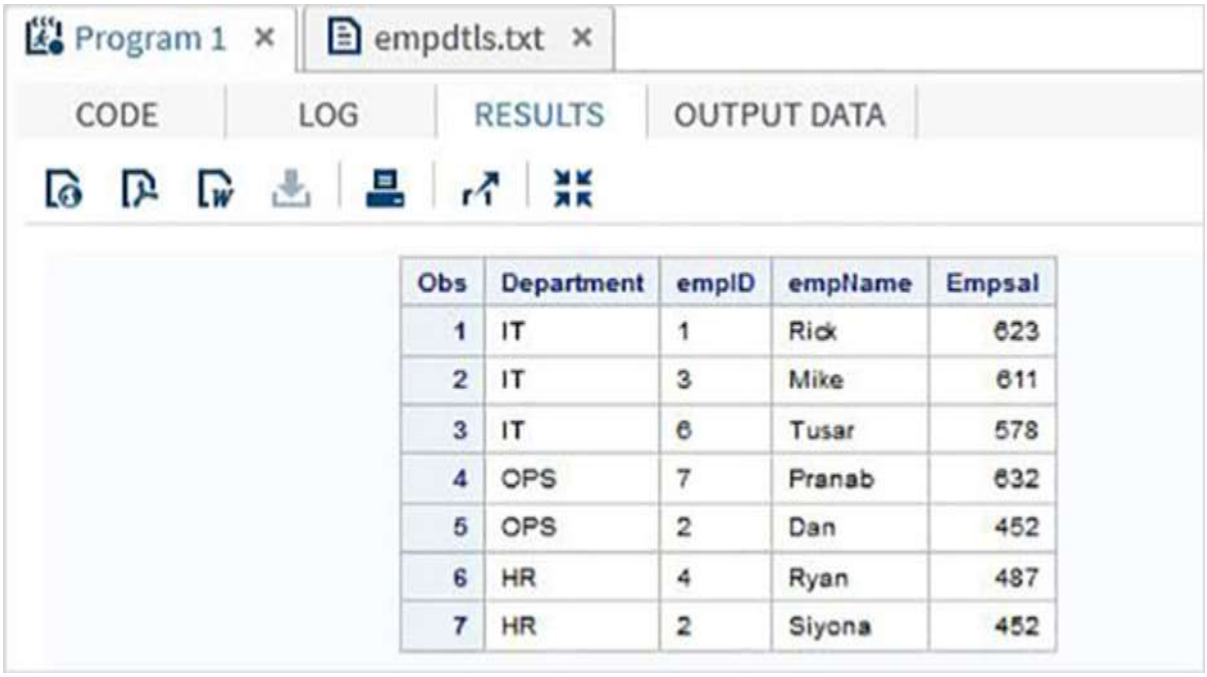
```
DEPT:IT
DTLS:1:Rick:623
DTLS:3:Mike:611
DTLS:6:Tusar:578
DEPT:OPS
DTLS:7:Pranab:632
DTLS:2:Dan:452
DEPT:HR
DTLS:4:Ryan:487
DTLS:2:Siyona:452
```

Example

To read the hierarchical file, we use the following code in which we identify the header record with an IF clause and use a Do loop to process the details record.

```
data employees(drop=Type);
   length Type $ 3  Department
          empID $ 3 empName $ 10 Empsal 3 ;
   retain Department;
   infile
   '/folders/myfolders/TutorialsPoint/empdtls.txt' dlm=':';
   input Type $ @;
   if Type='DEP' then
      input Department $;
   else do;
      input empID  empName $ Empsal ;
      output;
   end;
run;

 PROC PRINT DATA=employees;
RUN;
```

When the above code is executed, we get the following output.



Obs	Department	empID	empName	Empsal
1	IT	1	Rick	623
2	IT	3	Mike	611
3	IT	6	Tusar	578
4	OPS	7	Pranab	632
5	OPS	2	Dan	452
6	HR	4	Ryan	487
7	HR	2	Siyona	452

19. SAS – Write Data Sets

Similar to reading datasets, SAS can write datasets in different formats. It can write data from SAS files to normal text file. These files can be read by other software programs. SAS uses **PROC EXPORT** to write data sets.

PROC EXPORT

PROC EXPORT is a SAS in-built procedure. It is used to export the SAS data sets for writing the data into files of different formats.

Syntax

The basic syntax for writing the procedure in SAS is:

```
PROC EXPORT
DATA=libref.SAS data-set (SAS data-set-options)
OUTFILE="filename"
DBMS=identifier LABEL(REPLACE);
```

Following is the description of the parameters used:

- **SAS data-set** is the data set name which is being exported. SAS can share the data sets from its environment with other applications by creating files which can be read by different operating systems. It uses the inbuilt EXPORT function to out the data set files in a variety of formats. In this chapter we will see the writing of SAS data sets using **proc export** along with the options **dlm** and **dbms**.
- **SAS data-set-options** is used to specify a subset of columns to be exported.
- **filename** is the name of the file to which the data is written into.
- **identifier** is used to mention the delimiter that will be written into the file.
- **LABEL** option is used to mention the name of the variables written to the file.

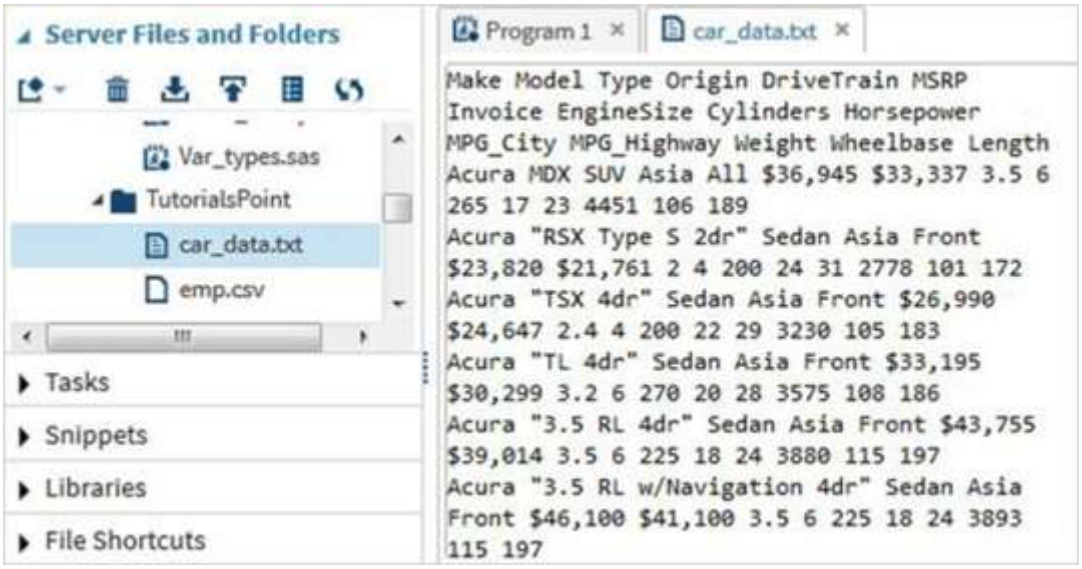
Example

We will use the SAS data set named cars available in the SASHELP library. We export it as a space delimited text file with the code as shown in the following program.

```
proc export data=sashelp.cars
   outfile=
 '/folders/myfolders/sasuser.v94/TutorialsPoint/car_data.txt'
   dbms=dlm;
   delimiter=' ';
```

```
run;
```

Upon execution of the above code, we can see the output as a text file and right-click on it to see its content as shown in the following screenshot.



Writing a CSV file

In order to write a comma delimited file, we can use the dlm option with a value "csv". The following code writes the file car_data.csv.

```
proc export data=sashelp.cars
   outfile=
 '/folders/myfolders/sasuser.v94/TutorialsPoint/car_data.csv'
   dbms=csv;
  run;
```

On executing the above code, we get the following output.


car_data.csv

```
Make,Model,Type,Origin,DriveTrain,MSRP,Invoice,EngineSize,Cylinders,Horsepow
er,MPG_City,MPG_Highway,Weight,Wheelbase,Length
Acura,MDX,SUV,Asia,All,"$36,945","$33,337",3.5,6,265,17,23,4451,106,189
Acura,RSX Type S
2dr,Sedan,Asia,Front,"$23,820","$21,761",2,4,200,24,31,2778,101,172
Acura,TSX
4dr,Sedan,Asia,Front,"$26,990","$24,647",2.4,4,200,22,29,3230,105,183
Acura,TL
4dr,Sedan,Asia,Front,"$33,195","$30,299",3.2,6,270,20,28,3575,108,186
Acura,3.5 RL
4dr,Sedan,Asia,Front,"$43,755","$39,014",3.5,6,225,18,24,3880,115,197
Acura,3.5 RL w/Navigation
4dr,Sedan,Asia,Front,"$46,100","$41,100",3.5,6,225,18,24,3893,115,197
Acura,NSX coupe 2dr manual
S,Sports,Asia,Rear,"$89,765","$79,978",3.2,6,290,17,24,3153,100,174
Audi,A4 1.8T
4dr,Sedan,Europe,Front,"$25,940","$23,508",1.8,4,170,22,31,3252,104,179
Audi,A41.8T convertible
2dr,Sedan,Europe,Front,"$35,940","$32,506",1.8,4,170,23,30,3638,105,180
Audi,A4 3.0
```

Writing a Tab Delimited File

In order to write a tab delimited file, we can use the **dlm** option with a value "tab". The following code writes the file **car_tab.txt**.

```
proc export data=sashelp.cars
   outfile=
 '/folders/myfolders/sasuser.v94/TutorialsPoint/car_tab.txt'
   dbms=csv;
  run;
```

Data can also be written as HTML file which we will see under the output delivery system chapter.

20. SAS – Concatenate Data Sets

Multiple SAS data sets can be concatenated to give a single data set using the **SET** statement. The total number of observations in the concatenated data set is the sum of the number of observations in the original data sets. The order of observations is sequential. All observations from the first data set are followed by all observations from the second data set, and so on.

Ideally all the combining data sets have same variables, but in case they have different number of variables, then in the result all the variables appear, with missing values for the smaller data set.

Syntax

The basic syntax for the SET statement in SAS is:

```
SET data-set 1 data-set 2 data-set 3.....;
```

Following is the description of the parameters used:

- **data-set1, data-set2** are dataset names written one after another.

Example

Consider the employee data of an organization which is available in two different data sets, one for the IT department and another for the Non-IT department. To get the complete details of all the employees, we concatenate both the data sets using the SET statement as shown in the following program.

```
DATA ITDEPT;
  INPUT empid name $ salary  ;
DATALINES;
1 Rick 623.3
3 Mike 611.5
6 Tusar 578.6
;
RUN;
DATA NON_ITDEPT;
  INPUT empid name $ salary  ;
DATALINES;
2 Dan 515.2
4 Ryan 729.1
5 Gary 843.25
7 Pranab 632.8
```

```
8 Rasmi 722.5
RUN;
```

```
DATA All_Dept;
  SET ITDEPT NON_ITDEPT;
RUN;
PROC PRINT DATA=All_Dept;
RUN;
```

When the above code is executed, we get the following output.

Obs	empid	name	salary
1	1	Rick	623.30
2	3	Mike	611.50
3	6	Tusar	578.60
4	2	Dan	515.20
5	4	Ryan	729.10
6	5	Gary	843.25
7	7	Pranab	632.80
8	8	Rasmi	722.50

Scenarios

When we have many variations in the data sets for concatenation, the result of variables can differ but the total number of observations in the concatenated data set is always the sum of the observations in each data set. Let us now consider different scenarios on this variation.

Different number of variables

If one of the original data sets has more number of variables than another, then the data sets still get combined but in the smaller data set those variables appear as missing.

Example

In the following example, the first data set has an extra variable named DOJ. In the result, the value of DOJ for the second data set will appear as missing.

```
DATA ITDEPT;
  INPUT empid name $ salary DOJ date9.  ;
DATALINES;
1 Rick 623.3 02APR2001
3 Mike 611.5 21OCT2000
6 Tusar 578.6 01MAR2009
;
RUN;
DATA NON_ITDEPT;
  INPUT empid name $ salary  ;
DATALINES;
2 Dan 515.2
4 Ryan 729.1
5 Gary 843.25
7 Pranab 632.8
8 Rasmi 722.5
RUN;
DATA All_Dept;
  SET ITDEPT NON_ITDEPT;
RUN;
PROC PRINT DATA=All_Dept;
RUN;
```

When the above code is executed, we get the following output.

Obs	empid	name	salary	DOJ
1	1	Rick	623.30	15067
2	3	Mike	611.50	14904
3	6	Tusar	578.60	17957
4	2	Dan	515.20	.
5	4	Ryan	729.10	.
6	5	Gary	843.25	.
7	7	Pranab	632.80	.
8	8	Rasmi	722.50	.

Different variable name

In this scenario, the data sets have the same number of variables but a variable name differs between them. In that case, a normal concatenation will produce all the variables in the result set. This normal concatenation will also give missing results for the two variables which differ. While we may not change the variable name in the original data sets we can apply the RENAME function in the concatenated data set we create. That will produce the same result as a normal concatenation but of course with one new variable name in place of two different variable names present in the original data set.

Example

In the following example, data set ITDEPT has the variable name **ename** whereas, the data set **NON_ITDEPT** has the variable name **empname**. Both of these variables represent the same type(character). We apply the **RENAME** function in the SET statement as shown in the following program.

```
DATA ITDEPT;
  INPUT empid ename $ salary  ;
DATALINES;
1 Rick 623.3
3 Mike 611.5
6 Tusar 578.6
;
RUN;
DATA NON_ITDEPT;
  INPUT empid empname $ salary  ;
DATALINES;
2 Dan 515.2
4 Ryan 729.1
5 Gary 843.25
7 Pranab 632.8
8 Rasmi 722.5
RUN;
DATA All_Dept;
  SET ITDEPT(RENAME =(ename=Employee) ) NON_ITDEPT(RENAME =(empname=Employee)
);
RUN;
PROC PRINT DATA=All_Dept;
RUN;
```

When the above code is executed, we get the following output.

Obs	empid	Employee	salary
1	1	Rick	623.30
2	3	Mike	611.50
3	6	Tusar	578.60
4	2	Dan	515.20
5	4	Ryan	729.10
6	5	Gary	843.25
7	7	Pranab	632.80
8	8	Rasmi	722.50

Different variable lengths

If the variable lengths in the two data sets are different than the concatenated data set will have values in which some data is truncated for the variable with smaller length. It happens if the first data set has a smaller length. To solve this, we apply the higher length to both the data set as shown in the following example.

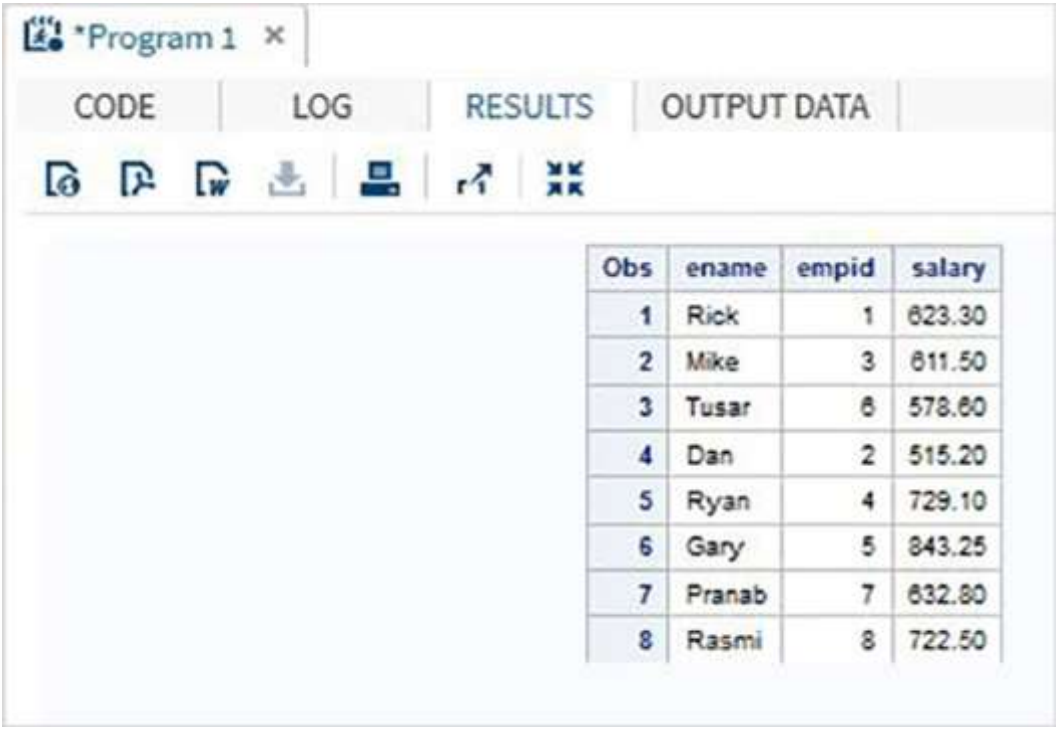
Example

In the following example, the variable **ename** is of length 5 in the first data set and 7 in the second. When concatenating, we apply the LENGTH statement in the concatenated data set to set the ename length to 7.

```
DATA ITDEPT;
  INPUT  empid 1-2 ename $ 3-7 salary 8-14  ;
DATALINES;
1 Rick  623.3
3 Mike  611.5
6 Tusar 578.6
;
RUN;
DATA NON_ITDEPT;
  INPUT  empid 1-2 ename $ 3-9  salary 10-16 ;

DATALINES;
```

```
2 Dan    515.2
4 Ryan   729.1
5 Gary   843.25
7 Pranab 632.8
8 Rasmi  722.5
RUN;
DATA All_Dept;
      LENGTH ename $ 7   ;
  SET ITDEPT  NON_ITDEPT ;
RUN;
PROC PRINT DATA=All_Dept;
RUN;
```

When the above code is executed, we get the following output.



Obs	ename	empid	salary
1	Rick	1	623.30
2	Mike	3	611.50
3	Tusar	6	578.60
4	Dan	2	515.20
5	Ryan	4	729.10
6	Gary	5	843.25
7	Pranab	7	632.80
8	Rasmi	8	722.50

21. SAS – Merge Data Sets

Multiple SAS data sets can be merged based on a specific common variable to give a single data set. This is done using the **MERGE** statement and the **BY** statement. The total number of observations in the merged data set is often less than the sum of the number of observations in the original data sets. It is because, the variables from both data sets get merged as one record. This is when there is a match in the value of the common variable.

Following are the two prerequisites for merging the data sets:

- input data sets must have at least one common variable to merge on.
- input data sets must be sorted by the common variable(s) that will be used to merge on.

Syntax

The basic syntax for MERGE and BY statement in SAS is:

```
MERGE Data-Set 1 Data-Set 2
BY Common Variable
```

Following is the description of the parameters used:

- **Data-set1, Data-set2** are data set names written one after another.
- **Common Variable** is the variable based on whose matching values the data sets will be merged.

Data Merging

Let us understand data merging with the help of an example.

Example

Consider two SAS data sets one containing the employee ID with name and salary and another containing the employee ID and the department. To get the complete information for each employee as in this case, we can merge these two data sets. The final data set will still have one observation per employee but it will contain both the salary and the department variables.

```
# Data set 1
ID NAME SALARY
1 Rick 623.3
2 Dan 515.2
3 Mike 611.5
```

```
4 Ryan 729.1
5 Gary 843.25
6 Tusar 578.6
7 Pranab 632.8
8 Rasmi 722.5

# Data set 2
ID DEPT
1 IT
2 OPS
3 IT
4 HR
5 FIN
6 IT
7 OPS
8 FIN

# Merged data set
ID NAME SALARY DEPT
1 Rick 623.3      IT
2 Dan 515.2       OPS
3 Mike 611.5      IT
4 Ryan 729.1    HR
5 Gary 843.25   FIN
6 Tusar 578.6   IT
7 Pranab 632.8  OPS
8 Rasmi 722.5   FIN
```

The above result is achieved by using the following code in which the common variable (ID) is used in the BY statement. Please note that the observations in both the datasets are already sorted in the ID column.

```
DATA SALARY;
  INPUT empid name $ salary  ;
DATALINES;
1 Rick 623.3
2 Dan 515.2
3 Mike 611.5
4 Ryan 729.1
```

```
5 Gary 843.25
6 Tusar 578.6
7 Pranab 632.8
8 Rasmi 722.5
;
RUN;
DATA DEPT;
  INPUT empid dEPT $ ;
DATALINES;
1 IT
2 OPS
3 IT
4 HR
5 FIN
6 IT
7 OPS
8 FIN
;
RUN;
DATA All_details;
MERGE SALARY DEPT;
BY (empid);
RUN;
PROC PRINT DATA=All_details;
RUN;
```

Missing values in the matching column

There may be cases when some values of the common variable will not match between the data sets. In such cases, the data sets still get merged but give missing values in the result.

Example

Consider the case of employee ID 3 missing from the dataset salary and employee ID 6 missing form data set DEPT. When the above code is applied, we get the following result.

```
ID NAME SALARY DEPT
1 Rick 623.3      IT
2 Dan 515.2       OPS
3 .         .            IT
```

```
4 Ryan 729.1    HR
5 Gary 843.25   FIN
6 Tusar 578.6   .
7 Pranab 632.8  OPS
8 Rasmi 722.5   FIN
```

Merging only the matches

To avoid the missing values in the result, we can consider keeping only the observations with matched values for the common variable. That is achieved by using the **IN** statement. The merge statement of the SAS program needs to be changed.

Example

In the following example, the **IN=** value keeps only the observations where the values from both the data sets **SALARY** and **DEPT** match.

```
DATA All_details;
MERGE SALARY(IN=a) DEPT(IN=b);
BY (empid);
IF a=1 and b=1;
RUN;
PROC PRINT DATA=All_details;
RUN;
```

Upon execution of the above SAS program with the above changed part, we get the following output.

```
1 Rick 623.3      IT
2 Dan 515.2       OPS
4 Ryan 729.1    HR
5 Gary 843.25   FIN
7 Pranab 632.8  OPS
8 Rasmi 722.5   FIN
```

22. SAS – Subsetting Data Sets

Subsetting a SAS data set means extracting a part of the data set by selecting fewer number of variables or fewer number of observations or both. While subsetting of variables is done by using the **KEEP** and the **DROP** statement, the subsetting of observations is done using the **DELETE** statement. Also the resulting data from the subsetting operation is held in a new data set which can be used for further analysis. Subsetting is mainly used for the purpose of analyzing a part of the data set without using those variables or observations which may not be relevant to the analysis.

Subsetting Variables

In this method, we extract only few variables from the entire data set.

Syntax

The basic syntax for subsetting variables in SAS is:

```
KEEP var1 var2 ... ;
DROP var1 var2 ... ;
```

Following is the description of the parameters used:

- **var1 and var2** are the variable names from the data set which needs to be kept or dropped.

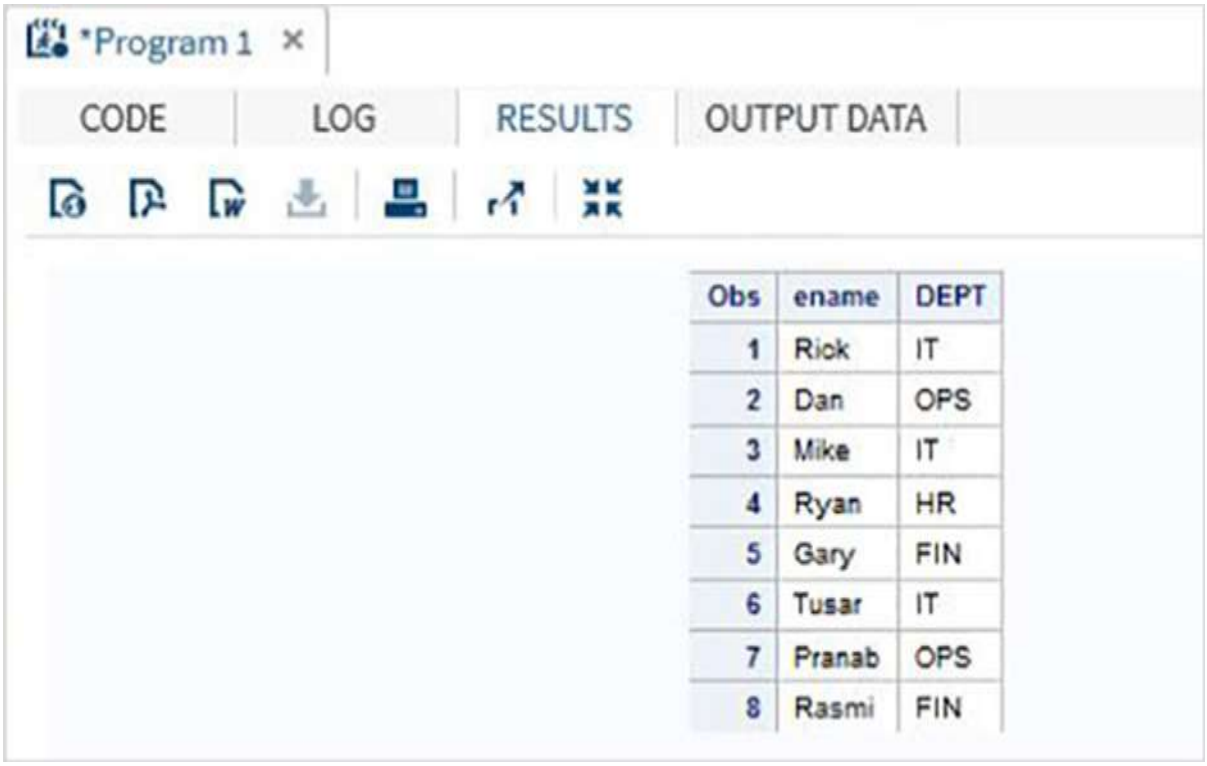
Example

Consider the following SAS data set containing the employee details of an organization. If we are interested only in getting the Name and Department values from the data set, then we can use the code given below.

```
DATA Employee;
  INPUT empid ename $ salary DEPT $ ;
DATALINES;
1 Rick 623.3      IT
2 Dan 515.2       OPS
3 Mike 611.5      IT
4 Ryan 729.1    HR
5 Gary 843.25   FIN
6 Tusar 578.6   IT
7 Pranab 632.8  OPS
8 Rasmi 722.5   FIN
;
```

```
RUN;
DATA OnlyDept;
 SET Employee;
 KEEP ename DEPT;
  RUN;
 PROC PRINT DATA=OnlyDept;
RUN;
```

When the above code is executed, we get the following output.



Obs	ename	DEPT
1	Rick	IT
2	Dan	OPS
3	Mike	IT
4	Ryan	HR
5	Gary	FIN
6	Tusar	IT
7	Pranab	OPS
8	Rasmi	FIN

The same result can be obtained by dropping the variables that are not required. The following code illustrates this.

```
DATA Employee;
  INPUT empid ename $ salary DEPT $ ;
DATALINES;
1 Rick 623.3      IT
2 Dan 515.2       OPS
3 Mike 611.5      IT
4 Ryan 729.1    HR
5 Gary 843.25   FIN
6 Tusar 578.6   IT
7 Pranab 632.8  OPS
```

```
8 Rasmi 722.5   FIN
;
RUN;
DATA OnlyDept;
 SET Employee;
 DROP empid salary;
  RUN;
 PROC PRINT DATA=OnlyDept;
RUN;
```

Subsetting Observations

In this method, we extract only few observations from the entire data set.

Syntax

We use PROC FREQ which keeps track of the observations selected for the new data set.

The syntax for subsetting observations is:

```
IF Var Condition THEN DELETE ;
```

Following is the description of the parameters used:

- **Var** is the name of the variable based on whose value the observations will be deleted using the specified condition.

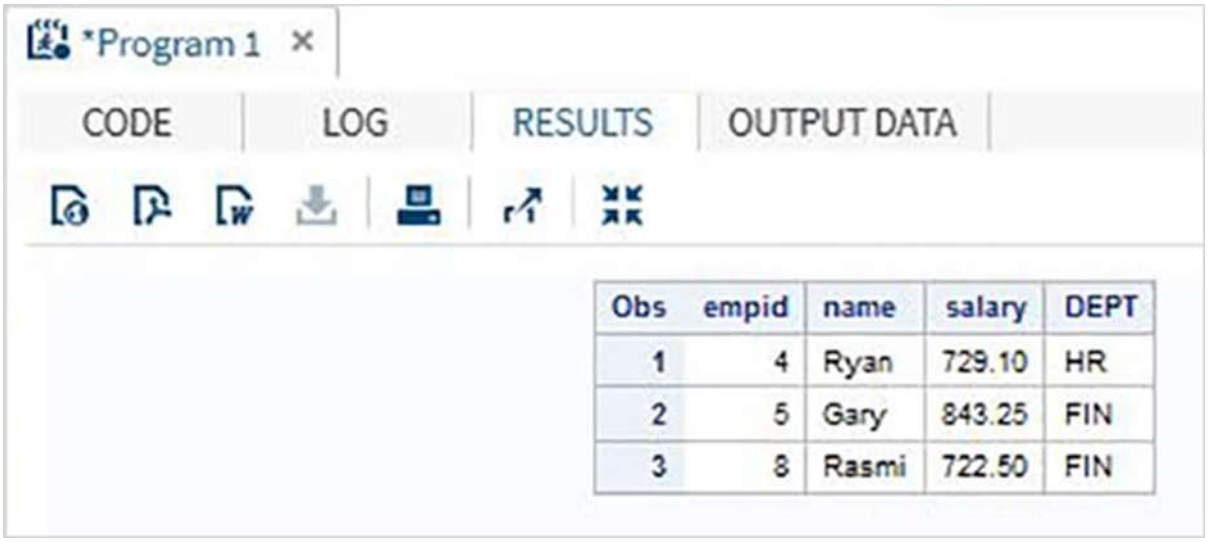
Example

Consider the following SAS data set containing the employee details of an organization. If we are interested only in getting the data for employees with salary greater than 700, then we use the following code.

```
DATA Employee;
  INPUT empid name $ salary DEPT $ ;
DATALINES;
1 Rick 623.3      IT
2 Dan 515.2       OPS
3 Mike 611.5      IT
4 Ryan 729.1    HR
5 Gary 843.25   FIN
6 Tusar 578.6   IT
7 Pranab 632.8  OPS
8 Rasmi 722.5   FIN
;
```

```
RUN;
DATA OnlyDept;
 SET Employee;
 IF salary < 700 THEN DELETE;
  RUN;
 PROC PRINT DATA=OnlyDept;
RUN;
```

When the above code is executed, we get the following output.



Obs	empid	name	salary	DEPT
1	4	Ryan	729.10	HR
2	5	Gary	843.25	FIN
3	8	Rasmi	722.50	FIN

23. SAS – Sort Data Sets

Data sets in SAS can be sorted on any of the variables present in them. This helps both in data analysis and performing other options like merging etc. Sorting can happen on any single variable as well as multiple variables. The SAS procedure used to carry out the sorting in SAS data set is named **PROC SORT**. The result after sorting is stored in a new data set and the original data set remains unchanged.

Syntax

The basic syntax for sort operation in data set in SAS is:

```
PROC SORT DATA=original dataset OUT=Sorted dataset;
  BY variable name;
```

Following is the description of the parameters used:

- **variable name** is the column name on which the sorting happens.
- **Original dataset** is the dataset name to be sorted.
- **Sorted dataset** is the dataset name after it is sorted.

Example

Let's consider the following SAS data set containing the employee details of an organization. We can sort the data set on salary by using the code given below.

```
DATA Employee;
  INPUT empid name $ salary DEPT $ ;
DATALINES;
1 Rick 623.3      IT
2 Dan 515.2       OPS
3 Mike 611.5      IT
4 Ryan 729.1    HR
5 Gary 843.25   FIN
6 Tusar 578.6   IT
7 Pranab 632.8  OPS
8 Rasmi 722.5   FIN
;
RUN;

PROC SORT DATA=Employee OUT=Sorted_sal ;
  BY salary;
```

```
RUN ;

PROC PRINT DATA=Sorted_sal;
RUN ;
```

When the above code is executed, we get the following output.

Obs	empid	name	salary	DEPT
1	2	Dan	515.20	OPS
2	6	Tusar	578.60	IT
3	3	Mike	611.50	IT
4	1	Rick	623.30	IT
5	7	Pranab	632.80	OPS
6	8	Rasmi	722.50	FIN
7	4	Ryan	729.10	HR
8	5	Gary	843.25	FIN

Reverse Sorting

The default sorting option is in ascending order, which means the observations are arranged as per lower to higher value of the sorted variable. But we may also want the sorting to happen in ascending order.

Example

In the following code, reverse sorting is achieved by using the DESCENDING statement.

```
DATA Employee;
  INPUT empid name $ salary DEPT $ ;
DATALINES;
1 Rick 623.3       IT
2 Dan 515.2        OPS
3 Mike 611.5       IT
4 Ryan 729.1     HR
5 Gary 843.25    FIN
6 Tusar 578.6    IT
```

```
7 Pranab 632.8  OPS
8 Rasmi 722.5   FIN
;
RUN;

PROC SORT DATA=Employee OUT=Sorted_sal_reverse ;
  BY DESCENDING salary;
RUN ;

PROC PRINT DATA=Sorted_sal_reverse;
RUN ;
```

When the above code is executed, we get the following output.

Obs	empid	name	salary	DEPT
1	2	Dan	515.20	OPS
2	6	Tusar	578.60	IT
3	3	Mike	611.50	IT
4	1	Rick	623.30	IT
5	7	Pranab	632.80	OPS
6	8	Rasmi	722.50	FIN
7	4	Ryan	729.10	HR
8	5	Gary	843.25	FIN

Sorting Multiple Variables

Sorting can be applied to multiple variables by using them with the **BY** statement. The variables get sorted with a priority from left to right.

Example

In the following code, the data set is sorted first on the variable department name and next on the variable name salary.

```
DATA Employee;
  INPUT empid name $ salary DEPT $ ;

DATALINES;
```

```
1 Rick 623.3       IT
2 Dan 515.2        OPS
3 Mike 611.5       IT
4 Ryan 729.1     HR
5 Gary 843.25    FIN
6 Tusar 578.6    IT
7 Pranab 632.8   OPS
8 Rasmi 722.5    FIN
;
RUN;

PROC SORT DATA=Employee OUT=Sorted_dept_sal ;
  BY salary DEPT;
RUN ;

PROC PRINT DATA=Sorted_dept_sal;
RUN ;
```

When the above code is executed, we get the following output.

Obs	empid	name	salary	DEPT
1	2	Dan	515.20	OPS
2	6	Tusar	578.60	IT
3	3	Mike	611.50	IT
4	1	Rick	623.30	IT
5	7	Pranab	632.80	OPS
6	8	Rasmi	722.50	FIN
7	4	Ryan	729.10	HR
8	5	Gary	843.25	FIN

24. SAS – Format Data Sets

In this chapter, we will discuss the Format Data Sets. Sometimes we prefer to show the analyzed data in a format which is different from the format in which it is already present in the data set. For example, we want to add the dollar sign and two decimal places to a variable which has price information. Or we may want to show a text variable, all in uppercase. We can use **FORMAT** to apply the in-built SAS formats and the **PROC FORMAT**, to apply user-defined formats. Also a single format can be applied to multiple variables.

Syntax

The basic syntax for applying in-built SAS formats is:

```
format variable name format name
```

Following is the description of the parameters used:

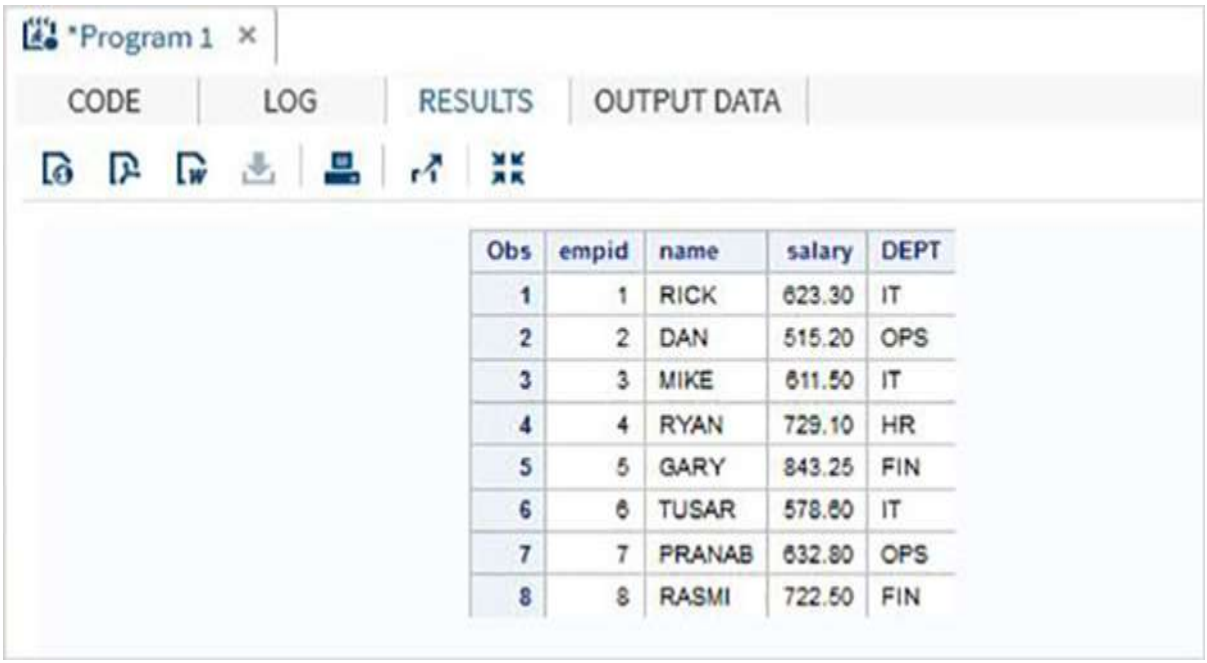
- **variable name** is the variable name used in dataset.
- **format name** is the data format to be applied on the variable.

Example

Let's consider the following SAS data set containing the employee details of an organization. We wish to show all the names in uppercase. The **formatstatement** is used to achieve this.

```
DATA Employee;
  INPUT empid name $ salary DEPT $ ;
  format name $upcase9. ;
DATALINES;
1 Rick 623.3      IT
2 Dan 515.2       OPS
3 Mike 611.5      IT
4 Ryan 729.1    HR
5 Gary 843.25   FIN
6 Tusar 578.6   IT
7 Pranab 632.8  OPS
8 Rasmi 722.5   FIN
;
RUN;
 PROC PRINT DATA=Employee;
RUN;
```

When the above code is executed, we get the following output.



Obs	empid	name	salary	DEPT
1	1	RICK	623.30	IT
2	2	DAN	515.20	OPS
3	3	MIKE	611.50	IT
4	4	RYAN	729.10	HR
5	5	GARY	843.25	FIN
6	6	TUSAR	578.60	IT
7	7	PRANAB	632.80	OPS
8	8	RASMI	722.50	FIN

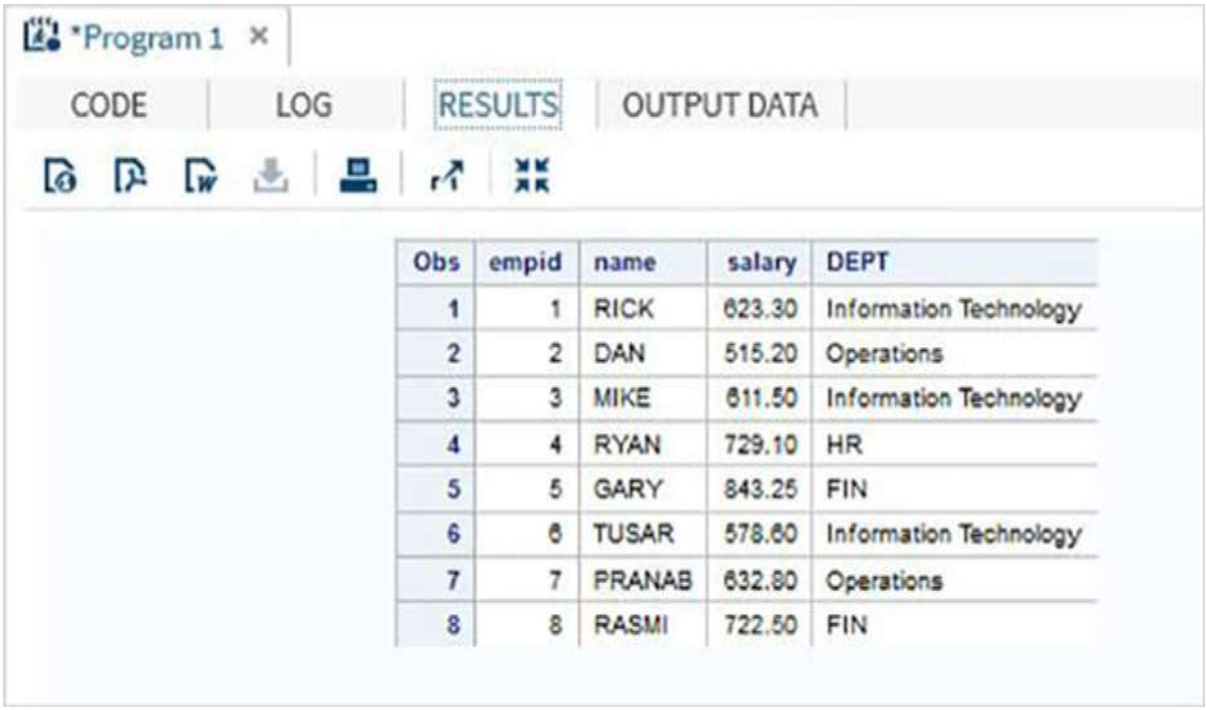
Using PROC FORMAT

We can also use **PROC FORMAT** to format data. In the following example, we assign new values to the variable DEPT expanding the name of the department.

```
DATA Employee;
  INPUT empid name $ salary DEPT $ ;

DATALINES;
1 Rick 623.3 IT
2 Dan 515.2 OPS
3 Mike 611.5 IT
4 Ryan 729.1 HR
5 Gary 843.25 FIN
6 Tusar 578.6 IT
7 Pranab 632.8 OPS
8 Rasmi 722.5 FIN
;
proc format;
value $DEP 'IT' = 'Information Technology'
      'OPS'= 'Operations' ;
RUN;
 PROC PRINT DATA=Employee;
```

```
 format name $upcase9. DEPT $DEP.;
RUN;
```

When the above code is executed, we get the following output.



Obs	empid	name	salary	DEPT
1	1	RICK	623.30	Information Technology
2	2	DAN	515.20	Operations
3	3	MIKE	611.50	Information Technology
4	4	RYAN	729.10	HR
5	5	GARY	843.25	FIN
6	6	TUSAR	578.60	Information Technology
7	7	PRANAB	632.80	Operations
8	8	RASMI	722.50	FIN

25. SAS – SQL

SAS offers extensive support to most of the popular relational databases by using SQL queries inside SAS programs. Most of the **ANSI SQL** syntax is supported. The procedure **PROC SQL** is used to process the SQL statements. This procedure can not only give back the result of an SQL query; it can also create SAS tables & variables. The example of all these scenarios is described below.

Syntax

The basic syntax for using PROC SQL in SAS is:

```
PROC SQL;
SELECT Columns
FROM TABLE
WHERE Columns
GROUP BY Columns
;
QUIT;
```

Following is the description of the parameters used:

- the SQL query is written below the PROC SQL statement followed by the QUIT statement.

We will now see how this SAS procedure can be used for the **CRUD** (Create, Read, Update and Delete) operations in SQL.

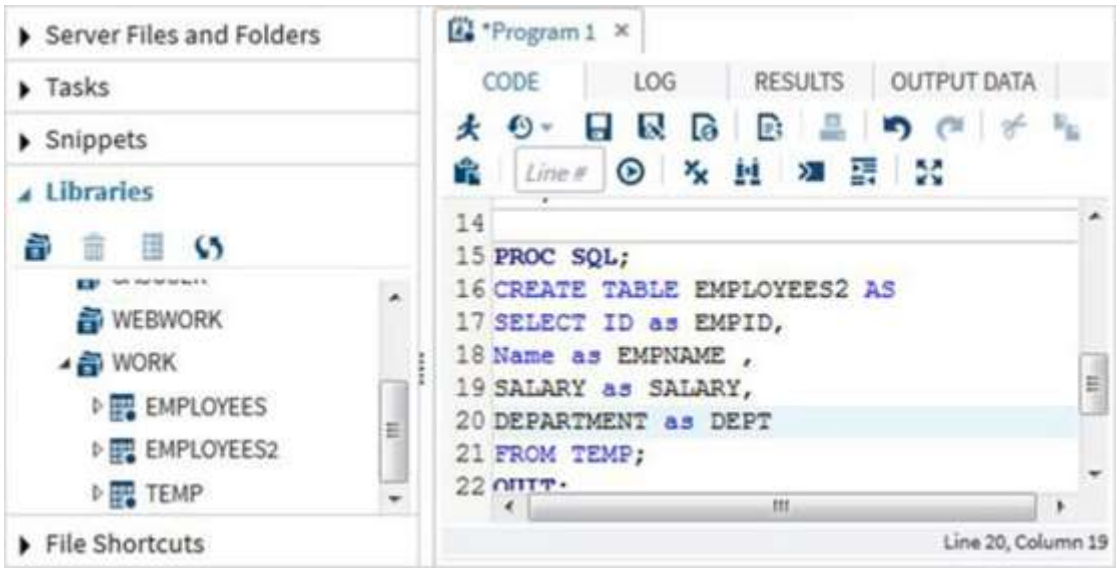
SQL Create Operation

Using SQL, we can create new data set from the raw data. In the following example, first we declare a data set named TEMP containing the raw data. Then we write an SQL query to create a table from the variables of this data set.

```
DATA TEMP;
INPUT ID $ NAME $ SALARY DEPARTMENT $;
DATALINES;
1 Rick 623.3 IT
2 Dan 515.2 Operations
3 Michelle 611 IT
4 Ryan 729 HR
5 Gary 843.25 Finance
6 Nina 578 IT
```

```
7 Simon 632.8 Operations
8 Guru 722.5 Finance
;
RUN;

PROC SQL;
CREATE TABLE EMPLOYEES AS
SELECT * FROM TEMP;
QUIT;

PROC PRINT data = EMPLOYEES;
RUN;
```

When the above code is executed we get the following result:

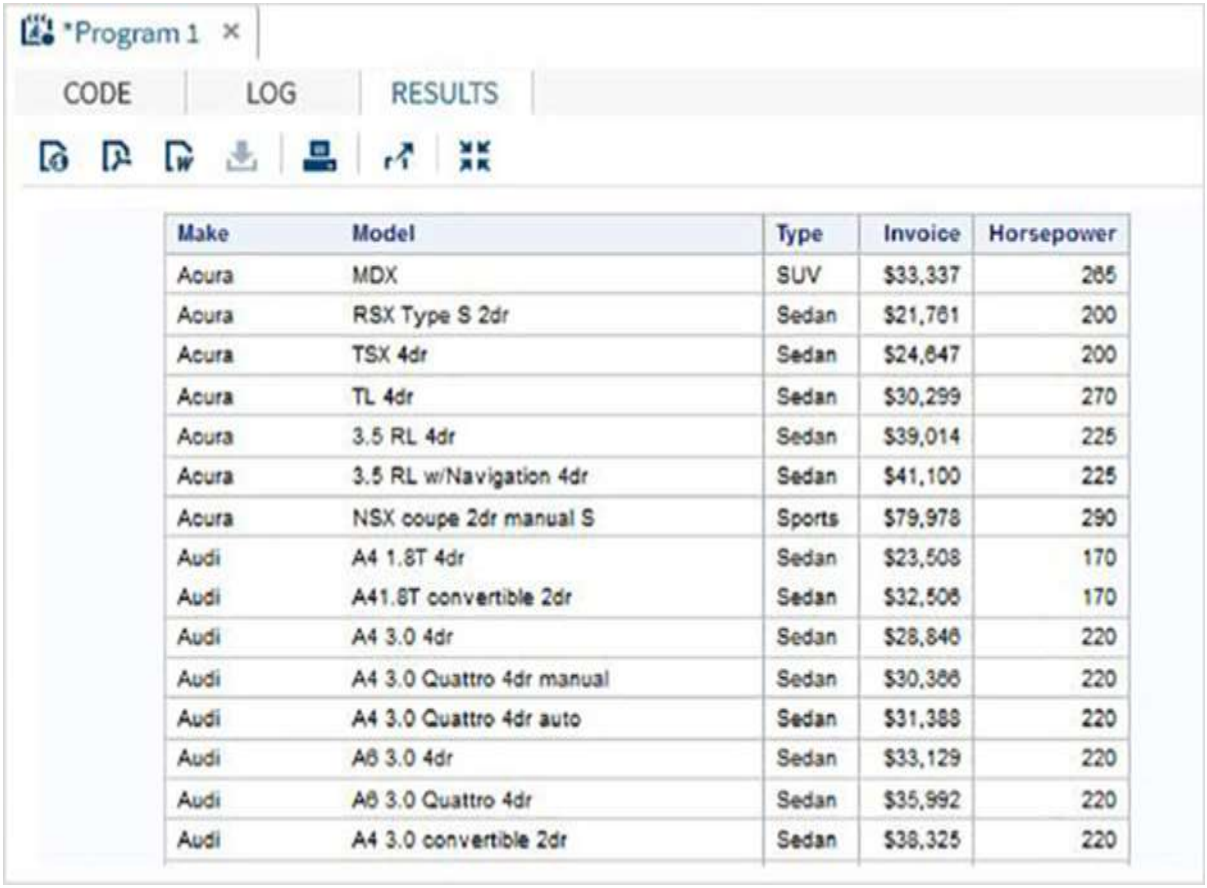


SQL Read Operation

The Read operation in SQL involves writing SQL SELECT queries to read the data from the tables. In the program given below, queries the SAS data set named CARS available in the library SASHELP. The query fetches some of the columns of the data set.

```
PROC SQL;
SELECT make,model,type,invoice,horsepower
 FROM
SASHELP.CARS
;
QUIT;
```

When the above code is executed, we get the following result:


*Program 1

CODE | LOG | RESULTS

Make	Model	Type	Invoice	Horsepower
Acura	MDX	SUV	$33,337	265
Acura	RSX Type S 2dr	Sedan	$21,761	200
Acura	TSX 4dr	Sedan	$24,647	200
Acura	TL 4dr	Sedan	$30,299	270
Acura	3.5 RL 4dr	Sedan	$39,014	225
Acura	3.5 RL w/Navigation 4dr	Sedan	$41,100	225
Acura	NSX coupe 2dr manual S	Sports	$79,978	290
Audi	A4 1.8T 4dr	Sedan	$23,508	170
Audi	A41.8T convertible 2dr	Sedan	$32,506	170
Audi	A4 3.0 4dr	Sedan	$28,846	220
Audi	A4 3.0 Quattro 4dr manual	Sedan	$30,366	220
Audi	A4 3.0 Quattro 4dr auto	Sedan	$31,388	220
Audi	A6 3.0 4dr	Sedan	$33,129	220
Audi	A6 3.0 Quattro 4dr	Sedan	$35,992	220
Audi	A4 3.0 convertible 2dr	Sedan	$38,325	220

SQL SELECT with WHERE Clause

The following program queries the CARS data set with a **Where** clause. In the result, we get only the observation which have make as 'Audi' and type as 'Sports'.

```
PROC SQL;
SELECT make,model,type,invoice,horsepower
 FROM
SASHELP.CARS
Where make = 'Audi'
and Type = 'Sports'
;
QUIT;
```

When the above code is executed, we get the following result:

Make	Model	Type	Invoice	Horsepower
Audi	RS 6 4dr	Sports	$76,417	450
Audi	TT 1.8 convertible 2dr (coupe)	Sports	$32,512	180
Audi	TT 1.8 Quattro 2dr (convertible)	Sports	$33,891	225
Audi	TT 3.2 coupe 2dr (convertible)	Sports	$36,739	250

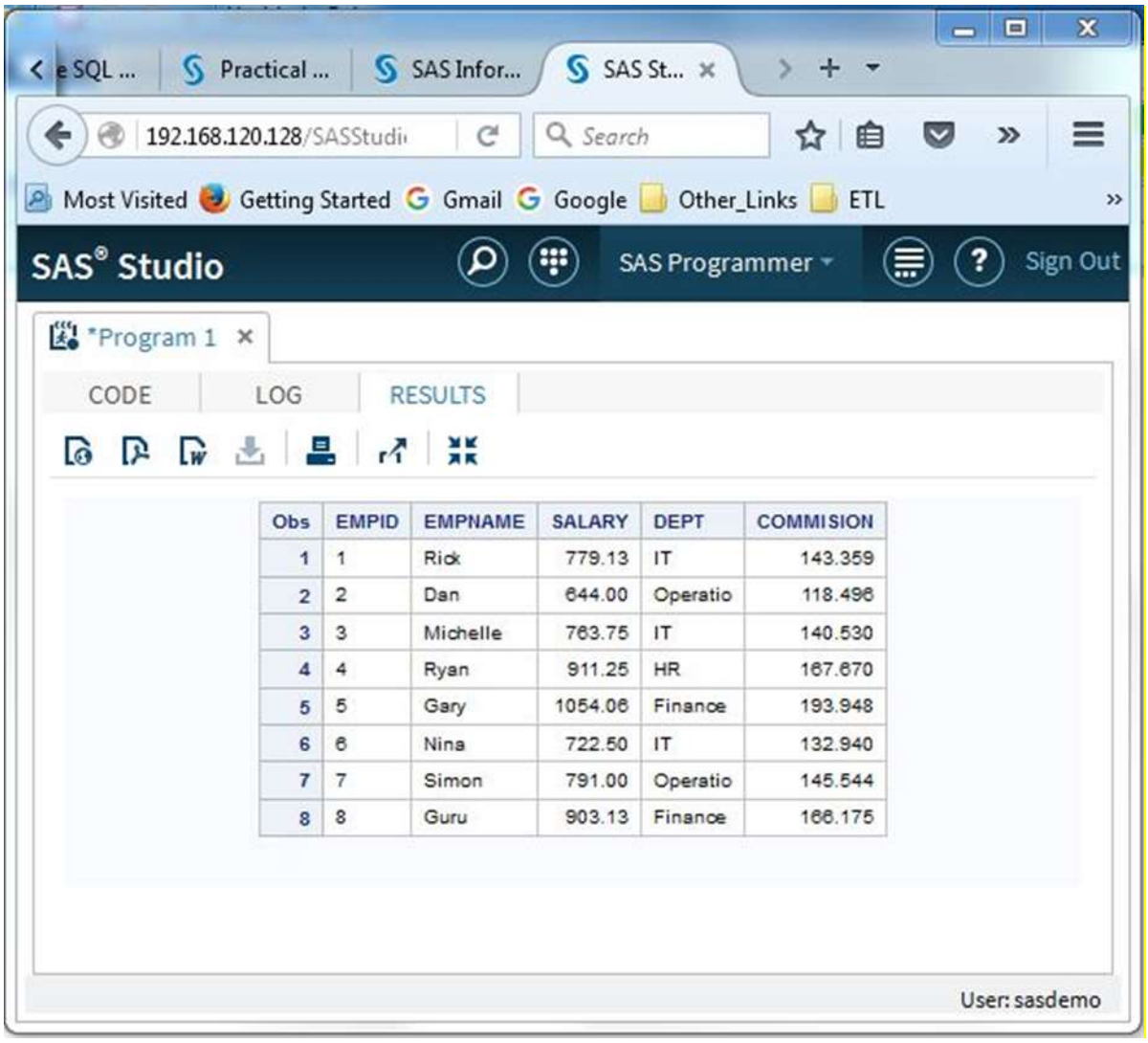
SQL UPDATE Operation

We can update the SAS table using the SQL Update statement. We will first create a new table named EMPLOYEES2 and then update it using the SQL UPDATE statement.

```
DATA TEMP;
INPUT ID $ NAME $ SALARY DEPARTMENT $;
DATALINES;
1 Rick 623.3 IT
2 Dan 515.2 Operations
3 Michelle 611 IT
4 Ryan 729 HR
5 Gary 843.25 Finance
6 Nina 578 IT
7 Simon 632.8 Operations
8 Guru 722.5 Finance
;
RUN;

PROC SQL;
CREATE TABLE EMPLOYEES2 AS
SELECT ID as EMPID,
Name as EMPNAME ,
SALARY as SALARY,
DEPARTMENT as DEPT,
SALARY*0.23 as COMMISION
FROM TEMP;
```

```
QUIT;

PROC SQL;
UPDATE EMPLOYEES2
      SET SALARY=SALARY*1.25;
 QUIT;
     PROC PRINT data = EMPLOYEES2;
RUN;
```

When the above code is executed, we get the following result:



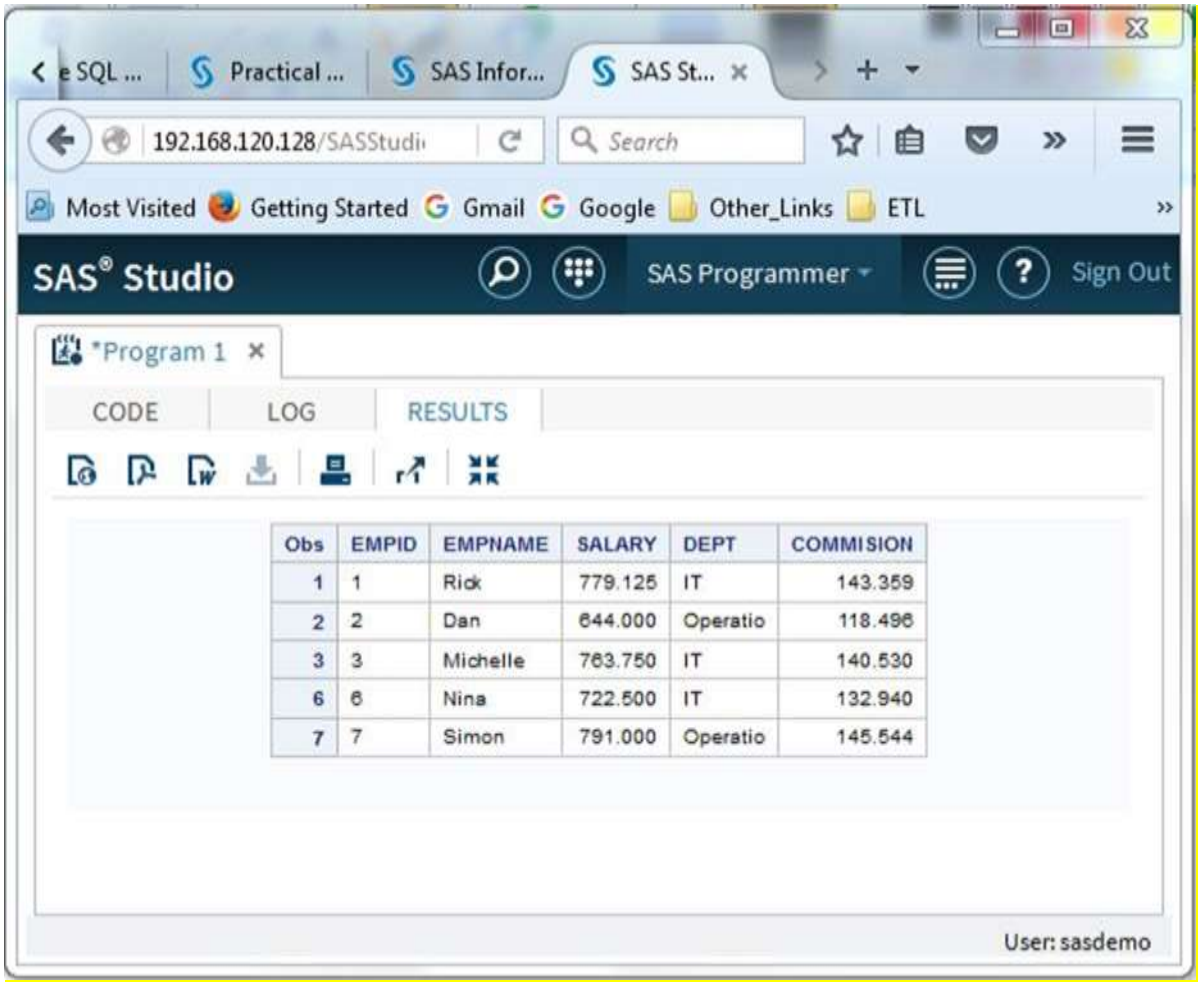
Obs	EMPID	EMPNAME	SALARY	DEPT	COMMISION
1	1	Rick	779.13	IT	143.359
2	2	Dan	644.00	Operatio	118.496
3	3	Michelle	763.75	IT	140.530
4	4	Ryan	911.25	HR	167.670
5	5	Gary	1054.06	Finance	193.948
6	6	Nina	722.50	IT	132.940
7	7	Simon	791.00	Operatio	145.544
8	8	Guru	903.13	Finance	166.175

SQL DELETE Operation

The delete operation in SQL involves removing certain values from the table using the SQL DELETE statement. We continue to use the data from the above example and delete the rows from the table in which the salary of the employees is greater than 900.

```
PROC SQL;
DELETE FROM EMPLOYEES2
      WHERE SALARY > 900;
QUIT;
      PROC PRINT data = EMPLOYEES2;
RUN;
```

When the above code is executed, we get the following result:



Obs	EMPID	EMPNAME	SALARY	DEPT	COMMISION
1	1	Rick	779.125	IT	143.359
2	2	Dan	644.000	Operatio	118.496
3	3	Michelle	763.750	IT	140.530
6	6	Nina	722.500	IT	132.940
7	7	Simon	791.000	Operatio	145.544

26. SAS – ODS

The output from a SAS program can be converted to more user-friendly forms like **.html** or **PDF**. This is done by using the **ODS** statement available in SAS. ODS stands for **Output Delivery System**. It is mostly used to format the output data of a SAS program to nice reports which are good to look at and understand. That also helps sharing the output with other platforms and software. It can also combine the results from multiple PROC statements in one single file.

Syntax

The basic syntax for using the ODS statement in SAS is:

```
ODS outputtype
PATH path name
FILE = Filename and Path
STYLE = StyleName
;
PROC some proc
;
ODS outputtype CLOSE;
```

Following is the description of the parameters used:

- **PATH** represents the statement used in case of HTML output. In other types of output, we include the path in the filename.

- **Style** represents one of the in-built styles available in the SAS environment.

Creating HTML Output

We create HTML output using the ODS HTML statement. In the following example, we create an html file in our desired path. We apply a style available in the styles library. We can see the output file in the mentioned path and we can download it to save in an environment different from the SAS environment. Please note that we have two proc SQL statements and both their output is captured into a single file.

```
ODS HTML
      PATH='/folders/myfolders/sasuser.v94/TutorialsPoint/'
      FILE='CARS2.html'
      STYLE=EGDefault;
proc SQL;
select make, model, invoice
from sashelp.cars
```

```
where make in ('Audi','BMW')
and type = 'Sports'
;
quit;

proc SQL;
select make,mean(horsepower)as meanhp
from sashelp.cars
where make in ('Audi','BMW')
group by make;
quit;

ODS HTML CLOSE;
```

When the above code is executed, we get the following result:

Make	Model	Invoice
Audi	RS 6 4dr	$76,417
Audi	TT 1.8 convertible 2dr (coupe)	$32,512
Audi	TT 1.8 Quattro 2dr (convertible)	$33,891
Audi	TT 3.2 coupe 2dr (convertible)	$36,739
BMW	M3 coupe 2dr	$44,170
BMW	M3 convertible 2dr	$51,815
BMW	Z4 convertible 2.5i 2dr	$31,065
BMW	Z4 convertible 3.0i 2dr	$37,575

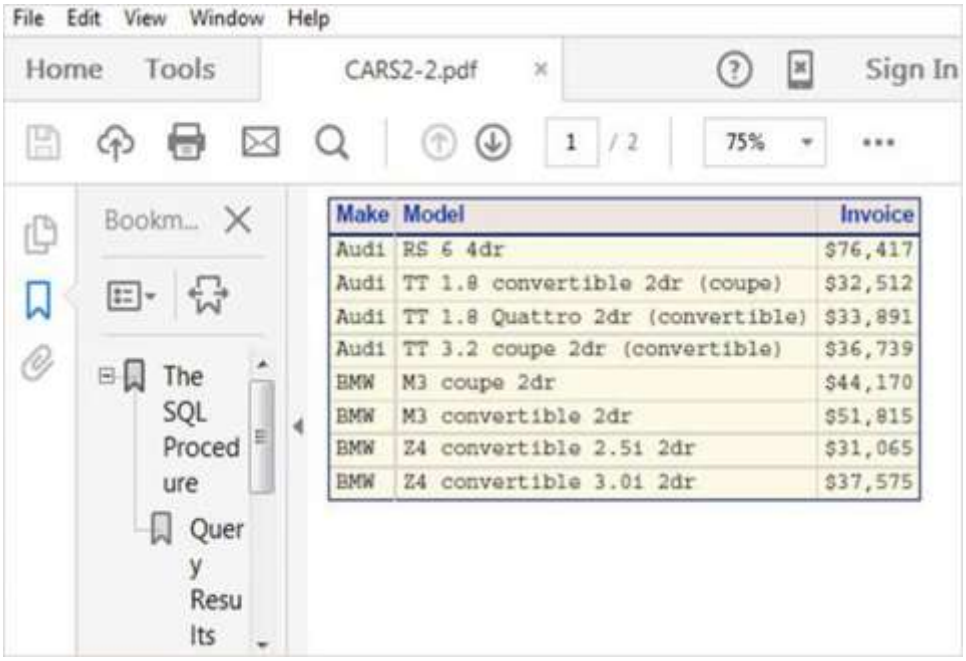
Make	meanhp
Audi	250.7895
BMW	241.45

Creating PDF Output

In the following example, we create a PDF file in our desired path. We apply a style available in the styles library. We can see the output file in the mentioned path and we can download it to save in an environment different from the SAS environment. Please note that we have two proc SQL statements and both their output is captured into a single file.

```
ODS PDF
     FILE='/folders/myfolders/sasuser.v94/TutorialsPoint/CARS2.pdf'
     STYLE=EGDefault;
proc SQL;
select make, model, invoice
from sashelp.cars
where make in ('Audi','BMW')
and type = 'Sports'
;
quit;

proc SQL;
select make,mean(horsepower)as meanhp
from sashelp.cars
where make in ('Audi','BMW')
group by make;
quit;

ODS PDF CLOSE;
```

When the above code is executed, we get the following result:



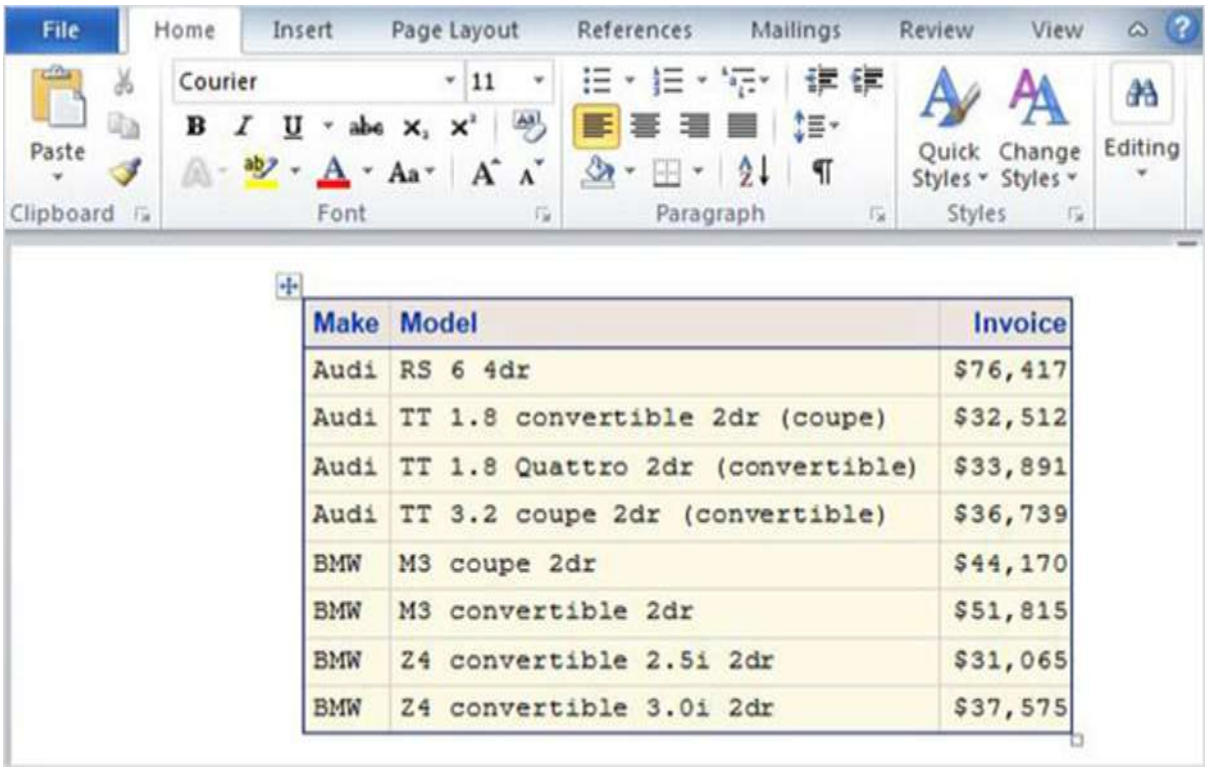
Creating TRF(Word) Output

In the following example, we create an RTF file in our desired path. We apply a style available in the styles library. We can see the output file in the mentioned path and we can download it to save in an environment different from the SAS environment. Please note that we have two proc SQL statements and both their output is captured into a single file.

```
ODS RTF
FILE='/folders/myfolders/sasuser.v94/TutorialsPoint/CARS.rtf'
STYLE=EGDefault;
proc SQL;
select make, model, invoice
from sashelp.cars
where make in ('Audi','BMW')
and type = 'Sports'
;
quit;

proc SQL;
select make,mean(horsepower)as meanhp
from sashelp.cars
where make in ('Audi','BMW')
group by make;
quit;
```

```
ODS rtf CLOSE;
```

When the above code is executed, we get the following result:



Make	Model	Invoice
Audi	RS 6 4dr	$76,417
Audi	TT 1.8 convertible 2dr (coupe)	$32,512
Audi	TT 1.8 Quattro 2dr (convertible)	$33,891
Audi	TT 3.2 coupe 2dr (convertible)	$36,739
BMW	M3 coupe 2dr	$44,170
BMW	M3 convertible 2dr	$51,815
BMW	Z4 convertible 2.5i 2dr	$31,065
BMW	Z4 convertible 3.0i 2dr	$37,575

27. SAS – Simulations

Simulation is a computational technique that uses repeating computation on different random samples in order to estimate a statistical quantity. Using SAS, we can simulate complex data that have specified statistical properties in real-world system. We use software to build a model of the system and numerically generate data that can be used for a better understanding of the behavior of the real-world system. Part of the art of designing a computer simulation model is deciding which aspects of the real-life system are necessary to include in the model so that the data generated by the model can be used to make effective decisions. Because of this complexity, SAS has a dedicated software component for Simulation.

The SAS software component which is used in creating SAS simulation is called **SAS Simulation Studio**. Its graphical user interface provides a full set of tools for building, executing, and analyzing the results of discrete event simulation models.

The different types of statistical distributions on which SAS simulation can be applied have been listed below.

- Simulate data from a continuous distribution
- Simulate data from a discrete distribution
- Simulate data from a mixture of distributions
- Simulate data from a complex distribution
- Simulate data from a multivariate distribution
- Approximate a sampling distribution
- Assess regression estimates

SAS Data Representation

28. SAS – Histograms

In this chapter, we will discuss how histograms work in SAS. A Histogram is graphical display of data using bars of different heights. It groups the various numbers in the data set into many ranges. It also represents the estimation of the probability of distribution of a continuous variable. In SAS, the **PROC UNIVARIATE** is used to create histograms with the options given below.

Syntax

The basic syntax to create a histogram in SAS is:

```
PROC UNIVARAITE DATA = DATASET;
HISTOGRAM variables;
RUN;
```

Following is the description of the parameters used:

- **DATASET** is the name of the dataset used.
- **variables** are the values used to plot the histogram.

Simple Histogram

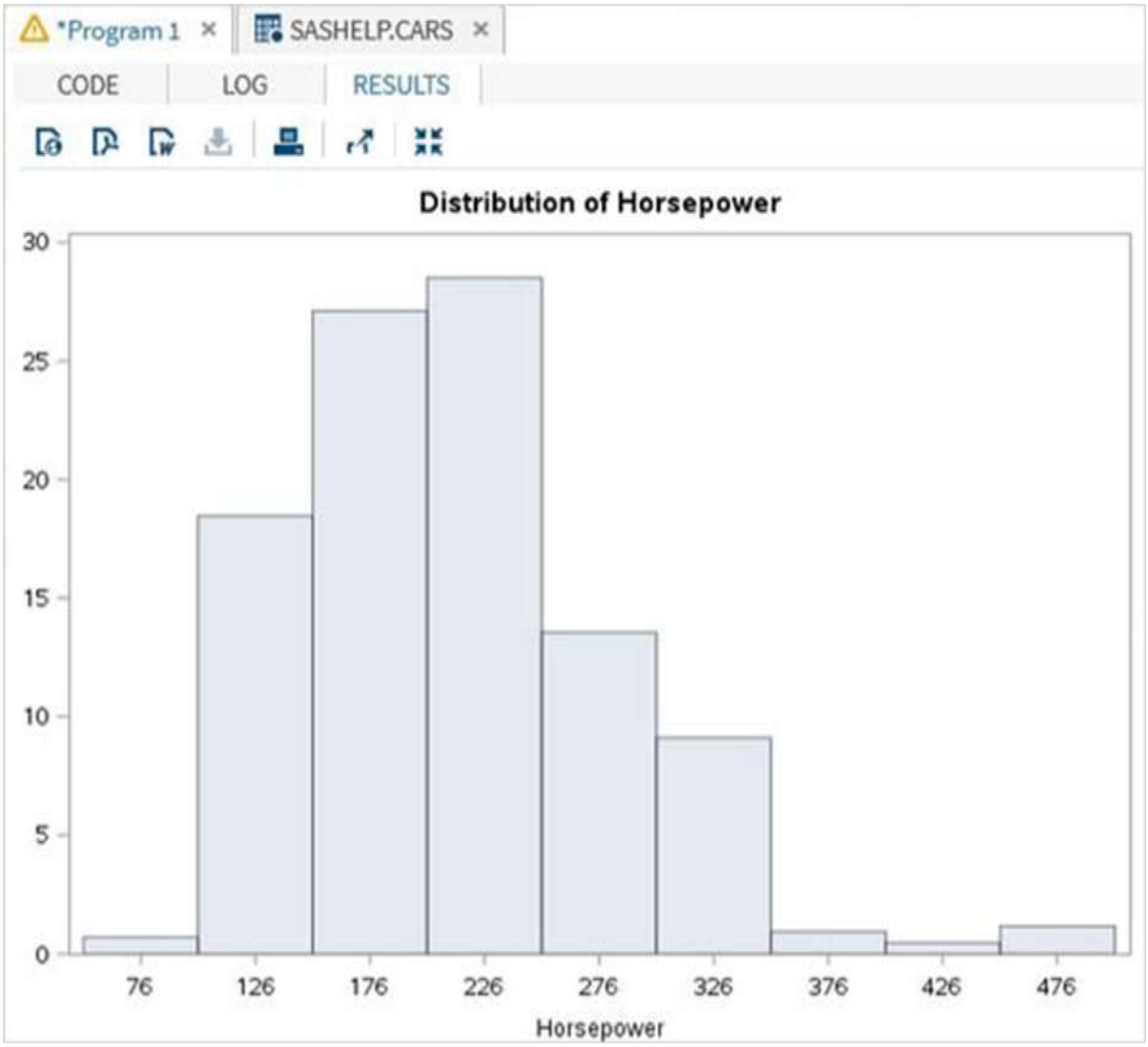
A simple histogram is created by specifying the name of the variable and the range to be considered to group the values.

Example

In the following example, we consider the minimum and maximum values of the variable horsepower and take a range of 50. So the values form a group in steps of 50.

```
proc univariate data=sashelp.cars;
 histogram horsepower
 / midpoints = 176 to 350 by 50;
run;
```

When we execute the above code, we get the following output:



Histogram with Curve Fitting

We can fit some distribution curves into the histogram using additional options.

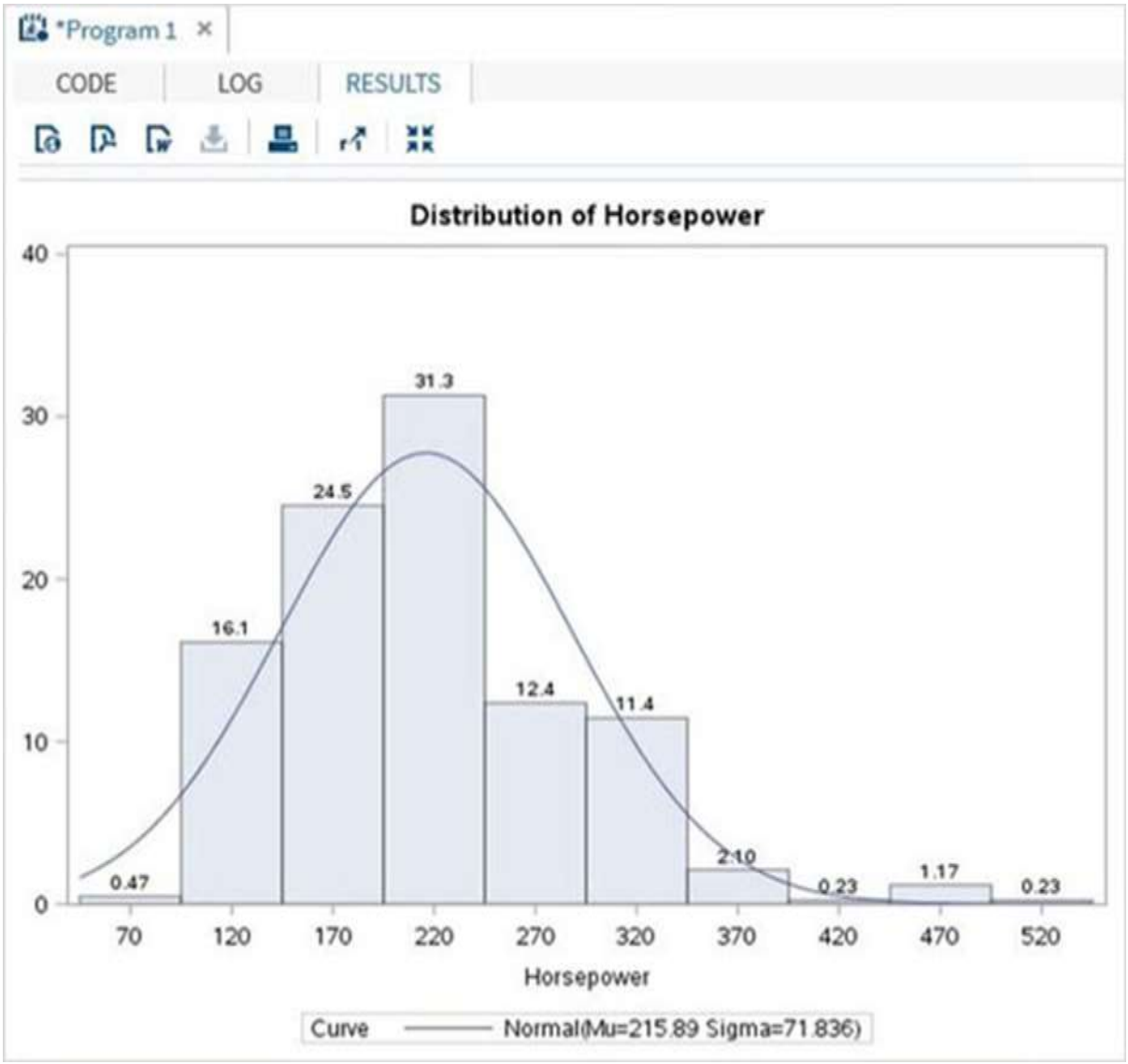
Example

In the following example, we fit a distribution curve with **mean** and **standard deviation** values mentioned as EST. This option uses an estimate of the parameters.

```
proc univariate data=sashelp.cars noprint;
 histogram horsepower
 /
 normal (
 mu = est
 sigma = est
```

```
 color = blue
 w = 2.5
 )
barlabel=percent
 midpoints = 70 to 550 by 50;
run;
```

When we execute the above code, we get the following output:



29. SAS – Bar Charts

A bar chart represents data in rectangular bars with length of the bar proportional to the value of the variable. SAS uses the procedure **PROC SGPLOT** to create bar charts. We can draw both simple and stacked bars in the bar chart. In the bar chart, each of the bars can be given different colors.

Syntax

The basic syntax to create a bar-chart in SAS is:

```
PROC SGPLOT DATA = DATASET;
VBAR variables;
RUN;
```

Following is the description of the parameters used:

- **DATASET** is the name of the dataset used.
- **variables** are the values used to plot the histogram.

Simple Bar chart

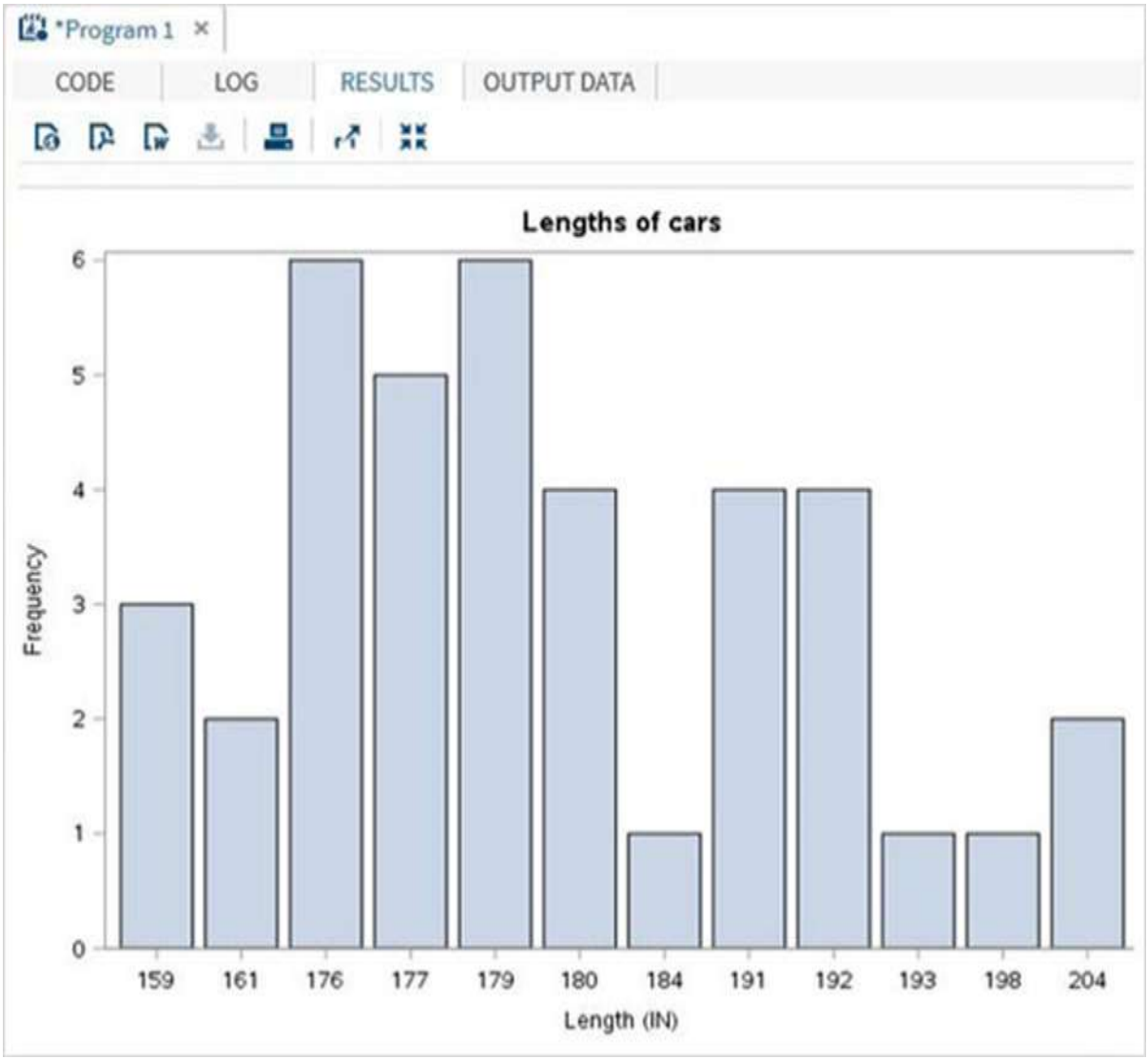
A simple bar chart is a chart in which a variable from the dataset is represented as bars.

Example

The following script will create a bar chart representing the length of cars as bars.

```
PROC SQL;
create table CARS1 as
SELECT make,model,type,invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;

proc SGPLOT data=work.cars1;
vbar length ;
title 'Lengths of cars';
run;
quit;
```

When we execute the above code, we get the following output:



Stacked Bar chart

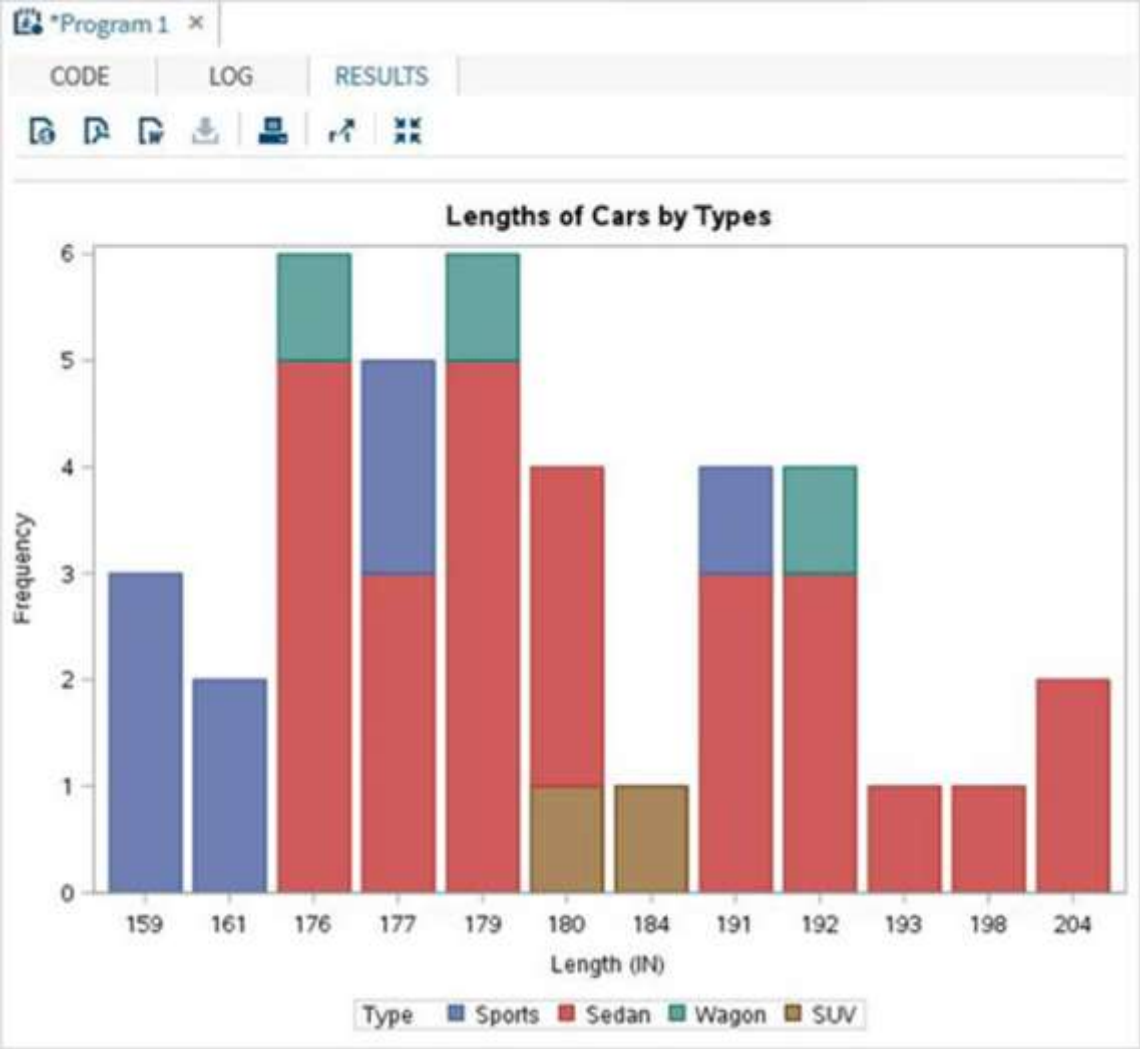
A stacked bar chart is a bar chart in which a variable from the dataset is calculated with respect to another variable.

Example

The following script will create a stacked bar-chart where the length of the cars are calculated for each car type. We use the group option to specify the second variable.

```
proc SGPLOT data=work.cars1;
vbar length /group = type ;
title 'Lengths of Cars by Types';
run;
quit;
```

When we execute the above code, we get the following output:



Clustered Bar chart

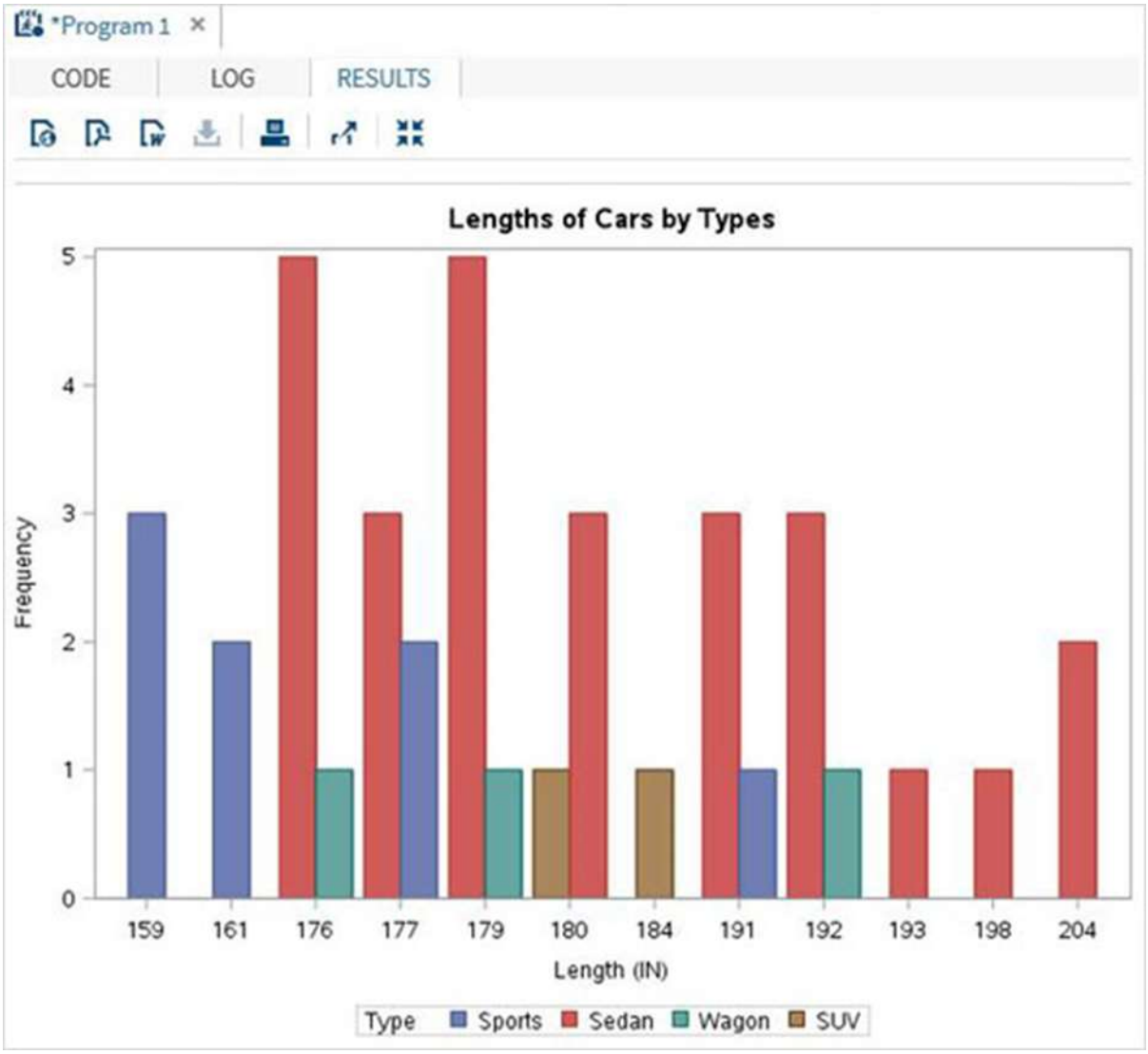
The clustered bar chart is created to show how the values of a variable are spread across a culture.

Example

The following script will create a clustered bar chart where the length of the cars is clustered around the car type. So we see two adjacent bars at length 191, one for the car type 'Sedan' and another for the car type 'Wagon'.

```
proc SGPLOT data=work.cars1;
vbar length /group = type GROUPDISPLAY = CLUSTER;
title 'Cluster of Cars by Types';
run;
quit;
```

When we execute the above code, we get the following output:



30. SAS – Pie Charts

In this chapter, let us discuss Pie Charts in SAS. A pie chart is a representation of values as slices of a circle with different colors. The slices are labeled and the numbers corresponding to each slice is also represented in the chart.

In SAS the pie chart is created using the **PROC TEMPLATE** which takes parameters to control percentage, labels, color, title etc.

Syntax

The basic syntax to create a pie-chart in SAS is:

```
PROC TEMPLATE;
  DEFINE STATGRAPH pie;
    BEGINGRAPH;
      LAYOUT REGION;
        PIECHART CATEGORY = variable /
          DATALABELLOCATION = OUTSIDE
          CATEGORYDIRECTION = CLOCKWISE
          START = 180 NAME = 'pie';
        DISCRETELEGEND 'pie' /
          TITLE = ' ';
      ENDLAYOUT;
    ENDGRAPH;
  END;
RUN;
```

Following is the description of the parameters used:

- **variable** is the value for which we create the pie chart.

Simple Pie Chart

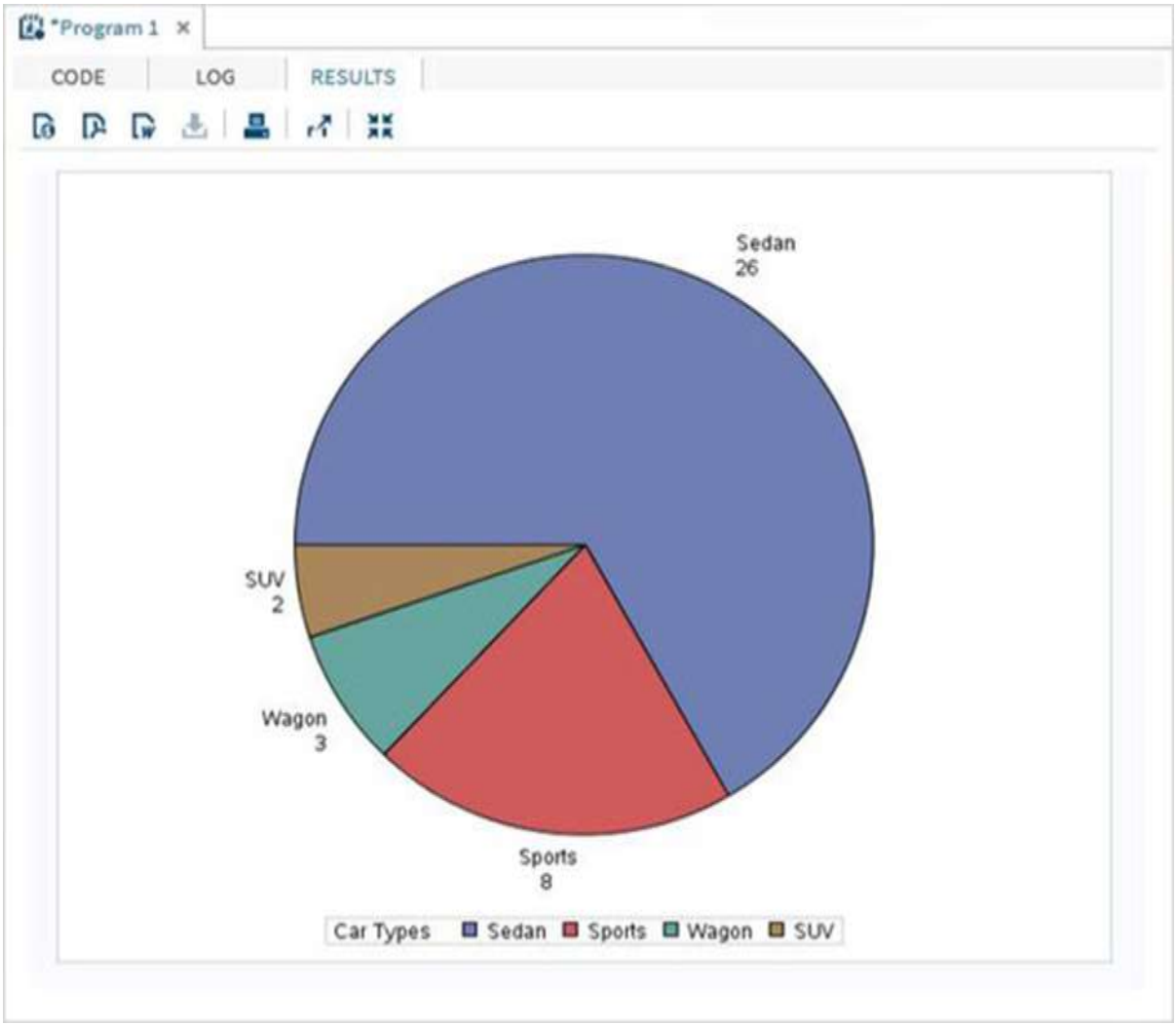
In this pie chart we take a single variable form the dataset. The pie chart is created with the value of the slices representing the fraction of the count of the variable with respect to the total value of the variable.

Example

In the following example, each slice represents the fraction of the type of car from the total number of cars.

```
PROC SQL;
create table CARS1 as
SELECT make,model,type,invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;

PROC TEMPLATE;
  DEFINE STATGRAPH pie;
    BEGINGRAPH;
      LAYOUT REGION;
        PIECHART CATEGORY = type /
          DATALABELLOCATION = OUTSIDE
          CATEGORYDIRECTION = CLOCKWISE
          START = 180 NAME = 'pie';
        DISCRETELEGEND 'pie' /
          TITLE = 'Car Types';
      ENDLAYOUT;
    ENDGRAPH;
  END;
RUN;
PROC SGRENDER DATA = cars1
          TEMPLATE = pie;
RUN;
```

When we execute the above code, we get the following output:



Pie Chart with Data Labels

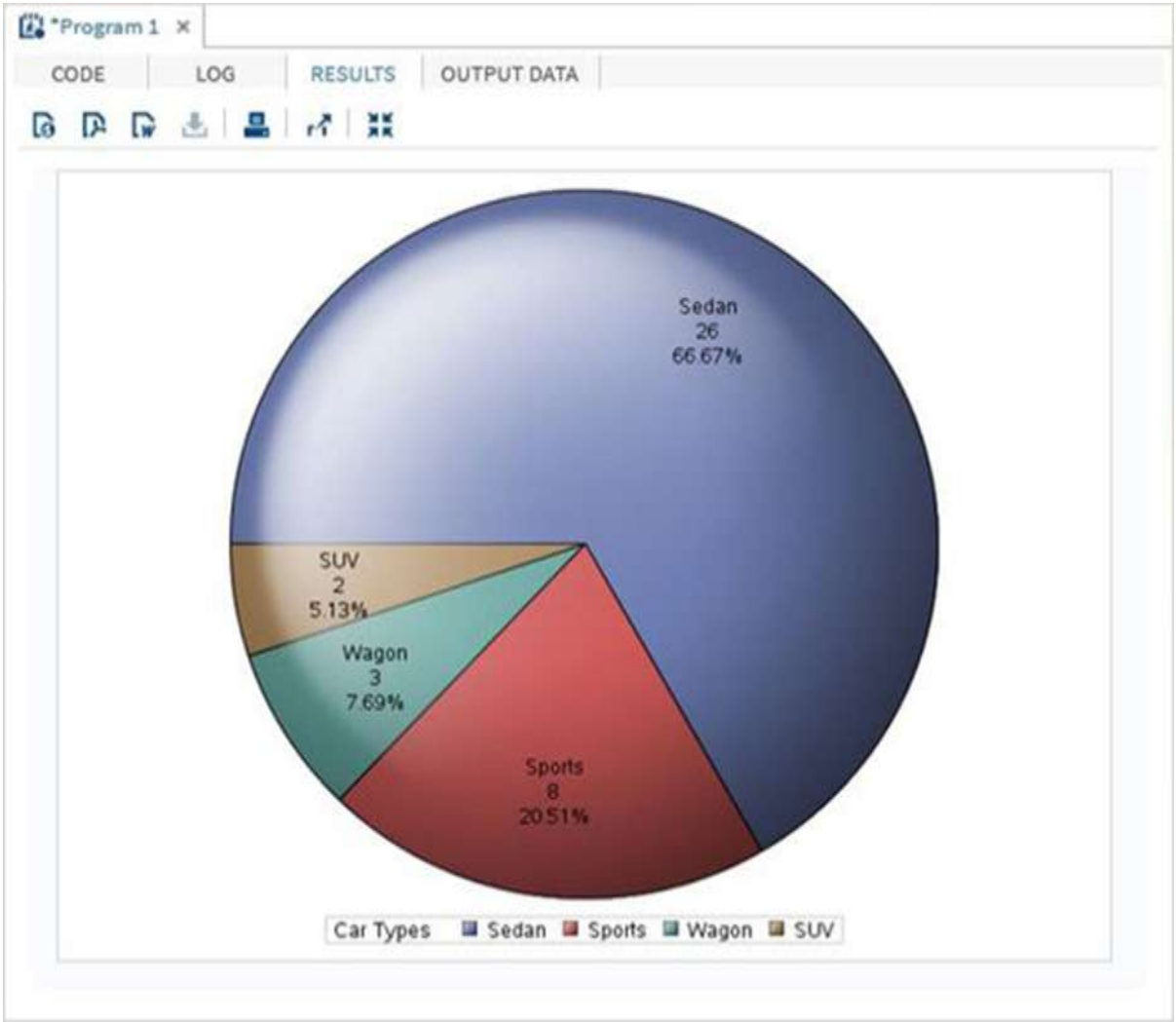
In this pie chart, we represent both the fractional value as well as the percentage value for each slice. We also change the location of the label to be inside the chart. The style of the appearance of the chart is modified by using the DATASKIN option. It uses one of the inbuilt styles, available in the SAS environment.

Example

```
PROC TEMPLATE;
  DEFINE STATGRAPH pie;
    BEGINGRAPH;
      LAYOUT REGION;
        PIECHART CATEGORY = type /
          DATALABELLOCATION = INSIDE
          DATALABELCONTENT=ALL
```

```
          CATEGORYDIRECTION = CLOCKWISE
          DATASKIN= SHEEN
          START = 180 NAME = 'pie';
        DISCRETELEGEND 'pie' /
          TITLE = 'Car Types';
      ENDLAYOUT;
    ENDGRAPH;
  END;
RUN;
PROC SGRENDER DATA = cars1
          TEMPLATE = pie;
RUN;
```

When we execute the above code, we get the following output:



Grouped Pie Chart

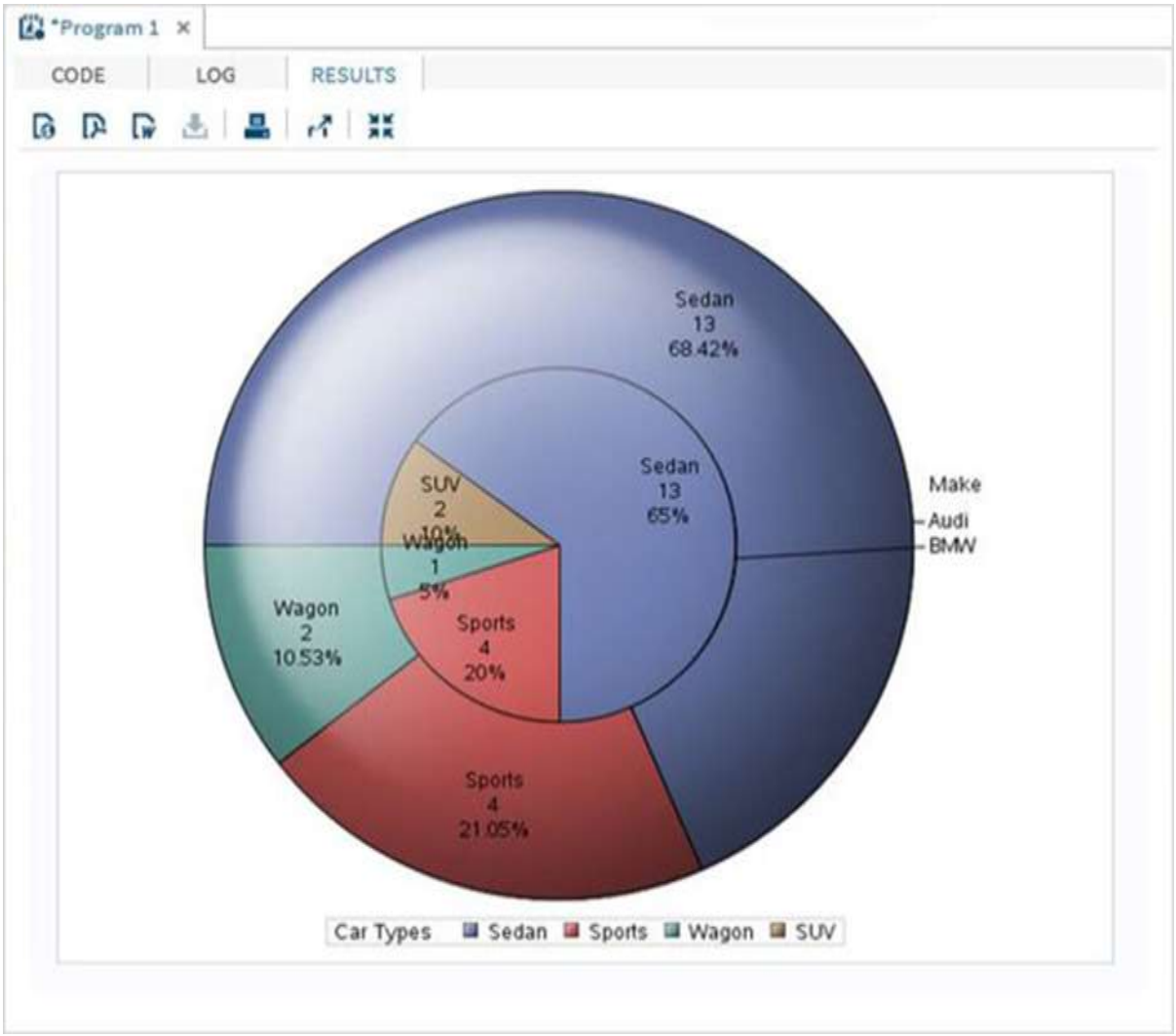
In this pie chart, the value of the variable presented in the graph is grouped with respect to another variable of the same data set. Each group becomes one circle and the chart has as many concentric circles as the number of groups available.

Example

In the following example, we group the chart with respect to the variable named "Make". As there are two values available ("Audi" and "BMW"), we get two concentric circles each representing slices of car types in its own make.

```
PROC TEMPLATE;
  DEFINE STATGRAPH pie;
    BEGINGRAPH;
      LAYOUT REGION;
        PIECHART CATEGORY = type / Group = make
          DATALABELLOCATION = INSIDE
          DATALABELCONTENT=ALL
          CATEGORYDIRECTION = CLOCKWISE
          DATASKIN= SHEEN
          START = 180 NAME = 'pie';
        DISCRETELEGEND 'pie' /
          TITLE = 'Car Types';
      ENDLAYOUT;
    ENDGRAPH;
  END;
RUN;
PROC SGRENDER DATA = cars1
          TEMPLATE = pie;
RUN;
```

When we execute the above code, we get the following output:



31. SAS – Scatter Plots

In this chapter, we will discuss scatter plots in SAS. A scatter plot is a type of graph which uses values from two variables plotted in a Cartesian plane. It is usually used to find the relationship between two variables. In SAS, we use **PROC SGSCATTER** to create scatterplots.

Please note that we create the data set named CARS1 in the first example and use the same data set for all the subsequent data sets. This data set remains in the work library till the end of the SAS session.

Syntax

The basic syntax to create a scatter plot in SAS is:

```
PROC sgscatter  DATA=DATASET;
   PLOT VARIABLE_1 * VARIABLE_2
   / datalabel = VARIABLE group = VARIABLE;
RUN;
```

Following is the description of the parameters used:

- **DATASET** is the name of data set.
- **VARIABLE** is the variable used from the dataset.

Simple Scatterplot

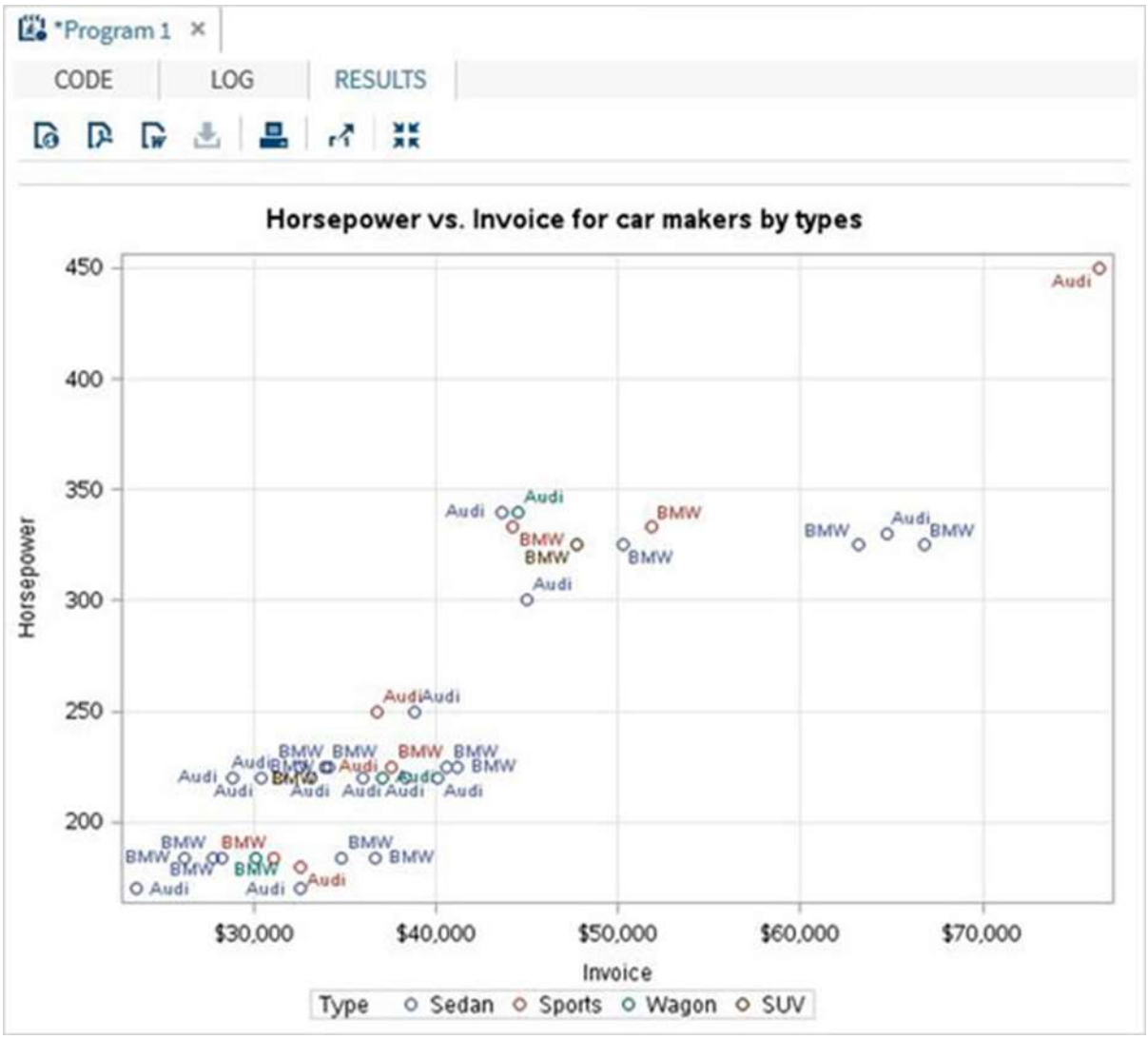
In a simple scatterplot we choose two variables from the dataset and group them with a third variable. We can also label the data. The result shows how the two variables are scattered in the **Cartesian plane**.

Example

```
PROC SQL;
create table CARS1 as
SELECT make,model,type,invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;
```

```
TITLE 'Scatterplot - Two Variables';
PROC sgscatter  DATA=CARS1;
   PLOT horsepower*Invoice
   / datalabel = make group = type grid;
   title 'Horsepower vs. Invoice for car makers by types';
RUN;
```

When we execute the above code, we get the following output:



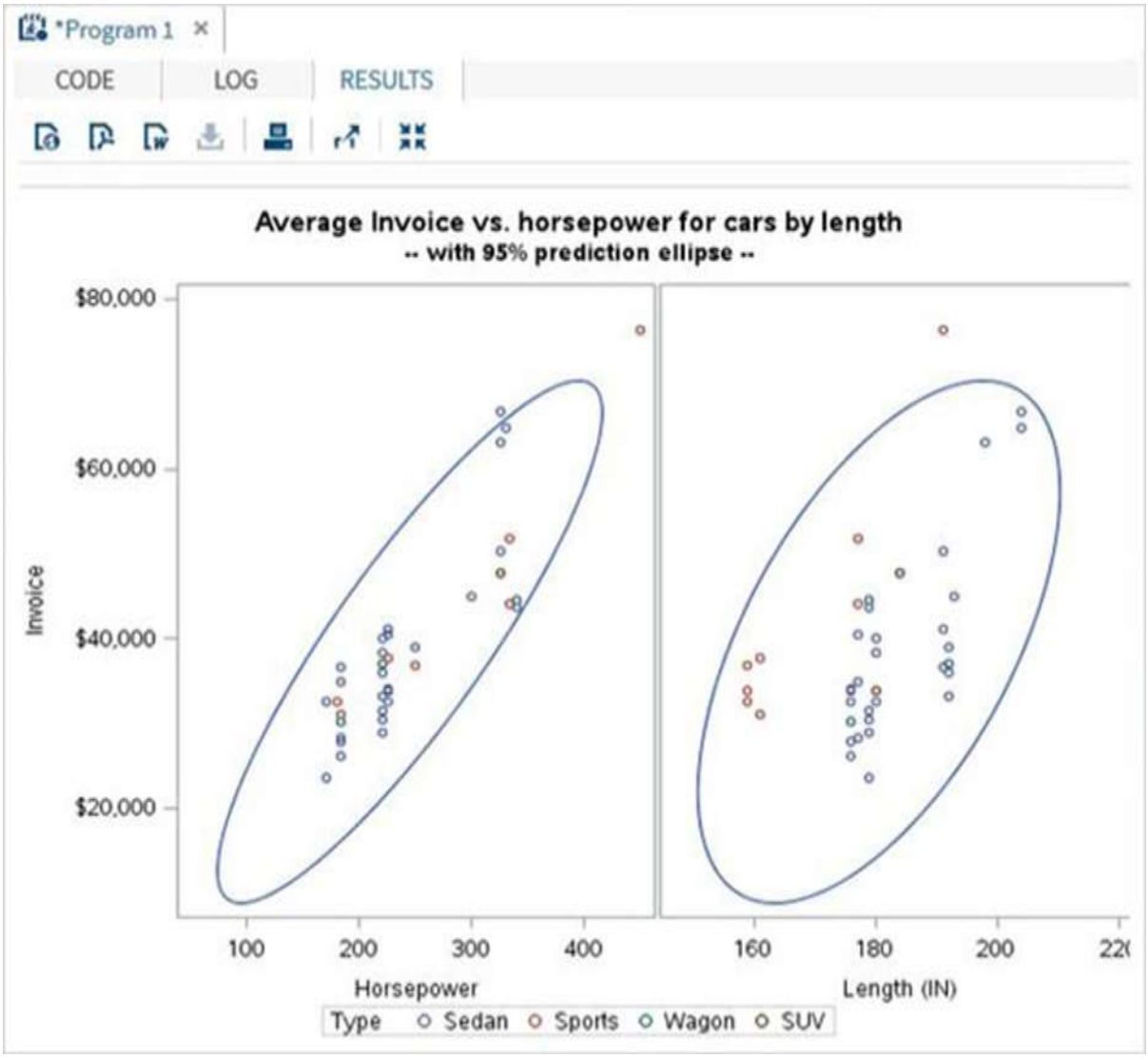
Scatterplot with Prediction

We can use an estimation parameter to predict the strength of correlation between by drawing an ellipse around the values. We use the additional options in the procedure to draw the ellipse as shown below.

Example

```
proc sgscatter data =cars1;
compare y = Invoice  x =(horsepower length)
           / group=type  ellipse =(alpha =0.05 type=predicted);
title
'Average Invoice vs. horsepower for cars by length';
title2
'-- with 95% prediction ellipse --'
;
format
Invoice dollar6.0;
run;
```

When we execute the above code, we get the following output:



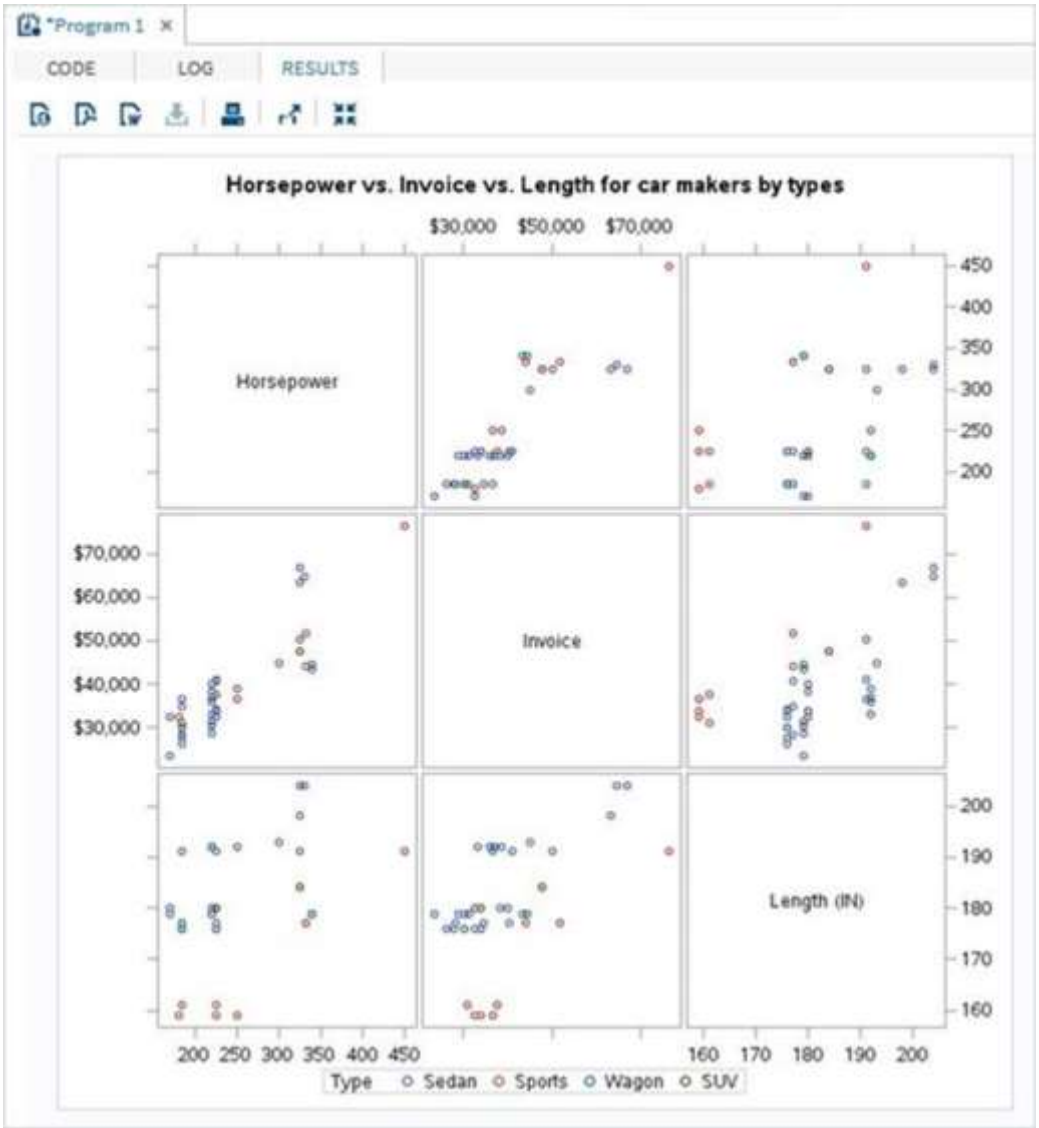
Scatter Matrix

We can also have a scatterplot involving more than two variables by grouping them into pairs. In the example given below, we consider three variables and draw a scatter plot matrix. We get 3 pairs of resulting matrix.

Example

```
PROC sgscatter  DATA=CARS1;
  matrix horsepower invoice length
  / group = type;

   title 'Horsepower vs. Invoice vs. Length for car makers by types';
RUN;
```

When we execute the above code, we get the following output:



32. SAS – Boxplots

In this chapter, let us discuss Boxplots in SAS. A Boxplot is a graphical representation of groups of numerical data through their quartiles. Boxplots may also have lines extending vertically from the boxes (whiskers) indicating variability outside the upper and lower quartiles. The bottom and the top of the box are always the first and third quartiles, and the band inside the box is always the second quartile (the median). In SAS, a simple Boxplot is created using **PROC SGPLOT** and the paneled boxplot is created using **PROC SGPANEL**.

Please note that we create the data set named CARS1 in the first example and use the same data set for all the subsequent data sets. This data set remains in the work library till the end of the SAS session.

Syntax

The basic syntax to create a boxplot in SAS is:

```
PROC SGPLOT  DATA=DATASET;
  VBOX VARIABLE / category = VARIABLE;
RUN;

PROC SGPANEL  DATA=DATASET;;
PANELBY VARIABLE;
  VBOX VARIABLE> / category = VARIABLE;
RUN;
```

Following is the description of the parameters used:

- **DATASET** is the name of the dataset used.
- **VARIABLE** is the value used to plot the Boxplot.

Simple Boxplot

In a simple Boxplot we choose one variable from the data set and another from a category. The values of the first variable are categorized in as many number of groups as the number of distinct values in the second variable.

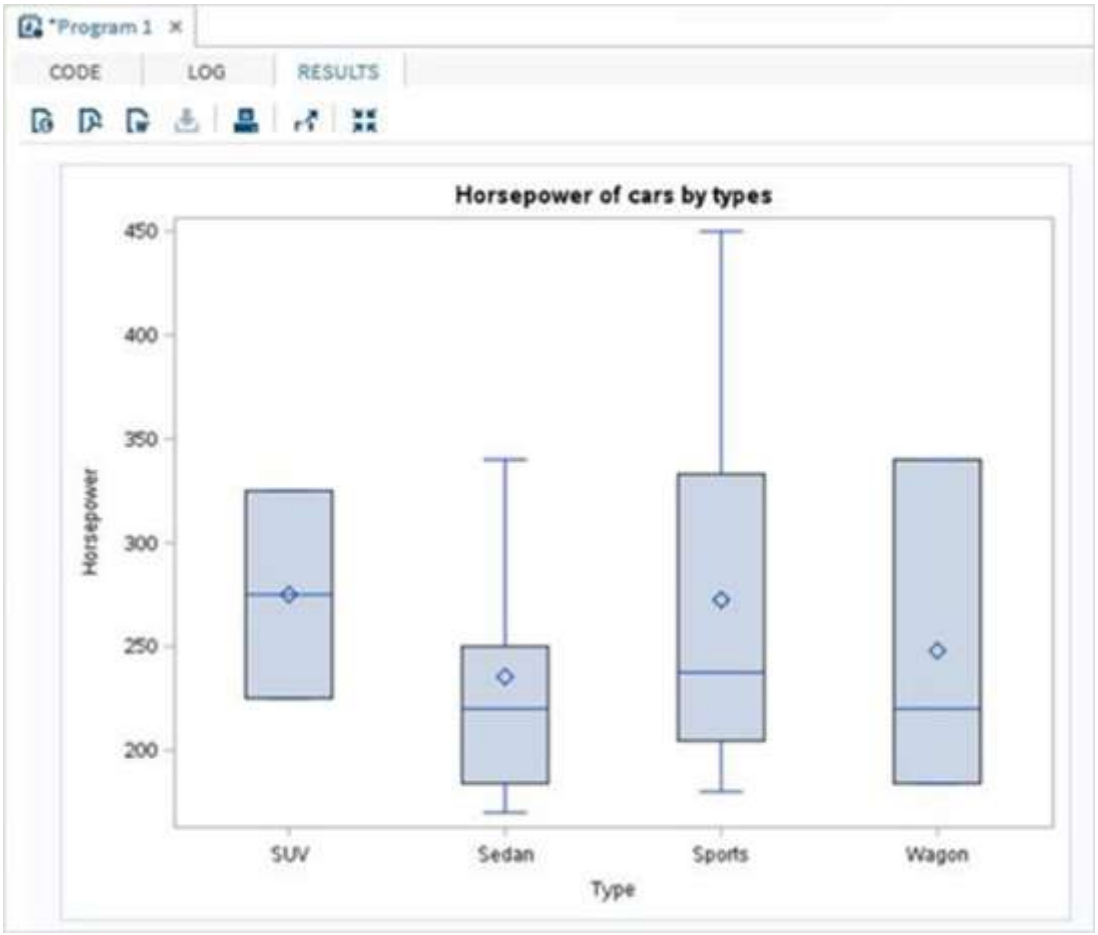
Example

In the following example, we choose the variable horsepower as the first variable and type will be the category variable. So we get boxplots for the distribution of values of horsepower for each type of car.

```
PROC SQL;
```

```
create table CARS1 as
SELECT make,model,type,invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;

PROC SGPLOT  DATA=CARS1;
  VBOX horsepower
  / category = type;

   title 'Horsepower of cars by types';
RUN;
```

When we execute the above code, we get the following output:



Boxplot in Vertical Panels

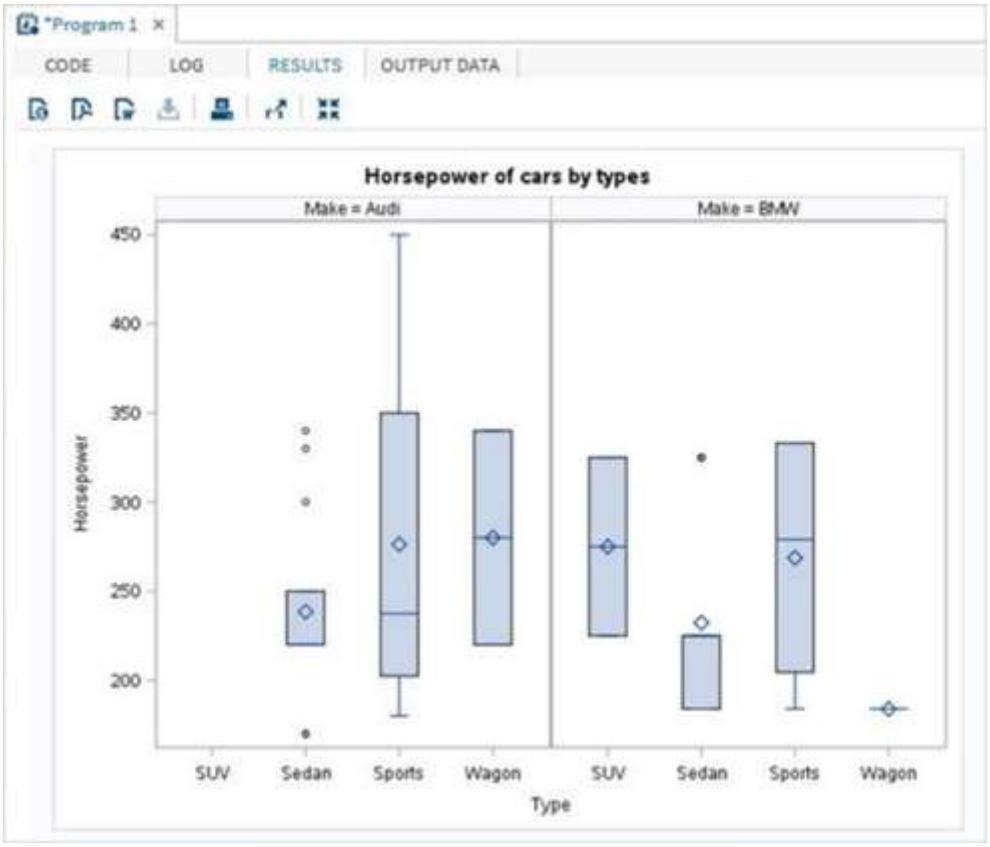
We can divide the Boxplots of a variable into many vertical panels(columns). Each panel holds the boxplots for all the categorical variables. The boxplots are further grouped using another third variable which divides the graph into multiple panels.

Example

In the following example, we have paneled the graph using the variable 'make'. As there are two distinct values of 'make', we get two vertical panels.

```
PROC SGPANEL  DATA=CARS1;
PANELBY MAKE;
  VBOX horsepower   / category = type;


   title 'Horsepower of cars by types';
RUN;
```

When we execute the above code, we get the following output:



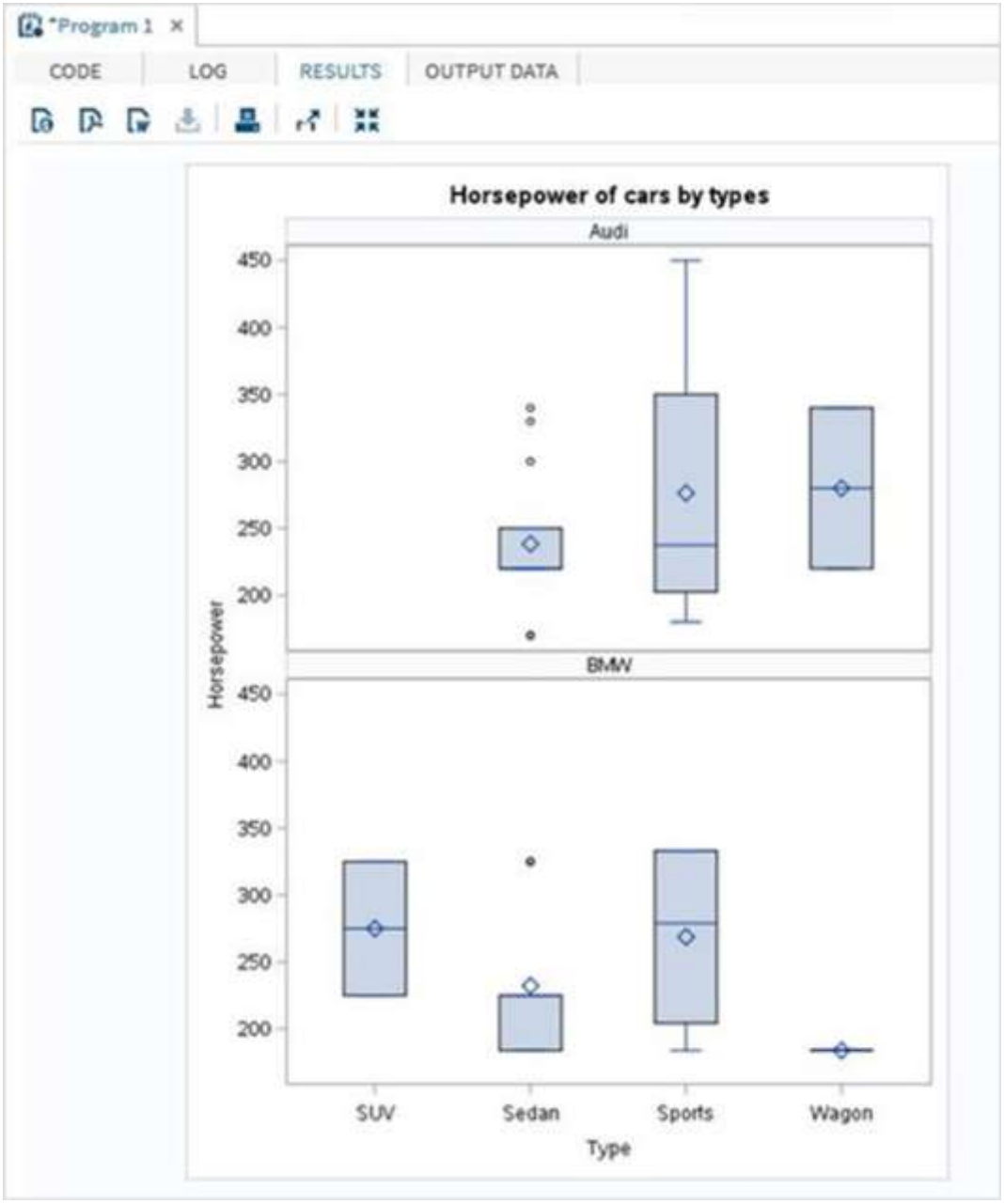
Boxplot in Horizontal Panels

We can divide the boxplots of a variable into many horizontal panels(rows). Each panel holds the boxplots for all the categorical variables. But the boxplots are further grouped using another third variable which divides the graph into multiple panels. In the following

example, we have paneled the graph using the variable 'make'. As there are two distinct values of 'make', we get two horizontal panels.

```
PROC SGPANEL  DATA=CARS1;
PANELBY MAKE / columns = 1 novarname;

  VBOX horsepower   / category = type;

   title 'Horsepower of cars by types';
RUN;
```

When we execute the above code, we get the following output:



SAS Basic Statistical Procedure

33. SAS – Arithmetic Mean

The arithmetic mean is the value obtained by summing the value of numeric variables and then dividing the sum with the number of variables. It is also called Average. In SAS, arithmetic mean is calculated using **PROC MEANS**. Using this SAS procedure, we can find the mean of all variables or some variables of a dataset. We can also form groups and find the mean of variables of values specific to that group.

Syntax

The basic syntax for calculating arithmetic mean in SAS is:

```
PROC MEANS DATA = DATASET;
CLASS Variables ;
VAR Variables;
```

Following is the description of the parameters used:

- **DATASET** is the name of the dataset used.
- **Variables** are the name of the variable from the dataset.

Mean of a Dataset

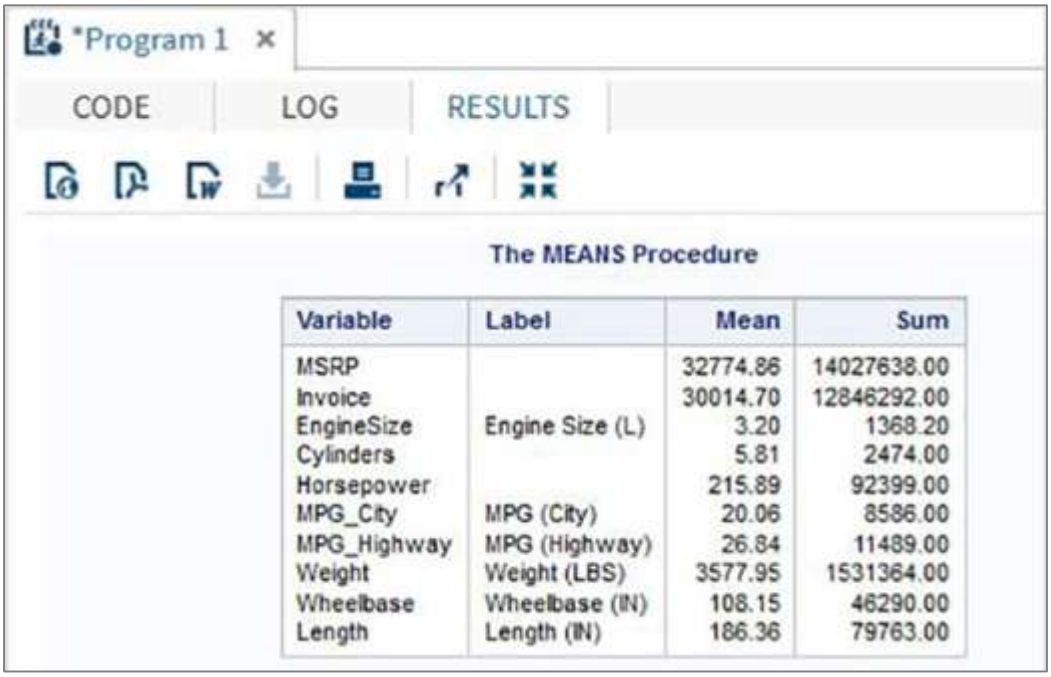
The mean of each of the numeric variable in a dataset is calculated by using the PROC by supplying only the dataset name without any variables.

Example

In the following example, we find the mean of all the numeric variables in the SAS dataset named CARS. We specify the maximum digits after decimal place to be 2 and also find the sum of those variables.

```
PROC MEANS DATA = sashelp.CARS Mean SUM MAXDEC=2;
RUN;
```

When the above code is executed, we get the following output:



*Program 1

CODE LOG RESULTS

The MEANS Procedure

Variable	Label	Mean	Sum
MSRP		32774.86	14027638.00
Invoice		30014.70	12846292.00
EngineSize	Engine Size (L)	3.20	1368.20
Cylinders		5.81	2474.00
Horsepower		215.89	92399.00
MPG_City	MPG (City)	20.06	8586.00
MPG_Highway	MPG (Highway)	26.84	11489.00
Weight	Weight (LBS)	3577.95	1531364.00
Wheelbase	Wheelbase (IN)	108.15	46290.00
Length	Length (IN)	186.36	79763.00

Mean of Select Variables

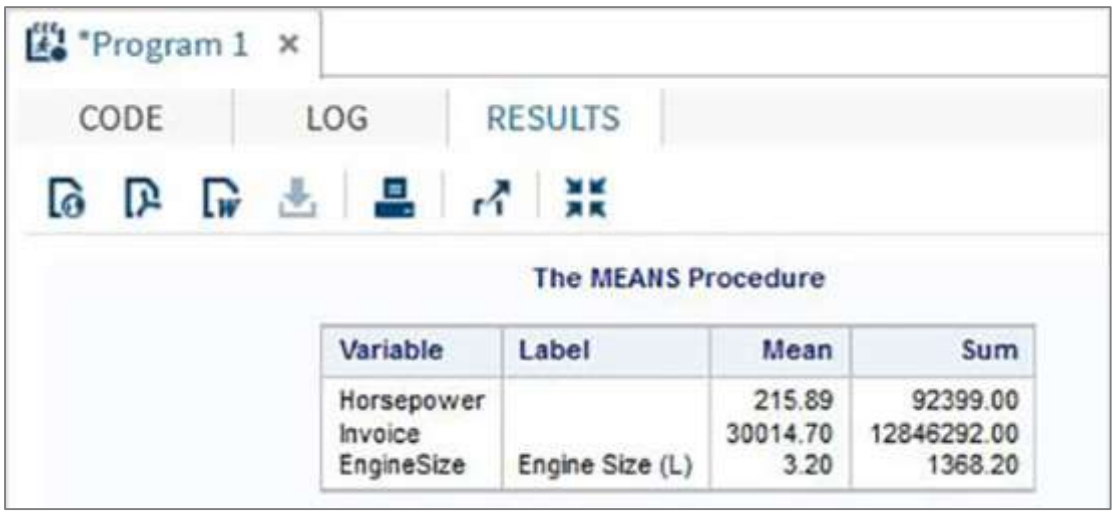
We can get the mean of some of the variables by supplying their names in the **var** option.

Example

In the following code, we calculate the mean of three variables.

```
PROC MEANS DATA = sashelp.CARS mean SUM MAXDEC=2 ;
var horsepower invoice EngineSize;
RUN;
```

When the above code is executed, we get the following output:



*Program 1

CODE LOG RESULTS

The MEANS Procedure

Variable	Label	Mean	Sum
Horsepower		215.89	92399.00
Invoice		30014.70	12846292.00
EngineSize	Engine Size (L)	3.20	1368.20

Mean by Class

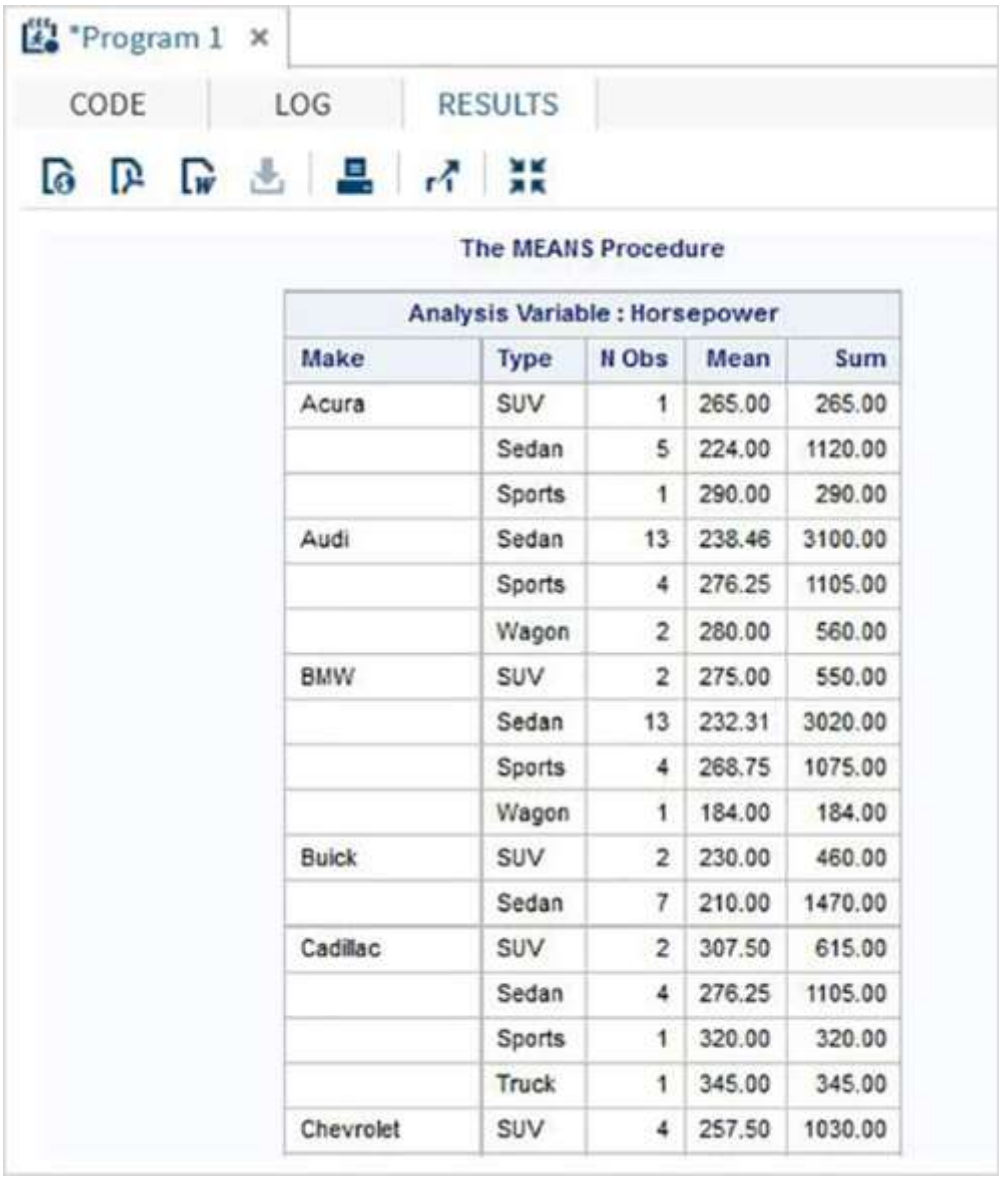
We can find the mean of the numeric variables by organizing them into groups by using some other variable.

Example

In the example given below, we find the mean of the variable horsepower for each type under each make of the car.

```
PROC MEANS DATA = sashelp.CARS mean SUM MAXDEC=2;
class make type;
var horsepower;
RUN;
```

When the above code is executed, we get the following output:



The MEANS Procedure

Analysis Variable : Horsepower				
Make	Type	N Obs	Mean	Sum
Acura	SUV	1	265.00	265.00
	Sedan	5	224.00	1120.00
	Sports	1	290.00	290.00
Audi	Sedan	13	238.46	3100.00
	Sports	4	276.25	1105.00
	Wagon	2	280.00	560.00
BMW	SUV	2	275.00	550.00
	Sedan	13	232.31	3020.00
	Sports	4	268.75	1075.00
	Wagon	1	184.00	184.00
Buick	SUV	2	230.00	460.00
	Sedan	7	210.00	1470.00
Cadillac	SUV	2	307.50	615.00
	Sedan	4	276.25	1105.00
	Sports	1	320.00	320.00
	Truck	1	345.00	345.00
Chevrolet	SUV	4	257.50	1030.00

34. SAS – Standard Deviation

Standard deviation (SD) is a measure of how varied is the data in a data set. Mathematically it measures how distant or close are each value to the mean value of a data set. A standard deviation value close to 0 indicates that the data points tend to be very close to the mean of the data set and a high standard deviation indicates that the data points are spread out over a wide range of values.

In SAS, the SD value is measured using PROC MEAN as well as PROC SURVEYMEANS.

Using PROC MEANS

To measure the SD using **proc means**, we choose the STD option in the PROC step. It brings out the SD values for each numeric variable present in the data set.

Syntax

The basic syntax for calculating the standard deviation in SAS is:

```
PROC means DATA = dataset STD;
```

Following is the description of the parameters used:

- **Dataset** is the name of the dataset.

Example

In the following example, we create the data set CARS1 form the CARS data set in the SASHELP library. We choose the STD option with the PROC means step.

```
PROC SQL;
create table CARS1 as
SELECT make,type,invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;

proc means data=CARS1 STD;
run;
```

When we execute the above code, it gives the following output:

Using PROC SURVEYMEANS

This procedure is also used for measurement of SD along with some advance features like measuring SD for categorical variables. The procedure also helps provide estimates in variance.

Syntax

The syntax for using PROC SURVEYMEANS is:

```
PROC SURVEYMEANS options statistic-keywords ;
BY variables ;
CLASS variables ;
VAR variables ;
```

Following is the description of the parameters used:

- **BY** indicates the variables used to create groups of observations.
- **CLASS** indicates the variables used for categorical variables.
- **VAR** indicates the variables for which SD will be calculated.

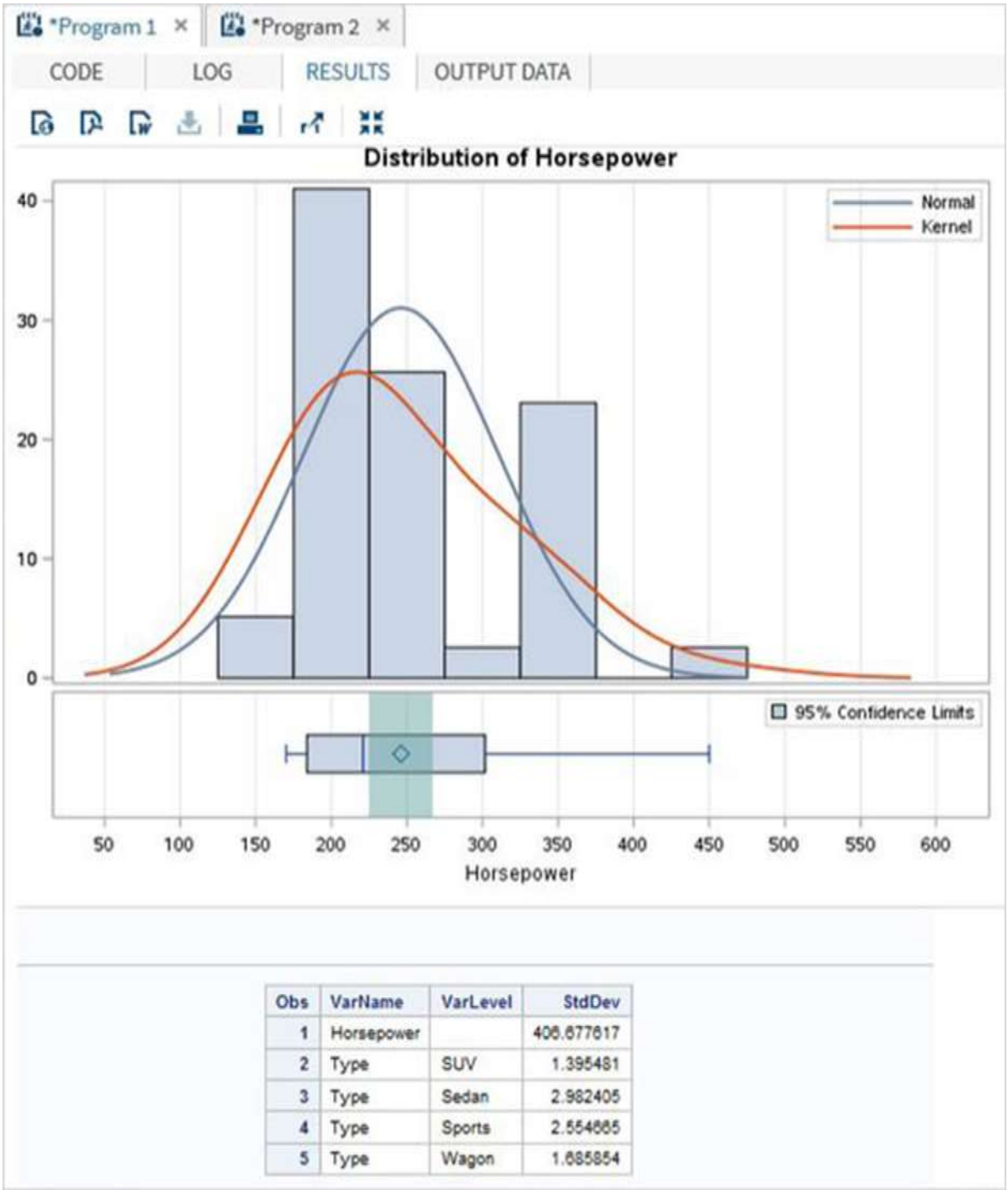
Example

The following example describes the use of the **class** parameter which creates the statistics for each of the values in the class variable.

```
proc surveymeans data=CARS1 STD;


class type;
var type horsepower;
```

```
ods output statistics=rectangle;
run;
proc print data=rectangle;
run;
```

When we execute the above code, it gives the following output:



Obs	VarName	VarLevel	StdDev
1	Horsepower		406.677617
2	Type	SUV	1.395481
3	Type	Sedan	2.982405
4	Type	Sports	2.554665
5	Type	Wagon	1.685854

Using BY Option

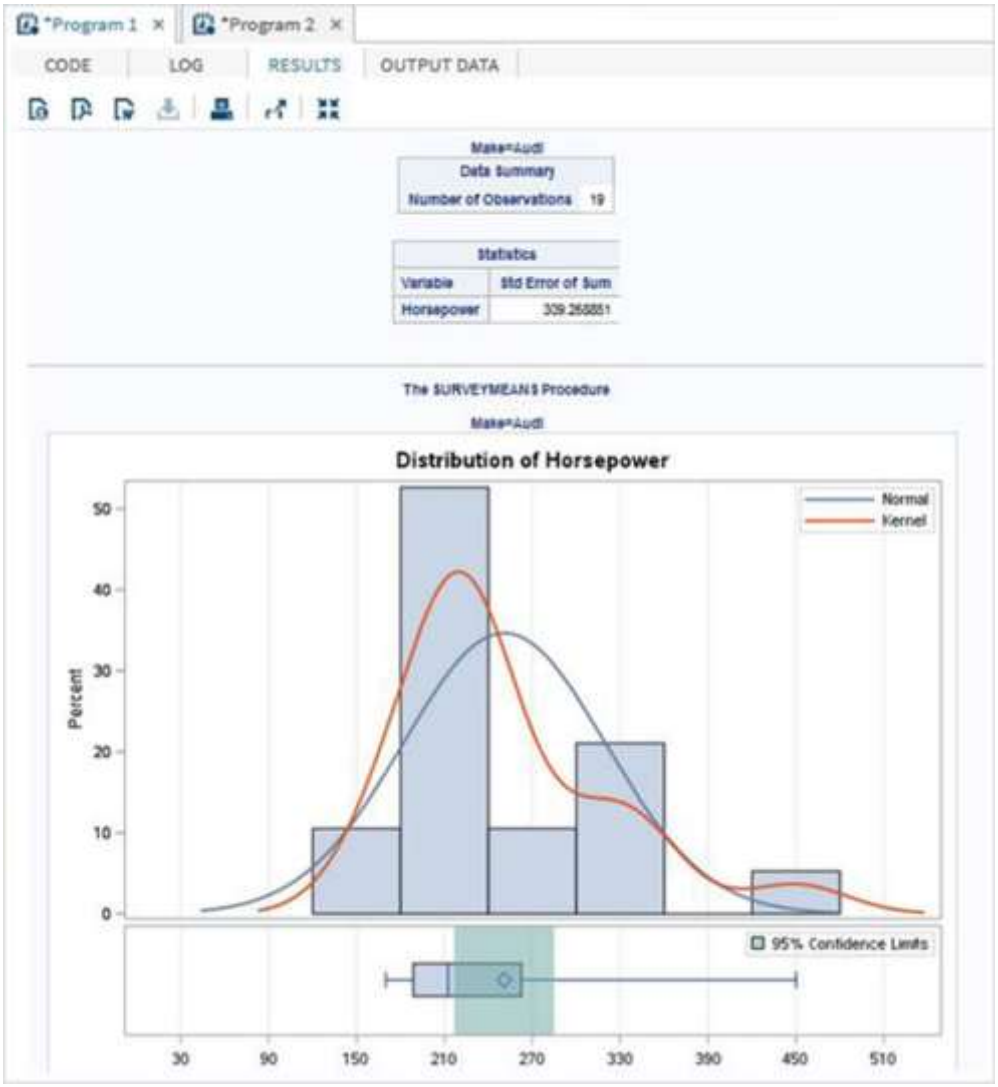
The following is an example of the **BY** option. Here, the result is grouped for each value in the BY option.

Example

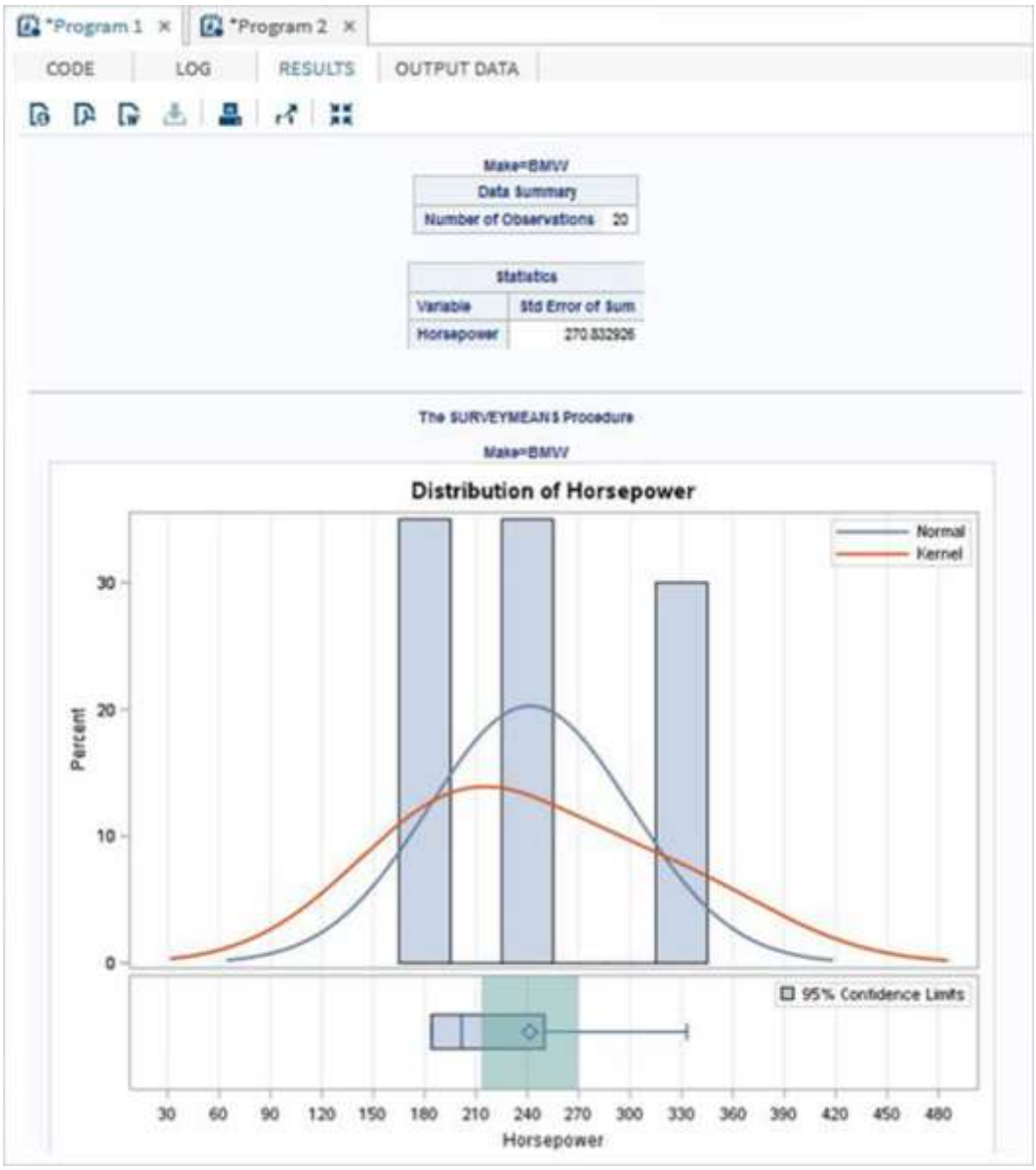
```
proc surveymeans data=CARS1 STD;
var horsepower;
BY make;
ods output statistics=rectangle;
run;
proc print data=rectangle;
run;
```

When we execute the above code, it gives the following output:

Result for make = "Audi"



Result for make = "BMW"



35. SAS – Frequency Distributions

A frequency distribution is a table showing the frequency of the data points in a data set. Each entry in the table contains the frequency or count of the occurrences of values within a particular group or interval, and in this way, the table summarizes the distribution of values in the sample.

SAS provides a procedure called **PROC FREQ** to calculate the frequency distribution of data points in a data set.

Syntax

The basic syntax for calculating frequency distribution in SAS is:

```
PROC FREQ DATA = Dataset ;
TABLES Variable_1 ;
BY Variable_2 ;
```

Following is the description of the parameters used:

- **Dataset** is the name of the dataset.
- **Variables_1** is the variable name of the dataset, the frequency distribution of which needs to be calculated.
- **Variables_2** is the variable name which categorized the frequency distribution result.

Single Variable Frequency Distribution

We can determine the frequency distribution of a single variable by using **PROC FREQ**. In this case, the result will show the frequency of each value of the variable. The result also shows the percentage distribution, cumulative frequency and cumulative percentage.

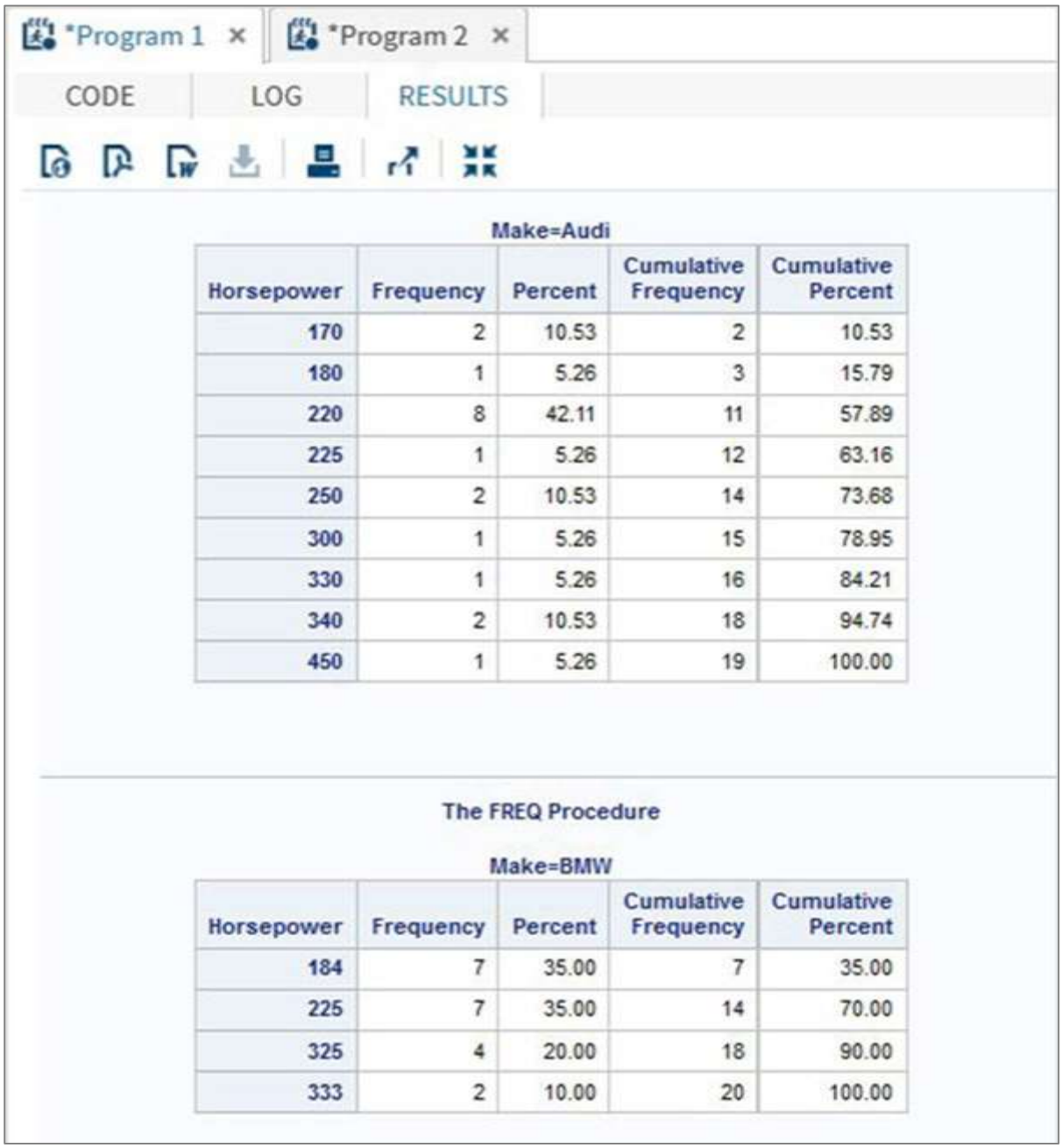
Example

In the following example, we find the frequency distribution of the variable horsepower for the dataset named **CARS1** which is created from the library **SASHELP.CARS**. We can see the result divided into two categories of results. One for each make of the car.

```
PROC SQL;
create table CARS1 as
SELECT make,model,type,invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
```

```
;
RUN;

proc FREQ data=CARS1 ;
tables horsepower;
by make;
run;
```

When the above code is executed, we get the following result:



Make=Audi

Horsepower	Frequency	Percent	Cumulative Frequency	Cumulative Percent
170	2	10.53	2	10.53
180	1	5.26	3	15.79
220	8	42.11	11	57.89
225	1	5.26	12	63.16
250	2	10.53	14	73.68
300	1	5.26	15	78.95
330	1	5.26	16	84.21
340	2	10.53	18	94.74
450	1	5.26	19	100.00

The FREQ Procedure

Make=BMW

Horsepower	Frequency	Percent	Cumulative Frequency	Cumulative Percent
184	7	35.00	7	35.00
225	7	35.00	14	70.00
325	4	20.00	18	90.00
333	2	10.00	20	100.00

Multiple Variable Frequency Distribution

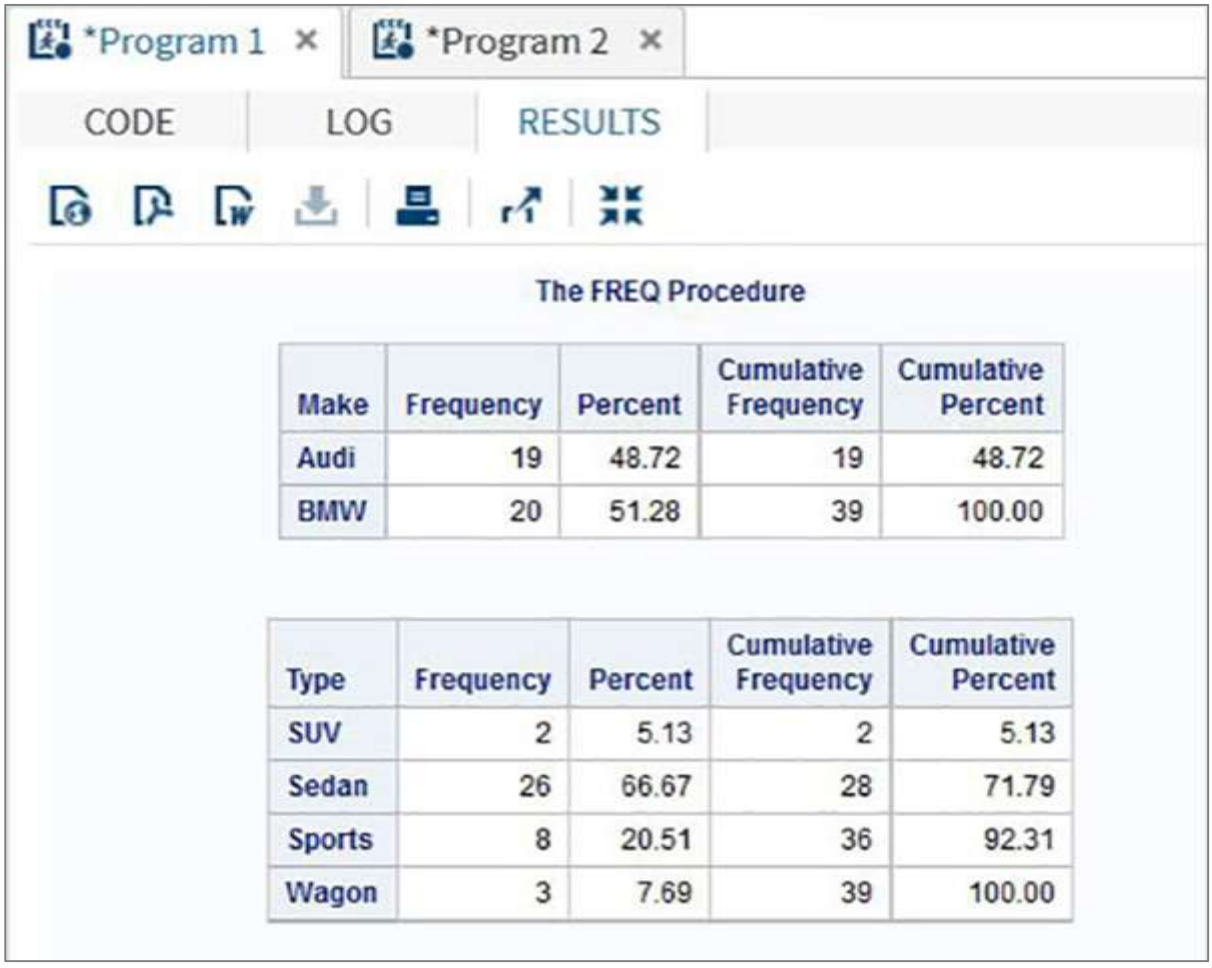
We can find the frequency distributions for multiple variables which groups them into all possible combinations.

Example

In the following example, we calculate the frequency distribution for the make of a car for **grouped by car type** and also the frequency distribution of each type of car **grouped by each make**.

```
proc FREQ data=CARS1 ;
tables make type;
run;
```

When the above code is executed, we get the following result:



Make	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Audi	19	48.72	19	48.72
BMW	20	51.28	39	100.00

Type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
SUV	2	5.13	2	5.13
Sedan	26	66.67	28	71.79
Sports	8	20.51	36	92.31
Wagon	3	7.69	39	100.00

Frequency Distribution with Weight

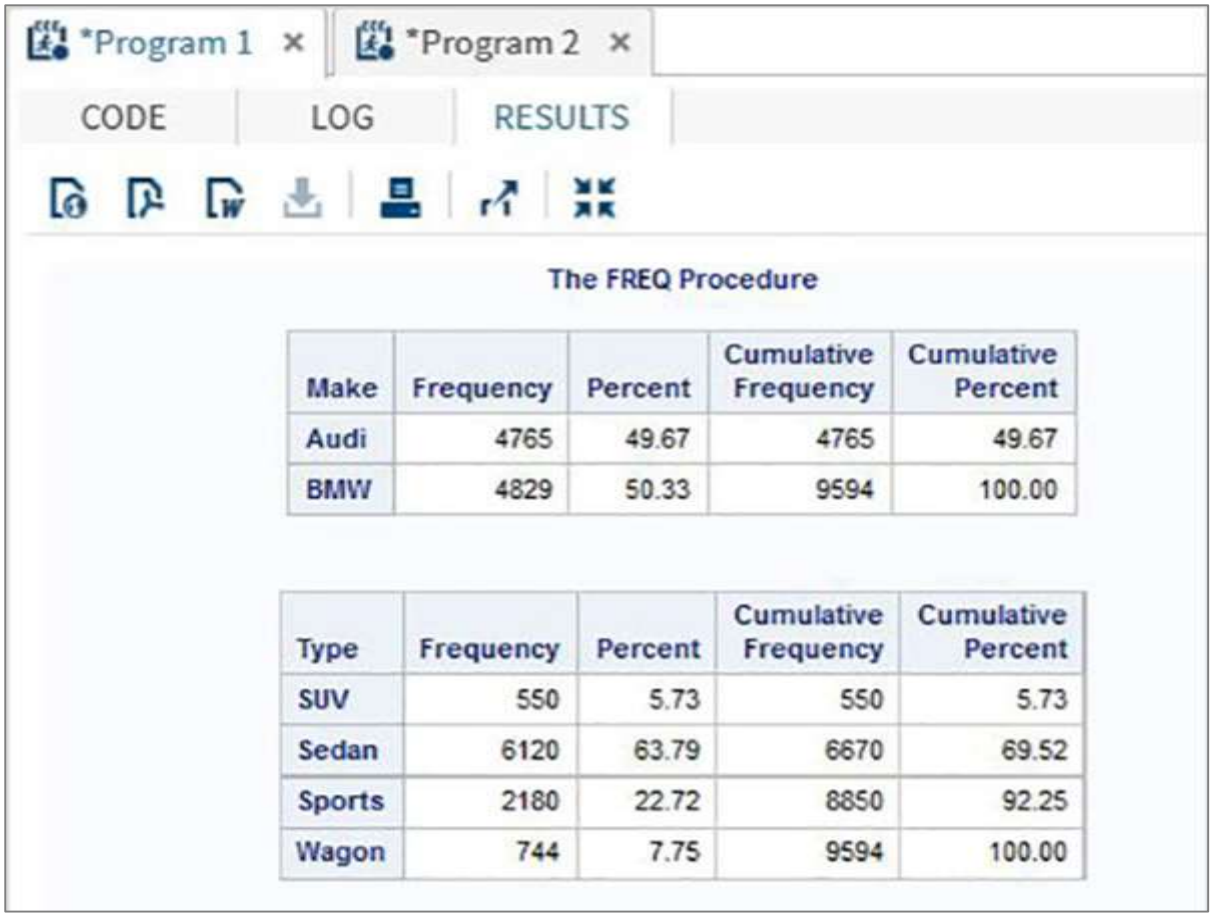
With the weight option, we can calculate the frequency distribution biased with the weight of the variable. Here the value of the variable is taken as the number of observations instead of the count of value.

Example

In the following example, we calculate the frequency distribution of the variables make and type with the weight assigned to horsepower.

```
proc FREQ data=CARS1 ;
tables make type;
weight horsepower;
run;
```

When the above code is executed, we get the following result:



Make	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Audi	4765	49.67	4765	49.67
BMW	4829	50.33	9594	100.00

Type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
SUV	550	5.73	550	5.73
Sedan	6120	63.79	6670	69.52
Sports	2180	22.72	8850	92.25
Wagon	744	7.75	9594	100.00

36. SAS – Cross Tabulations

In this chapter, we will discuss cross tabulations in SAS. Cross tabulation involves producing cross tables also called contingent tables using all possible combinations of two or more variables. In SAS, it is created using **PROC FREQ** along with the **TABLES** option. For example, if we need the frequency of each model for each make in each car type category, then we need to use the TABLES option of PROC FREQ.

Syntax

The basic syntax for applying cross tabulation in SAS is:

```
PROC FREQ DATA = dataset;
TABLES variable_1*Variable_2;
```

Following is the description of the parameters used:

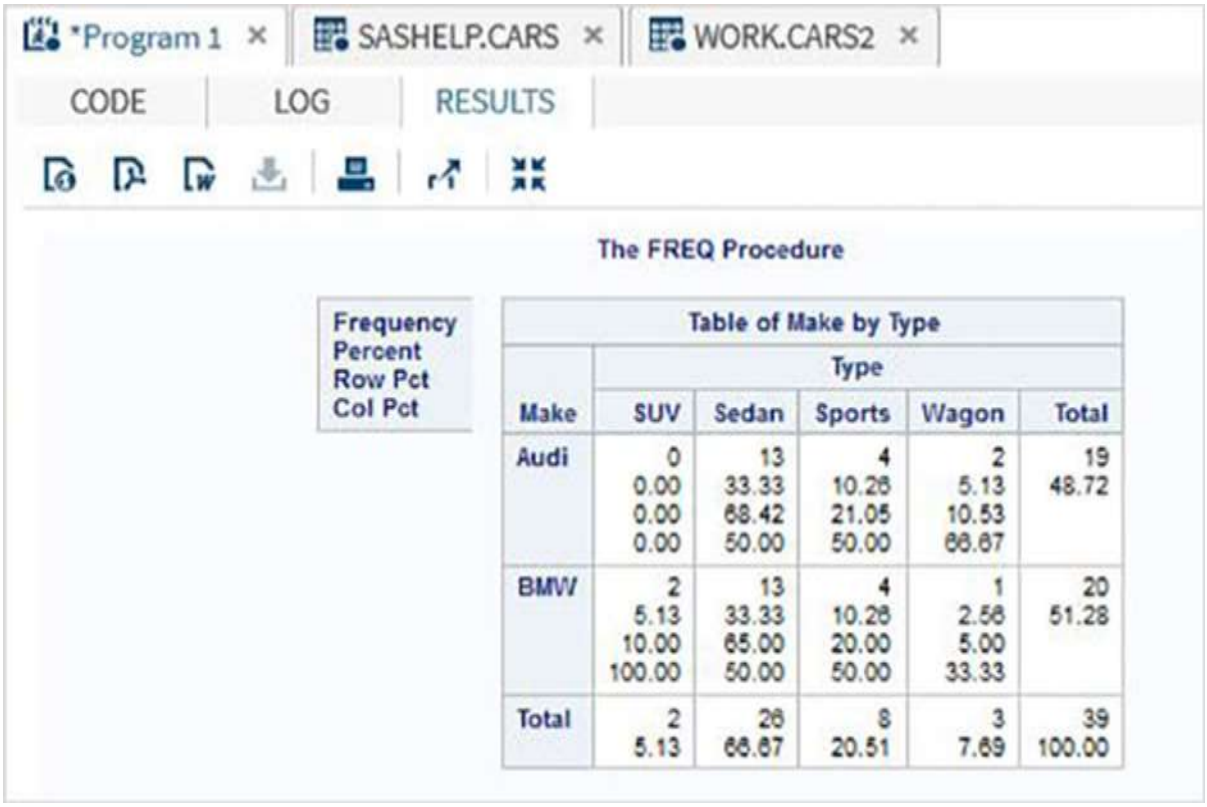
- **Dataset** is the name of the dataset.
- **Variable_1 and Variable_2** are the variable names of the dataset whose frequency distribution needs to be calculated.

Example

Consider the case of finding how many car types are available under each car brand from the dataset **cars1** which is created form **SASHELP.CARS** as shown below. In this case, we need the individual frequency values as well as the sum of the frequency values across the makes and across the types. We can observe that the result shows values across the rows and the columns.

```
PROC SQL;
create table CARS1 as
SELECT make,type,invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;

proc FREQ data=CARS1 ;
tables make*type;
run;
```

When the above code is executed, we get the following result:



*Program 1 | SASHELP.CARS | WORK.CARS2

CODE | LOG | RESULTS

The FREQ Procedure

Frequency
Percent
Row Pct
Col Pct

Table of Make by Type

Make	Type				
	SUV	Sedan	Sports	Wagon	Total
Audi	0 0.00 0.00 0.00	13 33.33 68.42 50.00	4 10.26 21.05 50.00	2 5.13 10.53 66.67	19 48.72
BMW	2 5.13 10.00 100.00	13 33.33 65.00 50.00	4 10.26 20.00 50.00	1 2.56 5.00 33.33	20 51.28
Total	2 5.13	26 66.67	8 20.51	3 7.69	39 100.00

Cross Tabulation of 3 Variables

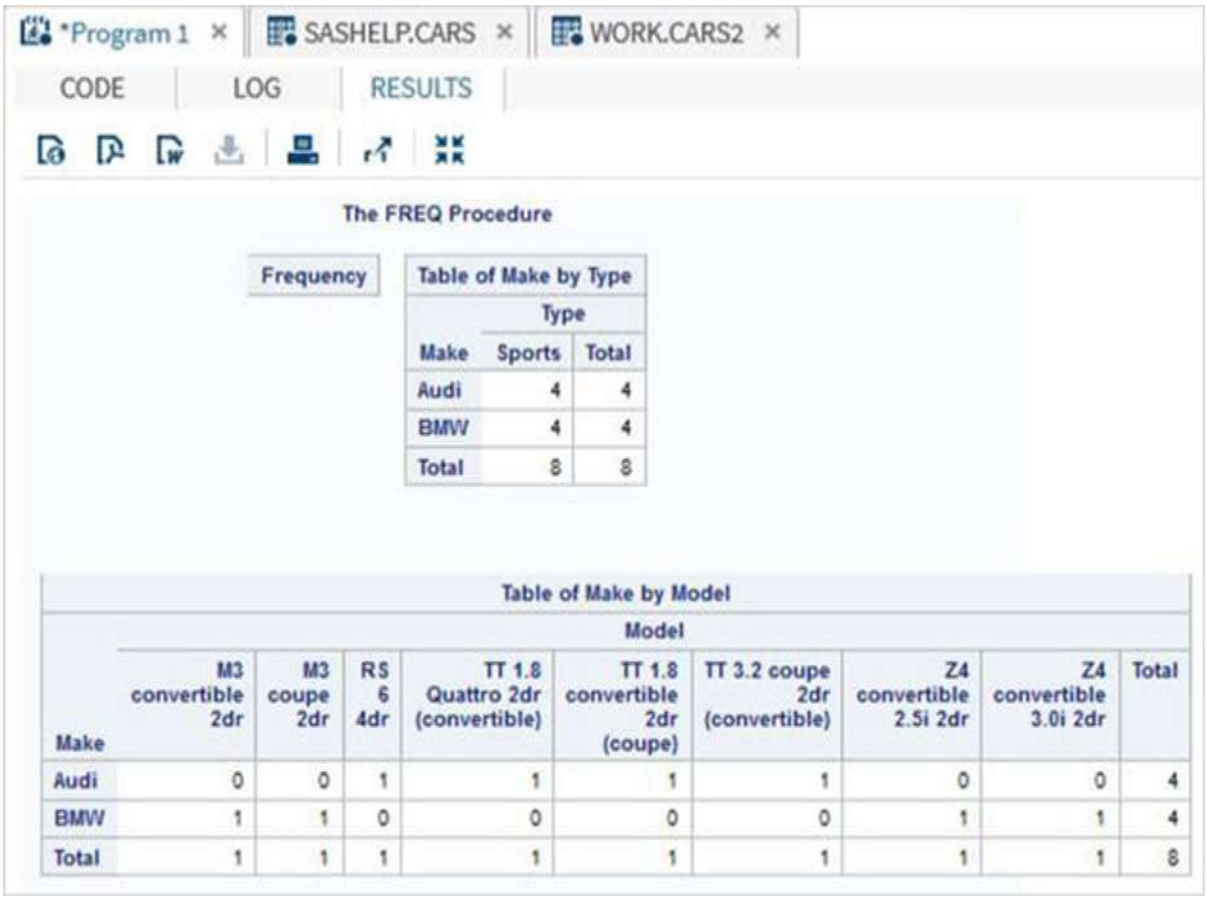
When we have three variables we can group 2 of them and cross tabulate each of these two with the third variable. So, the result will fetch two cross tables.

Example

In the following example, we find the frequency of each type of car and each model of car with respect to the make of the car. Also we use the **nocol** and **norow** option to avoid the sum and percentage values.

```
proc FREQ data=CARS2 ;
tables make * (type model)  / nocol norow nopercent;
run;
```

When the above code is executed, we get the following result:



*Program 1 | SASHELP.CARS | WORK.CARS2

CODE | LOG | RESULTS

The FREQ Procedure

Frequency

Table of Make by Type

Make	Type: Sports	Total
Audi	4	4
BMW	4	4
Total	8	8

Table of Make by Model

Make	Model: M3 convertible 2dr	M3 coupe 2dr	RS 6 4dr	TT 1.8 Quattro 2dr (convertible)	TT 1.8 convertible 2dr (coupe)	TT 3.2 coupe 2dr (convertible)	Z4 convertible 2.5i 2dr	Z4 convertible 3.0i 2dr	Total
Audi	0	0	1	1	1	1	0	0	4
BMW	1	1	0	0	0	0	1	1	4
Total	1	1	1	1	1	1	1	1	8

Cross Tabulation of 4 Variables

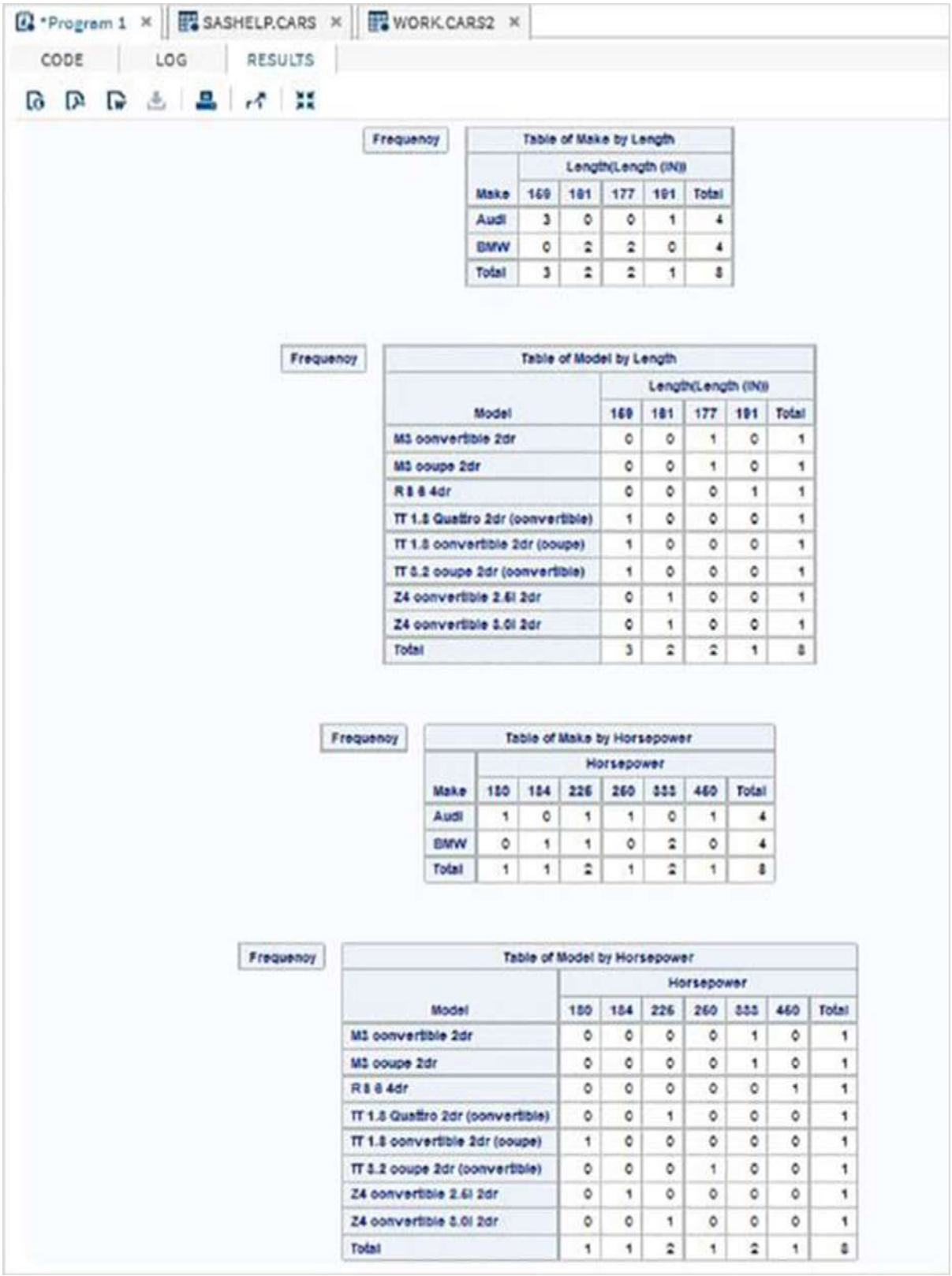
With 4 variables, the number of paired combinations increases to 4. Each variable from group 1 is paired with each variable of group 2.

Example

In the following example, we find the frequency of length of the car for each make and each model. Similarly, we also find the frequency of horsepower for each make and each model.

```
proc FREQ data=CARS2 ;
tables (make model) * (length  horsepower)  / nocol norow nopercent;
run;
```

When the above code is executed, we get the following result:



*Program 1 | SASHELP.CARS | WORK.CARS2

CODE | LOG | RESULTS

Frequency

Table of Make by Length

Make	Length(Length (IN)) 169	181	177	191	Total
Audi	3	0	0	1	4
BMW	0	2	2	0	4
Total	3	2	2	1	8

Frequency

Table of Model by Length

Model	Length(Length (IN)) 169	181	177	191	Total
M3 convertible 2dr	0	0	1	0	1
M3 coupe 2dr	0	0	1	0	1
R8 4dr	0	0	0	1	1
TT 1.8 Quattro 2dr (convertible)	1	0	0	0	1
TT 1.8 convertible 2dr (coupe)	1	0	0	0	1
TT 3.2 coupe 2dr (convertible)	1	0	0	0	1
Z4 convertible 2.5i 2dr	0	1	0	0	1
Z4 convertible 3.0i 2dr	0	1	0	0	1
Total	3	2	2	1	8

Frequency

Table of Make by Horsepower

Make	Horsepower 130	184	226	260	333	450	Total
Audi	1	0	1	1	0	1	4
BMW	0	1	1	0	2	0	4
Total	1	1	2	1	2	1	8

Frequency

Table of Model by Horsepower

Model	Horsepower 130	184	226	260	333	450	Total
M3 convertible 2dr	0	0	0	0	1	0	1
M3 coupe 2dr	0	0	0	0	1	0	1
R8 4dr	0	0	0	0	0	1	1
TT 1.8 Quattro 2dr (convertible)	0	0	1	0	0	0	1
TT 1.8 convertible 2dr (coupe)	1	0	0	0	0	0	1
TT 3.2 coupe 2dr (convertible)	0	0	0	1	0	0	1
Z4 convertible 2.5i 2dr	0	1	0	0	0	0	1
Z4 convertible 3.0i 2dr	0	0	1	0	0	0	1
Total	1	1	2	1	2	1	8

37. SAS – T-tests

The T-tests are performed to compute the confidence limits for one sample or two independent samples by comparing their means and mean differences. The SAS procedure named **PROC T-TEST** is used to carry out t-tests on a single variable and a pair of variables.

Syntax

The basic syntax for applying PROC TTEST in SAS is:

```
PROC TTEST DATA = dataset;
VAR variable;
CLASS Variable;
PAIRED Variable_1 * Variable_2;
```

Following is the description of the parameters used:

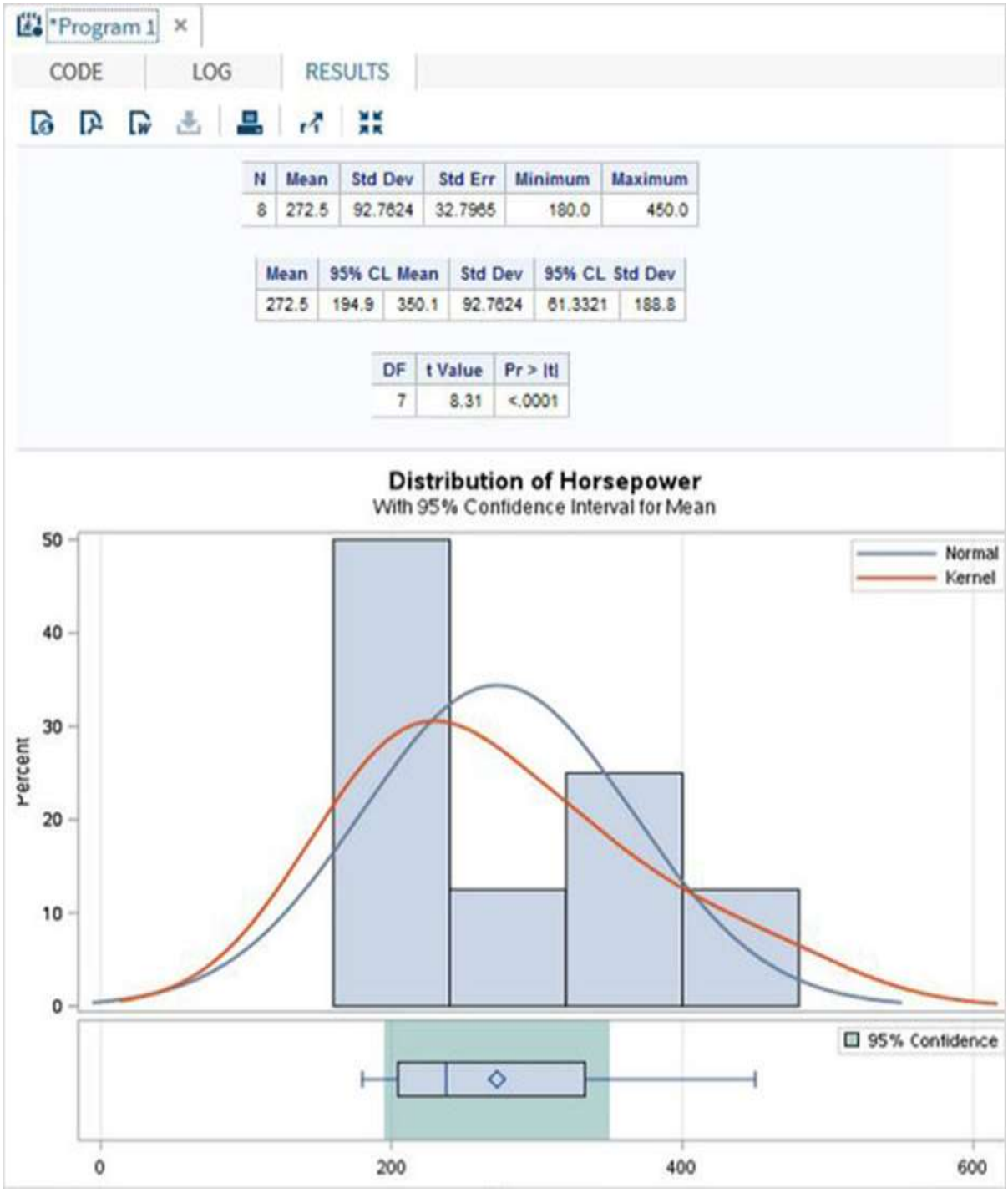
- **Dataset** is the name of the dataset.
- **Variable_1 and Variable_2** are the variable names of the dataset used in t test.

Example

The following program shows one sample t-test. This helps in finding the t-test estimation for the variable horsepower with 95 percent confidence limits.

```
PROC SQL;
create table CARS1 as
SELECT make,type,invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;

proc ttest data=cars1 alpha=0.05 h0=0;
     var horsepower;
   run;
```

When the above code is executed, we get the following result:



Paired T-test

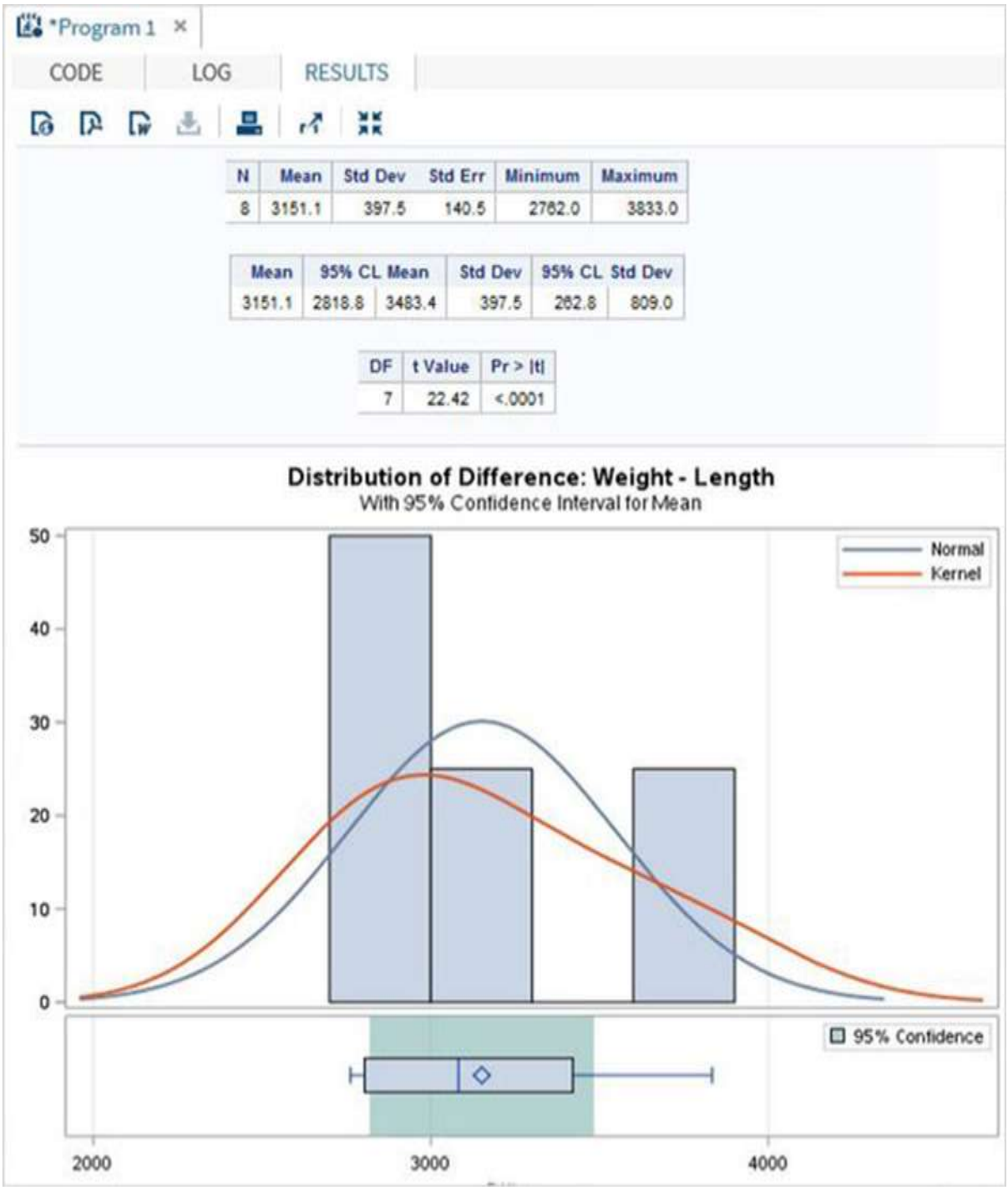
The paired T-test is carried out to test if two dependent variables are statistically different from each other or not.

Example

As the length and the weight of a car will be dependent on each other, we apply the paired T-test as shown in the following program.

```
proc ttest data=cars1 ;
    paired weight*length;
   run;
```

When the above code is executed, we get the following result:



Two Sample T-test

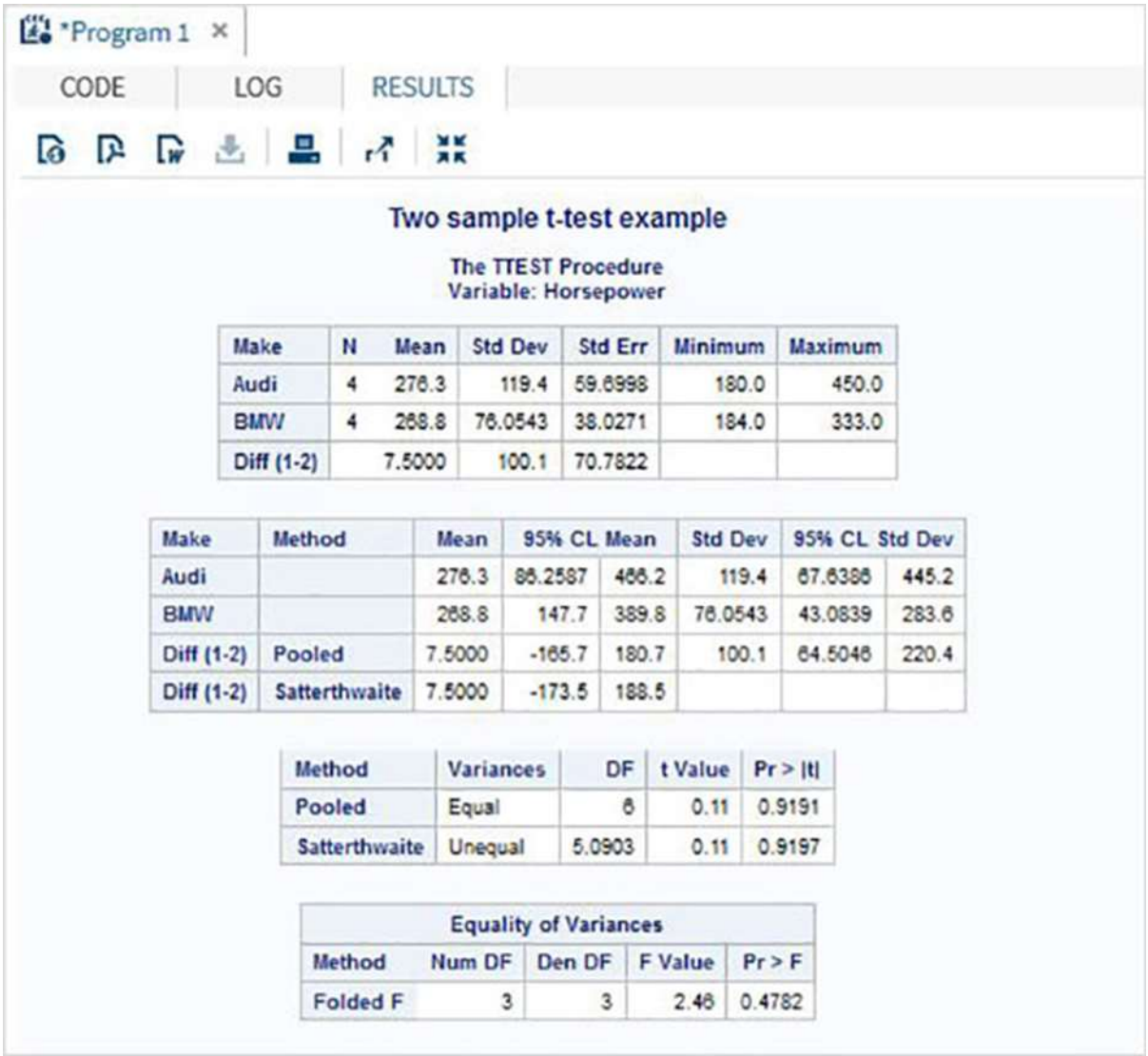
This t-test is designed to compare the means of same variable between two groups.

Example

In our case, we compare the mean of the variable horsepower between the two different makes of the cars ("Audi" and "BMW").

```
proc ttest data=cars1 sides=2 alpha=0.05 h0=0;
     title "Two sample t-test example";
     class make;
     var horsepower;
   run;
```

When the above code is executed, we get the following result:



*Program 1

CODE | LOG | RESULTS

Two sample t-test example

The TTEST Procedure
Variable: Horsepower

Make	N	Mean	Std Dev	Std Err	Minimum	Maximum
Audi	4	276.3	119.4	59.6998	180.0	450.0
BMW	4	268.8	76.0543	38.0271	184.0	333.0
Diff (1-2)		7.5000	100.1	70.7822		

Make	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
Audi		276.3	86.2587	466.2	119.4	67.6386	445.2
BMW		268.8	147.7	389.8	76.0543	43.0839	283.6
Diff (1-2)	Pooled	7.5000	-165.7	180.7	100.1	64.5046	220.4
Diff (1-2)	Satterthwaite	7.5000	-173.5	188.5			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	6	0.11	0.9191
Satterthwaite	Unequal	5.0903	0.11	0.9197

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	3	3	2.46	0.4782

38. SAS – Correlation Analysis

In this chapter, we will discuss correlation analysis in SAS. This deals with relationships among variables. The correlation coefficient is a measure of linear association between two variables. Values of the correlation coefficient are always between -1 and +1. SAS provides the procedure **PROC CORR** to find the correlation coefficients between a pair of variables in a dataset.

Syntax

The basic syntax for applying PROC CORR in SAS is:

```
PROC CORR DATA = dataset options;
VAR variable;
```

Following is the description of the parameters used:

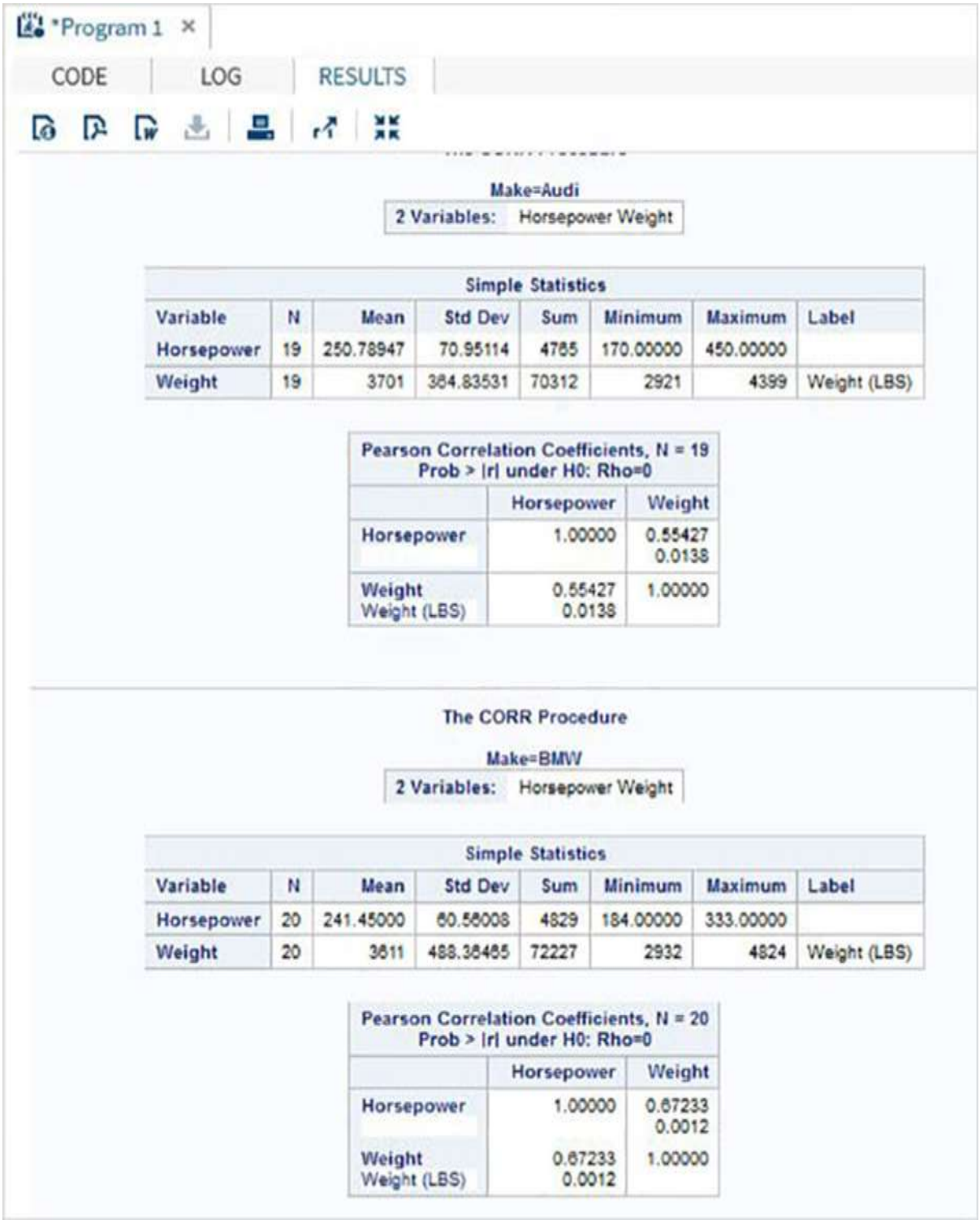
- **Dataset** is the name of the dataset.
- **Options** is the additional option with procedure like plotting a matrix etc.
- **Variable** is the variable name of the dataset used in finding the correlation.

Example

Correlation coefficients between a pair of variables available in a dataset can be obtained by using their names in the VAR statement. In the following example, we use the dataset CARS1 and get the result showing the correlation coefficients between horsepower and weight.

```
PROC SQL;
create table CARS1 as
SELECT invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;

proc corr data=cars1 ;
VAR horsepower weight ;
BY make;
run;
```

When the above code is executed, we get the following result:



Make=Audi

2 Variables: Horsepower Weight

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Horsepower	19	250.78947	70.95114	4765	170.00000	450.00000	
Weight	19	3701	384.83531	70312	2921	4399	Weight (LBS)

Pearson Correlation Coefficients, N = 19
Prob > |r| under H0: Rho=0

	Horsepower	Weight
Horsepower	1.00000	0.55427 0.0138
Weight Weight (LBS)	0.55427 0.0138	1.00000

The CORR Procedure

Make=BMW

2 Variables: Horsepower Weight

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Horsepower	20	241.45000	60.56008	4829	184.00000	333.00000	
Weight	20	3611	488.36485	72227	2932	4824	Weight (LBS)

Pearson Correlation Coefficients, N = 20
Prob > |r| under H0: Rho=0

	Horsepower	Weight
Horsepower	1.00000	0.67233 0.0012
Weight Weight (LBS)	0.67233 0.0012	1.00000

Correlation Between All Variables

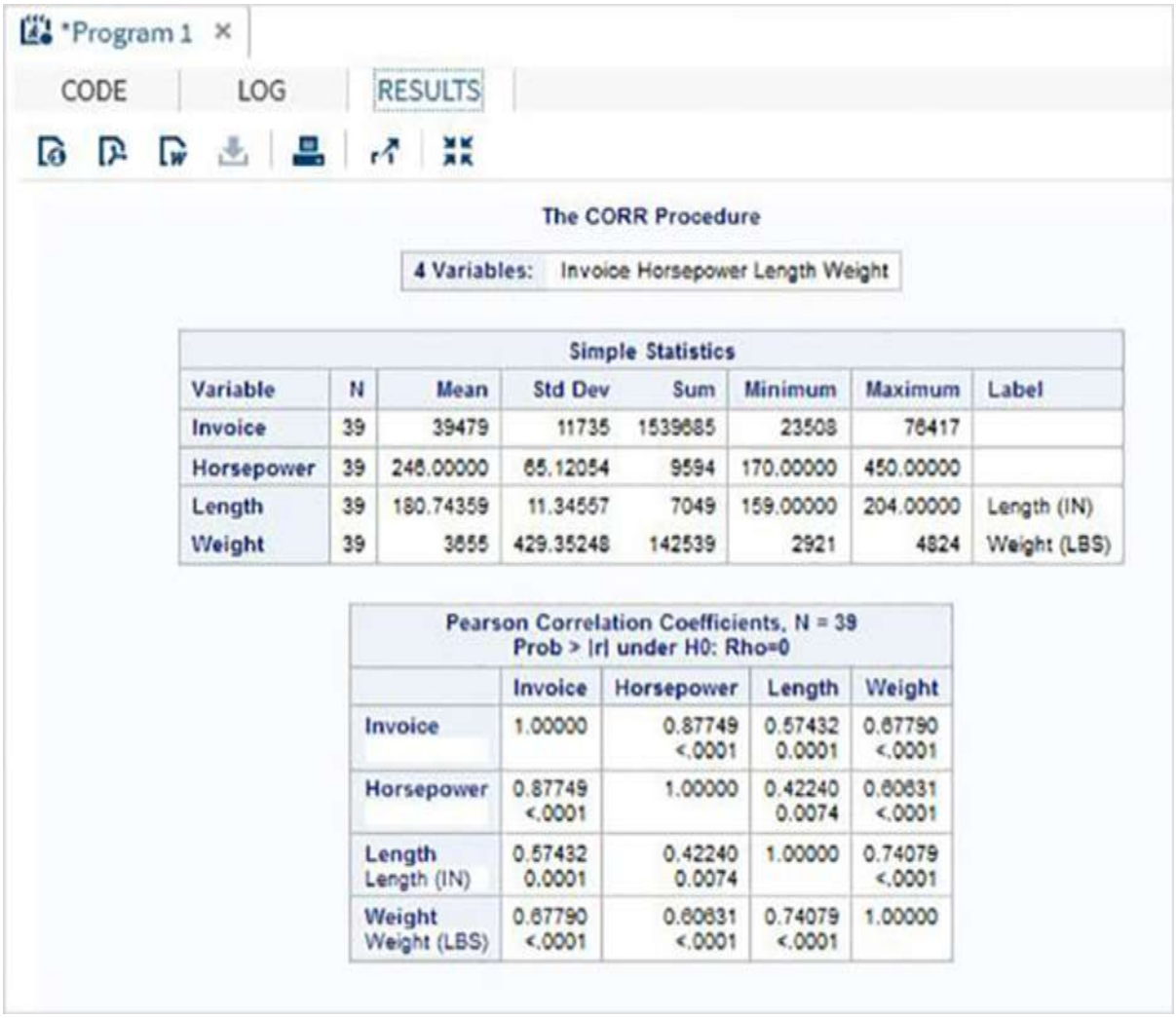
Correlation coefficients between all the variables available in a dataset can be obtained by simply applying the procedure with the dataset name.

Example

In the following example, we use the dataset **CARS1** and get the result showing the correlation coefficients between each pair of the variables.

```
proc corr data=cars1 ;
run;
```

When the above code is executed, we get the following result:



The CORR Procedure

4 Variables: Invoice Horsepower Length Weight

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Invoice	39	39479	11735	1539685	23508	76417	
Horsepower	39	246.00000	65.12054	9594	170.00000	450.00000	
Length	39	180.74359	11.34557	7049	159.00000	204.00000	Length (IN)
Weight	39	3655	429.35248	142539	2921	4824	Weight (LBS)

Pearson Correlation Coefficients, N = 39
Prob > |r| under H0: Rho=0

	Invoice	Horsepower	Length	Weight
Invoice	1.00000	0.87749 <.0001	0.57432 0.0001	0.67790 <.0001
Horsepower	0.87749 <.0001	1.00000	0.42240 0.0074	0.60831 <.0001
Length Length (IN)	0.57432 0.0001	0.42240 0.0074	1.00000	0.74079 <.0001
Weight Weight (LBS)	0.67790 <.0001	0.60831 <.0001	0.74079 <.0001	1.00000

Correlation Matrix

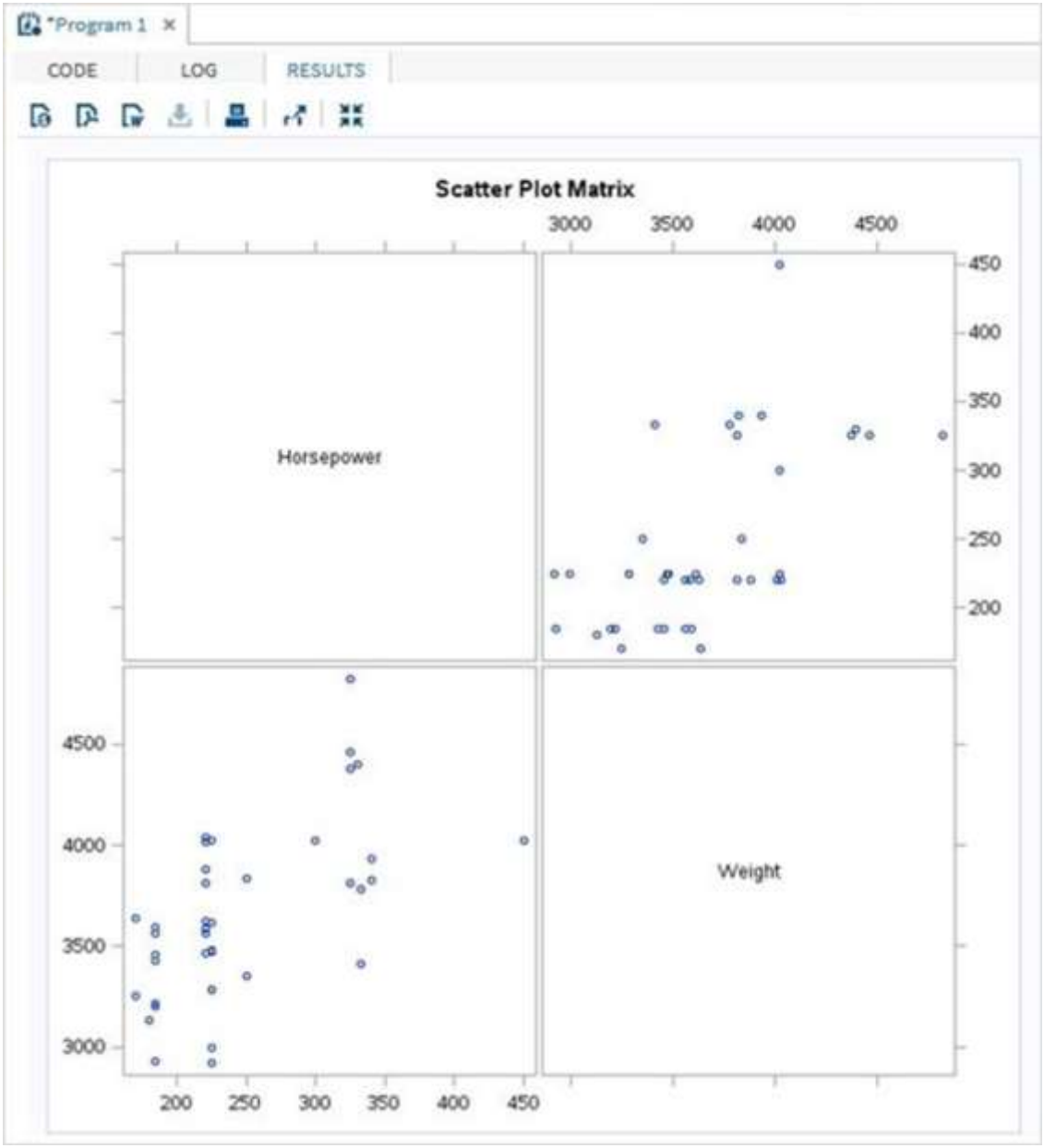
We can obtain a scatterplot matrix between the variables by choosing the option to plot matrix in the **PROC** statement.

Example

In the following example, we get the matrix between horsepower and weight.

```
proc corr data=cars1 plots=matrix ;
VAR horsepower weight ;
run;
```

When the above code is executed, we get the following result:



39. SAS – Linear Regression

In this chapter, we will discuss linear regression in SAS. Linear Regression is used to identify the relationship between a dependent variable and one or more independent variables. A model of the relationship is proposed, and estimates of the parameter values are used to develop an estimated regression equation.

Various tests are then used to determine if the model is satisfactory. If it is, then the estimated regression equation can be used to predict the value of the dependent variable given values for the independent variables. In SAS, the procedure **PROC REG** is used to find the linear regression model between two variables.

Syntax

The basic syntax for applying PROC REG in SAS is:

```
PROC REG DATA = dataset;
MODEL variable_1 = variable_2;
```

Following is the description of the parameters used:

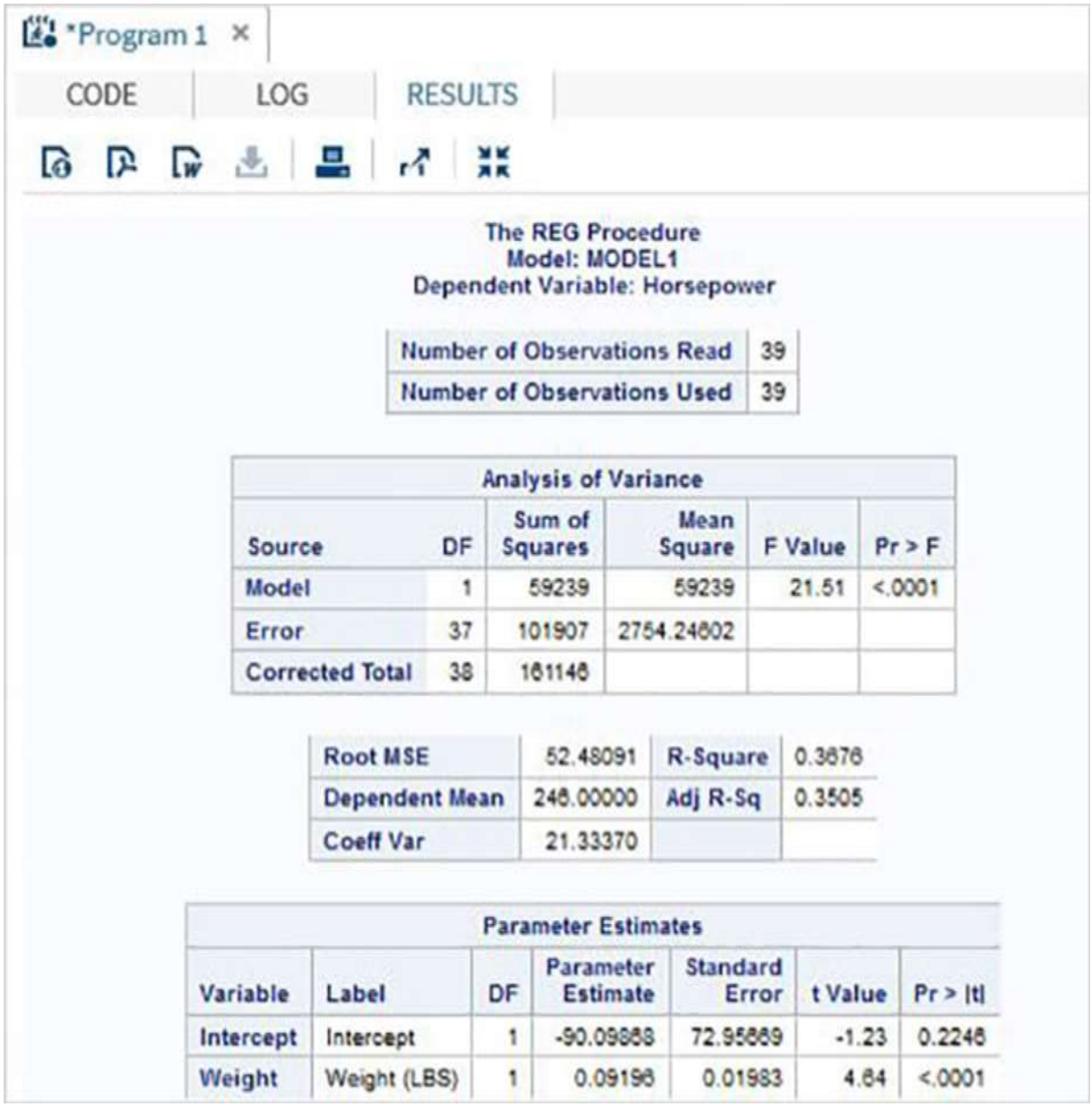
- **Dataset** is the name of the dataset.
- **variable_1 and variable_2** are the variable names of the dataset used in finding the correlation.

Example

The following example shows the process to find the correlation between the two variables horsepower and the weight of a car by using **PROC REG**. In the result we see the intercept values which can be used to form the regression equation.

```
PROC SQL;
create table CARS1 as
SELECT invoice,horsepower,length,weight
 FROM
SASHELP.CARS
WHERE make in ('Audi','BMW')
;
RUN;
proc reg data=cars1;
model horsepower= weight ;
run;
```

When the above code is executed, we get the following result:


*Program 1

CODE | LOG | RESULTS

The REG Procedure
Model: MODEL1
Dependent Variable: Horsepower

Number of Observations Read	39
Number of Observations Used	39

Analysis of Variance

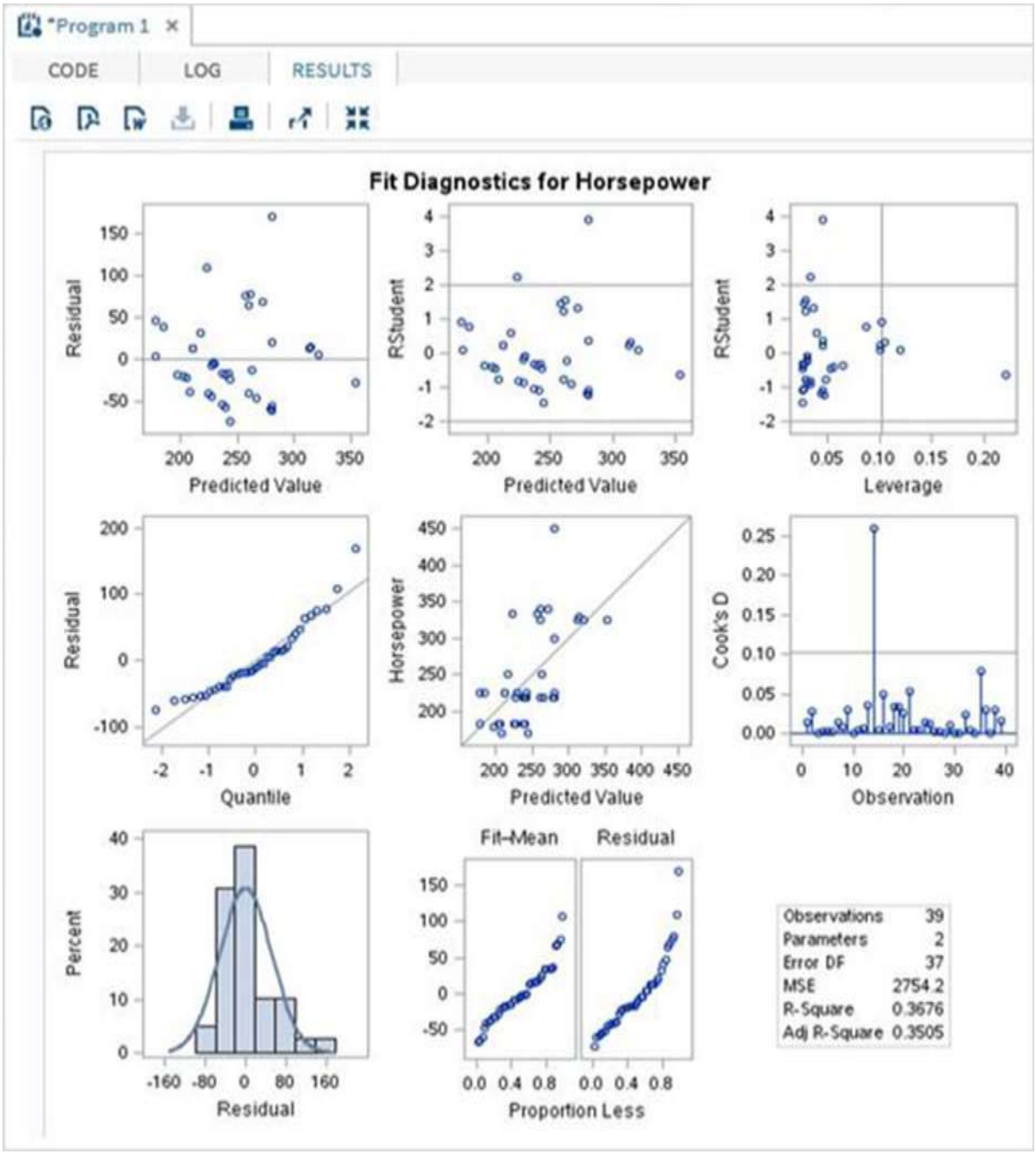
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	59239	59239	21.51	<.0001
Error	37	101907	2754.24602		
Corrected Total	38	161146			

Root MSE	52.48091	R-Square	0.3676
Dependent Mean	246.00000	Adj R-Sq	0.3505
Coeff Var	21.33370		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-90.09868	72.95869	-1.23	0.2246
Weight	Weight (LBS)	1	0.09196	0.01983	4.64	<.0001

The above code also gives the graphical view of various estimates of the model as shown in the following screenshot. Being an advanced SAS procedure it simply does not stop at giving the intercept values as the output.



40. SAS – Bland-Altman Analysis

In this chapter, we will discuss Bland-Altman analysis in SAS. The Bland-Altman analysis is a process to verify the extent of agreement or disagreement between two methods designed to measure the same parameters. A high correlation between the methods indicate that a better sample has been chosen in data analysis. In SAS, we create a Bland-Altman plot by calculating the mean, the upper limit and the lower limit of the variable values. We then use PROC SGPLOT to create the Bland-Altman plot.

Syntax

The basic syntax for applying PROC SGPLOT in SAS is:

```
PROC SGPLOT DATA = dataset;
SCATTER X=variable Y=Variable;
REFLINE value;
```

Following is the description of the parameters used:

- **Dataset** is the name of the dataset.
- **SCATTER** statement creates the scatter plot graph of the value supplied in form of X and Y.
- **REFLINE** creates a horizontal or vertical reference line.

Example

In the following example, we take the result of two experiments generated by two methods — new and old. We calculate the differences in the values of the variables and also the mean of the variables of the same observation. We also calculate the standard deviation values to be used in the upper and the lower limit of the calculation.

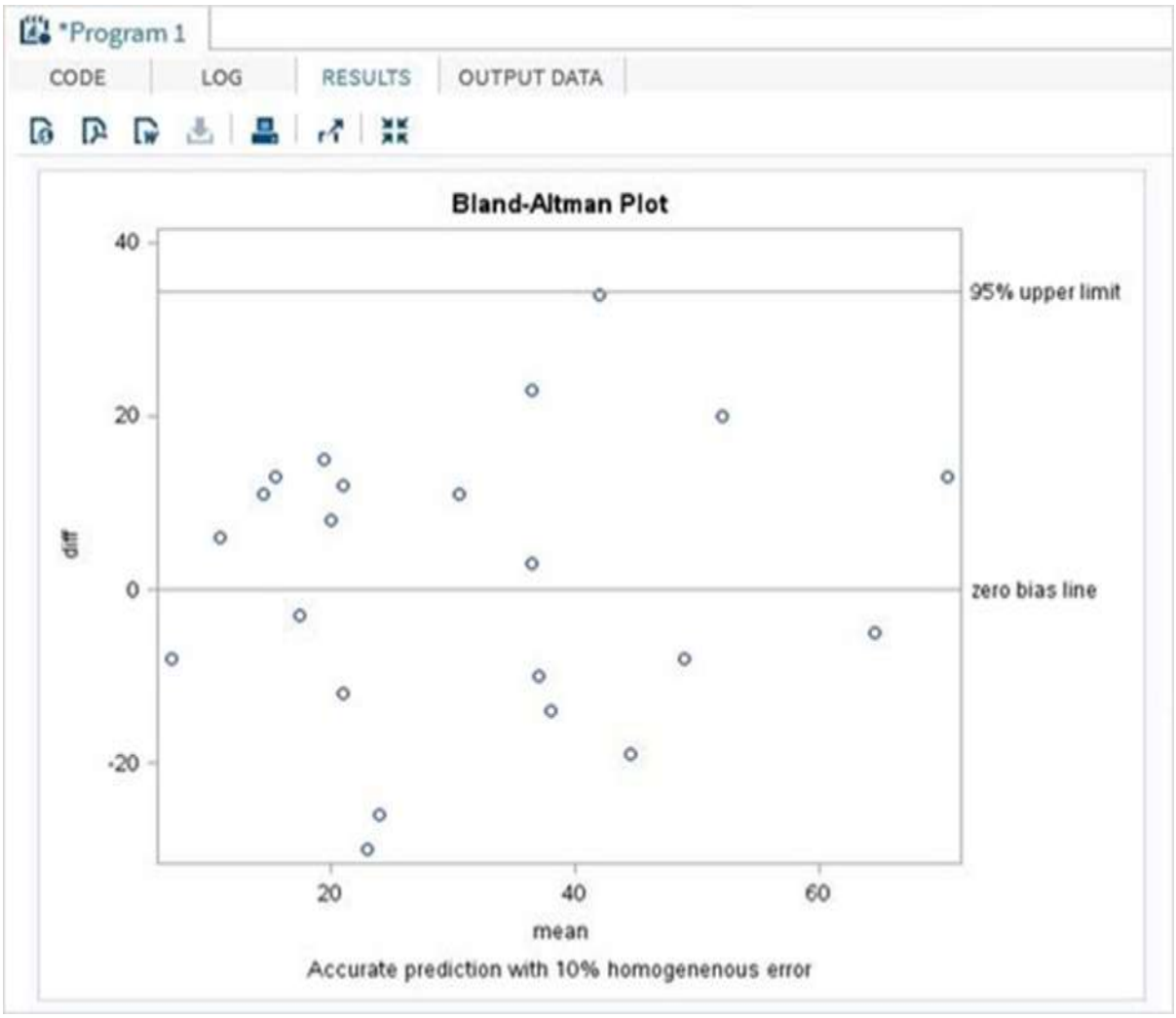
The result shows a Bland-Altman plot as a scatter plot.

```
data mydata;
input new old;
datalines;
31 45
27 12
11 37
36 25
14 8
27 15
3 11
62 42
```

```
38 35
20 9
35 54
62 67
48 25
77 64
45 53
32 42
16 19
15 27
22 9
8 38
24 16
59 25
;

data diffs ;
set mydata ;
/* calculate the difference */
diff=new-old ;
/* calculate the average */
mean=(new+old)/2 ;
run ;
proc print data=diffs;
run;

proc sql noprint ;
select mean(diff)-2*std(diff),  mean(diff)+2*std(diff)
into   :lower,  :upper
from diffs ;
quit;

proc sgplot data=diffs ;
scatter x=mean y=diff;
refline 0 &upper &lower / LABEL =  ("zero bias line" "95% upper limit" "95%
lower limit") ;
TITLE 'Bland-Altman Plot';
```

```
footnote 'Accurate prediction with 10% homogeneous error';
run ;
quit ;
```

When the above code is executed, we get the following result:



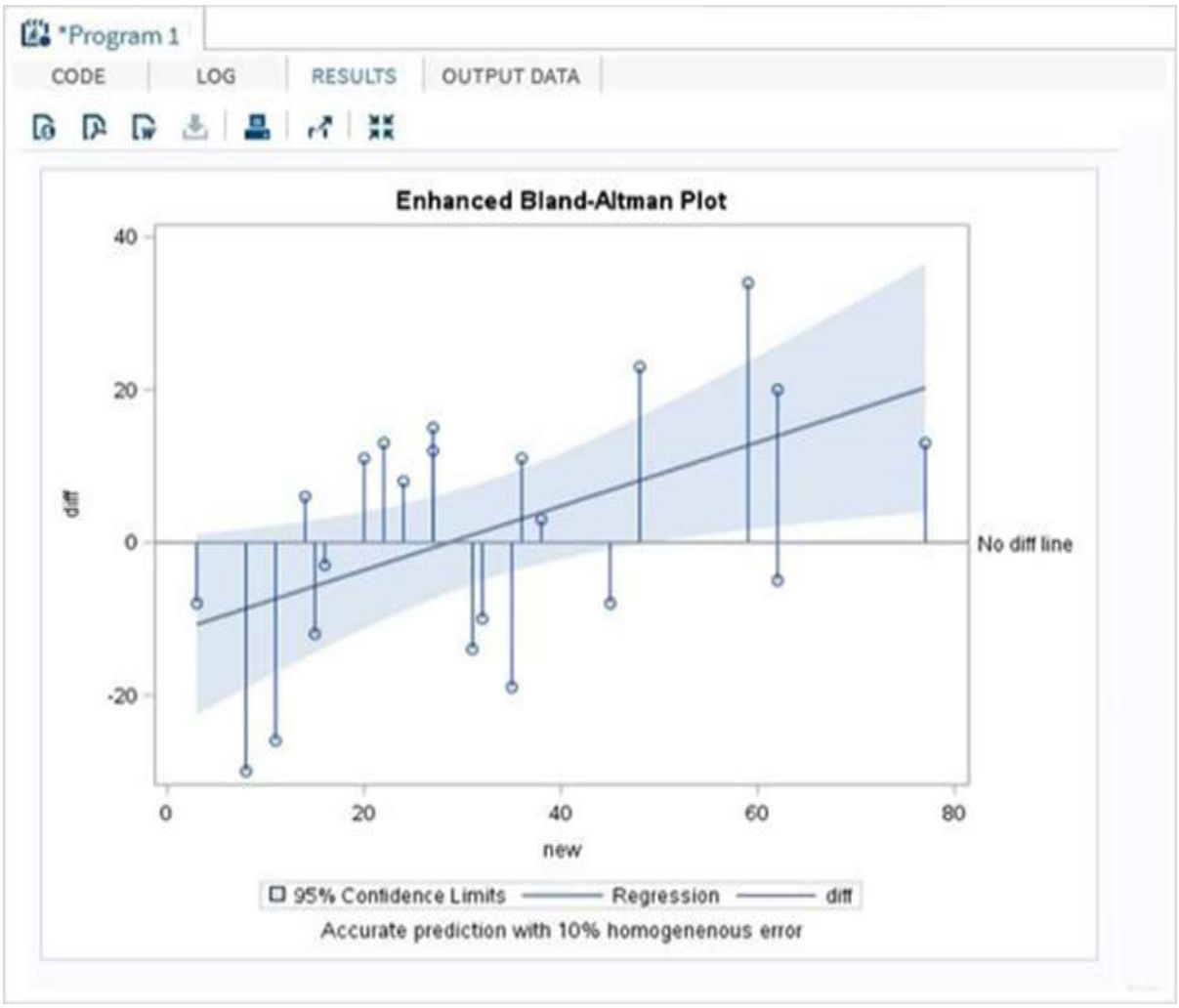
Enhanced Model

In an enhanced model of the above program, we get 95 percent confidence level curve fitting.

```
proc sgplot data=diffs ;
reg x = new y = diff/clm clmtransparency= .5;
needle x= new y=diff/baseline=0;
refline 0 / LABEL =  ('No diff line');
TITLE 'Enhanced Bland-Altman Plot';
```

```
footnote 'Accurate prediction with 10% homogeneous error';
run ;
quit ;
```

When the above code is executed, we get the following result:



41. SAS – Chi-Square

In this chapter, we will understand how a Chi-Square test is used in SAS. This test is used to examine the association between two categorical variables. It can be used to test both extent of dependence and extent of independence between Variables. SAS uses **PROC FREQ** along with the option **chisq** to determine the result of Chi-Square test.

Syntax

The basic syntax for applying PROC FREQ for Chi-Square test in SAS is:

```
PROC FREQ DATA = dataset;
TABLES variables
/CHISQ TESTP=(percentage values);
```

Following is the description of the parameters used:

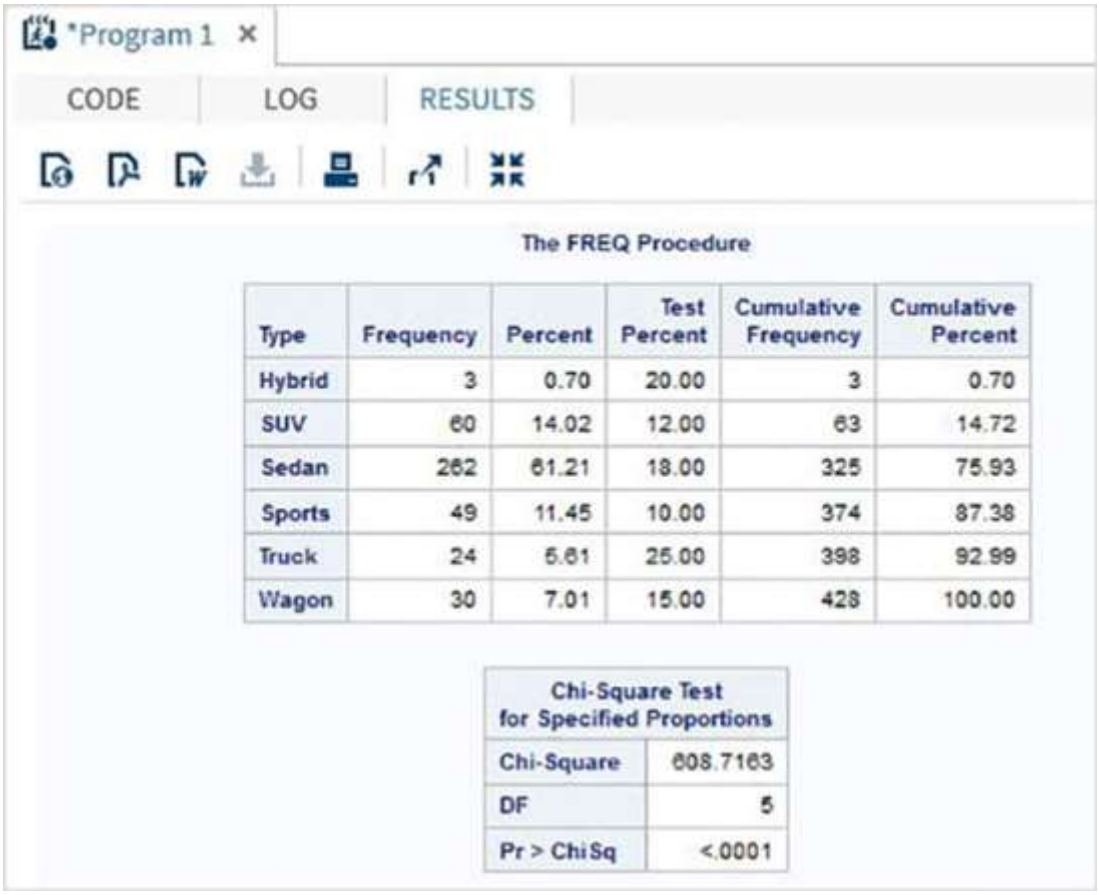
- **Dataset** is the name of the dataset.
- **Variables** are the variable names of the dataset use in chi-square test.
- **Percentage Values** in the TESTP statement represent the percentage of levels of the variable.

Example

In the following example, we consider a Chi-Square test on the variable named type in the dataset **SASHELP.CARS**. This variable has six levels and we assign percentage to each level as per the design of the test.

```
proc freq data = sashelp.cars;
tables type
/chisq
testp=(0.20 0.12 0.18 0.10 0.25 0.15);
run;
```

When the above code is executed, we get the following result:



The FREQ Procedure

Type	Frequency	Percent	Test Percent	Cumulative Frequency	Cumulative Percent
Hybrid	3	0.70	20.00	3	0.70
SUV	60	14.02	12.00	63	14.72
Sedan	262	61.21	18.00	325	75.93
Sports	49	11.45	10.00	374	87.38
Truck	24	5.61	25.00	398	92.99
Wagon	30	7.01	15.00	428	100.00

Chi-Square Test for Specified Proportions	
Chi-Square	608.7163
DF	5
Pr > ChiSq	<.0001

We also get the bar chart showing the deviation of the variable type as shown in the following screenshot.

Two-Way Chi-Square

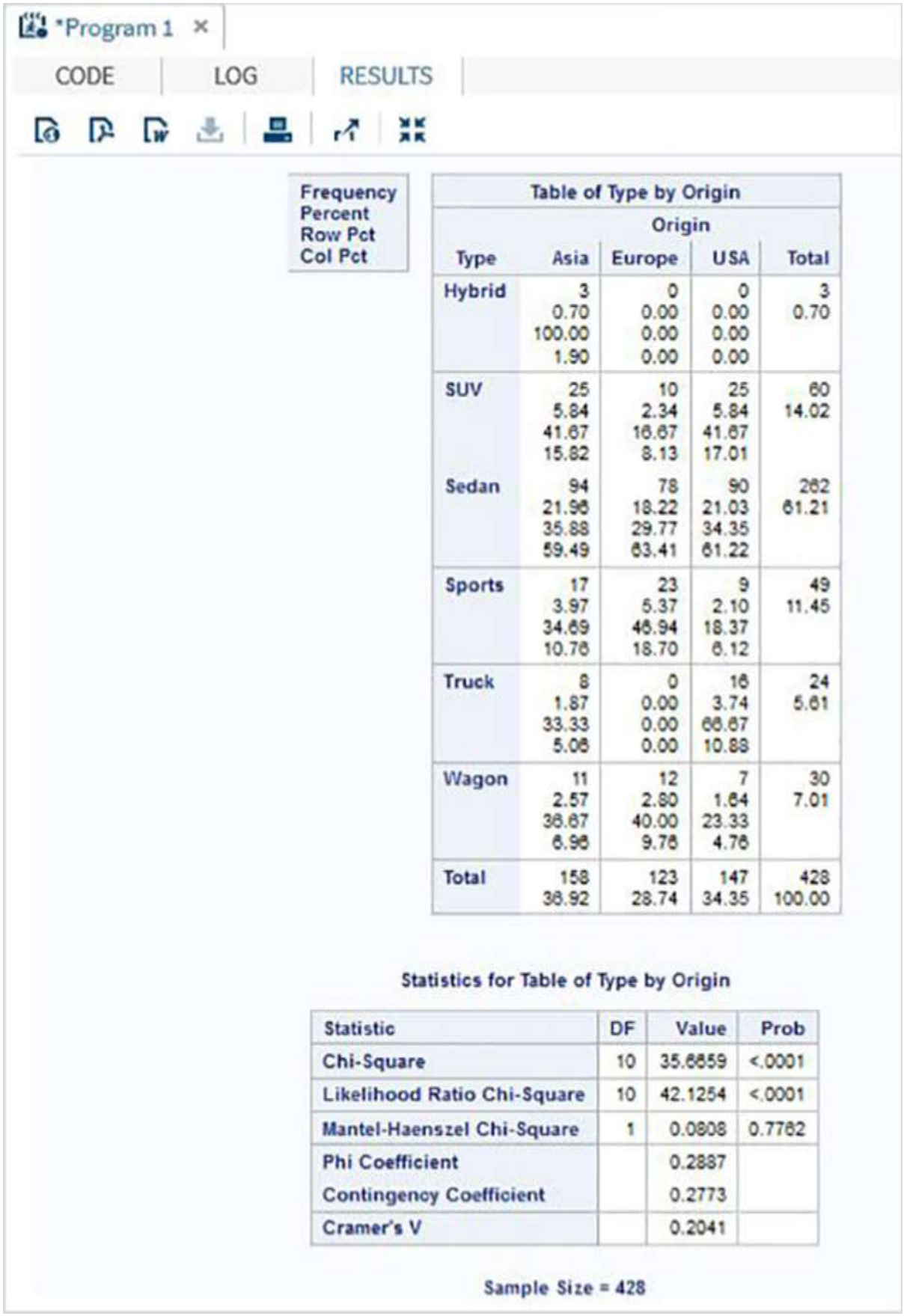
Two-way Chi-Square test is used when we apply the tests to two variables of the dataset.

Example

In the following example, we apply chi-square test on two variables named type and origin. The result shows the tabular form of all combinations of these two variables.

```
proc freq data = sashelp.cars;
tables type*origin
/chisq
;
run;
```

When the above code is executed, we get the following result:



Frequency
Percent
Row Pct
Col Pct

Table of Type by Origin

Type	Origin: Asia	Europe	USA	Total
Hybrid	3 0.70 100.00 1.90	0 0.00 0.00 0.00	0 0.00 0.00 0.00	3 0.70
SUV	25 5.84 41.67 15.82	10 2.34 16.67 8.13	25 5.84 41.67 17.01	60 14.02
Sedan	94 21.96 35.88 59.49	78 18.22 29.77 63.41	90 21.03 34.35 61.22	262 61.21
Sports	17 3.97 34.69 10.76	23 5.37 46.94 18.70	9 2.10 18.37 6.12	49 11.45
Truck	8 1.87 33.33 5.06	0 0.00 0.00 0.00	16 3.74 66.67 10.88	24 5.61
Wagon	11 2.57 36.67 6.96	12 2.80 40.00 9.76	7 1.64 23.33 4.76	30 7.01
Total	158 36.92	123 28.74	147 34.35	428 100.00

Statistics for Table of Type by Origin

Statistic	DF	Value	Prob
Chi-Square	10	35.6659	<.0001
Likelihood Ratio Chi-Square	10	42.1254	<.0001
Mantel-Haenszel Chi-Square	1	0.0808	0.7762
Phi Coefficient		0.2887	
Contingency Coefficient		0.2773	
Cramer's V		0.2041	

Sample Size = 428

42. SAS – Fisher's Exact Tests

Fisher's exact test is a statistical test used to determine if there are nonrandom associations between two categorical variables. In SAS, this is carried out using **PROC FREQ**. We use the Tables option to use the two variables subjected to Fisher Exact test.

Syntax

The basic syntax for applying Fisher Exact test in SAS is:

```
PROC FREQ DATA = dataset ;
TABLES Variable_1*Variable_2 / fisher;
```

Following is the description of the parameters used:

- **dataset** is the name of the dataset.
- **Variable_1*Variable_2** are the variables form the dataset .

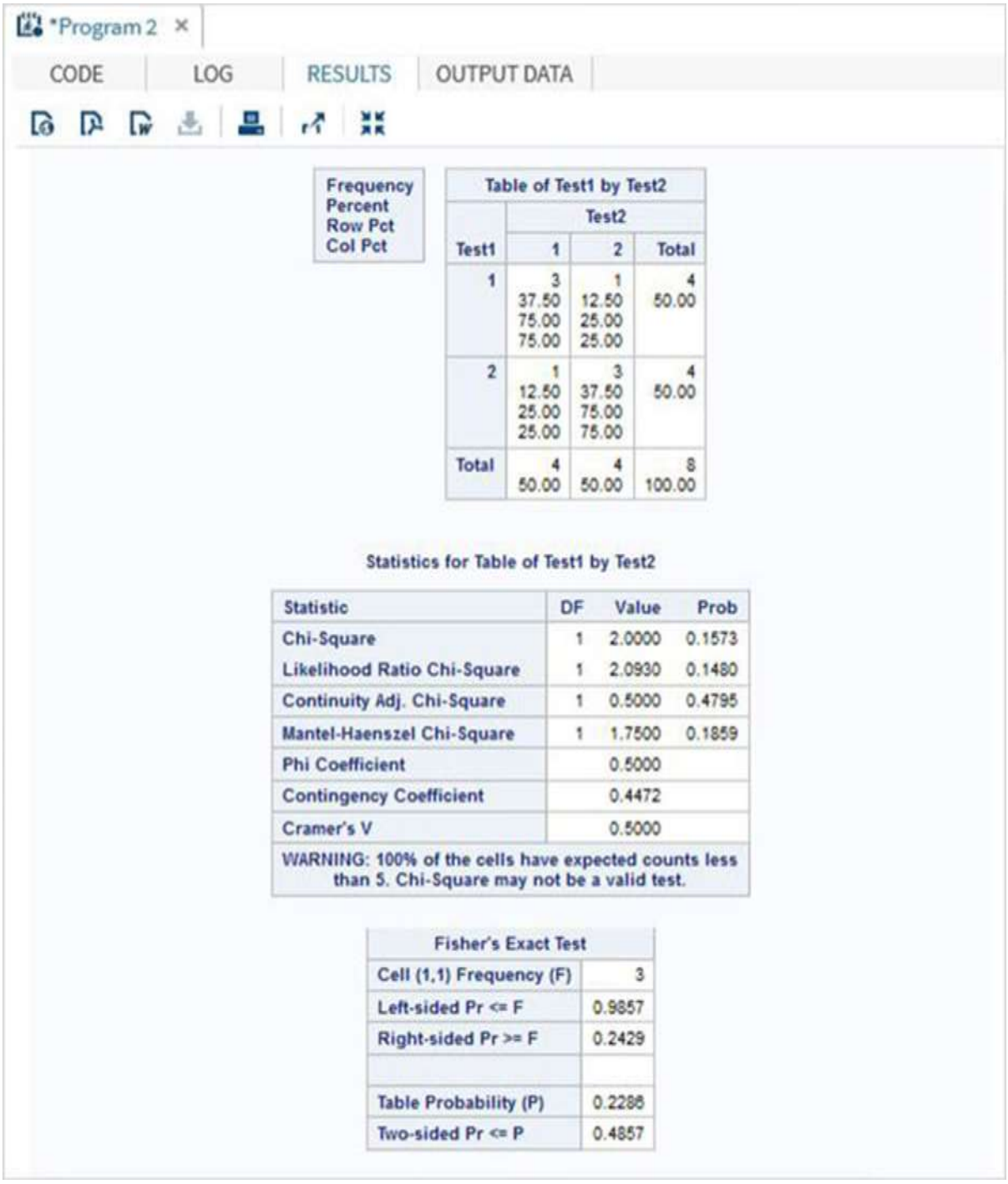
Applying Fisher Exact Test

To apply Fisher's Exact Test, we choose two categorical variables named Test1 and Test2 and their result. We use **PROC FREQ** to apply the test as shown in the following program.

Example

```
data temp;
input  Test1 Test2 Result @@;
datalines;
1 1 3 1 2 1 2 1 1 2 2 3
;
proc freq;
tables Test1*Test2 / fisher;
run;
```

When the above code is executed, we get the following result:



*Program 2

CODE | LOG | RESULTS | OUTPUT DATA

Frequency
Percent
Row Pct
Col Pct

Table of Test1 by Test2

Test1	Test2 1	Test2 2	Total
1	3 37.50 75.00 75.00	1 12.50 25.00 25.00	4 50.00
2	1 12.50 25.00 25.00	3 37.50 75.00 75.00	4 50.00
Total	4 50.00	4 50.00	8 100.00

Statistics for Table of Test1 by Test2

Statistic	DF	Value	Prob
Chi-Square	1	2.0000	0.1573
Likelihood Ratio Chi-Square	1	2.0930	0.1480
Continuity Adj. Chi-Square	1	0.5000	0.4795
Mantel-Haenszel Chi-Square	1	1.7500	0.1859
Phi Coefficient		0.5000	
Contingency Coefficient		0.4472	
Cramer's V		0.5000	

WARNING: 100% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Fisher's Exact Test	
Cell (1,1) Frequency (F)	3
Left-sided Pr <= F	0.9857
Right-sided Pr >= F	0.2429
Table Probability (P)	0.2286
Two-sided Pr <= P	0.4857

43. SAS – Repeated Measure Analysis

Repeated measure analysis is used when all members of a random sample are measured under a number of different conditions. As the sample is exposed to each condition in turn, the measurement of the dependent variable is repeated. Using a standard ANOVA in this case is not appropriate because it fails to model the correlation between the repeated measures.

One should be clear about the difference between a **repeated measures design** and a **simple multivariate design**. For both, sample members are measured on several occasions, or trials; but in the repeated measures design, each trial represents the measurement of the same characteristic under a different condition.

In SAS, **PROC GLM** is used to carry out repeated measure analysis.

Syntax

The basic syntax for PROC GLM in SAS is:

```
PROC GLM DATA=dataset;
  CLASS variable;
  MODEL variables = group / NOUNI ;
  REPEATED TRIAL n;
```

Following is the description of the parameters used:

- **dataset** is the name of the dataset.
- **CLASS** gives the variables the variable used as classification variable.
- **MODEL** defines the model to be fit using certain variables form the dataset.
- **REPEATED** defines the number of repeated measures of each group to test the hypothesis.

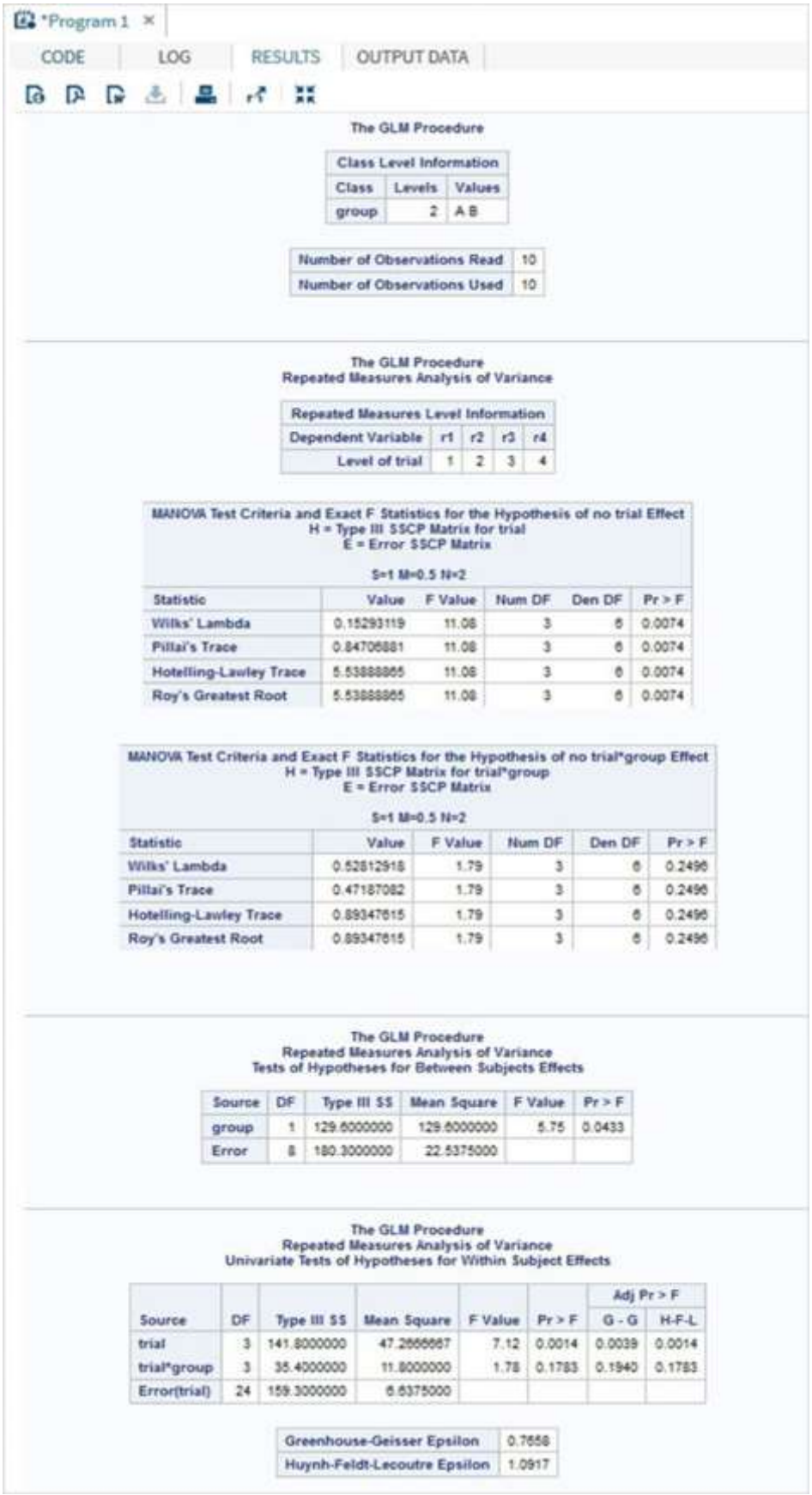
Example

Consider the following example in which we have two groups of people subjected to test the effect of a drug. The reaction time of each person is recorded for each of the four drug types tested. Here, 5 trials are done for each group of people to see the strength of correlation between the effect of the four drug types.

```
DATA temp;
  INPUT person group $ r1 r2 r3 r4;
CARDS;
1 A  2  1  6  5
2 A  5  4 11  9
3 A  6 14 12 10
```

```
4 A  2  4  5  8
5 A  0  5 10  9
6 B  9 11 16 13
7 B  12 4 13 14
8 B  15 9 13  8
9 B  6  8 12  5
10 B 5  7 11  9
;
RUN;

PROC PRINT DATA=temp ;
RUN;

 PROC GLM DATA=temp;
  CLASS group;
  MODEL r1-r4 = group / NOUNI ;
  REPEATED trial 5;
RUN;
```

When the above code is executed, we get the following result:



*Program 1

CODE | LOG | RESULTS | OUTPUT DATA

The GLM Procedure

Class Level Information		
Class	Levels	Values
group	2	A B

Number of Observations Read	10
Number of Observations Used	10

The GLM Procedure
Repeated Measures Analysis of Variance

Repeated Measures Level Information				
Dependent Variable	r1	r2	r3	r4
Level of trial	1	2	3	4

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of no trial Effect
H = Type III SSCP Matrix for trial
E = Error SSCP Matrix

S=1 M=0.5 N=2

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.15293119	11.08	3	6	0.0074
Pillai's Trace	0.84706881	11.08	3	6	0.0074
Hotelling-Lawley Trace	5.53888865	11.08	3	6	0.0074
Roy's Greatest Root	5.53888865	11.08	3	6	0.0074

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of no trial*group Effect
H = Type III SSCP Matrix for trial*group
E = Error SSCP Matrix

S=1 M=0.5 N=2

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.52812916	1.79	3	6	0.2496
Pillai's Trace	0.47187082	1.79	3	6	0.2496
Hotelling-Lawley Trace	0.89347615	1.79	3	6	0.2496
Roy's Greatest Root	0.89347615	1.79	3	6	0.2496

The GLM Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
group	1	129.6000000	129.6000000	5.75	0.0433
Error	8	180.3000000	22.5375000		

The GLM Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F	Adj Pr > F G - G	Adj Pr > F H-F-L
trial	3	141.8000000	47.2666667	7.12	0.0014	0.0039	0.0014
trial*group	3	35.4000000	11.8000000	1.78	0.1783	0.1940	0.1783
Error(trial)	24	159.3000000	6.6375000				

Greenhouse-Geisser Epsilon	0.7658
Huynh-Feldt-Lecoutre Epsilon	1.0917

44. SAS — One Way Anova

ANOVA stands for Analysis of Variance. In SAS, it is done using **PROC ANOVA**. It performs analysis of the data from a wide variety of experimental designs. In this process, a continuous response variable, known as a dependent variable, is measured under experimental conditions identified by classification variables, known as independent variables. The variation in the response is assumed to be due to effects in the classification, with random error accounting for the remaining variation.

Syntax

The basic syntax for applying PROC ANOVA in SAS is:

```
PROC ANOVA dataset ;
CLASS Variable;
MODEL Variable1=variable2 ;
MEANS ;
```

Following is the description of the parameters used:

- **dataset** is the name of the dataset.
- **CLASS** gives the variables the variable used as classification variable.
- **MODEL** defines the model to be fit using certain variables from the dataset.
- **Variable_1 and Variable_2** are the variable names of the dataset used in analysis.
- **MEANS** defines the type of computation and comparison of means.

Applying ANOVA

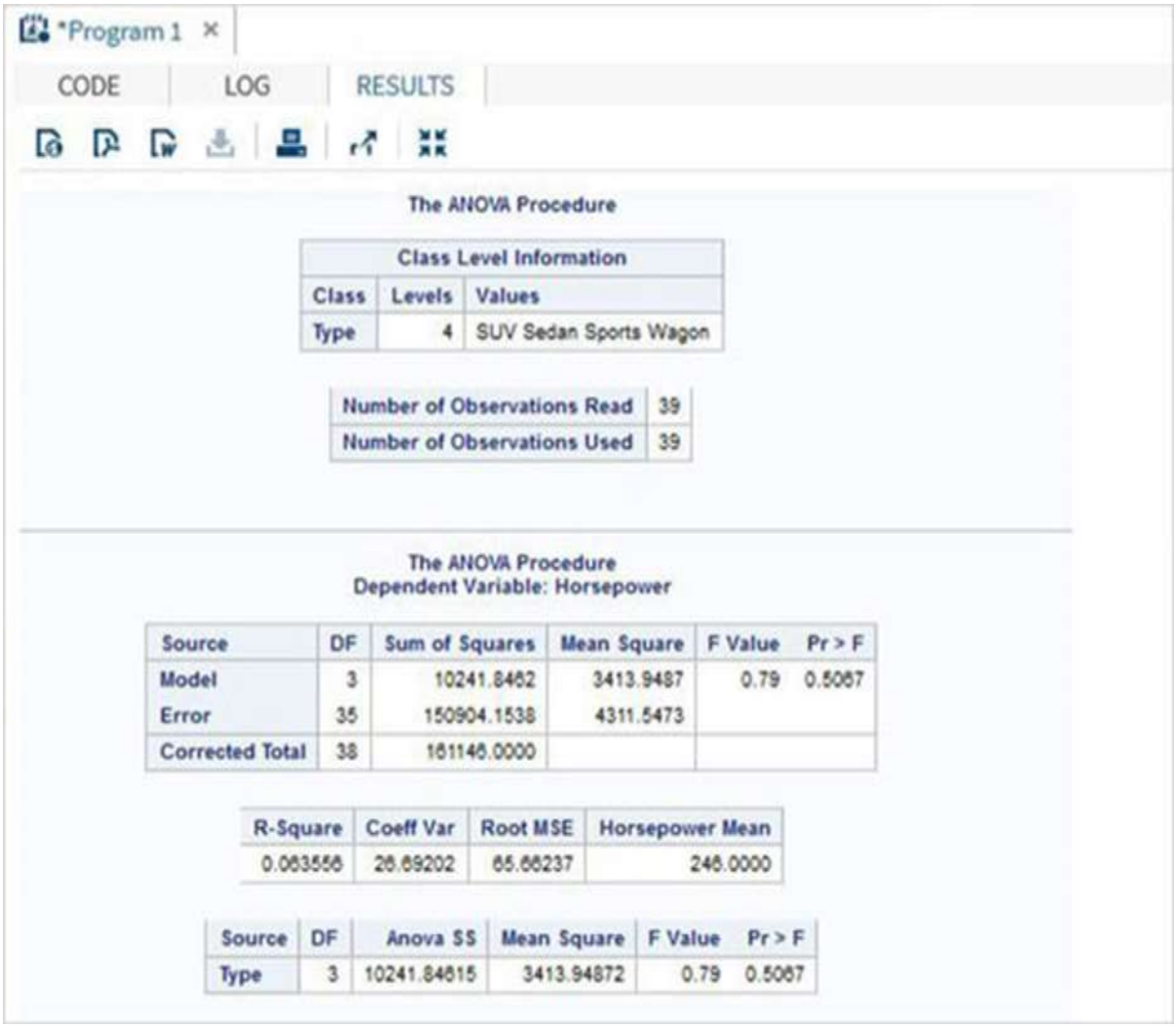
Let us now understand the concept of applying ANOVA in SAS.

Example

Let us consider the dataset **SASHELP.CARS**. Here we study the dependence between the variables car type and their horsepower. As the car type is a variable with categorical values, we take it as class variable and use both these variables in the MODEL.

```
PROC ANOVA DATA = SASHELPS.CARS;
CLASS type;
MODEL horsepower = type;
RUN;
```

When the above code is executed, we get the following result:



Applying ANOVA with MEANS

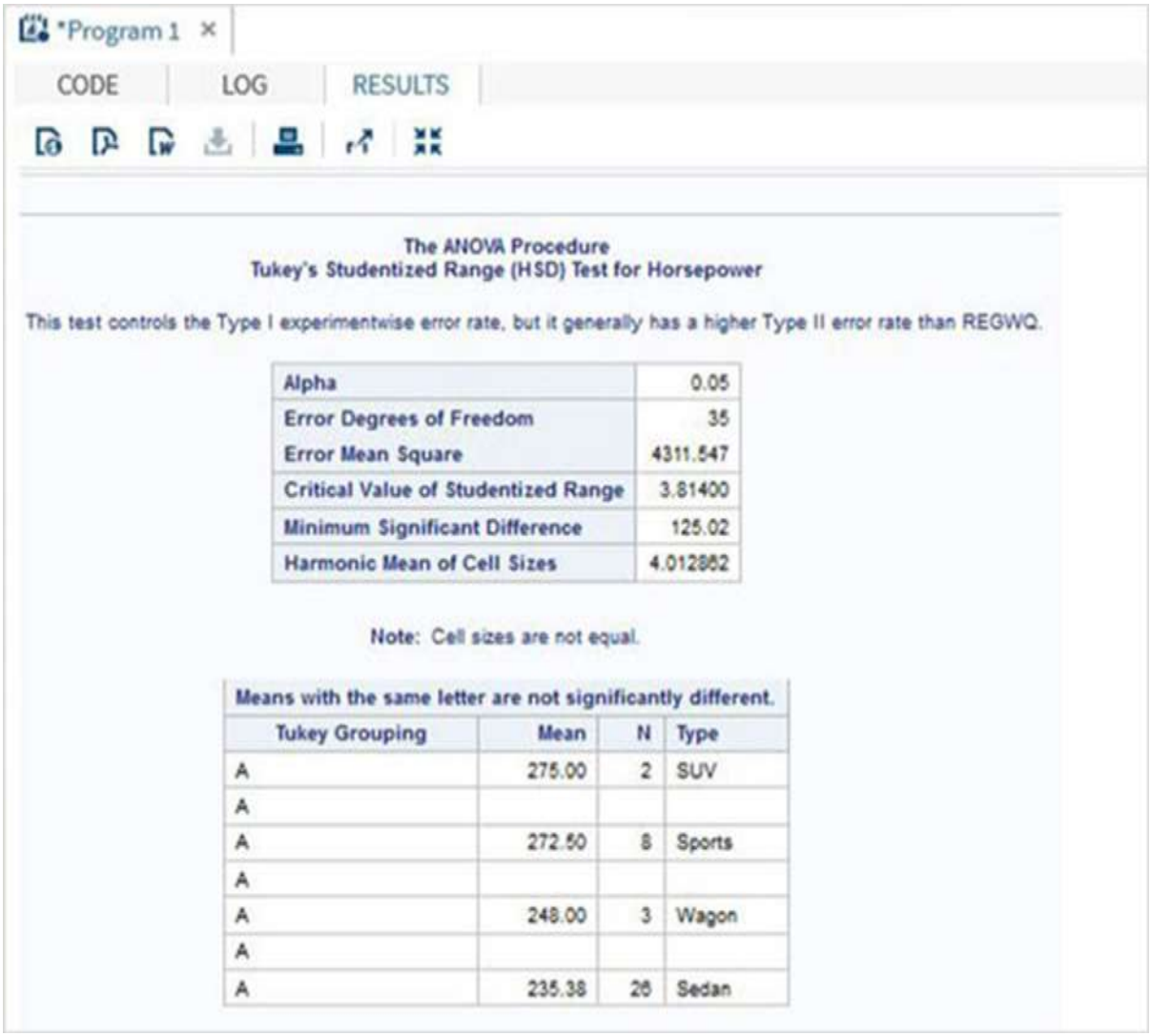
Let us now understand the concept of applying ANOVA with MEANS in SAS.

Example

We can also extend the model by applying the MEANS statement in which we use Tukey's Studentized method to compare the mean values of various car types. The category of car types is listed with the mean value of horsepower in each category along with some additional values like error mean square etc.

```
PROC ANOVA DATA = SASHELPS.CARS;
CLASS type;
MODEL horsepower = type;
MEANS type / tukey lines;
RUN;
```

When the above code is executed, we get the following result:



45. SAS – Hypothesis Testing

Hypothesis testing is the use of statistics to determine the probability that a given hypothesis is true. The usual process of hypothesis testing consists of four steps as shown below.

Step 1: Formulate the null hypothesis H0 (commonly, that the observations are the result of pure chance) and the alternative hypothesis H1 (commonly, that the observations show a real effect combined with a component of chance variation).

Step 2: Identify a test statistic that can be used to assess the truth of the null hypothesis.

Step 3: Compute the P-value, which is the probability that a test statistic at least as significant as the one observed would be obtained assuming that the null hypothesis was true. The smaller the P-value, the stronger the evidence against the null hypothesis.

Step 4: Compare the P-value to an acceptable significance value alpha (sometimes called an alpha value). If p**<=**alpha, that the observed effect is statistically significant, the null hypothesis is ruled out, and the alternative hypothesis is valid.

SAS programming language has features to carry out various types of hypothesis testing as shown below.

Test	Description	SAS PROC
T-Test	A t-test is used to test whether the mean of one variable is significantly different from a hypothesized value. We also determine whether means for two independent groups are significantly different and whether means for dependent or paired groups are significantly different.	**PROC TTEST**
ANOVA	It is also used to compare means when there is one independent categorical variable. We want to use one-way ANOVA when testing to see if the means of the interval dependent variable are different according to the independent categorical variable.	**PROC ANOVA**
Chi-Square	We use **chi-square goodness of fit test** to assess if frequencies of a categorical variable were likely to happen due to chance. Use of a chi-square test is necessary to check whether proportions of a categorical variable are a hypothesized value.	**PROC FREQ**
Linear Regression	Simple linear regression is used when one wants to test how well a variable predicts another variable. Multiple linear regression allows one to test how well multiple variables predict a variable of interest. When using multiple linear regression, we additionally assume the predictor variables are independent.	**PROC REG**