临床研究SAS高级编程
——SAS概述

What is SAS?

- Used to stand for “Statistical Analysis System”
  - One of the largest software company in the world
  - Now the most widely used statistical software

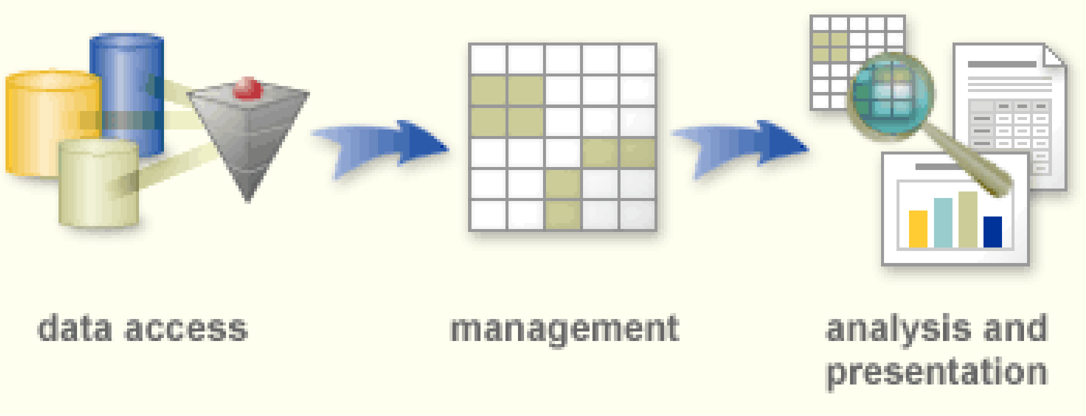
Contents

- 1. An Overview of SAS
- 2. SAS Windowing Environment
- 3. SAS Programs
- 4. Mastering Fundamental Concepts

Components of the SAS System

- Base SAS
  - data management and basic procedures
- SAS/STAT
  - statistical analysis
- SAS/GRAPH
  - presentation quality graphics
- SAS/OR
  - Operations Research
- SAS/ETS
  - Econometrics and Time Series Analysis
- SAS/QC
  - quality control

What to do with SAS

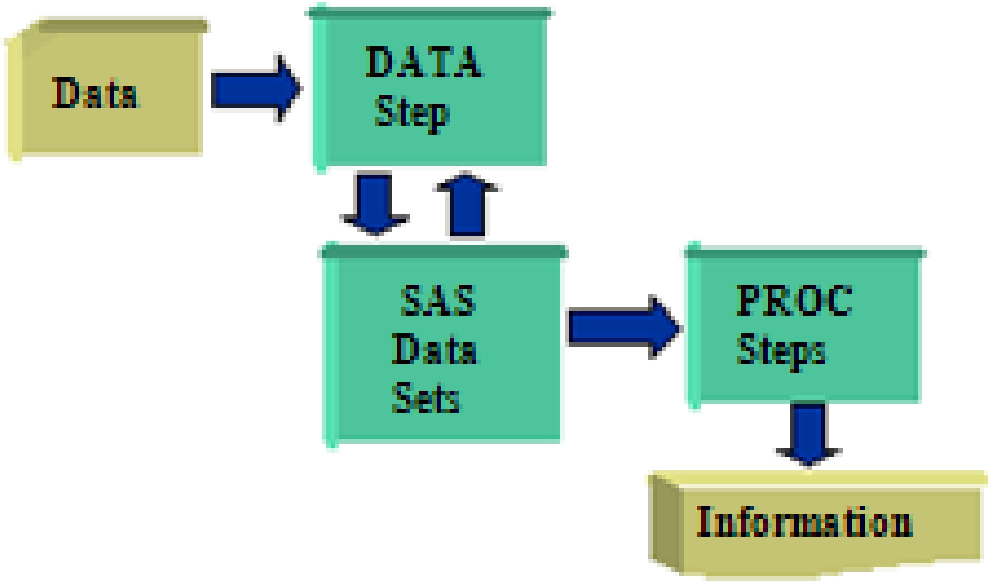


✓ access data from many sources

✓ manage your data

✓ analyze your data and present it as meaningful information in a report that you can deliver to any platform, in any format you need.

General Work Flow



2. SAS Windowing Environment

- When you first start SAS, the five main SAS windows open:

1. In the **Explorer** window, you can view and manage your SAS files
2. In the **Editor** window, to enter, edit, and submit SAS programs
3. The **Log** window displays messages about your SAS session and any SAS programs that you submit.
4. The **Output** window displays the output from SAS programs that you submit.
5. The **Results** window helps you navigate and manage output from SAS programs that you submit.

Enhanced Editor

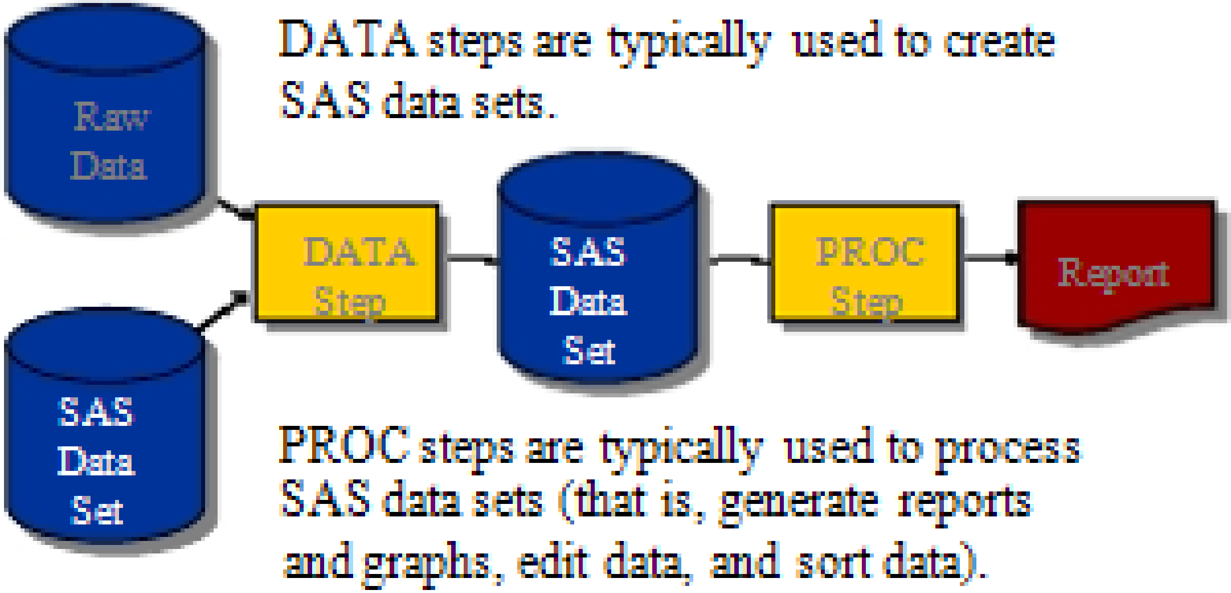
- It provides many helpful features, including color coding and automatically retaining the program after each submit, eliminating the need to recall your program

Submit SAS program

- Issue the submit command
- Click on 🏃
- Select Run Submit on the toolbar

3. SAS Programs

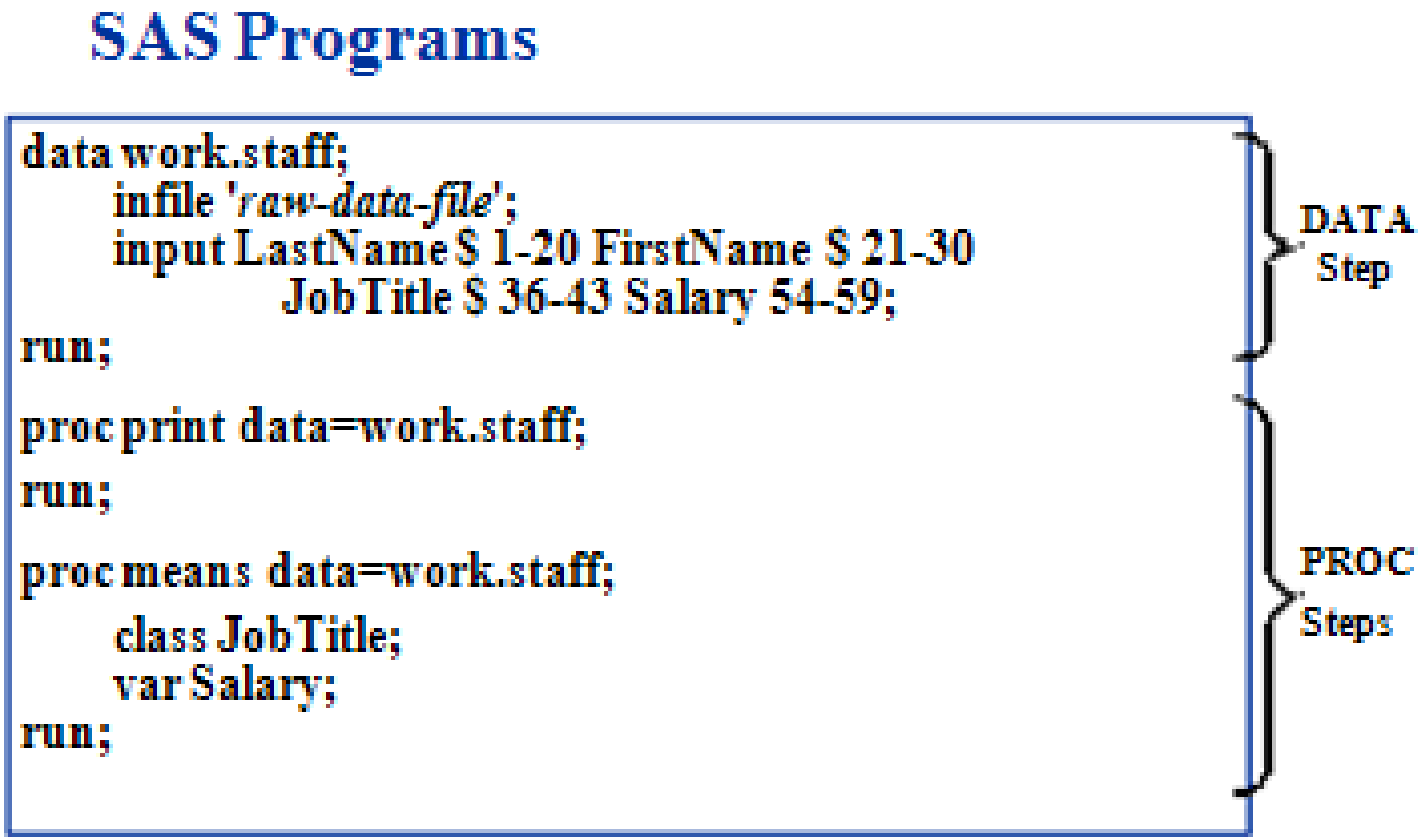
- A SAS program is a sequence of steps that the user submits for execution



DATA steps are typically used to create SAS data sets.

PROC steps are typically used to process SAS data sets (that is, generate reports and graphs, edit data, and sort data).

3. SAS Programs



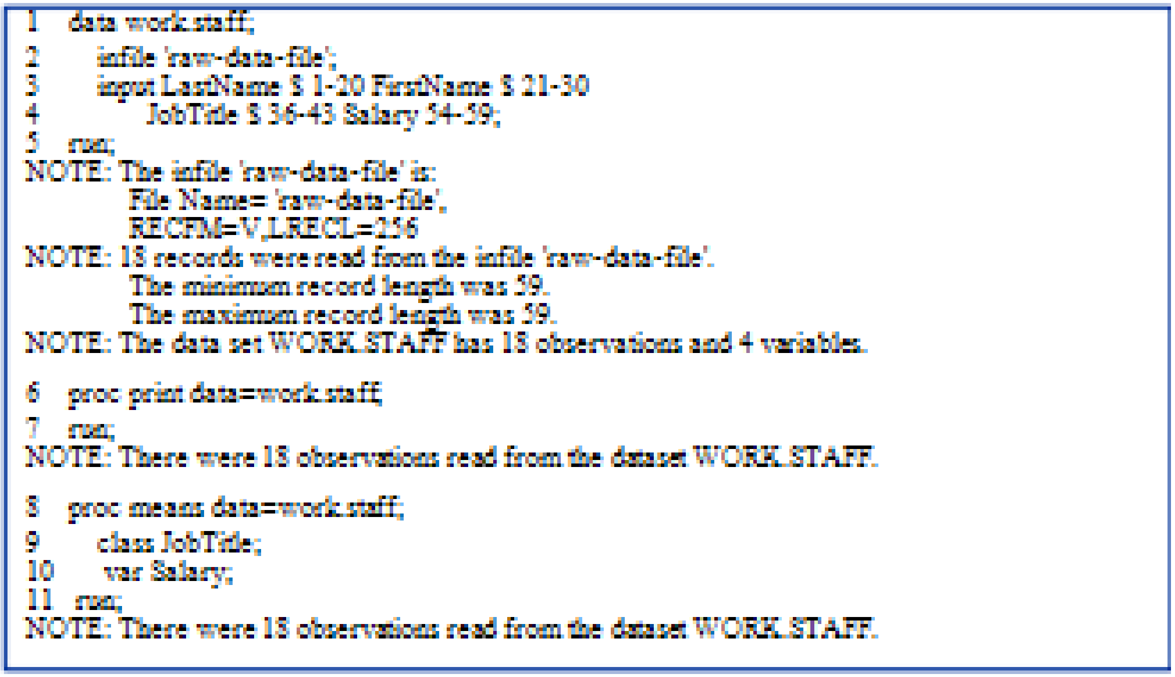
SAS Programs

```
data work.staff;
      infile 'raw-data-file';
      input LastName $ 1-20 FirstName $ 21-30
                  JobTitle $ 36-43 Salary 54-59;
run;
proc print data=work.staff;
run;
proc means data=work.staff;
      class JobTitle;
      var Salary;
run;
```

Run a SAS Program

- You can invoke SAS in
  - Interactive windowing mode (SAS windowing environment)
  - Interactive menu-driven mode (SAS Enterprise Guide, SAS/ASSIST, SAS/EIS , etc)
  - Batch mode
  - Noninteractive mode

SAS Log



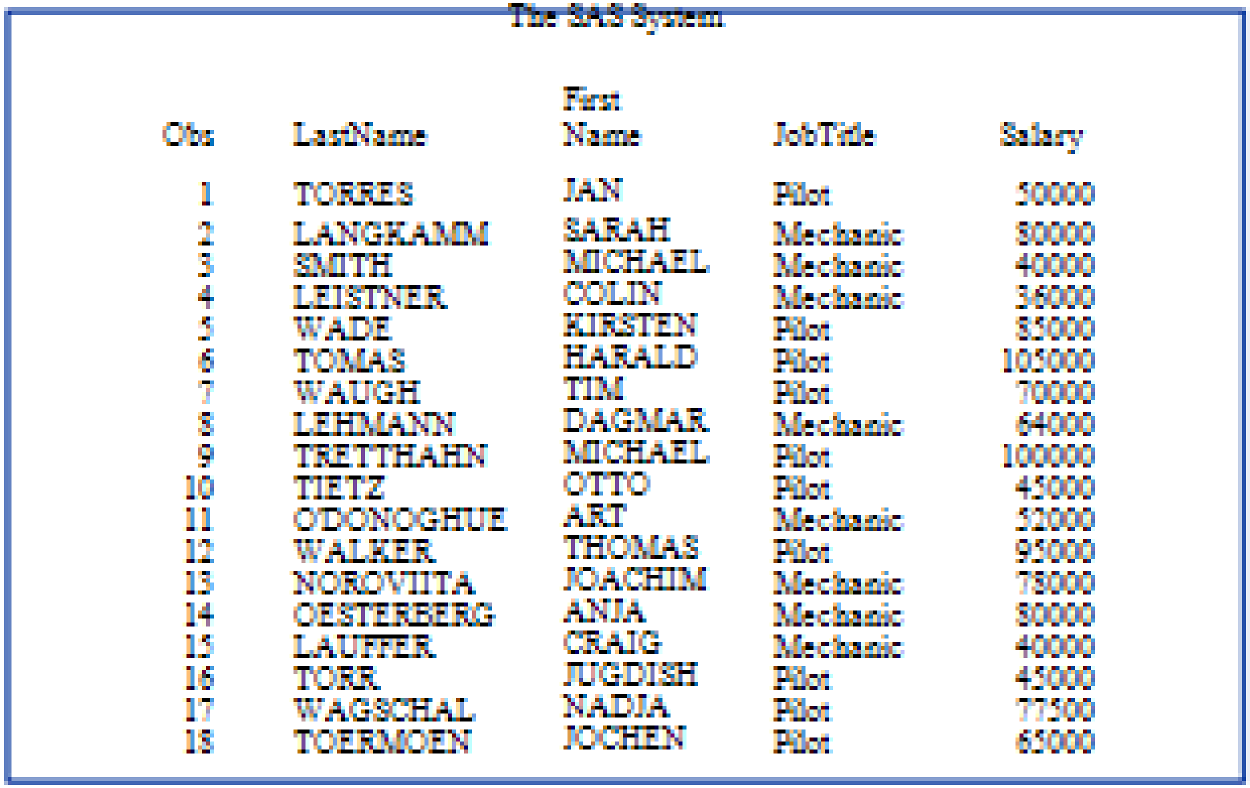
```
1    data work.staff;
2       infile 'raw-data-file';
3       input LastName $ 1-20 FirstName $ 21-30
4             JobTitle $ 36-43 Salary 54-59;
5    run;
NOTE: The infile 'raw-data-file' is:
           File Name= 'raw-data-file',
           RECFM=V,LRECL=256
NOTE: 18 records were read from the infile 'raw-data-file'.
           The minimum record length was 59.
           The maximum record length was 59.
NOTE: The data set WORK.STAFF has 18 observations and 4 variables.

6    proc print data=work.staff;
7    run;
NOTE: There were 18 observations read from the dataset WORK.STAFF.

8    proc means data=work.staff;
9       class JobTitle;
10       var Salary;
11   run;
NOTE: There were 18 observations read from the dataset WORK.STAFF.
```

SAS Output example

PROC PRINT Output



```
                              The SAS System

                                First
  Obs      LastName             Name       JobTitle       Salary

    1      TORRES               JAN        Pilot           50000
    2      LANGKAMM             SARAH      Mechanic        80000
    3      SMITH                MICHAEL    Mechanic        40000
    4      LEISTNER             COLIN      Mechanic        36000
    5      WADE                 KIRSTEN    Pilot           85000
    6      TOMAS                HARALD     Pilot          105000
    7      WAUGH                TIM        Pilot           70000
    8      LEHMANN              DAGMAR     Mechanic        64000
    9      TRETTHAHN            MICHAEL    Pilot          100000
   10      TIETZ                OTTO       Pilot           45000
   11      O'DONOGHUE           ART        Mechanic        52000
   12      WALKER               THOMAS     Pilot           95000
   13      NOROVIITA            JOACHIM    Mechanic        78000
   14      OESTERBERG           ANJA       Mechanic        80000
   15      LAUFFER              CRAIG      Mechanic        40000
   16      TORR                 JUGDISH    Pilot           45000
   17      WAGSCHAL             NADIA      Pilot           77500
   18      TOERMOEN             JOCHEN     Pilot           65000
```

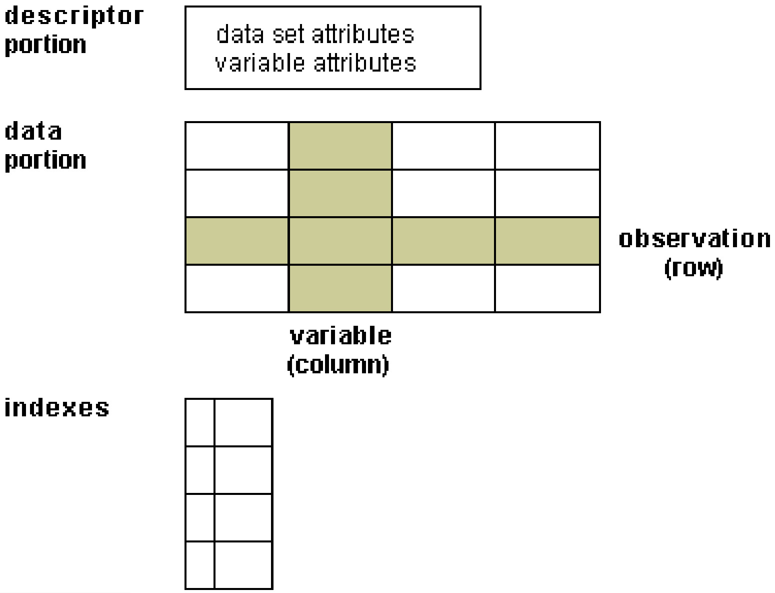
4. Mastering Fundamental Concepts

- 4.1 SAS dataset
- 4.2 SAS variable and Values
- 4.3 Syntax

4.1 SAS Data Sets - Overview

Overview of SAS data sets

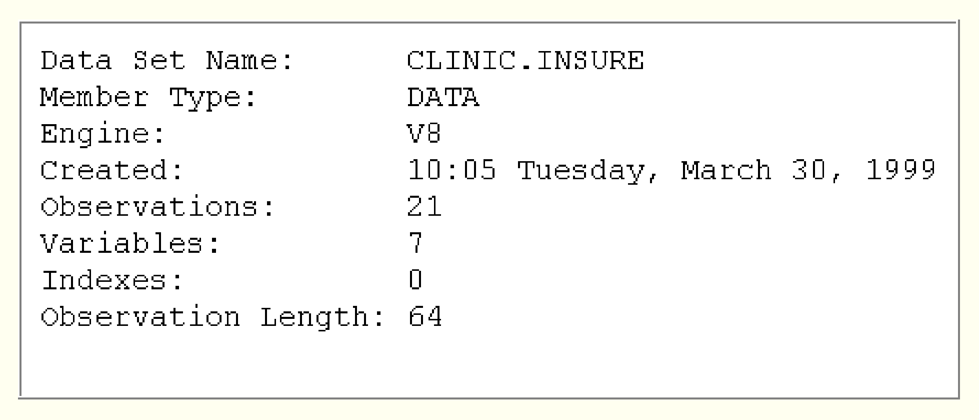
- A SAS data set is a file that consists of two parts: a **descriptor portion** and a **data portion**. Sometimes a SAS data set also points to one or more indexes, which enable SAS to locate records in the data set more efficiently.



4.1 SAS Data Sets - Descriptor portion

Descriptor portion

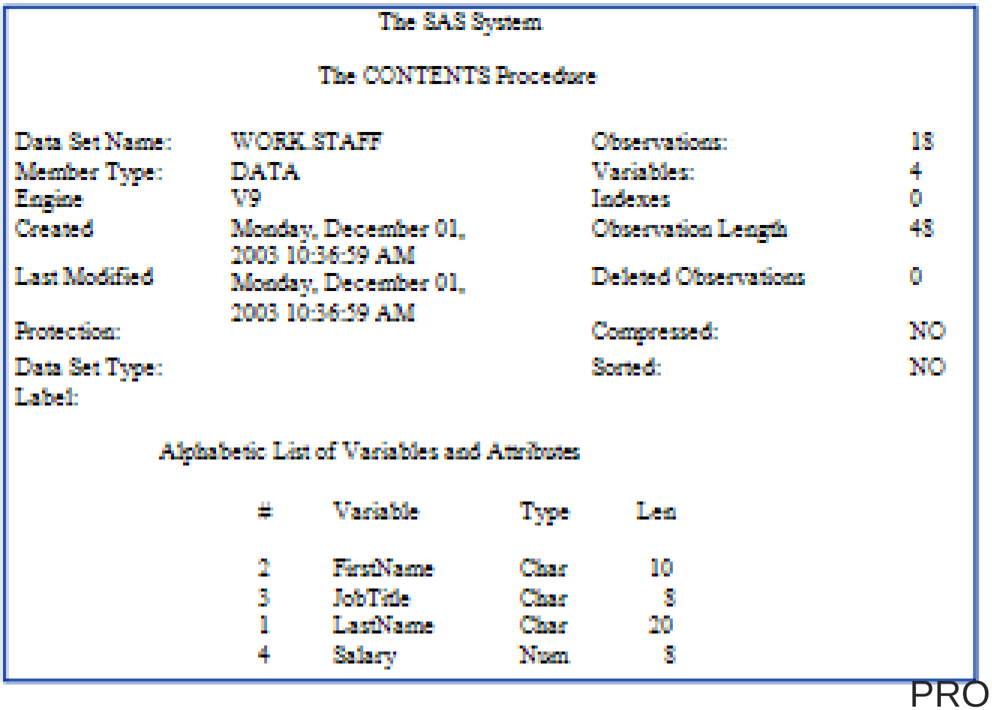
- The descriptor portion of a SAS data set contains information about the data set, including
  - the name of the data set
  - the date and time that the data set was created
  - the number of observations
  - the number of variables.
- Let's look at another SAS data set. The table below lists part of the descriptor portion of the data set **Clinic.Insure**.



```
Data Set Name:          CLINIC.INSURE
Member Type:            DATA
Engine:                 V8
Created:                10:05 Tuesday, March 30, 1999
Observations:           21
Variables:              7
Indexes:                0
Observation Length:     64
```

Example

Partial PROC CONTENTS Output



```
                              The SAS System

                         The CONTENTS Procedure

Data Set Name:     WORK.STAFF                 Observations:            18
Member Type:       DATA                       Variables:               4
Engine             V9                         Indexes                  0
Created            Monday, December 01,       Observation Length       48
                   2003 10:36:39 AM
Last Modified      Monday, December 01,       Deleted Observations     0
                   2003 10:36:39 AM
Protection:                                   Compressed:              NO
Data Set Type:                                Sorted:                  NO
Label:

              Alphabetic List of Variables and Attributes

                   #      Variable        Type      Len

                   2      FirstName       Char       10
                   3      JobTitle        Char        8
                   1      LastName        Char       20
                   4      Salary          Num         8
```

```
PROC CONTENTS DATA=sas-data-set; RUN;
```

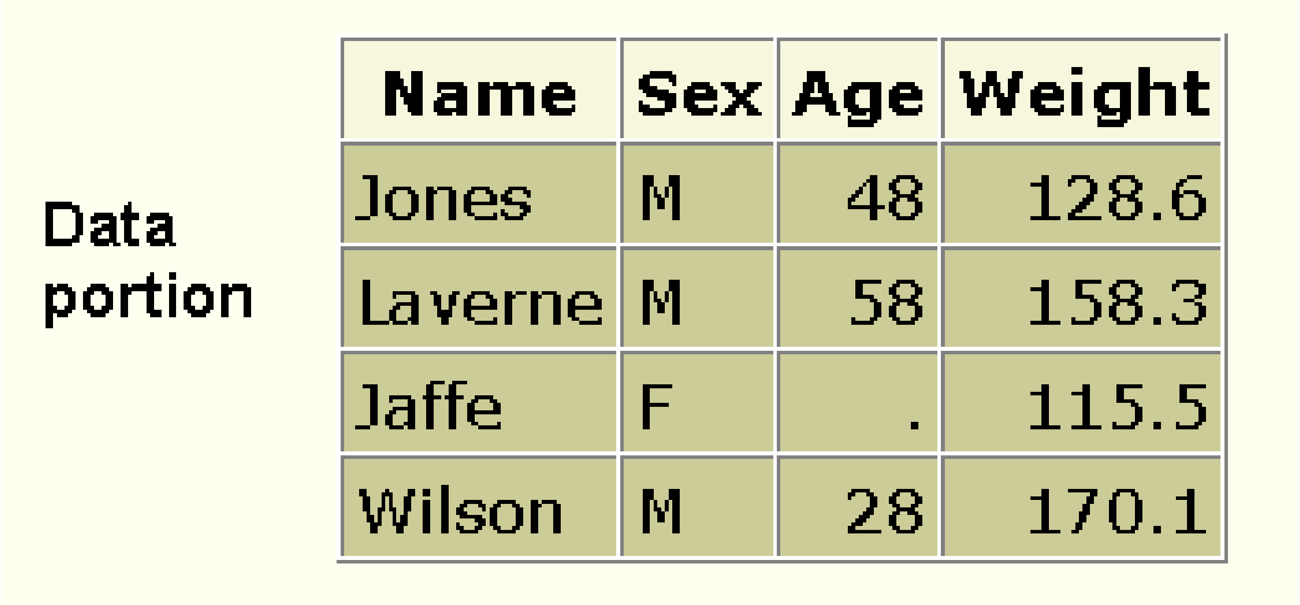
or

```
PROC DATASETS LIBRARY=sas-library;
            CONTENTS sas-data-set; Run;
```

4.1 SAS Data Sets - Data portion

Data portion

The data portion of a SAS data set is a collection of data values that are arranged in a rectangular table. In the example below, the name *Jones* is a data value, the weight *158.3* is a data value, and so on.



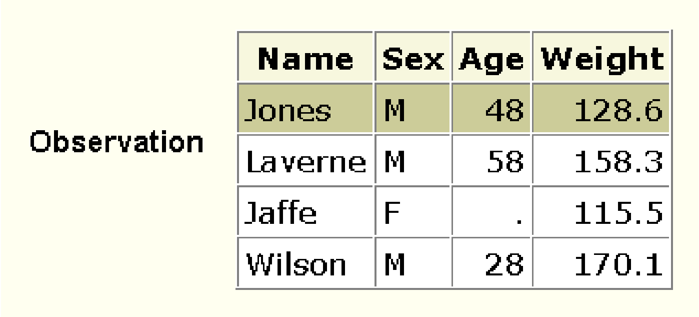
Data portion

Name	Sex	Age	Weight
Jones	M	48	128.6
Laverne	M	58	158.3
Jaffe	F	.	115.5
Wilson	M	28	170.1

4.1 SAS Data Sets – observations & columns

Observations (Rows)

- **Rows** (called **observations**) in the data set are collections of data values that usually relate to a single object. The values *Jones*, *M*, *48*, and *128.6* comprise a single observation in the data set shown below.

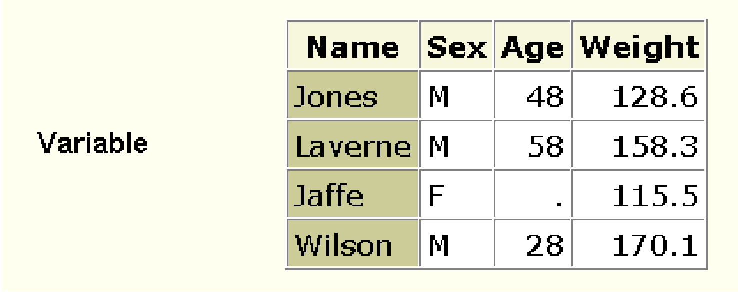


Observation

Name	Sex	Age	Weight
Jones	M	48	128.6
Laverne	M	58	158.3
Jaffe	F	.	115.5
Wilson	M	28	170.1

Variables (Columns)

- Columns (called **variables**) in the data set are collections of values that describe a particular characteristic. The values *Jones*, *Laverne*, *Jaffe*, and *Wilson* comprise the variable Name in the data set shown below.



Variable

Name	Sex	Age	Weight
Jones	M	48	128.6
Laverne	M	58	158.3
Jaffe	F	.	115.5
Wilson	M	28	170.1

4. Mastering Fundamental Concepts

- 4.1 SAS dataset
- 4.2 SAS variable and Values
- 4.3 Syntax

4.2.1 SAS Names

- SAS Data Set and Variable Names

- Can be 32 characters long
- Can be uppercase, lowercase, or mixed-case
- Must start with a letter or underscore, subsequent characters can be letters, underscore, or numeric digits

In version 6 and earlier, data set and variable names can only be a maximum of 8 characters long.

Starting in Version 8, special characters can be used in data set and variable names if you put the name in quotes followed immediately by letter N

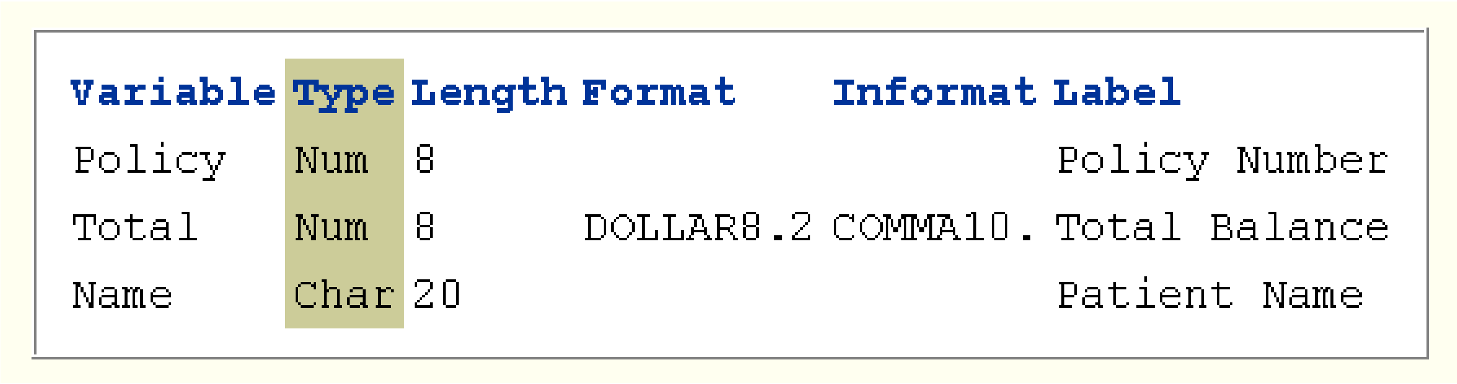
Example: ‘Flight#’n;

In order to use special characters in variables names, the VALIDVARNAME option must be set to ANY;

Example: options validvarname=any;

4.2.2 Variable Type

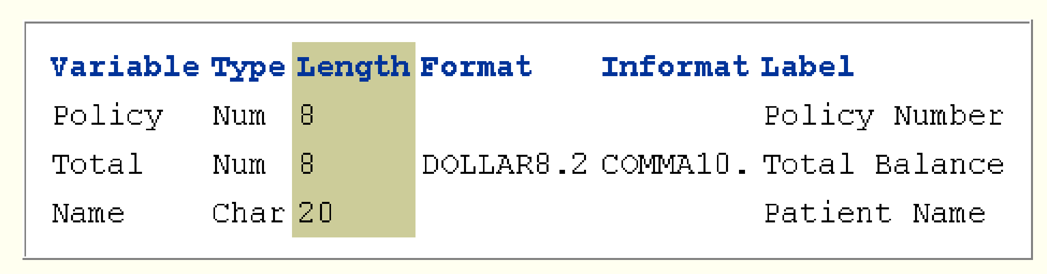
- A variable's type is either **character** or **numeric**.
  - ► Character variables, such as Name (shown below), can contain **any values**.
  - ► Numeric variables, such as Policy and Total (shown below), can contain **only numeric values** (the digits 0 through 9, +, -, ., and E for scientific notation).



Variable	Type	Length	Format	Informat	Label
Policy	Num	8			Policy Number
Total	Num	8	DOLLAR8.2	COMMA10.	Total Balance
Name	Char	20			Patient Name

4.2.3 Variable Length

- A variable's **length** (the number of bytes used to store it) is related to its type.
  - Character variables can be up to **32K** long. In the example below, Name has a length of 20 characters and uses 20 bytes of storage.
  - All numeric variables have a default length of **8**. Numeric values (no matter how many digits they contain) are stored as floating-point numbers in 8 bytes of storage, unless you specify a different length.

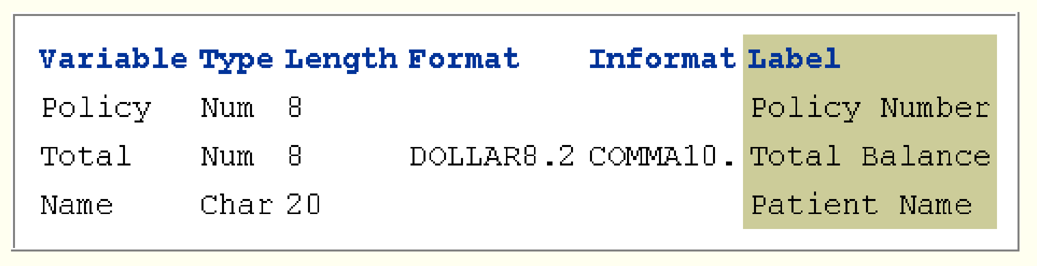


```
Variable Type Length Format     Informat Label
Policy   Num  8                          Policy Number
Total    Num  8      DOLLAR8.2 COMMA10.  Total Balance
Name     Char 20                         Patient Name
```

4.2.4 Variable Label

- A variable can have a **label**, which consists of descriptive text up to **256** characters long. By default, many reports identify variables by their names. You may want to display more descriptive information about the variable by assigning a label to the variable.

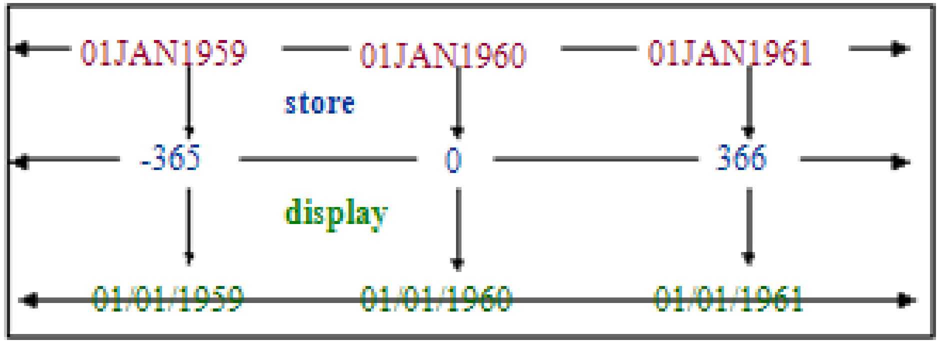
- For example, you can label Policy as **Policy Number**, Total as **Total Balance**, and Name as **Patient Name** to display these labels in reports.



Variable	Type	Length	Format	Informat	Label
Policy	Num	8			Policy Number
Total	Num	8	DOLLAR8.2	COMMA10.	Total Balance
Name	Char	20			Patient Name

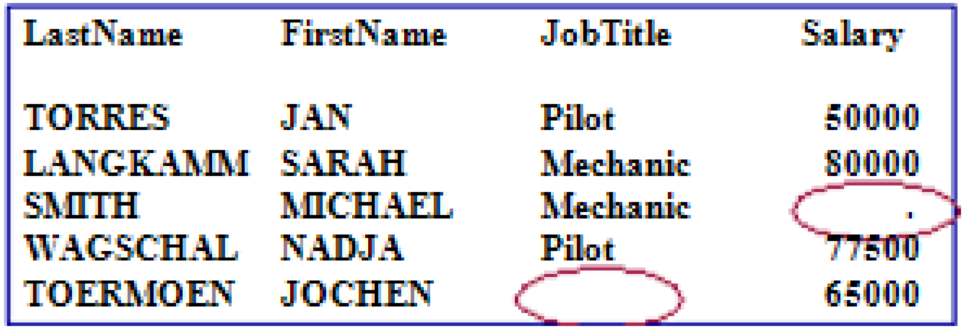
4.2.5 SAS Data Value - Date

- SAS stores date values as numeric values
- A SAS date value is stored as the number of days between Jan 1st, 1960, and a specific date



4.2.5 SAS Data Value - Missing Data Values

- A value must exist for every variable for each observation.
- Missing values are valid values
  - A numeric missing value is displayed as a period
  - A character missing value is displayed as a blank



```
LastName     FirstName    JobTitle     Salary

TORRES       JAN          Pilot         50000
LANGKAMM     SARAH        Mechanic      80000
SMITH        MICHAEL      Mechanic          .
WAGSCHAL     NADJA        Pilot         77500
TOERMOEN     JOCHEN                     65000
```

4. Mastering Fundamental Concepts

- 4.1 SAS dataset
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4.3.1 Basic Structure of SAS

DATA step

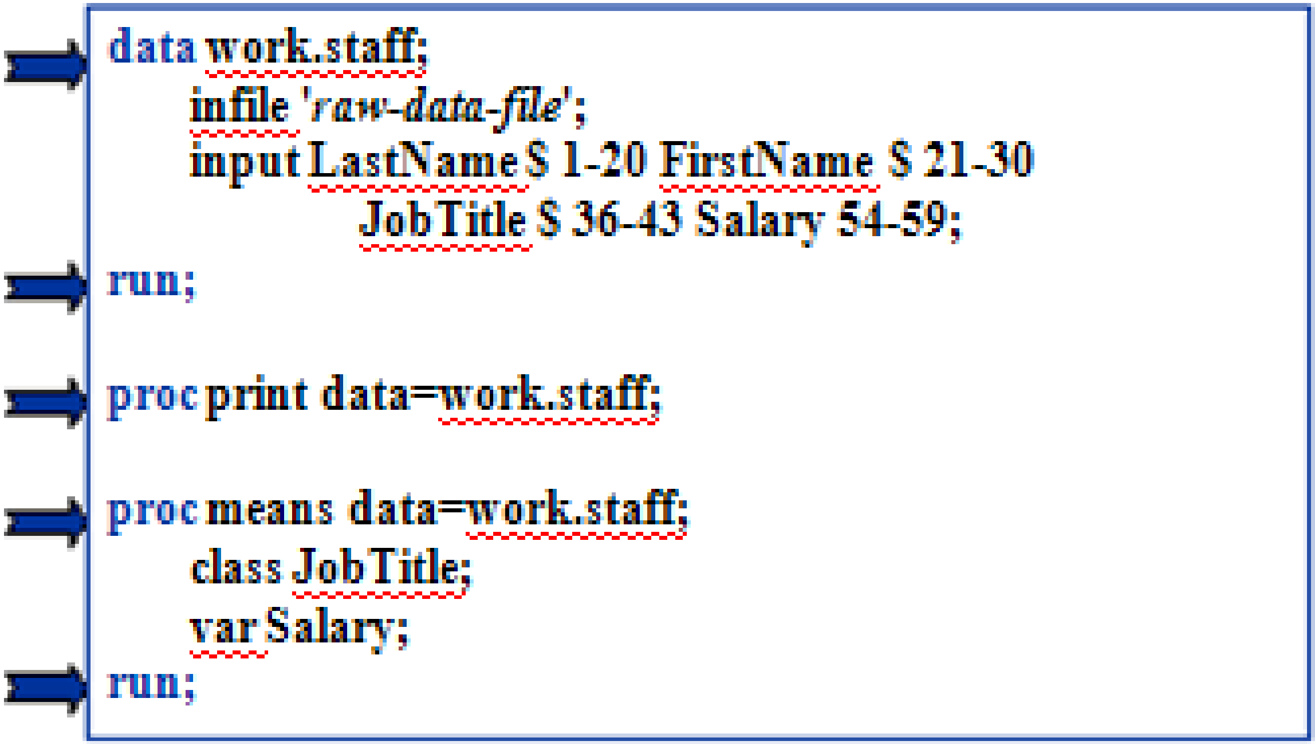
- reads data from external sources,
- manipulates and combines it with other data set and
- prints reports

PROC step

- perform analysis on the data, and
- produce output

Step Boundaries

- SAS Steps **begin** with a
  - DATA statement
  - PROC statement
- SAS Detects the **end** of a step when if encounters
  - A RUN statement (for most steps)
  - A QUIT statement (for some procedures)
  - The beginning of another steps



```
data work.staff;
     infile 'raw-data-file';
     input LastName $ 1-20 FirstName $ 21-30
              JobTitle $ 36-43 Salary 54-59;
run;

proc print data=work.staff;

proc means data=work.staff;
     class JobTitle;
     var Salary;
run;
```

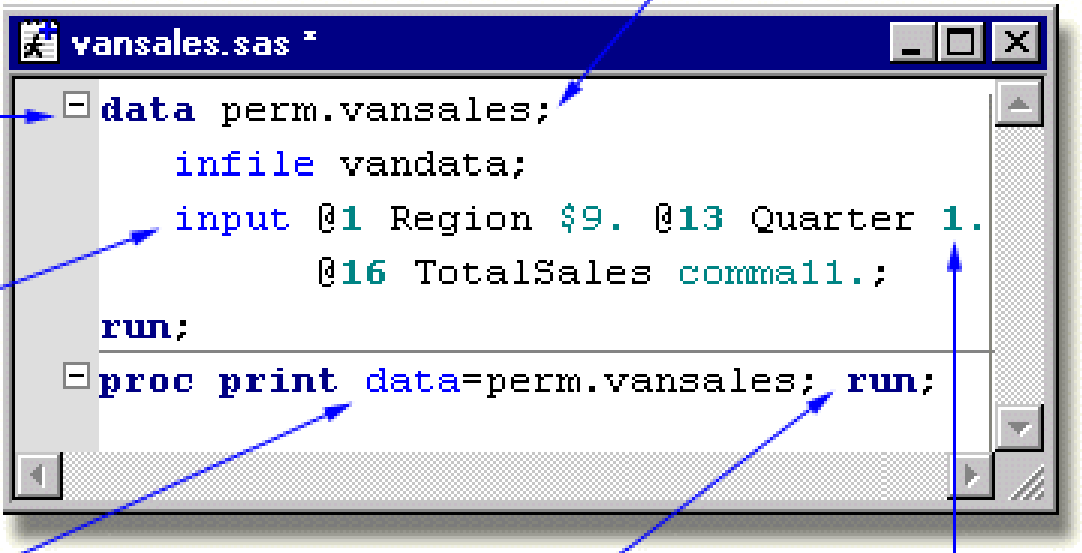
4.3.2 SAS Syntax Rules

- SAS statements usually begin with an identifying keyword, always end with a semicolon;

- SAS statements are free-format：
  - ✓ One or more blanks or special characters can be used to separate words
  - ✓ They can begin and end in any column
  - ✓ A single statement can span multiple lines
  - ✓ Several statements can be on the same line

SAS programming statements are easier to read if you begin DATA, PROC, and RUN statements in column one and indent the other statements

SAS statements...



vansales.sas *

```
data perm.vansales;
   infile vandata;
   input @1 Region $9. @13 Quarter 1.
         @16 TotalSales comma11.;
run;
proc print data=perm.vansales; run;
```

...usually begin with a SAS keyword.

...always end with a semicolon.

...can begin anywhere on a line.

...contain blanks or special characters to separate words.

...can be combined on one line.

...can continue over several lines.

Words - definition

Definition of word

- A word or token in the SAS programming language is a collection of characters that communicates a meaning to SAS and which cannot be divided into smaller units that can be used independently.
- A word or token ends when SAS encounters one of the following:
  - the beginning of a new token
  - a blank after a name or a number token
  - the ending quotation mark of a literal token.

Words - types

- Types of words or tokens
  - **Name** is a series of characters that begin with a letter or an underscore. Later characters can include letters, underscores, and numeric digits.
    - Examples: `_new, year_99`
  - **Literal** consists of 1 to 32,767 characters enclosed in single or double quotation marks.
    - Examples: `‘Chicago’, “1990-91”`
  - **Number** is composed entirely of numeric digits, with an optional decimal point and a leading plus or minus sign. SAS also recognizes: scientific (E−) notation, hexadecimal notation, missing value symbols, and date and time literals.
    - Examples: `2.35, 5.4E-1, 0b0x, ’24aug90’d`
  - **Special character** is usually any single keyboard character other than letters, numbers, the underscore, and the blank.
    - Examples: `=, +, @`

Words - spacing

- Placement and spacing of words in SAS statements
  - Spacing requirements
    - You can begin SAS statements in any column of a line and write several statements on the same line.
    - You can begin a statement on one line and continue it on another line, but you cannot split a word between two lines.
    - A blank is not treated as a character in a SAS statement unless it is enclosed in quotation marks as a literal or part of a literal.
    - The rules for recognizing the boundaries of words or tokens determine the use of spacing between them in SAS programs.
  - Example:
    - Blanks are not required*:* total=x+y;
    - Blanks are required: input group 15 room 20;

4.3.3 SAS Comments

There are two forms of comment statements:

- **One line:**
  - ✓ **text*;
  - ✓ to use the asterisk at the beginning of the comment.

- **Multiple lines:**
  - ✓ */*text*/*
  - ✓ Type /* to begin a comment
  - ✓ Type */ to end the comment

- SAS ignores text between comment symbols during processing.

The following program shows some of the ways comments can be used to describe a SAS program.

```
/* Read national sales data for vans */
* from an external raw data file;
data perm.vansales;
  infile vandata;
  input @1 Region $9.
        @13 Quarter 1. /* Values are 1, 2, 3, or 4 */
        @16 TotalSales comma11.;
/* Print the entire data set */
proc print data=perm.vansales;
run;
```

Quiz

- Which of the following variable names is valid?
  - *a.* 4BirthDate
  - *b.* $Cost
  - *c.* _Items_
  - *d.* Tax-Rate

- Correct answer: c
  - Variable names follow the same rules as SAS data set names. They can be 1 to 32 characters long, must begin with a letter (A-Z, either uppercase or lowercase) or an underscore, and can continue with any combination of numbers, letters, or underscores.

Exercises

- SAS statements usually begin with a________
- Every SAS statement ends with a ___________
- Character variable values can be up to ______ characters long, and use ____byte(s) of storage per character
- A SAS variable name has __to __characters and begin with a ____or an ______
- By default, numeric variables are stored in __byes of storage
- The internally stored SAS date value for Jan 23rd, 1960, is ______

Exercises

- A missing character value is displayed as a ____
- A missing numeric value is displayed as a _____
- What are the two kinds of Steps?
- What are the two portions of SAS data set?
- What are the two types of variables?

Q&A