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The New Shape of SAS® Code

Charu Shankar, SAS® Institute Inc.

ABSTRACT

What is SAS Code? How many SAS languages exist to manipulate data? If these questions got you thoughtful, then this presentation is just for you.

Come explore the many dimensions of SAS code, the commonality and differences between the various languages in SAS.

this presentation you will learn the basics of 4 familiar SAS languages, like the Base SAS data step, PROC SQL, PERL language elements, the SAS Macro language plus a 5th, an introduction to the language of CAS(cloud analytic services). . Learn to check your data with elegant techniques like Boolean logic in PROC SQL, operators in the DATA step/PROC step, functions like the SCAN function within the DATA step, efficient checking of your data with PERL regular expression, and last but not least the amazing marriage between PROC SQL & the SAS macro language to reuse data. You will also learn where CAS can be beneficial for manipulating data in the clou. . This presentation will focus on coding techniques for data investigation and manipulation using Base SAS & SAS Viya.

DATA USED IN THIS PRESENTATION

TABLE NAME	DETAILS
Sashelp.demographics	The Sashelp.demographics data set provides the 2004 revision of data derived from world population prospects. The data set contains 197 observations.
Sashelp.mwelect	The Sashelp.mwelect data set provides midwest electrical supply monthly sales by product group. The data set contains 11,296 observations.
Pflugerville	Code to build the dataset is provided in the References section of this paper

Table 1. Details about the data sets used in this Hands-on workshop.

INTRODUCTION

When the author set out to share the power of different languages in the SAS® toolkit, her initial targeted audience was the novice user. What she didn't fully realize was the value of this topic to experienced users as well. For example, there is value to the user who came up to the author after her presentation to share that they were now able to view PROC SQL with a Boolean angle, and the

advanced user also benefitted by learning about PERL regular expressions in SAS. Clearly, this paper won't be able to teach you every single nuance of these majestic languages in the short timeframe of a hands-on workshop. The purpose of this paper is to synthesize & distill each language to its best strengths. Whether you are a novice user or an experienced SAS coder, the hope is for you to get something new out of this paper. Comments and feedback are always appreciated.

The goal of this Hands-on workshop is to understand the shape of 4 SAS® languages. Four business scenarios have been developed in this Hands-on workshop to practice the four SAS® languages:

Business Scenario 1 – Using the most misspelled city in Texas, this scenario will discuss the fundamental concepts of the SAS data step and how to filter data using the WHERE clause with the Sounds-like operator and the Contains Operator. It will also reveal where the sounds-like operator works well and where the contains operator may be a better fit.

Business Scenario 2 – Using the SASHELP. Mwelect dataset, this scenario will discuss how to find a pattern using the language of Perl.

Business Scenario 3 – Using the SASHELP. demographics dataset, this scenario will discuss how to create a macro variable to find the country with the highest population in 2004.

Business Scenario 4 – Using the SASHELP. demographics dataset, this scenario will discuss how to use Boolean logic in PROC SQL to obtain population range counts by region.

Business Scenario 5 – Using PROC CAS, to create a dictionary object similar to a python dictionary.

REVIEW OF SAS PROGRAMS

A SAS program is a sequence of one or more steps.

DATA steps typically build and manipulate SAS data sets. So, we can reference the DATA step as the **Builder**. Keeping the building capability in mind helps while writing data step code as the executable statements are, for the most part processed in sequence.

PROC steps typically process SAS data sets to generate reports and graphs, and to manage data. So, we can reference the PROC Step as the **Analyzer**. Keeping the analytic capability in mind helps while writing PROC steps as the order of statements is usually not important.

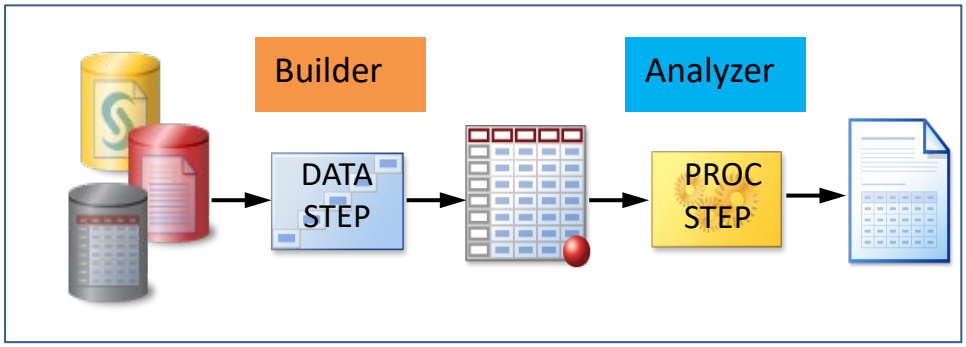

Figure 1. The role of the DATA STEP vs the PROC STEP

DATA EXTRACTION TOOL – LIBRARY TO READ SAS DATASETS

A SAS data library is a collection of one or more SAS files that are recognized by SAS and can be referenced and stored as a unit. A library is simply an alias, a pointer or a reference pointing to a physical location on your computer, e.g., a folder on your C drive.

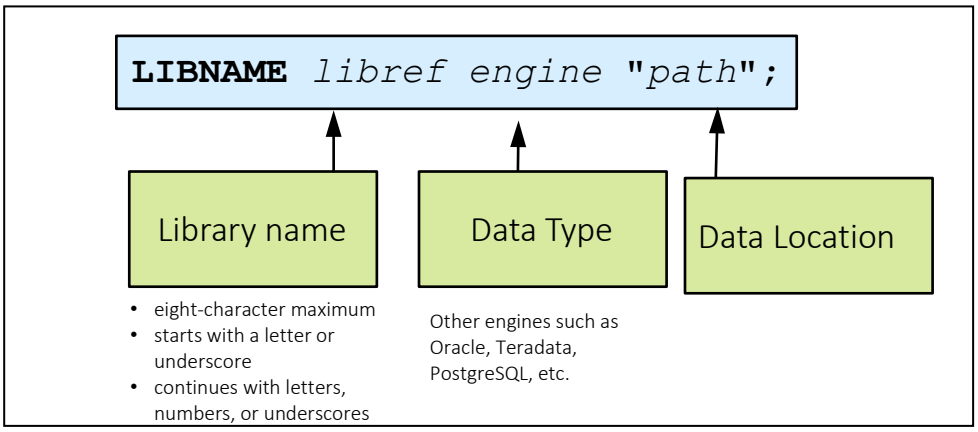

Figure 2. The Libname Statement

Libname Code

```
libname Pharmasug24 "&path";
```

1. SHAPE 1 - THE SAS DATA STEP – THE MANIPULATOR

BUSINESS SCENARIO 1 – FIND ALL PFLUGERVILLE RECORDS

You have been tasked to find all records for the city of Pflugerville in Texas. However, there's a small problem. The city's name is so misspelled. How can you filter your data?

Figure 3. Map of Texas with Pflugerville

USING THE DATA STEP TO CREATE A SAS DATASET

The Data Step is a powerful tool to create, clean, and prepare your data. These are some of the tasks it can perform:

- Filter rows and columns
- Compute new columns
- Conditionally process data

```
DATA output-table;
   SET input-table;
RUN;
```

Figure 4. Data Step Code

FILTER DATA WITH THE WHERE CLAUSE

The WHERE expression defines the condition (or conditions) for selecting observations.

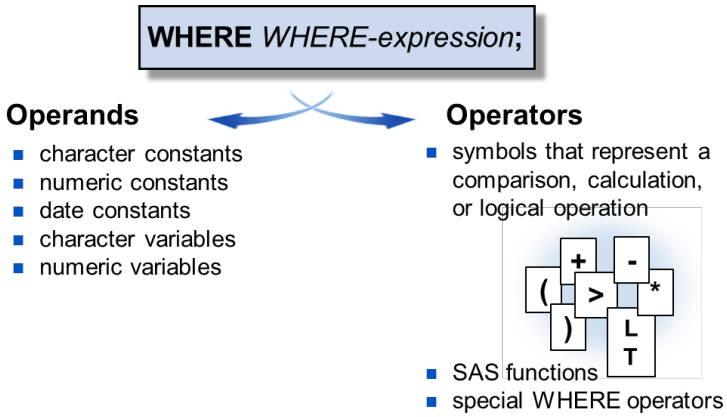

Figure 5. The Where Expression

THE SOUNDS LIKE OPERATOR

The sounds-like operator =* is very useful when fuzzy matching of character values is needed. It matches character strings based on their phonetic values. The sounds-like operator is based on the SOUNDEX algorithm for identifying words that sound alike.

Data step Code

```
daa citytypo;
        set pharmasug24.citysoundslike;
             where city=*'Pflugerville';
 run;
```

Data step Results

	studentId	Name	city	state
1	1111	aaaa	ploogervile	TX
2	2222	bbbb	Phlugerville	TX
3	3333	cccc	plugerville	TX
4	4444	dddd	Phloogerville	TX
5	5555	eeee	Plugerville	Tx

However, the sounds like operator does not work in every instance. Observe what happens when we try to find all students named John in the SASHELP.CLASS data set.

Data Step Code

```
data pharmasg24.john;
    set sashelp.class;
       where name =*'John';
run;
```

Data Step Results

	Name	Sex	Age	Height	Weight
1	Jane	F	12	59.8	84.5
2	John	M	12	59	99.5

THE SOUNDEX ALGORITHM

Why did our search for John return Jane as well? Consider the Soundex Algorithm. Soundex is an indexing system that translates a name into a 4-digit code. The advantage of Soundex is its ability to locate names by the way they sound, rather than by exact spelling.

Code	Letter
1	B F P V
2	C G J K Q S X Z
3	D T
4	L
5	M N
6	R
No code	A E H I O U Y W

Figure 6. The Soundex Algorithm Chart

The steps used by SOUNDEX to derive the phonetic equivalent of a character string are as follows:

a) Retain the first letter of the character string.

b) Discard the letters A E H I O U W Y.

c) Assign a numeric value to the following consonants:

1. B F P V
2. C G J K Q S Z
3. D T
4. L
5. M N
6. R

d) Discard all duplicate classification values if they are adjacent. That is, DT results in a single value of 3, and NN results in a single value of 5).

Here is the answer to our puzzle as to why a search for John pulled up Jane as well.

JOHN	Soundex	JANE	Soundex
J	J	J	J
O	discarded	A	discarded
H	discarded	N	5
N	5	E	discarded

Figure 7. John sounds like Jane

THE CONTAINS OPERATOR

The *CONTAINS operator* selects observations that include the specified substring.

- ? can be used instead of the mnemonic.
- The position of the substring within the variable's values is not important.
- Comparisons made with the CONTAINS operator are case sensitive.

Equivalent Statements

```
where Job_Title contains 'Rep';
where Job_Title ? 'Rep';
```

Figure 8. The Contains Operator

Let's see what happens when we use the contains operator.

Data Step Code

```
data pharmasug24.thisisJohn;
     set sashelp.class;
```

```
        where name contains "John";
run;
```

Data Step Results

	Name	Sex	Age	Height	Weight
1	John	M	12	59	99.5

2. SHAPE 2 - PERL – MATCH A PATTERN

BUSINESS SCENARIO 2 - MATCH A PATTERN

We have been tasked to isolate all SKUs that match this pattern 'DDD ddddd '.

SalesInUsd	SalesCost	QuantityInvoi...	SKU
2,121.42	1,589.61	2419	CPR 00108N 0800XR
2,495.77	2,099.13	1260	CPR 00108N 0800XR
2,942.77	1,682.82	1581	CPR 00108N 0800XR
2,412.63	1,171.20	1760	CPR 00108N 0800XR
2,006.53	1,506.36	1297	CPR 00108N 0800XR
1,911.10	1,988.19	1799	CPR 00200 0400XR
1,232.64	1,273.59	1864	CPR 00200 0400XR
1,839.40	1,997.69	1674	CPR 00200 0400XR
2,313.42	2,476.13	2039	CPR 00200 0400XR

Figure 9. Matching a pattern

USING PERL FOR PATTERN MATCHING

Perl was designed specifically for text processing. The 1990s saw the growth of the World Wide Web. It also saw the rise of text-based information during that period. As one of the languages very capable of text manipulation and undergoing rapid development, Perl was suited to the task at hand. As a result, it became a very popular web programming language, even being referred to as the 'duct-tape of the Web'.

Perl is a very high-level language. That means that the code is quite dense. A Perl program might be around 30% to 70% as long as the corresponding program in C.

PERL IN SAS

Perl regular expressions were added to SAS in Version 9. SAS regular expressions (similar to Perl regular expressions but using a different syntax to indicate text patterns) have been around since version 6.12, but many SAS users are unfamiliar with either SAS or Perl regular expressions.

Because SAS already has such a powerful set of string functions, you might wonder why you need regular expressions. Many of the string processing tasks can be performed either with the traditional character functions or regular expressions. However, regular expressions can sometimes provide a much more compact solution to a complicated string manipulation task.

MATCHING A PATTERN

Since the backslash, forward slash, parentheses, and several other characters have special meaning in a regular expression, you may wonder, how do you search a string for a \ character or a left or right parenthesis? You do this by preceding any of these special characters with a backslash character (in Perl jargon called an escape character). So, to match a \ in a string, you code two backslashes like this: \\. To match an open parenthesis, you use \(.

/ delimiters
\(matches an open paranthesis
\D matches a non-digit
\d matches a digit
\s matches a space
{n,m} Matches the previous subexpression n or more times, but no more than m
\) matches a closed paranthesis

Perl Code

```
title 'Midwest Electrical Supply Monthly Sales by product group';
title2 "SKUs that match this pattern only 'DDD ddddd ";

proc print data=sashelp.mwelect;
     where prxmatch(("/\D{3}\s\d{5}\s/"), SKU) > 0;
run;
```

Perl Results

Midwest Electrical Supply Monthly Sales by product group
SKUs that match this pattern only 'DDD ddddd '

Obs	Date	ProductGroup	SalesRegion	SalesOffice	SalesInUsd	SalesCost	QuantityInvoiced	SKU
33	JAN2001	Electrical	East	Buffalo	1,740.32	1,600.65	.	CPR 00200 0400RI
34	FEB2001	Electrical	East	Buffalo	815.36	750.66	.	CPR 00200 0400RI
35	MAR2001	Electrical	East	Buffalo	1,848.45	1,705.65	.	CPR 00200 0400RI
36	APR2001	Electrical	East	Buffalo	324.92	291.21	.	CPR 00200 0400RI
37	MAY2001	Electrical	East	Buffalo	648.24	584.88	.	CPR 00200 0400RI
38	JUN2001	Electrical	East	Buffalo	898.90	856.74	.	CPR 00200 0400RI
39	JUL2001	Electrical	East	Buffalo	.	.	.	CPR 00200 0400RI
40	AUG2001	Electrical	East	Buffalo	.	.	.	CPR 00200 0400RI
41	SEP2001	Electrical	East	Buffalo	.	.	.	CPR 00200 0400RI

3. SHAPE 3 - MACRO – AUTOMATE FIND AND REPLACE

BUSINESS SCENARIO 3 - USING MACRO VARIABLES TO AUTOMATE

We have been asked to find the country with the highest population in 2004. Since we would like to feed this data to another report, we will store the country name and the population count in 2 macro variables that we can reuse over and over again.

Figure 10. Using macro variables to automate results.

CREATING AND REFERENCING MACRO VARIABLES

The process of creating macro variables is simple. First, we create the macro variables and then submit code to create a report using the defined macro variables.

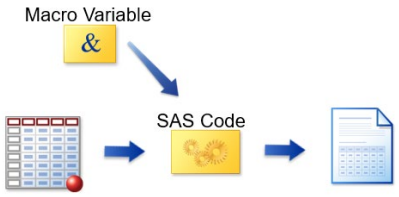

Figure 11. Creating and referencing macro variables

CREATING MACRO VARIABLES WITH PROC SQL

In PROC SQL, use an INTO clause to create macro variables and assign a value to them or to update existing macro variable values. The INTO clause must follow the SELECT clause.

```
SELECT …
        INTO …
FROM table|view …
      <additional clauses>
```

Figure 12. Creating macro variables with PROC SQL

CREATING MACRO VARIABLES: SYNTAX 1

Syntax 1 places values from the *first row* returned by an SQL query into one or more macro variables. Data from additional rows returned by the query is ignored. The value from the first column in the SELECT clause is placed in the first macro variable listed in the INTO clause, and so on.

SELECT *column-1* format=*format-name.* <, …*column-n*>
INTO :*macvar_1*<, ... :*macvar_n*>
FROM *table*|*view* …

Figure 13. Creating macro variables: Syntax 1

MACRO TO GRAB COUNTRY WITH THE HIGHEST POPULATION

Macro Code

```
proc sql noprint;
      select pop format comma13. , name
            into : Maxpop , : country
                  from sashelp.demographics
                        order by 1 descending;
%put &=country;
%put &=maxpop;
```

Macro Results in the log

```
45                 %put &=country;
COUNTRY=CHINA
46                 %put &=maxpop;
MAXPOP=1,323,344,591
```

4. SHAPE 4 – PROC SQL – SPEAK THE ELEGANT BOOLEAN

BUSINESS SCENARIO 4 - USING BOOLEAN LOGIC TO COUNT ROWS

We would like to obtain population range counts by region.

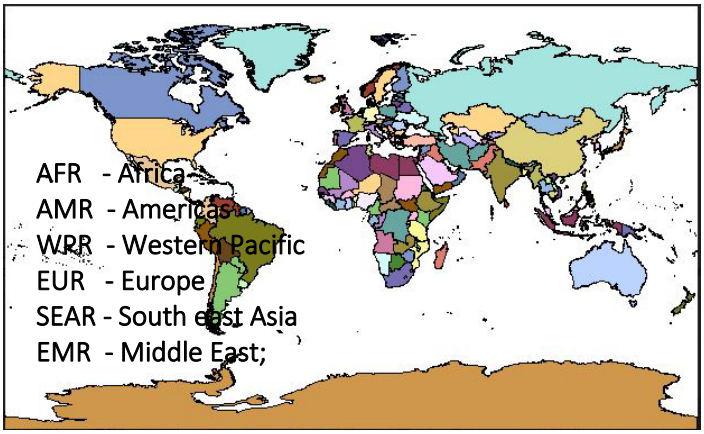

Figure 14. World map with region names

BOOLEAN LOGIC IN PROC SQL

Everything in the digital world can be broken down into 1 or 0, or rather Yes or No. We will take advantage of this Boolean capacity to get population counts by each region. First, it would be useful to understand the syntax order of PROC SQL.

PROC SQL SYNTAX ORDER

The specified order of the clauses below, within the SELECT statement is required.

```
PROC SQL;
SELECT object-item <, ...object-item>
                FROM from-list
        <WHERE sql-expression>
        <GROUP BY object-item <, … object-item >>
        <HAVING sql-expression>
        <ORDER BY order-by-item <DESC> <, …order-by-item>>;
QUIT;
```

Figure 15. PROC SQL Syntax Order

USING PROC SQL TO GET COUNTS

Proc Sql Code

```
title "population counts by country";
title2 "&country";
title3 "had the maximum population of &maxpop in 2005";
proc sql;
   select  region,
     sum(pop <= 1000000) 'upto 1,000,000',
     sum(pop between    1000001 and    10000000)    '1 -  10 million',
     sum(pop between   10000001 and    50000000)   '10 -  50 million',
     sum(pop between   50000001 and   100000000)   '50 - 100 million',
     sum(pop between  100000001 and   500000000)  '100 - 500 million',
     sum(pop >  500000001 )  '500 million and above'
     from sashelp.demographics
      group by 1
   ;
quit;
```

Proc Sql Results

population counts by country
CHINA
had the maximum population of 1,323,344,591 in 2005

Region	upto 1,000,000	1 - 10 million	10 - 50 million	50 - 100 million	100 - 500 million	500 million and above
AFR	5	20	18	2	1	0
AMR	11	12	9	0	3	0
EMR	3	7	8	2	1	0
EUR	7	26	13	8	1	0
SEAR	2	1	3	2	2	1
WPR	14	5	6	2	1	1

5. SHAPE 5 – CAS – GET EFFICIENT IN THE CLOUD

The Compute Server aka the original SAS 9 Workspace Server
In your organization, you will have data in a variety of data sources like databases, streaming data, the cloud, or folder paths. With SAS Viya, you can access these sources using either the Compute Server or the CAS server depending on your needs.

For example, you can use the traditional Compute Server to access some (or all) of those data sources using SAS libraries like you always have.

In this example, the Compute Server has been set up to access four out of the five data sources. You will use the familiar LIBNAME statement to read data into the Compute Server for processing. In SAS Viya, this works the same as it does in SAS®9.

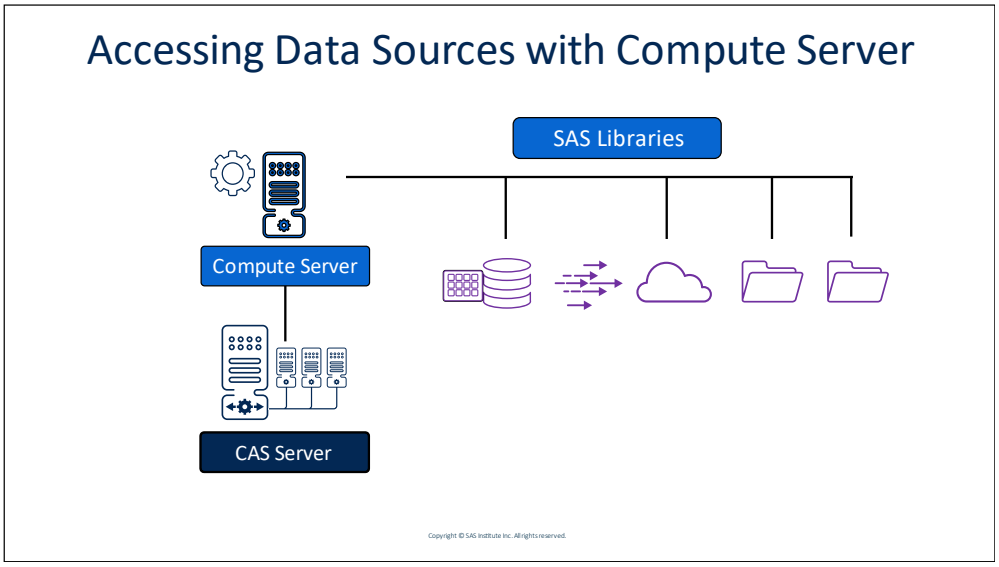

Figure 16. The SAS Compute Server

The CAS Server

Remember that CAS can also access a variety of data sources using caslibs. The Compute Server and the CAS server are analytic engines that process data differently.

In sas Viya you can also start a CAS session from your compute session.
Cas provides for scalable, distributed parallel computing on multiple worker nodes that are remote from your compute SAS session.

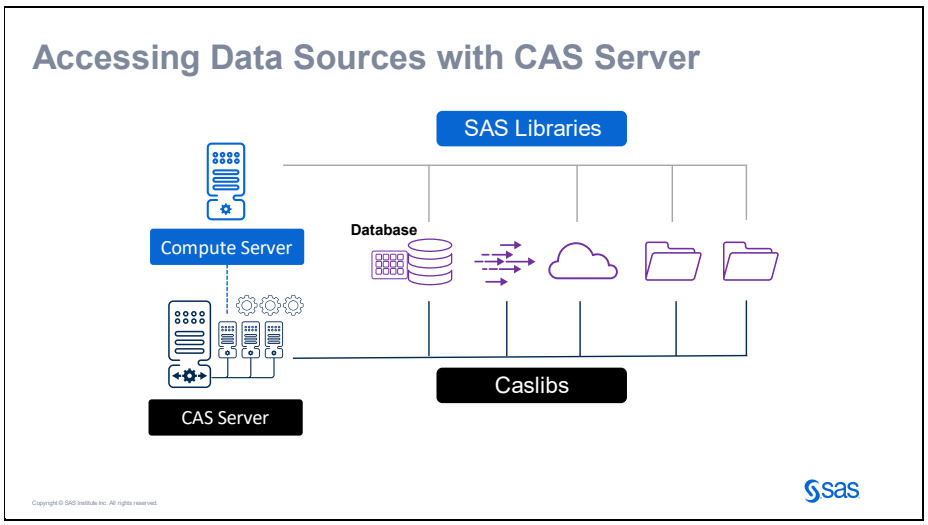

Figure 17. The CAS Server

CASL – The Dot operator

CASL is not object oriented, but does have internal Class variables such as arrays, dictionaries, and result tables. The primary operator in CASL is the DOT (‘.’) operator. This operator is polymorphic, meaning that the operation depends on the data type of two operands. If the 1st operand is a dictionary, then the second operand is either an index in the dictionary list or a key used to look up the values.

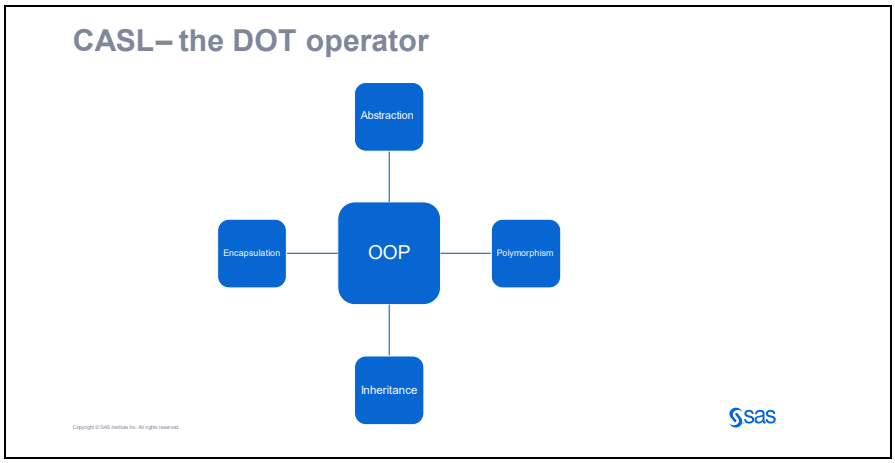

Figure 19. CASL – The Dot operator

Let's take a look at an example of this with CASL code where I want to create a dictionary object similar to a python dictionary. Notice the ease of usage & similarity in dot notation syntax.

CASL Code

```
proc cas;
      table.fileInfo result=samples_files / caslib='samples';
      print samples_files;
      myTbl = samples_files['FileInfo'];
      myFilesToLoad = myTbl[,'Name'];
      print myFilesToLoad;

      do fileName over myFilesToLoad;
            print fileName;
      end;
quit;
```

Essentially, we are creating a dictionary object like we would in Python, which contains a key called fileinfo. That key holds a table which contains all the files in samples. We're instructing CAS to get all rows of the name column(which is all table names) and automatically create a list called myfilestoload that we will later load into memory.

6. ACKNOWLEDGEMENT

The author is grateful to the many SAS users that have entered her life. Each User has either asked or answered a question. This in turn gave the author the impetus to research and study new ways to express the wonderful shape of SAS code. Sometimes a user appeared in the form of a teacher to show her the many ways in which to express the New Shape of SAS code. The users are too many to thank individually so this is a thank you to every single user who has touched her life. She is grateful to the Pharmasug Academic Committee for inviting her to present a paper. She would also like to express her gratitude to her manager, James Waite without whose guidance, support and permission, this paper would not be possible.

7. CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author at:

Charu Shankar
SAS Institute Canada, Inc.
Charu.shankar@sas.com
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Code for building the Pflugerville dataset

```
data pharmasug24.misspelled;
    length studentId $4 Name $7 city $20 state $2;
    input studentid $ name $ city $ state $;
    datalines;
```

```
1111 aaaa ploogervile TX
2222 bbbb Phlugerville TX
3333 cccc plugerrville TX
4444 dddd Phloogerville TX
5555 eeee Plugerville Tx
;

run;
```