

Exploring DATA Step Merge and PROC SQL Join Techniques

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Abstract

Explore the various DATA step merge and PROC SQL join processes. This presentation examines the similarities and differences between each, and provides examples of effective coding techniques. Attendees examine the objectives and principles behind merging and joining, as well as the coding constructs associated with inner and outer merges and joins, hash techniques, and selected Set operators.

Introduction

This paper illustrates the similarities and differences between the Base-SAS software DATA step merge and PROC SQL join techniques. We'll examine two "key" topics that most users are confronted with when working with their tables of data, conditional logic scenarios and merges/joins. This paper introduces brief explanations, guidelines and "simple" techniques for users to consider when confronted with conditional logic scenarios and merges/joins. You are encouraged to explore these and other techniques to make your SAS experience an exciting one.

Example Tables

The data used in all the examples in this paper consist of a selection of movies that I've viewed over the years. The Movies table contains four character columns: title, category, studio, and rating, and two numeric columns: length and year. The data stored in the Movies table is shown below.

MOVIES Table

	Title	Length	Category	Year	Studio	Rating
1	Brave Heart	177	Action/Adventure	1995	Paramount Pictures	R
2	Casablanca	103	Drama	1942	MGM / UA	PG
3	Christmas Vacation	97	Comedy	1989	Warner Brothers	PG-13
4	Coming to America	116	Comedy	1988	Paramount Pictures	R
5	Dracula	130	Horror	1993	Columbia TriStar	R
6	Dressed to Kill	105	Drama/Mysteries	1980	Filmways Pictures	R
7	Forrest Gump	142	Drama	1994	Paramount Pictures	PG-13
8	Ghost	127	Drama/Romance	1990	Paramount Pictures	PG-13
9	Jaws	125	Action/Adventure	1975	Universal Studios	PG
10	Jurassic Park	127	Action	1993	Universal Pictures	PG-13
11	Lethal Weapon	110	Action/Cops & Robber	1987	Warner Brothers	R
12	Michael	106	Drama	1997	Warner Brothers	PG-13
13	National Lampoon's Vacation	98	Comedy	1983	Warner Brothers	PG-13
14	Poltergeist	115	Horror	1982	MGM / UA	PG
15	Rocky	120	Action/Adventure	1976	MGM / UA	PG
16	Scarface	170	Action/Cops & Robber	1983	Universal Studios	R
17	Silence of the Lambs	118	Drama/Suspense	1991	Orion	R
18	Star Wars	124	Action/Sci-Fi	1977	Lucas Film Ltd	PG
19	The Hunt for Red October	135	Action/Adventure	1989	Paramount Pictures	PG
20	The Terminator	108	Action/Sci-Fi	1984	Live Entertainment	R
21	The Wizard of Oz	101	Adventure	1939	MGM / UA	G
22	Titanic	194	Drama/Romance	1997	Paramount Pictures	PG-13

The data stored in the ACTORS table consists of three columns: title, actor_leading, and actor_supporting, all of which are defined as character columns. The data stored in the Actors table is illustrated below.

ACTORS Table

	Title	Actor_Leading	Actor_Supporting
1	Brave Heart	Mel Gibson	Sophie Marceau
2	Christmas Vacation	Chevy Chase	Beverly D'Angelo
3	Coming to America	Eddie Murphy	Arsenio Hall
4	Forrest Gump	Tom Hanks	Sally Field
5	Ghost	Patrick Swayze	Demi Moore
6	Lethal Weapon	Mel Gibson	Danny Glover
7	Michael	John Travolta	Andie MacDowell
8	National Lampoon's Vacation	Chevy Chase	Beverly D'Angelo
9	Rocky	Sylvester Stallone	Talia Shire
10	Silence of the Lambs	Anthony Hopkins	Jodie Foster
11	The Hunt for Red October	Sean Connery	Alec Baldwin
12	The Terminator	Arnold Schwarzenegger	Michael Biehn
13	Titanic	Leonardo DiCaprio	Kate Winslet

The Process of Merging and Joining

A merge or join is the process of combining two or more tables' side-by-side (horizontally). Its purpose is to gather and manipulate data from across tables for exciting insights into data relationships. The process consists of a matching process between a table's rows bringing together some or all of the tables' contents, as illustrated below.



The ability to define relationships between multiple tables and retrieve information based on these relationships is a powerful feature of the relational model. A merge or join of two or more tables provides a means of gathering and manipulating data. Merges and joins are specified on a minimum of two tables at a time, where a column from each table is used for the purpose of connecting the two tables. Connecting columns should have *"like"* values and the same column attributes since the processes' success is dependent on these values.

Contrasting Merges and Joins

The difference between a DATA step merge and a join are subtle, but differences do exist.

Merge Features

1. Relevant only to the SAS System – not portable to other vendor data bases.
2. More steps are often needed than with the SQL procedure.
3. Data must first be sorted using by-value.
4. Requires common variable name.
5. Duplicate matching column is automatically overlaid.
6. Results are not automatically printed.

Join Features

1. Portable to other vendor data bases.
2. Data does not need to be sorted using BY-value.
3. Does not require common variable name.
4. Duplicate matching column is not automatically overlaid.
5. Results are automatically printed unless NOPRINT option is specified.

Cartesian Product

A Cartesian Product is defined as a result set of all the possible rows and columns contained in two or more data sets or tables. The DATA step doesn't really lend itself to easily creating a Cartesian Product – PROC SQL is the desired approach. Its most noticeable coding characteristic is the absence of a WHERE-clause. The resulting set of data resulting from a Cartesian Product can be extremely large and unwieldy as illustrated below, that is a set of 286 rows. Although rarely produced, a Cartesian Product join nicely illustrates a base (or internal representation) for all joins.

Code

```
PROC SQL;  
  SELECT *  
    FROM MOVIES(KEEP=TITLE LENGTH RATING),  
         ACTORS(KEEP=TITLE ACTOR_LEADING);  
QUIT;
```

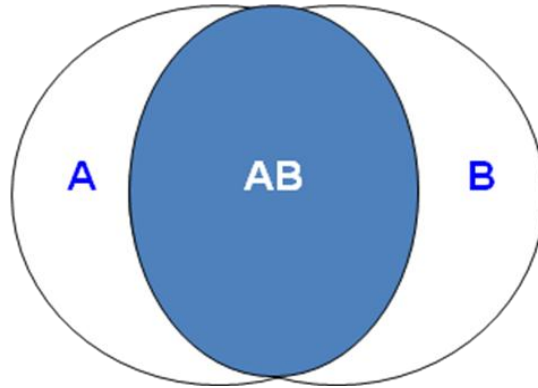
Results

The SAS System					
Title	Length	Rating	Title	Actor Leading	
Brave Heart	177	R	Brave Heart	Mel Gibson	
Casablanca	103	PG	Brave Heart	Mel Gibson	
Christmas Vacation	97	PG-13	Brave Heart	Mel Gibson	
Coming to America	116	R	Brave Heart	Mel Gibson	
Dracula	130	R	Brave Heart	Mel Gibson	
Dressed to Kill	105	R	Brave Heart	Mel Gibson	
Forrest Gump	142	PG-13	Brave Heart	Mel Gibson	
Ghost	127	PG-13	Brave Heart	Mel Gibson	
Jaws	125	PG	Brave Heart	Mel Gibson	
Jurassic Park	127	PG-13	Brave Heart	Mel Gibson	
Lethal Weapon	110	R	Brave Heart	Mel Gibson	
Michael	106	PG-13	Brave Heart	Mel Gibson	
National Lampoon's Vacation	98	PG-13	Brave Heart	Mel Gibson	
Poltergeist	115	PG	Brave Heart	Mel Gibson	
Rocky	120	PG	Brave Heart	Mel Gibson	
Scarface	170	R	Brave Heart	Mel Gibson	
...	< Some Data Omitted >
Forrest Gump	142	PG-13	Titanic	Leonardo DiCaprio	
Ghost	127	PG-13	Titanic	Leonardo DiCaprio	
Jaws	125	PG	Titanic	Leonardo DiCaprio	
Jurassic Park	127	PG-13	Titanic	Leonardo DiCaprio	
Lethal Weapon	110	R	Titanic	Leonardo DiCaprio	
Michael	106	PG-13	Titanic	Leonardo DiCaprio	
National Lampoon's Vacation	98	PG-13	Titanic	Leonardo DiCaprio	
Poltergeist	115	PG	Titanic	Leonardo DiCaprio	
Rocky	120	PG	Titanic	Leonardo DiCaprio	
Scarface	170	R	Titanic	Leonardo DiCaprio	
Silence of the Lambs	118	R	Titanic	Leonardo DiCaprio	
Star Wars	124	PG	Titanic	Leonardo DiCaprio	
The Hunt for Red October	135	PG	Titanic	Leonardo DiCaprio	
The Terminator	108	R	Titanic	Leonardo DiCaprio	
The Wizard of Oz	101	G	Titanic	Leonardo DiCaprio	
Titanic	194	PG-13	Titanic	Leonardo DiCaprio	

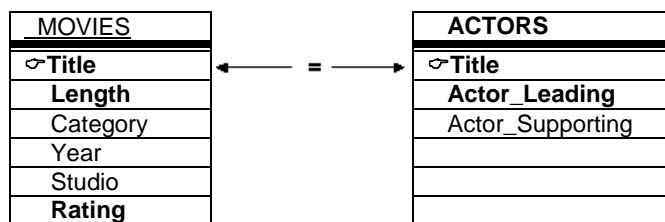
Match Merging or Joining

Merging or joining two or more tables together is a relatively easy process in the SAS System. The most reliable way to merge or join two or more tables together, and to avoid creating a Cartesian product, is to reduce the resulting set of data using one or more common columns. *The result of a **Matched merge or join** is illustrated by the shaded area (AB) in the following Venn diagram.*

Venn Diagram – Matched Merge or Join



To illustrate how a match merge or join works, two tables are linked together using the movie title (TITLE) in the following diagram.



Merge Code

```
PROC SORT DATA=MOVIES;  
  BY TITLE;  
RUN;  
  
PROC SORT DATA=ACTORS;  
  BY TITLE;  
RUN;  
  
DATA MERGED;  
  MERGE MOVIES (IN=M KEEP=TITLE LENGTH RATING)  
        ACTORS (IN=A KEEP=TITLE ACTOR_LEADING);  
  BY TITLE;  
  IF M AND A;  
RUN;  
  
PROC PRINT DATA=MERGED NOOBS;  
RUN;
```

Results

The SAS System			
Title	Length	Rating	Actor_Leading
Brave Heart	177	R	Mel Gibson
Christmas Vacation	97	PG-13	Chevy Chase
Coming to America	116	R	Eddie Murphy
Forrest Gump	142	PG-13	Tom Hanks
Ghost	127	PG-13	Patrick Swayze
Lethal Weapon	110	R	Mel Gibson
Michael	106	PG-13	John Travolta
National Lampoon's Vacation	98	PG-13	Chevy Chase
Rocky	120	PG	Sylvester Stallone
Silence of the Lambs	118	R	Anthony Hopkins
The Hunt for Red October	135	PG	Sean Connery
The Terminator	108	R	Arnold Schwarzenegge
Titanic	194	PG-13	Leonardo DiCaprio

The corresponding SQL procedure code to produce a “matched” row result set is shown below.

SQL Code

```
PROC SQL;  
  CREATE TABLE JOINED AS  
  SELECT *  
    FROM MOVIES(KEEP=TITLE LENGTH RATING),  
         ACTORS(KEEP=TITLE ACTOR_LEADING)  
  WHERE MOVIES.TITLE = ACTORS.TITLE;  
  
  SELECT * FROM JOINED;  
QUIT;
```

Results

The SAS System			
Title	Length	Rating	Actor Leading
Brave Heart	177	R	Mel Gibson
Christmas Vacation	97	PG-13	Chevy Chase
Coming to America	116	R	Eddie Murphy
Forrest Gump	142	PG-13	Tom Hanks
Ghost	127	PG-13	Patrick Swayze
Lethal Weapon	110	R	Mel Gibson
Michael	106	PG-13	John Travolta
National Lampoon's Vacation	98	PG-13	Chevy Chase
Rocky	120	PG	Sylvester Stallone
Silence of the Lambs	118	R	Anthony Hopkins
The Hunt for Red October	135	PG	Sean Connery
The Terminator	108	R	Arnold Schwarzenegge
Titanic	194	PG-13	Leonardo DiCaprio

Asymmetric Merging and Joining

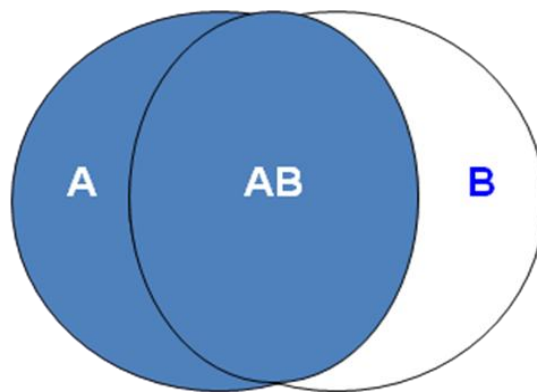
A typical merge or join consists of a process of relating rows in one table with rows in another symmetrically. But occasionally, rows from one or both tables that have no related rows can be retained. This approach is sometimes referred to as an asymmetric type of join because its primary purpose is row preservation. This type of processing is a significant feature offered by the outer join construct.

There are syntax and operational differences between inner (natural) and outer joins. The obvious difference between an inner and outer join is the way the syntax is constructed. Outer joins use keywords such as LEFT JOIN, RIGHT JOIN, and FULL JOIN, and has the WHERE clause replaced with an ON clause. These distinctions help identify outer joins from inner joins. But, there are operational differences as well.

Unlike an inner join, the maximum number of tables that can be specified in an outer join construct is two. Similar to an inner join, an outer join relates rows in both tables. But this is where the similarities end because the resulting set of data also includes rows with no related rows from one or both of the tables. This special handling of “matched” and “unmatched” rows of data is what differentiates a symmetric inner join from an asymmetric outer join. Essentially the resulting set of data from an outer join process contains rows that “match” the ON-clause plus any “unmatched” rows from the left, right, or both tables.

The result of a **Left Outer merge or join** is illustrated by the shaded areas (A and AB) in the following Venn diagram.

Venn Diagram – Left Outer Merge or Join



Left Outer Merge or Join

The result of a Left Outer merge or join produces matched rows from both tables while preserving all unmatched rows from the left table. The following merge code illustrates a left outer merge construct that selects “matched” movies based on their titles from the MOVIES and ACTORS tables, plus all “unmatched” movies from the MOVIES table.

Merge Code

```
PROC SORT DATA=MOVIES;  
  BY TITLE;  
RUN;  
  
PROC SORT DATA=ACTORS;  
  BY TITLE;  
RUN;  
  
DATA LEFT OUTER MERGE;  
  MERGE MOVIES (IN=M KEEP=TITLE LENGTH RATING)  
        ACTORS (IN=A KEEP=TITLE ACTOR_LEADING);  
  BY TITLE;  
  IF M;  
RUN;  
  
PROC PRINT DATA=LEFT_OUTER_MERGE NOOBS;  
RUN;
```

Results

The SAS System			
Title	Length	Rating	Actor_Leading
Brave Heart	177	R	Mel Gibson
Casablanca	103	PG	
Christmas Vacation	97	PG-13	Chevy Chase
Coming to America	116	R	Eddie Murphy
Dracula	130	R	
Dressed to Kill	105	R	
Forrest Gump	142	PG-13	Tom Hanks
Ghost	127	PG-13	Patrick Swayze
Jaws	125	PG	
Jurassic Park	127	PG-13	
Lethal Weapon	110	R	Mel Gibson
Michael	106	PG-13	John Travolta
National Lampoon's Vacation	98	PG-13	Chevy Chase
Poltergeist	115	PG	
Rocky	120	PG	Sylvester Stallone
Scarface	170	R	
Silence of the Lambs	118	R	Anthony Hopkins
Star Wars	124	PG	
The Hunt for Red October	135	PG	Sean Connery
The Terminator	108	R	Arnold Schwarzenegge
The Wizard of Oz	101	G	
Titanic	194	PG-13	Leonardo DiCaprio

The corresponding SQL procedure code to produce a left outer join row result set is shown below.

SQL Code

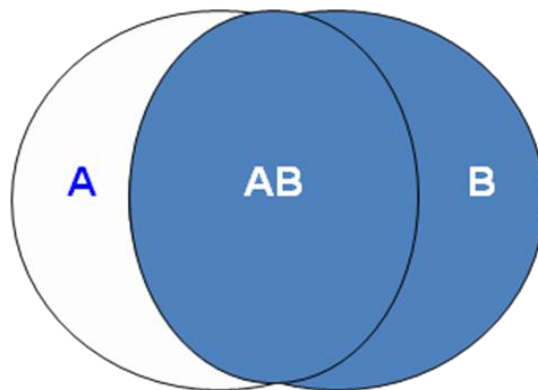
```
PROC SQL;  
  CREATE TABLE LEFT_OUTER_JOIN AS  
  SELECT *  
    FROM MOVIES(KEEP=TITLE LENGTH RATING)  
  LEFT JOIN  
    ACTORS(KEEP=TITLE ACTOR_LEADING)  
  ON MOVIES.TITLE = ACTORS.TITLE;  
  
  SELECT * FROM LEFT_OUTER_JOIN;  
QUIT;
```

Results

The SAS System			
Title	Length	Rating	Actor Leading
Brave Heart	177	R	Mel Gibson
Casablanca	103	PG	
Christmas Vacation	97	PG-13	Chevy Chase
Coming to America	116	R	Eddie Murphy
Dracula	130	R	
Dressed to Kill	105	R	
Forrest Gump	142	PG-13	Tom Hanks
Ghost	127	PG-13	Patrick Swayze
Jaws	125	PG	
Jurassic Park	127	PG-13	
Lethal Weapon	110	R	Mel Gibson
Michael	106	PG-13	John Travolta
National Lampoon's Vacation	98	PG-13	Chevy Chase
Poltergeist	115	PG	
Rocky	120	PG	Sylvester Stallone
Scarface	170	R	
Silence of the Lambs	118	R	Anthony Hopkins
Star Wars	124	PG	
The Hunt for Red October	135	PG	Sean Connery
The Terminator	108	R	Arnold Schwarzenegge
The Wizard of Oz	101	G	
Titanic	194	PG-13	Leonardo DiCaprio

The result of a **Right Outer merge or join** is illustrated by the shaded areas (B and AB) in the following Venn diagram.

Venn Diagram – Right Outer Merge or Join



Right Outer Merge or Join

The result of a Right Outer merge or join produces matched rows from both tables while preserving all unmatched rows from the right table. The following merge code illustrates a right outer merge construct that selects “matched” movies based on their titles from the MOVIES and ACTORS tables, plus all “unmatched” movies from the ACTORS table.

Merge Code

```
PROC SORT DATA=MOVIES;
  BY TITLE;
RUN;

PROC SORT DATA=ACTORS;
  BY TITLE;
RUN;

DATA RIGHT_OUTER_MERGE;
  MERGE MOVIES (IN=M KEEP=TITLE LENGTH RATING)
        ACTORS (IN=A KEEP=TITLE ACTOR_LEADING);
  BY TITLE;
  IF A;
RUN;

PROC PRINT DATA=RIGHT_OUTER_MERGE NOOBS;
RUN;
```

Results

The SAS System			
Title	Length	Rating	Actor_Leading
Brave Heart	177	R	Mel Gibson
Christmas Vacation	97	PG-13	Chevy Chase
Coming to America	116	R	Eddie Murphy
Forrest Gump	142	PG-13	Tom Hanks
Ghost	127	PG-13	Patrick Swayze
Lethal Weapon	110	R	Mel Gibson
Michael	106	PG-13	John Travolta
National Lampoon's Vacation	98	PG-13	Chevy Chase
Rocky	120	PG	Sylvester Stallone
Silence of the Lambs	118	R	Anthony Hopkins
The Hunt for Red October	135	PG	Sean Connery
The Terminator	108	R	Arnold Schwarzenegge
Titanic	194	PG-13	Leonardo DiCaprio

The corresponding SQL procedure code to produce a right outer join row result set is shown below.

SQL Code

```
PROC SQL;  
CREATE TABLE RIGHT_OUTER_JOIN AS  
SELECT *  
FROM MOVIES(KEEP=TITLE LENGTH RATING)  
RIGHT JOIN  
ACTORS(KEEP=TITLE ACTOR_LEADING)  
ON MOVIES.TITLE = ACTORS.TITLE;  
  
SELECT * FROM RIGHT_OUTER_JOIN;  
QUIT;
```

Results

The SAS System				
Title	Length	Rating	Actor	Leading
Brave Heart	177	R	Mel	Gibson
Christmas Vacation	97	PG-13	Chevy	Chase
Coming to America	116	R	Eddie	Murphy
Forrest Gump	142	PG-13	Tom	Hanks
Ghost	127	PG-13	Patrick	Swayze
Lethal Weapon	110	R	Mel	Gibson
Michael	106	PG-13	John	Travolta
National Lampoon's Vacation	98	PG-13	Chevy	Chase
Rocky	120	PG	Sylvester	Stallone
Silence of the Lambs	118	R	Anthony	Hopkins
The Hunt for Red October	135	PG	Sean	Connery
The Terminator	108	R	Arnold	Schwarzenegge
Titanic	194	PG-13	Leonardo	DiCaprio

Conclusion

The Base-SAS DATA step and SQL procedure are wonderful languages for SAS users to explore and use in a variety of application situations. This paper has presented explanations, guidelines and “simple” techniques for users to consider when confronted with conditional logic scenarios and merges/joins. You are encouraged to explore these and other techniques to make your SAS experience an exciting one.

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