Contents

About This Book .......................................................................................... vii
About The Author ....................................................................................... xi
Acknowledgments ...................................................................................... xiii
Preface ........................................................................................................ xv

Chapter 1: An Overview of Hash Objects .................................................. 1
What Are Hash Objects? ............................................................................... 2
Introducing a Simple Hash Object Application ................................................. 2

Chapter 2: Hash Object Terminology and Concepts ............................... 7
What Is a SAS Hash Object? .......................................................................... 7
Defining Terms Associated with Hash Objects ............................................... 8
Writing Code That Works with Hash Objects ................................................ 9
Understanding How SAS Stores Hash Objects in Memory ................................ 10
Understanding How Long Hash Objects Persist .............................................. 11
Specifying the Contents of Hash Objects ...................................................... 11
Initializing Variables in a DATA Step That Contains a Hash Object ............. 14
Illustrating How the Program Data Vector Connects DATA Step Variables and Hash Object Items ................................................................. 15

Chapter 3: Basic Hash Object Applications ........................................... 25
Using a Hash Object As a Lookup Table ..................................................... 26
Defining a Hash Object................................................................................... 26
Finding Key Values in a Hash Object ............................................................ 28
Defining the Key Structure in a Hash Object ................................................ 30
Understanding How the FIND and CHECK Methods Alter the Values of DATA Step Variables and Hash Object Data Items ................................. 30
Application Example: Verifying Presence of Key Values .............................. 33
Application Example: Returning Data Items from a Hash Object ........................................... 36
Application Example: Defining the Key Value During Processing of the DATA Step .......... 39
Application Example: Searching for a Key Value in Multiple Hash Objects ................... 41
Application Example: Combining Data from Multiple Sources ......................................... 44
Using Multiple Key Items to Look Up Data ........................................................................... 49
Traversing Hash Objects ......................................................................................................... 53
Specifying a Hash Iterator Object ......................................................................................... 53
Understanding the Methods That Control Traversal of a Hash Object .............................. 54
Illustrating How the Hash Iterator Object Traverses a Hash Object ................................. 55
Application Example: Traversing a Hash Object from Beginning to End ....................... 59
Application Example: Linking Hierarchically Related Data Sets ...................................... 62
Application Example: Performing a Fuzzy Merge Using a Hash Iterator Object ............ 66

Chapter 4: Creating Data Sets from Hash Objects and Updating Contents of Hash Objects ............................................................................................................. 71
Creating a Data Set from a Hash Object .................................................................................. 72
Adding, Modifying, and Removing Data from a Hash Object ............................................... 73
Defining the Key Structure in a Hash Object ........................................................................... 74
Understanding How to Specify the KEY and DATA Argument Tags .................................... 75
Identifying the Variables That the OUTPUT Method Writes to a Data Set ......................... 77
Understanding the Interaction between DATA Step Variables and Hash Object Data Items When Replacing Data in a Hash Object ................................................................. 78
Replacing Key Item Values When a Key Item Is Also a Data Item ..................................... 80
Comparing the DATA Statement and the OUTPUT Method ................................................. 83
Application Example: Finding the Unique Values of a Variable in a Data Set .................. 87
Application Example: Ordering Observations by Variables Not Saved to a Data Set Created from a Hash Object ......................................................................................... 90
Application Example: Using Hash Objects to Apply Transactions to Master Data Sets—Part 1 ......................................................................................................................... 92
Application Example: Using Hash Objects to Apply Transactions to Master Data Sets—Part 2 ......................................................................................................................... 97
Application Example: Summarizing Data with the Hash Iterator Object .......................... 102
Application Example: Summarizing Hierarchically Related Data .................................... 106
## Chapter 5: Hash Objects with Multiple Sets of Data Items per Key Value

Understanding the Concepts of Duplicate Key Values and Multiple Sets of Data Items per Key Value in a Hash Object................................................................. 114
Defining Hash Objects That Process Multiple Sets of Data Items per Key Value.............. 115
Illustrating How the MULTIDATA and DUPLICATE Argument Tags Affect Hash Object Processing.............................................................................................................................. 117
Understanding the Methods That Look for Multiple Sets of Data Items per Key ............... 121
Understanding How SAS Stores Multiple Sets of Data Items per Key.............................. 123
Comparing Retrieval of Data from a Hash Object That Allows Multiple Sets of Data Items per Key Value to a Hash Iterator Object ................................................................. 123
Modifying Data in a Hash Object That Allows Multiple Sets of Data Items per Key Value 129
Summarizing Data in Hash Objects That Allow Multiple Sets of Data Items per Key Value .................................................................................................................................... 143
Application Example: Summarizing and Sorting a Data Set............................................. 144
Application Example: Creating Data Sets Based on a Series of Observations .................. 147
Application Example: Creating a Data Set That Contains All Combinations of Specific Variables When the Number of Combinations Is Large........................................ 151
Application Example: Linking Hierarchically Related Data Using a Hash Object That Allows Multiple Sets of Data Items per Key Value............................................. 154

## Chapter 6: Managing Hash Objects

Creating, Deleting, and Clearing Hash Objects During Execution of a DATA Step ............... 159
Determining the Number of Items in a Hash Object .......................................................... 164
Application Example: Creating a Data Set for Each BY Group ........................................ 166
Comparing Two Hash Objects............................................................................................... 170
Specifying Memory Structure Usage of a Hash Object ...................................................... 174
Determining the Size of an Entry in a Hash Object ............................................................. 174

Index ........................................................................................................................................ 181
Chapter 1: An Overview of Hash Objects

What Are Hash Objects? ........................................................................................................2
Introducing a Simple Hash Object Application .................................................................2

Programming hash objects in SAS sounds like a geeky process. A quick review of the statements
associated with hash objects shows that the statements look geeky too. Although the items that are
associated with hash object programming seem to resemble statements or functions, they are not
called statements or functions. Instead they are called methods and they’re written in something
called dot notation!

If you are reading this book, you probably already know how to write a DATA step. And you may
have picked up this book to figure out if it’s worth your time to learn a new way of processing data
in the DATA step. You understand how SAS compiles and executes a DATA step. You know how
to apply procedures like SORT, SQL, and FORMAT to structure your data the way you need to
and to look up information efficiently.

If you are already a skilled SAS programmer and you know how to use SAS procedures
effectively; why should you learn how to use hash objects? The answer is that they are an
amazingly efficient tool for looking up information and joining information from data sets and
tables.

Because you already know how SAS processes data, you can quickly learn how to write code that
includes hash objects. The methods that define and work with hash objects are used in the DATA
step in ways that are familiar to you.

This book shows you how to make hash objects fit into what you already know, and it often
comparisons the hash solution to a solution that uses SAS language and procedures, one that you’re
likely already familiar with applying. This book introduces you to hash object programming and
connects it to concepts you already understand.

If you write lots of SAS programs and use SAS procedures to structure and look up data, then it is
worth it to take the time to learn how to use hash objects. Once you become familiar with the
syntax, you will find many places where you can use a hash object. You are likely to save
programming time and computer processing time when you incorporate hash object programming
in your SAS programming toolkit. If you’ve already used hash objects some, then this book offers you some examples for techniques that you may not have tried or understood how to use.

The examples in this book vary in complexity and are generally organized in order of increasing complexity. By studying how an example uses a hash object, you will find ways to adapt hash objects programming techniques to your own applications.

What Are Hash Objects?
Technically, hash objects, interchangeably called hash tables in this book, are data structures that provide a way to efficiently search data. Hash object programming is a feature in many programming languages. A hash object is a type of array that a program accesses using keys. A hash object consists of key items and data items. The programming language applies a hash function that maps the keys to positions in the array.

When you define an array in SAS, SAS allocates a fixed amount of memory based on the number of elements you specify and the attributes of the variables that make up the array. A hash object is a more dynamic structure. It grows and expands as you add and remove items from the table following the instructions in your programs.

A SAS hash object exists only within the DATA step in which it creates the hash object. When the DATA step ends, SAS deletes the hash object.

Introducing a Simple Hash Object Application
In general, SAS language in a SAS DATA step follows a linear, logical process. A typical DATA step processes a SAS data set one observation at a time or it reads a raw data file one record at a time. SAS executes the statements one after the other. While your statements can direct processing to different locations within a DATA step, a DATA step typically starts at the top and proceeds sequentially statement-by-statement to the bottom of the DATA step.

A common SAS programming task is to look up information based on data in the observation currently being processed. Many methods exist in SAS to look up information. Some of these include:

- IF-THEN and SELECT statements
- referencing elements of arrays
- applying formats
- merging data sets
- joining tables
Some of these methods require more than just a single DATA step or PROC step to achieve the lookup.

For example, as shown in the first table in Output 1.1, say you have data set EMPHOURS with hours worked for a group of employees where each employee is identified in each observation solely by employee ID. To complete the employee report, you need the employee’s full name. This data is stored in another data set, EMPLOYEES, as shown in the second table in Output 1.1 that contains both the employee ID and demographic information about the employee.

Output 1.1 PROC PRINT of EMPHOURS (all 6 observations) and EMPLOYEES (first 20 observations)

| EMPHOURS |
|---|---|
| Obs | empid | emphours |
| 1 | 6XBIFI | 38.5 |
| 2 | WA4D7N | 22.0 |
| 3 | VPA9EF | 43.0 |
| 4 | TZ6OUB | 11.5 |
| 5 | L6KKHS | 29.0 |
| 6 | 8TN7WL | 38.0 |

| EMPLOYEES |
|---|---|---|---|---|---|---|---|
| Obs | empid | empln | empfn | empmi | gender | startdate | emppaylevel |
| 1 | 6XBIFI | Ramirez | Danielle | N | F | 04/21/1989 | Alb |
| 2 | WA4D7N | Thompson | Catherine | D | F | 06/18/1986 | PIIa |
| 3 | 06KH8Q | Chang | William | T | M | 07/23/2002 | PIIa |
| 4 | WA4D7N | Garcia | Breanna | X | F | 08/20/1982 | Alb |
| 5 | OQQT3Z | Jones | Brooke | E | F | 08/28/1994 | MIIa |
| 6 | 1JU28B | Smith | Matthew | I | M | 08/22/1982 | TIIib |
| 7 | VBOARE | Hall | Samuel | B | M | 05/25/2010 | Plb |
| 8 | 1GTXQ2 | Parker | Nathaniel | S | M | 08/12/1996 | Plc |
| 9 | VPA9EF | Baker | Cheyenne | C | F | 02/24/1990 | Alla |
| 10 | 0IP7L6 | Hughes | Alexander | N | M | 08/08/1991 | TIlb |
| 11 | Q1A4SU | Sanchez | Nathaniel | W | M | 08/13/1998 | TIIId |
| 12 | ANWFGX | Green | Tyler | I | M | 12/04/1991 | Tcl |
| 13 | L118Y7 | Edwards | Angelica | O | F | 11/18/1991 | MIIa |
| 14 | TZ6OUB | White | Heather | T | F | 01/27/1999 | Alla |
| 15 | 235TWE | King | Briana | M | F | 10/08/1992 | TIlc |
| 16 | XYOJC7 | Scott | Mark | T | M | 01/15/2002 | TIIa |
| 17 | 8TN7WL | Miller | Tyler | J | M | 08/31/1998 | Alllc |
Typing a series of IF-THEN or SELECT statements to find an employee’s name seems prohibitive, especially if your demographic lookup data set is large. Probably a merge in the DATA step or a PROC SQL join would work to obtain the names of the employees based on their employee IDs. If you do the merge, both your hours-worked data set and your demographic data set must be sorted or indexed by the employee ID prior to the DATA step that does the merge.

While PROC SQL does not require that you sort your tables before you have PROC SQL join them, the step processes more efficiently if your tables are sorted or indexed by the columns that do the join. However, when you use PROC SQL, if you need to do other processing of the table, like calculations, it can be more difficult to code those statements in SQL than if you wrote SAS language statements in a DATA step. If you add a second SELECT statement to your PROC SQL step or if you follow the PROC SQL step with a DATA step, you’ve now processed your data set twice.

Example 1.1 presents sample code that shows a DATA step merge solution.

**Example 1.1 DATA Step Merge**

```sas
proc sort data=emphours;
  by empid;
run;
proc sort data=mylib.employees;
  by empid;
run;
data empnames;
  merge emphours(in=inhours)
      mylib.employees(keep=empid empln empfn empmi in=inall);
  by empid;
  length empname $ 60;
  if inhours;
    if inall then empname=catx(' ',empfn,empmi,empln);
    else empname='** Not Found';
run;
```

With hash object programming, you can achieve both the lookup of employee demographic data and additional SAS language processing in one DATA step. Your DATA step starts by loading the demographic data set into a hash object.

To further streamline the lookup process, you can tell SAS to load only certain variables and observations into the hash object. For this simple example, you load the names of the employees in the hash object, and you tell SAS that the key to find data in the hash object is the employee ID.
Perhaps you know that your employee data set has observations for employees that have a specific job classification. You could tell SAS to load the hash object with the names of employees only from that subset of the employee population.

Since hash objects reside in memory, it’s highly likely that the DATA step with the hash object runs more quickly than any of the solutions in the list above, and this is especially true if your data sets are large.

Example 1.2 presents a DATA step that uses a hash object to find employee names for administrative employees. The values of EMPPAYLEVEL for administrative employees start with “A”. While the language in this step may look strange to you, it is really easy to understand and code once you have a little knowledge.

**Example 1.2 DATA Step That Uses a Hash Object**

```sas
data empnames;
  length empid $ 6 empln $ 30 empfn $ 25 empmi $ 1 empname $ 60;
  if _n_=1 then do;
    declare hash e(dataset: 'mylib.employees(where=(emppaylevel="A")');
    e.definekey('empid');
    e.definedata('empln','empfn','empmi');
    e.definedone();
    call missing(empln,empfn,empmi);
  end;
  set emphours;
  drop rc;
  rc=e.find();
  if rc=0 then empname=catx(' ',empfn,empmi,empln);
  else empname='** Not Found';
run;
```

The step starts with an IF-THEN block that executes only on the first iteration. This code defines hash object E and loads it with demographic information from data set EMPLOYEES. Having been defined on the first iteration of the DATA step, hash object E remains in memory throughout execution of the DATA step so that you can quickly retrieve from it the demographic data you need for each observation in the EMPHOURS data set.

The statements that follow the IF-THEN block execute once for every observation in EMPHOURS. The statement with the FIND method retrieves information from hash object E based on the values of EMPID. The IF-THEN statement that follows it executes when SAS finds a match in hash object E. The ELSE statement executes when SAS does not find a match in hash object E.
Specifically, the statements in the IF _N_=1 block that executes on the first iteration of the DATA step do the following:

1. Create hash object called E.
2. Load into hash object E the observations in MYLIB.EMPLOYEES for administrative employees (EMPPAYLEVEL="A").
3. Identify variable EMPID as the key to find data in hash object E.
4. Load only variables EMPLN, EMPFN, and EMPMI from MYLIB.EMPLOYEES into hash object E as data.
5. Initialize to missing the DATA step variables with the same names as the items that SAS loads into hash object E.

The statements outside of the IF _N_=1 block that execute on each iteration of the DATA step do the following:

6. Read each observation from data set EMPHOURS.
7. Look for a match in hash object E for the value of EMPID in the EMPHOUR observation currently being processed.
8. When SAS finds a match in hash object E, concatenate the information retrieved from hash object E into variable EMPNAME.
9. When SAS does not find a match in hash object E, assign informative text to the variable EMPNAME.

The LENGTH statement at the beginning of the DATA step adds to the Program Data Vector (PDV) the three variables whose values are retrieved from hash object E. SAS outputs these three variables, the employee ID (EMPID), and the new variable EMPNAME to data set EMPNAMES.

Example 1.2, which is the DATA step with the hash object, executes the same way as a DATA step without a hash object. You could think of the block of code that defined hash object E as similar to how you might define an array that provides lookup values. Yet, hash object programming provides much more functionality than arrays. In this simple DATA step in Example 1.2, you can see that in one statement the DATA step looks for a match in hash object E and it retrieves the values of three data items when SAS finds a match. If you used arrays, your code would likely require multiple arrays, or possibly multi-dimensional arrays.

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