Multiple SET Statements in a DATA Step

Why and how to use them

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inVentiv Health

Topics

1. SET statement very easy
2. How multiple SETs work or don‘t work
3. Excursion: Program data vector (PDV)
4. SQL vs. Multiple SETs
5. Do-loops or DoW-loops

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1) 

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DATA STEP – Basic scenarios

```
data C;
    set B;
    *Manipulate data here;
run;
```


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DATA STEP – Basic scenarios

```
data C;
    set B;
    *Manipulate data here;
run;
```

```
data C;
    set A  B;
    *Manipulate data here;
run;
```

A

Name	Age
Amy	32
Jake	28
Tom	55

B

Name	Age
Ben	36
Mary	35

C unsorted

Name	Age
Amy	32
Jake	28
Tom	55
Ben	36
Mary	35

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DATA STEP – Interleaving

```
data C;
    set  A  B;
    by  name;
    *Manipulate data here;
run;
```

C (sorted)

Name	Age
Amy	32
Ben	36
Jake	28
Mary	35
Tom	55

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2) How multiple SETs work or don‘t work

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Multiple SET statements – How they work (or don‘t)

```
data overwriteC;
    set A;
    set B;
run;
```

A

Name	Gender
Amy	F
Jake	M
Tom	M

B

Name	Age
Ben	36
Mary	35

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Multiple SET statements – How they work (or don‘t)

```
data overwriteC;
    set A;
    set B;
run;
```

A

Name	Gender
Amy	F
Jake	M
Tom	M

B

Name	Age
Ben	36
Mary	35

overwriteC

Name	Gender	Age
~~Amy~~ Ben	F	36
~~Jake~~ Mary	M	35

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Multiple SET statements – How they work (or don‘t)

```
data overwriteC;
    set A;
    set B;
run;
```

A

Name	Gender
Amy	F
Jake	M
Tom	M

B

Name	Age
Ben	36
Mary	35

overwriteC

Name	Gender	Age
~~Amy~~ Ben	F	36
~~Jake~~ Mary	M	35

1) Reads 1st obs from A and places it into the PDV

_N_	_Error_	Name	Gender
1	0	Amy	F

2) Reads 1st obs from B and places it into the PDV

SAS overwrites values of common variables from A with the new values from B

_N_	_Error_	Name	Gender	Age
1	0	Ben	F	36

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Excursion:
3) Program data vector (PDV)

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PDV – Program data vector

- “A logical area in memory where SAS builds a data set, one observation at a time.”

- **Automatic variables** created by the DATA step.
  - Retained from one iteration of the DATA step to the next
  - Not written to the output data set
  - Cannot be kept, dropped, or renamed
  - **_N_**: number of times the DATA step has iterated
  - **_ERROR_** (0= no error / 1= error)
  - **first.*BY-variable*** and **last.*BY-variable***
- **Temporary variables**
  - **IN**=*variable* (0 / 1)
  - **END**=*variable*: indicates the end of the input data reached.

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PDV – Program data vector

```
data a;
   put "after compile before execution: " _all_;
   do i=1 to 5;
      y=i*2;
      output;
      put _all_;
   end;
   put "at end of execution:" _all_;
run;
```

SAS LOG:

after compile before execution:
I= Y= _ERROR_=0 _N_=1
I=1 Y=2 _ERROR_=0 _N_=1
I=2 Y=4 _ERROR_=0 _N_=1
I=3 Y=6 _ERROR_=0 _N_=1
I=4 Y=8 _ERROR_=0 _N_=1
I=5 Y=10 _ERROR_=0 _N_=1
at end of execution:I=6 Y=10 _ERROR_=0 _N_=1
NOTE: The data set WORK.A has 5 observations and 2 variables.

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PDV – Program data vector

```
data a;
   set a(in=inoperator)  end=eof;
   by i;
   put _all_;
run;
```

```
INOPERATOR=1 EOF=0 I=1 Y=2 FIRST.I=1 LAST.I=1 _ERROR_=0 _N_=1
INOPERATOR=1 EOF=0 I=2 Y=4 FIRST.I=1 LAST.I=1 _ERROR_=0 _N_=2
INOPERATOR=1 EOF=0 I=3 Y=6 FIRST.I=1 LAST.I=1 _ERROR_=0 _N_=3
INOPERATOR=1 EOF=0 I=4 Y=8 FIRST.I=1 LAST.I=1 _ERROR_=0 _N_=4
INOPERATOR=1 EOF=1 I=5 Y=10 FIRST.I=1 LAST.I=1 _ERROR_=0 _N_=5

NOTE: There were 5 observations read from the data set WORK.A
```


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4a) Summaries with SQL vs. Multiple SETs

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Example: Calculate summary statistics with SQL

```
proc sql;
   create table b as select
         *
         ,sum(age) as sum_age
         ,count(*) as n_age
         ,mean(age) as m_age
   from sashelp.class;
quit;
```

	Name	Sex	Age	Height	Weight	sum_age	n_age	m_age
1	Alfred	M	14	69	112.5	253	19	13.315789...
2	Alice	F	13	56.5	84	253	19	13.315789...
3	Barbara	F	13	65.3	98	253	19	13.315789...
4	Carol	F	14	62.8	102.5	253	19	13.315789...
5	Henry	M	14	63.5	102.5	253	19	13.315789...
6	James	M	12	57.3	83	253	19	13.315789...
7	Jane	F	12	59.8	84.5	253	19	13.315789...
8	Janet	F	15	62.5	112.5	253	19	13.315789...
9	Jeffrey	M	13	62.5	84	253	19	13.315789...
10	John	M	12	59	99.5	253	19	13.315789...
11	Joyce	F	11	51.3	50.5	253	19	13.315789...
12	Judy	F	14	64.3	90	253	19	13.315789...
13	Louise	F	12	56.3	77	253	19	13.315789...
14	Mary	F	15	66.5	112	253	19	13.315789...
15	Philip	M	16	72	150	253	19	13.315789...
16	Robert	M	12	64.8	128	253	19	13.315789...
17	Ronald	M	15	67	133	253	19	13.315789...
18	Thomas	M	11	57.5	85	253	19	13.315789...
19	William	M	15	66.5	112	253	19	13.315789...

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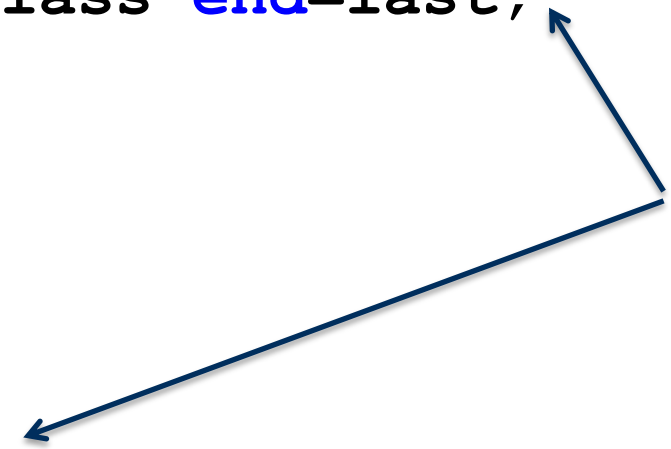
Summary statistics with multiple SETs

```
data b;
   if _n_=1 then
  do until (last);
        set sashelp.class end=last;
        n+1;
        sum+age;
  end;
   m_age=sum/n;
   set sashelp.class;
run;
```



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Summary statistics with multiple SETs

```
data a;
  do _n_ = 1 by 1 until (last.sex);
    set class;
    by sex ;
    total = sum(total, age) ;
  end ;
   mean = total / _n_ ;
  do until (last.sex) ;
    set class;
    by sex;
    output;
  end;
run;
```

grouped summary

	NAME	SEX	AGE	HEIGHT	WEIGHT	TOTAL	MEAN
1	Alice	F	13	56.5	84	119	13.222222222
2	Barbara	F	13	65.3	98	119	13.222222222
3	Carol	F	14	62.8	102.5	119	13.222222222
4	Jane	F	12	59.8	84.5	119	13.222222222
5	Janet	F	15	62.5	112.5	119	13.222222222
6	Joyce	F	11	51.3	50.5	119	13.222222222
7	Judy	F	14	64.3	90	119	13.222222222
8	Louise	F	12	56.3	77	119	13.222222222
9	Mary	F	15	66.5	112	119	13.222222222
10	Alfred	M	14	69	112.5	134	13.4
11	Henry	M	14	63.5	102.5	134	13.4
12	James	M	12	57.3	83	134	13.4
13	Jeffrey	M	13	62.5	84	134	13.4
14	John	M	12	59	99.5	134	13.4
15	Philip	M	16	72	150	134	13.4
16	Robert	M	12	64.8	128	134	13.4
17	Ronald	M	15	67	133	134	13.4
18	Thomas	M	11	57.5	85	134	13.4
19	William	M	15	66.5	112	134	13.4

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Multiple Sets in do-loops / „Change from Baseline“

```
data vs;
  do until(last.subjidn);
     set vs;
     by subjidn paramcd;
     if ablfn=1  then base = aval;
     else chg = aval - base;
     output;
  end;
run;
```

	SUBJIDN	PARAMCD	VISITNUM	ABLFN	AVAL	BASE	CHG
1	1	Systolic Bloo…	0.0000		105.000		
2	1	Systolic Bloo…	1.1000		100.000		
3	1	Systolic Bloo…	1.1000	Y	100.000	100	
4	1	Systolic Bloo…	1.2800		105.000	100	5
5	1	Systolic Bloo…	1.5600		102.000	100	2
6	1	Systolic Bloo…	3.5600		95.000	100	-5
7	1	Systolic Bloo…	9900.0000		100.000	100	0
8	7	Systolic Bloo…	0.0000		120.000		
9	7	Systolic Bloo…	1.1000		115.000		
10	7	Systolic Bloo…	1.1000	Y	115.000	115	
11	7	Systolic Bloo…	1.2800		120.000	115	5
12	7	Systolic Bloo…	4.1400		135.000	115	20
13	7	Systolic Bloo…	6.1400		125.000	115	10
14	7	Systolic Bloo…	9900.0000		115.000	115	0

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4b)
Many-to-many merge
SQL
or
multiple SET?

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Many-to-many merge

Adverse Events

	SUBJIDN	AELLT	ASTDT	AEENDT
1	7	Stomachache	01NOV2013	01NOV2013
2	7	Headache	27OCT2013	27OCT2013
3	7	Common cold	05DEC2013	11DEC2013
4	7	Sore throat	29NOV2013	11DEC2013
5	7	Backache	17JAN2014	19JAN2014
6	7	Stomachache	19JAN2014	19JAN2014
7	7	Backache	31JAN2014	31JAN2014
8	7	Vomiting	10JUN2014	10JUN2014
9	7	Clavicle frac...	13JUL2014	25AUG2014
10	7	Fracture pain	13JUL2014	25AUG2014
11	7	Nausea	13JUL2014	20JUL2014
12	10	Cystitis	07NOV2013	09NOV2013
13	10	Dental impla...	27JAN2014	27JAN2014
14	10	Cystitis	27AUG2014	30SEP2014

Exposure

	SUBJIDN	VISITNUM	EXDT	TRTAN
1	7	1.0000	05SEP2013	3
2	7	2.0000	03OCT2013	3
3	7	3.0000	02NOV2013	3
4	7	4.0000	29NOV2013	3
5	7	5.0000	27DEC2013	3
6	7	6.0000	24JAN2014	3
7	7	7.0000	21FEB2014	3
8	7	8.0000	21MAR2014	3
9	7	9.0000	18APR2014	3
10	10	1.0000	04NOV2013	1
11	10	2.0000	31DEC2013	1
12	10	3.0000	21FEB2014	1
13	10	4.0000	23APR2014	1
14	10	5.0000	17JUN2014	1
15	10	6.0000	11AUG2014	1

- SQL join ☺
- Merge ☠💣

```
NOTE: MERGE statement has more
than one data set with repeats of BY values
```


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Why many-to-many merge fails

The **merge** statement fails to produce the correct results due to two important SAS rules:

1. In a data step, SAS reads observations sequentially.

2. Once an observation is read into the PDV, it is never re-read.

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Task: Merge Adverse Events with Exposure where treatment started 30 days before AE

Adverse Events

	SUBJIDN	AELLT	ASTDT	AEENDT
1	7	Stomachache	01NOV2013	01NOV2013
2	7	Headache	27OCT2013	27OCT2013
3	7	Common cold	05DEC2013	11DEC2013
4	7	Sore throat	29NOV2013	11DEC2013
5	7	Backache	17JAN2014	19JAN2014
6	7	Stomachache	19JAN2014	19JAN2014
7	7	Backache	31JAN2014	31JAN2014
8	7	Vomiting	10JUN2014	10JUN2014
9	7	Clavicle frac...	13JUL2014	25AUG2014
10	7	Fracture pain	13JUL2014	25AUG2014
11	7	Nausea	13JUL2014	20JUL2014
12	10	Cystitis	07NOV2013	09NOV2013
13	10	Dental impla...	27JAN2014	27JAN2014
14	10	Cystitis	27AUG2014	30SEP2014

Exposure

	SUBJIDN	VISITNUM	EXDT	TRTAN
1	7	1.0000	05SEP2013	3
2	7	2.0000	03OCT2013	3
3	7	3.0000	02NOV2013	3
4	7	4.0000	29NOV2013	3
5	7	5.0000	27DEC2013	3
6	7	6.0000	24JAN2014	3
7	7	7.0000	21FEB2014	3
8	7	8.0000	21MAR2014	3
9	7	9.0000	18APR2014	3
10	10	1.0000	04NOV2013	1
11	10	2.0000	31DEC2013	1
12	10	3.0000	21FEB2014	1
13	10	4.0000	23APR2014	1
14	10	5.0000	17JUN2014	1
15	10	6.0000	11AUG2014	1

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Task: Merge Adverse Events with Exposure where treatment started 30 days before AE

```
proc sql;
   create table ae_ex as
         select l.*
                ,r.visitnum
                ,r.exdt
                ,r.trtan
   from ae as l
   join ex as r
   on l.subjidn=r.subjidn and 0<=astdt-exdt<=30
   order by subjidn, aellt, visitnum;
quit;
```

	SUBJIDN 1	AELLT 2	ASTDT	AEENDT	VISITNUM 3	EXDT	TRTAN
1	7	Backache	17JAN2014	19JAN2014	5.0000	27DEC2013	3
2	7	Backache	31JAN2014	31JAN2014	6.0000	24JAN2014	3
3	7	Common cold	05DEC2013	11DEC2013	4.0000	29NOV2013	3
4	7	Headache	27OCT2013	27OCT2013	2.0000	03OCT2013	3
5	7	Sore throat	29NOV2013	11DEC2013	3.0000	02NOV2013	3
6	7	Sore throat	29NOV2013	11DEC2013	4.0000	29NOV2013	3
7	7	Stomachache	01NOV2013	01NOV2013	2.0000	03OCT2013	3
8	7	Stomachache	19JAN2014	19JAN2014	5.0000	27DEC2013	3
9	10	Cystitis	07NOV2013	09NOV2013	1.0000	04NOV2013	1
10	10	Cystitis	27AUG2014	30SEP2014	6.0000	11AUG2014	1
11	10	Dental impla…	27JAN2014	27JAN2014	2.0000	31DEC2013	1

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Task: Merge Adverse Events with Exposure where treatment started 30 days before AE

```
data ae_ex2(drop=idnum);
     set ae;
     do i=1 to num;
          set ex(rename=(subjidn=idnum)) nobs=num point=i;
          if subjidn=idnum and  0<=astdt-exdt<=30 then output;
     end;
run;
```

	SUBJIDN	AELLT	ASTDT	AEENDT	VISITNUM	EXDT	TRTAN
1	7	Stomachache	01NOV2013	01NOV2013	2.0000	03OCT2013	3
2	7	Headache	27OCT2013	27OCT2013	2.0000	03OCT2013	3
3	7	Common cold	05DEC2013	11DEC2013	4.0000	29NOV2013	3
4	7	Sore throat	29NOV2013	11DEC2013	3.0000	02NOV2013	3
5	7	Sore throat	29NOV2013	11DEC2013	4.0000	29NOV2013	3
6	7	Backache	17JAN2014	19JAN2014	5.0000	27DEC2013	3
7	7	Stomachache	19JAN2014	19JAN2014	5.0000	27DEC2013	3
8	7	Backache	31JAN2014	31JAN2014	6.0000	24JAN2014	3
9	10	Cystitis	07NOV2013	09NOV2013	1.0000	04NOV2013	1
10	10	Dental impla...	27JAN2014	27JAN2014	2.0000	31DEC2013	1
11	10	Cystitis	27AUG2014	30SEP2014	6.0000	11AUG2014	1

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5) Do-loops or DoW-loops?

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Basic approach: DoW-loops / multiple Sets

- Named after **Ian Whitlock** and **Don Henderson**.
- Uses DO loops to read data for tasks which require break-event processing, such as:
  - BY-group processing (FIRST. and LAST.)
  - checking for a specific value or a missing value

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Basic approach: DoW-loops / multiple Sets

```
DATA ...;
   <Stuff done before break-event>;
  DO<Index Specs> UNTIL(Break-Event);
      Set A;
      <Stuff done for each record>;
  END;
   <Stuff done after break-event... >;
RUN;
```

Separates before-, during, after- actions →intuitively logic

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Reference

- ***In Lockstep with the DoW-Loop***, Paul M. Dorfman, SESUG 2011 proceedings, http://analytics.ncsu.edu/sesug/2011/SS01.Dorfman.pdf

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Thank you very much for your attention!

Questions & Answers

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