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

© Copyright 2016 by Tutorials Point (I) Pvt. Ltd.

All the content and graphics published in this e-book are the property of Tutorials Point (I) Pvt. Ltd. The user of this e-book is prohibited to reuse, retain, copy, distribute or republish any contents or a part of contents of this e-book in any manner without written consent of the publisher.

We strive to update the contents of our website and tutorials as timely and as precisely as possible, however, the contents may contain inaccuracies or errors. Tutorials Point (I) Pvt. Ltd. provides no guarantee regarding the accuracy, timeliness or completeness of our website or its contents including this tutorial. If you discover any errors on our website or in this tutorial, please notify us at contact@tutorialspoint.com.
# Table of Contents

About the Tutorial ........................................................................................................................ i
Audience .......................................................................................................................................... i
Prerequisites ................................................................................................................................... i
Disclaimer & Copyright .................................................................................................................. i
Table of Contents ........................................................................................................................... ii

1. SAS – Overview ........................................................................................................................ 1
   Uses of SAS ................................................................................................................................. 1
   Types of SAS Software ............................................................................................................... 3
   Libraries in SAS ......................................................................................................................... 4

2. SAS – Environment ................................................................................................................... 5
   Download SAS University Edition ......................................................................................... 5
   The SAS Environment ............................................................................................................... 14

3. SAS – User Interface ................................................................................................................ 15
   SAS Main Window ..................................................................................................................... 15
   Code Autocomplete .................................................................................................................. 16
   Program Execution ................................................................................................................... 16
   Program Log .............................................................................................................................. 17
   Program Result ........................................................................................................................ 17
   Program Tabs ............................................................................................................................ 18

4. SAS – Program Structure ......................................................................................................... 22
   SAS Program Structure ........................................................................................................... 22
   DATA Step ................................................................................................................................. 22
   PROC Step ............................................................................................................................... 23
   The OUTPUT Step ..................................................................................................................... 23
   The Complete SAS Program ................................................................................................... 24
   Program Output ....................................................................................................................... 24

5. SAS – Basic Syntax ................................................................................................................... 26
   SAS Statements ......................................................................................................................... 26
   SAS Variable Names ................................................................................................................. 26
   SAS Data Set ............................................................................................................................ 27
   SAS File Extensions .................................................................................................................. 27
   Comments in SAS ...................................................................................................................... 28

6. SAS – Data Sets ......................................................................................................................... 29
   SAS Built-In Data Sets .............................................................................................................. 29
   Importing External Data Sets ................................................................................................. 31

7. SAS – Variables ......................................................................................................................... 35
   SAS Variable Types .................................................................................................................. 35
   Use of Variables in SAS Program ............................................................................................ 36
   Using the Variables .................................................................................................................. 37

8. SAS – Strings ............................................................................................................................ 39
   Declaring String Variables ....................................................................................................... 39
   String Functions ....................................................................................................................... 40
9. **SAS – Arrays** ................................................................. 43
   Accessing Array Values ...................................................... 44
   Using the OF operator ....................................................... 44
   Using the IN operator ....................................................... 45

10. **SAS – Numeric Formats** ............................................ 47
    Reading Numeric formats .................................................. 47
    Displaying Numeric formats ............................................. 48

11. **SAS – Operators** ..................................................... 50
    Arithmetic Operators ..................................................... 50
    Logical Operators ......................................................... 51
    Comparison Operators .................................................. 52
    Minimum/Maximum Operators ....................................... 53
    Concatenation Operator ................................................ 54
    Operators Precedence ................................................... 55

12. **SAS – Loops** .......................................................... 56
    Flow Diagram .................................................................... 56
    SAS – DO Index Loop ..................................................... 57
    SAS – DO WHILE Loop .................................................. 58
    SAS – DO UNTIL Loop ................................................... 59

13. **SAS – Decision Making** ........................................... 60
    SAS – IF Statement ........................................................ 61
    SAS – IF THEN ELSE Statement ..................................... 63
    SAS – IF THEN ELSE IF Statement ................................ 65
    SAS – IF-THEN-DELETE Statement .................................. 66

14. **SAS – Functions** .................................................... 68
    Function Categories ....................................................... 68
    Mathematical Functions ................................................ 68
    Date and Time Functions .............................................. 69
    Character Functions ..................................................... 70
    Truncation Functions ..................................................... 71
    Miscellaneous Functions ............................................... 72

15. **SAS – Input Methods** ............................................... 74
    List Input Method ........................................................ 74
    Named Input Method ..................................................... 75
    Column Input Method ..................................................... 76
    Formatted Input Method ................................................ 77

16. **SAS – Macros** ......................................................... 79
    Macro Variables .......................................................... 79
    Local Macro Variable .................................................... 80
    Macro Programs .......................................................... 81
    Commonly Used Macros ................................................ 82
    Macro % RETURN ........................................................ 83
    Macro % END .................................................................. 84
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.</td>
<td>SAS – Date Times</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>SAS Date Informat</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>SAS Date output format</td>
<td>87</td>
</tr>
<tr>
<td>18.</td>
<td>SAS – Read Raw Data</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Reading ASCII (Text) Data Set</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Reading Delimited Data</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Reading Excel Data</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Reading Hierarchical Files</td>
<td>92</td>
</tr>
<tr>
<td>19.</td>
<td>SAS – Write Data Sets</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>PROC EXPORT</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Writing a CSV file</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Writing a Tab Delimited File</td>
<td>96</td>
</tr>
<tr>
<td>20.</td>
<td>SAS – Concatenate Data Sets</td>
<td>97</td>
</tr>
<tr>
<td>21.</td>
<td>SAS – Merge Data Sets</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>Data Merging</td>
<td>103</td>
</tr>
<tr>
<td>22.</td>
<td>SAS – Subsetting Data Sets</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Subsetting Variables</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Subsetting Observations</td>
<td>109</td>
</tr>
<tr>
<td>23.</td>
<td>SAS – Sort Data Sets</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Reverse Sorting</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>Sorting Multiple Variables</td>
<td>113</td>
</tr>
<tr>
<td>24.</td>
<td>SAS – Format Data Sets</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td>Using PROC FORMAT</td>
<td>116</td>
</tr>
<tr>
<td>25.</td>
<td>SAS – SQL</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>SQL Create Operation</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>SQL Read Operation</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>SQL SELECT with WHERE Clause</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>SQL UPDATE Operation</td>
<td>121</td>
</tr>
<tr>
<td></td>
<td>SQL DELETE Operation</td>
<td>123</td>
</tr>
<tr>
<td>26.</td>
<td>SAS – ODS</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td>Creating HTML Output</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td>Creating PDF Output</td>
<td>126</td>
</tr>
<tr>
<td></td>
<td>Creating TRF(Word) Output</td>
<td>127</td>
</tr>
<tr>
<td>27.</td>
<td>SAS – Simulations</td>
<td>129</td>
</tr>
</tbody>
</table>
SAS DATA REPRESENTATION.................................................................................................................. 130

28. SAS – Histograms .............................................................................................................................. 131
   Simple Histogram ............................................................................................................................... 131
   Histogram with Curve Fitting ............................................................................................................ 132

29. SAS – Bar Charts .............................................................................................................................. 134
   Simple Bar chart ............................................................................................................................... 134
   Stacked Bar chart ............................................................................................................................ 135
   Clustered Bar chart .......................................................................................................................... 136

30. SAS – Pie Charts ............................................................................................................................... 138
   Simple Pie Chart ............................................................................................................................. 138
   Pie Chart with Data Labels ............................................................................................................. 140
   Grouped Pie Chart .......................................................................................................................... 142

31. SAS – Scatter Plots ............................................................................................................................ 144
   Simple Scatterplot .......................................................................................................................... 144
   Scatterplot with Prediction ............................................................................................................. 145
   Scatter Matrix ............................................................................................................................... 147

32. SAS – Boxplots .................................................................................................................................. 148
   Simple Boxplot .............................................................................................................................. 148
   Boxplot in Vertical Panels ............................................................................................................. 150
   Boxplot in Horizontal Panels ......................................................................................................... 150

SAS BASIC STATISTICAL PROCEDURE ............................................................................................. 152

33. SAS – Arithmetic Mean ...................................................................................................................... 153
   Mean of a Dataset ........................................................................................................................... 153
   Mean of Select Variables ................................................................................................................. 154
   Mean by Class ................................................................................................................................. 155

34. SAS – Standard Deviation .................................................................................................................. 156
   Using PROC MEANS ...................................................................................................................... 156
   Using PROC SURVEYMEANS ....................................................................................................... 157
   Using BY Option ............................................................................................................................ 159

35. SAS – Frequency Distributions .......................................................................................................... 161
   Single Variable Frequency Distribution ......................................................................................... 161
   Multiple Variable Frequency Distribution ..................................................................................... 163
   Frequency Distribution with Weight ............................................................................................. 164

36. SAS – Cross Tabulations ..................................................................................................................... 165
   Cross Tabulation of 3 Variables ..................................................................................................... 166
   Cross Tabulation of 4 Variables ...................................................................................................... 167

37. SAS – T-tests .................................................................................................................................... 169
   Paired T-test ................................................................................................................................... 170
   Two Sample T-test .......................................................................................................................... 172
38. SAS — Correlation Analysis .................................................................173
    Correlation Between All Variables ..................................................175
    Correlation Matrix ..................................................................176

39. SAS — Linear Regression ................................................................177

40. SAS — Bland-Altman Analysis ..........................................................180
    Enhanced Model ........................................................................182

41. SAS — Chi-Square .........................................................................184
    Two-Way Chi-Square ................................................................186

42. SAS — Fisher’s Exact Tests ..............................................................188
    Applying Fisher Exact Test ............................................................188

43. SAS — Repeated Measure Analysis ..................................................190

44. SAS — One Way Anova .................................................................193
    Applying ANOVA ....................................................................193
    Applying ANOVA with MEANS ....................................................194

45. SAS — Hypothesis Testing ...............................................................196
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.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>SAS Component &amp; their Usage</th>
</tr>
</thead>
</table>
| 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.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>SAS Window &amp; their Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>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.</td>
</tr>
<tr>
<td>2</td>
<td>Editor Window is that part of SAS where we write all the codes. It is like a notepad.</td>
</tr>
<tr>
<td>3</td>
<td>Output Window is the result window where we can see the output of our program.</td>
</tr>
<tr>
<td>4</td>
<td>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.</td>
</tr>
<tr>
<td>5</td>
<td>Explore Window has all the libraries listed in it. You can also browse your system SAS supported files from here.</td>
</tr>
</tbody>
</table>
## 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:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>SAS Window &amp; their Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Temporary or Work Library</strong></td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Permanent Library</strong></td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>
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](https://www.sas.com/en_us/software/ainer-6fa4_par_subtabctrl-945). 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.

<table>
<thead>
<tr>
<th>Windows</th>
<th>Oracle VM VirtualBox</th>
<th>VMware Workstation 12 Player</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS X</td>
<td>Oracle VM VirtualBox</td>
<td>VMware Fusion for OS X 7 or later</td>
</tr>
<tr>
<td>Linux</td>
<td>Oracle VM VirtualBox</td>
<td>VMware Player for Linux 7 or later</td>
</tr>
</tbody>
</table>
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.

---

**Step 2: Get the Quick Start Guide (PDF or video) for your virtualization software package.**

Don't just *download* the PDF – actually *read* it. Or watch the video if that's more your thing. Or do both! You'll find a lot of useful info in the Quick Start Guides, including step-by-step instructions. Seriously. You won't regret it.

- **Oracle VirtualBox Quick Start Guide**
  - Download the PDF
  - Watch the video

- **VMware Player Quick Start Guide**
  - Download the PDF
  - Watch the video

- **VMware Fusion Quick Start Guide**
  - Download the PDF
  - Watch the video
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.
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.
End of ebook preview

If you liked what you saw...

Buy it from our store @ https://store.tutorialspoint.com