Update A Two-Dimensional Matrix Using The Macro Facility

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Abstract

One of the most significant features of macro facility within the SAS System is its ability to make internal and dynamic updates possible. This paper will introduce a utility macro which can be used to update a two-dimensional matrix dynamically and internally. The macro code demonstrates how to use some very important macro functions and macro statements in the SAS macro language and related techniques to solve the complicated real world problems.

1. Introduction

The potential pay-back for time and efforts invested in well-designed, modular generic utility macros can be very large in creating very sophisticated self-modifying programs for gaining efficiency and accuracy, especially for the routine file maintenance. When one maintains a large macro-based information system, usually there are many macro variables needed to be updated each time period, for example, each month. In order to update the information accurately and efficiently, utility macros are definitely helpful during file maintenance. With this kind of utility macros, macro variables in the system can be dynamically and internally updated during program compilation.

This short paper consists of four sections. The first section, closing here, provides a brief introduction to the need for file maintenance. Section 2 describes the requirements from a real world problem. The next section details the mathematical derivation. The macro source code is discussed in the last section.

2. Description of Requirements

Here is the description of requirements from a real world problem in an insurance company. A macro-based information system is maintained monthly. There are three macro variables (i.e. LAGL1, LAGL2, and LAGL3) used to assign initial values for three arrays in several programs. These values, sometimes called lag values, are employed to indicate how old each claim (i.e. each observation) is and to make appropriate mathematical adjustment for each claim later on. For a certain reporting purpose, 18 month data are considered enough to have complete claims. When the 18th month is reached, it is thought that the claim with 18 month lag is complete. Beyond 18 months, all values will be assigned as 18 to indicate the completion of those claims. For example one maintains a system in April 1997, which is indicated by \( k_0 \) (i.e. month). The most current claim data files are available for March 1997. The macro variables are defined as Figure 1.

Using a matrix notation to represent these expressions in Figure 1 gives a \( 3 \times 12 \) matrix shown in Figure 2.

In order to use the matrix notation to solve this problem, the above matrix can be rearranged to obtain a generalized \( 3 \times 12 \) matrix for the lag values (see Figure 4).

\[
\begin{array}{ccccccccc}
1997 & LAGL1 = & 2 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1996 & LAGL2 = & 14 & 13 & 12 & 11 & 10 & 9 & 8 & 7 & 6 & 5 & 4 & 3 \\
1995 & LAGL3 = & 18 & 18 & 18 & 18 & 18 & 18 & 18 & 17 & 16 & 15 \\
\end{array}
\]

Figure 1. Three Initialized Values for Array LAG1, LAG2, and LAG3
The major role this utility macro plays is that given a value in year $1$ the utility macro \%UTILITY() can update all values in this matrix $[C_{i,j}]$. In other words, the goal is to create a dynamic utility macro and generate information dynamically for the system.

3. Mathematical Derivation

[Proposition]

Let $k_0$ be the initial value (month) retrieved from the current system. The element of the lag matrix $[C_{i,j}]$ for the system can be defined as:

$$C_{i,j} = \begin{cases} 0, & \text{if } 12*(i-1)+j \leq k_0+1 \\ 18, & \text{if } 12*(i-1)+j \geq k_0+19 \\ 12*(i-1)+j-k_0-1, & \text{otherwise} \end{cases}$$

where the year index $i=1,2,3$; and the month index $j=1,2,...,12$.

[Proof] In order to prove the above expression, it is easy for us to use an one-dimensional transformation matrix, which is an $1\times36$ matrix $[T_k]$ (the index $k=1,2,...,36$).

$$[T_1, T_2, ..., T_{36}] = [C_{1,1}, C_{1,2}, ..., C_{1,13}, C_{2,1}, C_{2,2}, ..., C_{2,12}, C_{3,1}, C_{3,2}, ..., C_{3,12}]$$

The relation between the year index $i$, the month index $j$, and index $k$ can be defined as:

$$k = 12*(i-1)+j,$$

where $i=1,2,3$; and $j=1,2,3$, ..., 12.

Since the values of these lags are incremented by one each month, the system date for the month is the best choice for the initial value. If initial value (i.e. current month) from the system is $k_0$, which is the month when the system is run, the data used is for the month $k_0+1$.

For the most current month data, 0 month lag is assigned for $[T_k]$ when the index $k=k_0+1$.

If $k \neq k_0+1$, $T_k = 0$

For the index $k=k_0+2$, $T_k=1$.

When $k=k_0+3$, $T_k=2$, ...

When $k=k_0+18$, $T_k=17$,

When $k=k_0+19$, $T_k=18$,

When $k \neq k_0+20$, $T_k=18$, ...

By induction, we have:

if $k \neq k_0+1$, then $T_k = 0$. \hspace{1cm} (1)

if $k \neq k_0+19$, then $T_k=18$, \hspace{1cm} (2)

otherwise, $T_k = k-k_0-1$. \hspace{1cm} (3)

Substituting $k$ with $i$ and $j$ in above (1), (2), and (3), the following expressions for $[C_{i,j}]$ can be obtained:

if $12*(i-1)+j \neq k_0+1$, then $C_{i,j} = 0$, \hspace{1cm} (1')

if $12*(i-1)+j \neq k_0+19$, then $C_{i,j} = 18$, \hspace{1cm} (2')

otherwise, $C_{i,j} = 12*(i-1)+j- k_0-1$. \hspace{1cm} (3')
Writing these expressions \((1')\), \((2')\), and \((3')\) in the following form completes the proof.

\[
C_{i,j} = \begin{cases} 
1 & \text{if } 12(i-l)+j \leq k+1 \\
18 & \text{if } 12(i-l)+j \geq k+19 \\
12(i-l)+j-k-1, & \text{otherwise}
\end{cases}
\]

where \(i=1,2,3\); and \(j=1,2,...,12\).

4. Utility Macro \(\%\text{UTILITY}()\)

a. SAS Macro Source Code

Figure 5 gives a SAS macro source code for this utility. The automatic macro variable SYSDATE is used to accomplish the dynamic and internal updates (Sun, 1997).

```sas
%MACRO UTILITY(NEWDATE=&SYSDATE);
%LOCAL MNLIST MONTH0 MINDEX LAG1 LAG2 LAG3;
%GLOBAL LAGL1 LAGL2 LAGL3;
%LET MONTH0=%SUBSTR(&NEWDATE,3,3);
%LET MON0=1;
%LET MNLIST=JAN DEC NOV OCT SEP AUG JUL JUN MAY APR MAR FEB JAN;
%DO %UNTIL (%SCAN(&MNLIST,&MON0) = &MONTH0);
%LET MON0 = %EVAL(&MON0+1);
%END;
%LET MINDEX=%EVAL(&MON0-1);
%DO I=1 %TO 3;
%DO J=1 %TO 12;
%IF %EVAL(12*(I-1)+J) LE %EVAL(&MINDEX+1) %THEN
%DO;
%LET C&I&J=0;
%END;
%ELSE %IF %EVAL(12*(I-1)+J) GE %EVAL(&MINDEX+19) %THEN
%DO;
%LET C&I&J=18;
%END;
%ELSE
%LET C&I&J=%EVAL(12*(I-1)+J-%MINDEX-1);
%END;
%END;
%END;
%DO P=1 %TO 3;
%LET LAGG1 = &&C&P.12%STR( )&&C&P.11%STR( )&&C&P.10%STR( )&&C&P.9;
%LET LAGG2 = &&C&P.8%STR( )&&C&P.7%STR( )&&C&P.6%STR( )&&C&P.5;
%LET LAGG3 = &&C&P.4%STR( )&&C&P.3%STR( )&&C&P.2%STR( )&&C&P.1;
%LET LAG&P = &LAGG1.%STR( )&LAGG2.%STR( )&LAGG3;
%END;
%IF &MINDEX NE 12 %THEN
%DO;
%LET LAGL1=&&LAGG1;
%LET LAGL2=&&LAGG2;
%LET LAGL3=&&LAGG3;
%END;
%ELSE
%DO;
%LET LAGL1=&&LAG2;
%LET LAGL2=&&LAG3;
%END;
%MEND UTILITY;
```

Figure 5. Macro Code for the Utility Macro \(\%\text{UTILITY}()\)

b. Invocation

This macro utility only has one keyword parameter NEWDATA as follows.

\(\%\text{UTILITY( NEWDATE=&SYSDATE)}\)

The default value is highlighted that \(\%\text{UTILITY()}\) will assume if you omit it. For the information system monthly run, it is not necessary to assign any value to this parameter because this macro utility can retrieve information from the hosting system. When in an unusual case, for instance, re-running the information system in a different month, one has to set up a value for this parameter.

\(\%\text{UTILITY( NEWDATE=03FEB97)}\)

This utility macro makes it possible to perform dynamic and internal system update based on the information retrieved from the hosting platform.

Reference


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