

Package Validation for “procs”

Background: The “procs” package simulates some SAS® procedures in R. The package was written to make it easier for SAS® programmers to work in R. The package was also written to align statistical output between SAS® and R, as the native R functions do not necessarily match SAS®. This “pre-validation” will reduce the number of discrepancies in statistical output, and speed the process of analysis.

Purpose: The purpose of this document is to validate the R “procs” package against equivalent SAS® output.

Methodology: For this validation, first a test was defined that could be accomplished in both SAS® and R. Then a programmer wrote a small script in each language that produced similar results. The results were compared visually to ensure a match. Any discrepancies would be investigated and resolved either by modifying the comparison scripts, or modifying the “procs” package code until it matched SAS®. Comparison code and results were documented.

SAS Version: SAS Studio 3.81

R Version: 4.3.1

Procs Version: 1.0.3

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Last Modified Date: 9/4/2023

Change History

Date	Item	Procs Version
2023/06/23	Initial version.	0.0.9007
2023/06/24	Created first few tests for each function.	0.0.9007
2023/07/05	Discovered discrepancy in Procs-means-009 Upper 95% confidence limit. Had to change code to add alpha option and one-sided confidence limit calculation.	0.0.9007
2023/07/08	Resolved discrepancy on confidence limits. Added test means-010 to confirm two-sided CL.	0.0.9008
2023/07/10	Added Procs-means-011 tests for means t-test and p-value.	0.0.9008
2023/07/11	Added Procs-means-012 test for Uncorrected Sum of Squares.	0.0.9008
2023/07/20	Added Procs-means-013 test for skewness and kurtosis.	0.0.9008
2023/07/25	Added ability to use factors for sorting proc_freq output.	0.0.9008
2023/07/26	Fixed Fisher’s exact test for Cell 1.1. This was off when table was sorted properly.	0.0.9008
2023/07/29	Incremented to version 1.0.0 for CRAN submission.	1.0.0
2023/08/08	Incremented to version 1.0.2 for CRAN fixes	1.0.2

2023/08/10	Fixed zero-fill row on <code>proc_freq()</code> when user supplied a factor.	1.0.2
2023/08/11	Fixed n-way class summaries on <code>proc_means()</code> when multiple class vars are present.	1.0.2
2023/08/13	Fixed some labels on <code>proc_means()</code> report output.	1.0.2
2023/08/18	Add means-015 for more complicated statistics with <code>by</code> variable.	1.0.2
2023/09/04	Upgrade version and prepare for CRAN submission.	1.0.3

Freq Data

SAS	R
<pre> data Color; input Region Eyes \$ Hair \$ Count @@; label Eyes ='Eye Color' Hair ='Hair Color' Region='Geographic Region'; datalines; 1 blue fair 23 1 blue red 7 1 blue medium 24 1 blue dark 11 1 green fair 19 1 green red 7 1 green medium 18 1 green dark 14 1 brown fair 34 1 brown red 5 1 brown medium 41 1 brown dark 40 1 brown black 3 2 blue fair 46 2 blue red 21 2 blue medium 44 2 blue dark 40 2 blue black 6 2 green fair 50 2 green red 31 2 green medium 37 2 green dark 23 2 brown fair 56 2 brown red 42 2 brown medium 53 2 brown dark 54 2 brown black 13 ; </pre>	<pre> dat <- read.table(header = TRUE, text = ' Region Eyes Hair Count 1 blue fair 23 1 blue dark 11 1 green medium 18 1 brown red 5 1 brown black 3 2 blue medium 44 2 green fair 50 2 green dark 23 2 brown medium 53 1 blue red 7 1 green fair 19 1 green dark 14 1 brown medium 41 2 blue fair 46 2 blue dark 40 2 green red 31 2 brown fair 56 2 brown dark 54 1 blue medium 24 1 green red 7 1 brown fair 34 1 brown dark 40 2 blue red 21 2 blue black 6 2 green medium 37 2 brown red 42 2 brown black 13 ') </pre>
<p>** Above input data will be used for all frequency comparisons unless data is provided in the script itself.</p>	

proc_freq-001

SAS Code and Output

```
proc freq data=Color;
  tables Eyes Hair Eyes*Hair / out=FreqCount outexpect sparse;
  weight Count;
  title 'Eye and Hair Color of European Children';
run;
```

Eye and Hair Color of European Children

The FREQ Procedure

Eye Color				
Eyes	Frequency	Percent	Cumulative Frequency	Cumulative Percent
blue	222	29.13	222	29.13
brown	341	44.75	563	73.88
green	199	26.12	762	100.00

Hair Color				
Hair	Frequency	Percent	Cumulative Frequency	Cumulative Percent
black	22	2.89	22	2.89
dark	182	23.88	204	26.77
fair	228	29.92	432	56.69
medium	217	28.48	649	85.17
red	113	14.83	762	100.00

Frequency
Percent
Row Pct
Col Pct

Table of Eyes by Hair						
Eyes(Eye Color)	Hair(Hair Color)					Total
	black	dark	fair	medium	red	
blue	6	51	69	68	28	222
	0.79	6.69	9.06	8.92	3.67	29.13
	2.70	22.97	31.08	30.63	12.61	
	27.27	28.02	30.26	31.34	24.78	
brown	16	94	90	94	47	341
	2.10	12.34	11.81	12.34	6.17	44.75
	4.69	27.57	26.39	27.57	13.78	
	72.73	51.65	39.47	43.32	41.59	
green	0	37	69	55	38	199
	0.00	4.86	9.06	7.22	4.99	26.12
	0.00	18.59	34.67	27.64	19.10	
	0.00	20.33	30.26	25.35	33.63	
Total	22	182	228	217	113	762
	2.89	23.88	29.92	28.48	14.83	100.00

R Code and Output

```
library(procs)

proc_freq(dat, tables = v(Eyes, Hair, Eyes * Hair), weight = Count,
          title = "Eye and Hair Color of European Children")
```

Eye and Hair Color of European Children

Table of Eyes					
Eyes	N	Frequency	Percent	Cumulative Frequency	Cumulative Percent
blue	762	222	29.13	222	29.13
brown	762	341	44.75	563	73.88
green	762	199	26.12	762	100.00

Table of Hair					
Hair	N	Frequency	Percent	Cumulative Frequency	Cumulative Percent
black	762	22	2.89	22	2.89
dark	762	182	23.88	204	26.77
fair	762	228	29.92	432	56.69
medium	762	217	28.48	649	85.17
red	762	113	14.83	762	100.00

Table of Eyes by Hair							
Eyes	Statistic	Hair					Total
		black	dark	fair	medium	red	
blue	Frequency	6	51	69	68	28	222
	Percent	0.79	6.69	9.06	8.92	3.67	29.13
	Row Pct	2.70	22.97	31.08	30.63	12.61	
	Col Pct	27.27	28.02	30.26	31.34	24.78	
brown	Frequency	16	94	90	94	47	341
	Percent	2.10	12.34	11.81	12.34	6.17	44.75
	Row Pct	4.69	27.57	26.39	27.57	13.78	
	Col Pct	72.73	51.65	39.47	43.32	41.59	
green	Frequency	0	37	69	55	38	199
	Percent	0.00	4.86	9.06	7.22	4.99	26.12
	Row Pct	0.00	18.59	34.67	27.64	19.10	
	Col Pct	0.00	20.33	30.26	25.35	33.63	
Total	Frequency	22	182	228	217	113	762
	Percent	2.89	23.88	29.92	28.48	14.83	100.00

Comparison

Compare basic one and two way frequencies with weight option.

Results

Pass

proc_freq-002

SAS Code and Output

```
proc freq data=Color nlevels;
  tables Eyes Hair Eyes*Hair / out=FreqCount outexpect sparse;
  title 'Eye and Hair Color of European Children';
run;
```

Eye and Hair Color of European Children
The FREQ Procedure

Number of Variable Levels		
Variable	Label	Levels
Eyes	Eye Color	3
Hair	Hair Color	5

Eye Color				
Eyes	Frequency	Percent	Cumulative Frequency	Cumulative Percent
blue	9	33.33	9	33.33
brown	10	37.04	19	70.37
green	8	29.63	27	100.00

Hair Color				
Hair	Frequency	Percent	Cumulative Frequency	Cumulative Percent
black	3	11.11	3	11.11
dark	6	22.22	9	33.33
fair	6	22.22	15	55.56
medium	6	22.22	21	77.78
red	6	22.22	27	100.00

Eyes(Eye Color)	Hair(Hair Color)					Total
	black	dark	fair	medium	red	
blue	1 3.70 11.11 33.33	2 7.41 22.22 33.33	2 7.41 22.22 33.33	2 7.41 22.22 33.33	2 7.41 22.22 33.33	9 33.33
brown	2 7.41 20.00 66.67	2 7.41 20.00 33.33	2 7.41 20.00 33.33	2 7.41 20.00 33.33	2 7.41 20.00 33.33	10 37.04
green	0 0.00 0.00 0.00	2 7.41 25.00 33.33	2 7.41 25.00 33.33	2 7.41 25.00 33.33	2 7.41 25.00 33.33	8 29.63
Total	3 11.11	6 22.22	6 22.22	6 22.22	6 22.22	27 100.00

R Code and Output

```
proc_freq(dat, tables = v(Eyes, Hair, Eyes * Hair),
  title = "Eye and Hair Color of European Children",
  options = v(nlevels))
```

**Eye and Hair Color
of European
Children**

Variable	Levels
Eyes	3

Table of Eyes					
Eyes	N	Frequency	Percent	Cumulative Frequency	Cumulative Percent
blue	27	9	33.33	9	33.33
brown	27	10	37.04	19	70.37
green	27	8	29.63	27	100.00

Variable	Levels
Hair	5

Table of Hair					
Hair	N	Frequency	Percent	Cumulative Frequency	Cumulative Percent
black	27	3	11.11	3	11.11
dark	27	6	22.22	9	33.33
fair	27	6	22.22	15	55.56
medium	27	6	22.22	21	77.78
red	27	6	22.22	27	100.00

Variable	Levels
Eyes	3
Hair	5

Table of Eyes by Hair							
Eyes	Statistic	Hair					Total
		black	dark	fair	medium	red	
blue	Frequency	1	2	2	2	2	9
	Percent	3.70	7.41	7.41	7.41	7.41	33.33
	Row Pct	11.11	22.22	22.22	22.22	22.22	
	Col Pct	33.33	33.33	33.33	33.33	33.33	
brown	Frequency	2	2	2	2	2	10
	Percent	7.41	7.41	7.41	7.41	7.41	37.04
	Row Pct	20.00	20.00	20.00	20.00	20.00	
	Col Pct	66.67	33.33	33.33	33.33	33.33	
green	Frequency	0	2	2	2	2	8
	Percent	0.00	7.41	7.41	7.41	7.41	29.63
	Row Pct	0.00	25.00	25.00	25.00	25.00	
	Col Pct	0.00	33.33	33.33	33.33	33.33	
Total	Frequency	3	6	6	6	6	27
	Percent	11.11	22.22	22.22	22.22	22.22	100.00

Comparison

Compare basic frequencies with no weight and nlevels option.

Result

Pass

proc_freq-003

SAS Code and Output																																							
<pre>data SummerSchool; input Gender \$ Internship \$ Enrollment \$ Count @@; datalines; boys yes yes 35 boys no no 27 boys no yes 14 girls yes no 10 girls yes yes 32 girls no no 23 girls no yes 53 girls . no 25 boys yes . 29 girls . no 29 ; proc freq data=SummerSchool order=data nlevels; tables Internship / out = Fork missing; options missing=. mi; run;</pre>	<p style="text-align: center;">The FREQ Procedure</p> <table border="1" style="margin: 10px auto;"> <thead> <tr> <th colspan="4">Number of Variable Levels</th> </tr> <tr> <th>Variable</th> <th>Levels</th> <th>Missing Levels</th> <th>Nonmissing Levels</th> </tr> </thead> <tbody> <tr> <td>Internship</td> <td>3</td> <td>1</td> <td>2</td> </tr> </tbody> </table> <table border="1" style="margin: 10px auto;"> <thead> <tr> <th>Internship</th> <th>Frequency</th> <th>Percent</th> <th>Cumulative Frequency</th> <th>Cumulative Percent</th> </tr> </thead> <tbody> <tr> <td>.</td> <td>2</td> <td>20.00</td> <td>2</td> <td>20.00</td> </tr> <tr> <td>yes</td> <td>4</td> <td>40.00</td> <td>6</td> <td>60.00</td> </tr> <tr> <td>no</td> <td>4</td> <td>40.00</td> <td>10</td> <td>100.00</td> </tr> </tbody> </table>	Number of Variable Levels				Variable	Levels	Missing Levels	Nonmissing Levels	Internship	3	1	2	Internship	Frequency	Percent	Cumulative Frequency	Cumulative Percent	.	2	20.00	2	20.00	yes	4	40.00	6	60.00	no	4	40.00	10	100.00						
Number of Variable Levels																																							
Variable	Levels	Missing Levels	Nonmissing Levels																																				
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yes	4	40.00	6	60.00																																			
no	4	40.00	10	100.00																																			
R Code and Output																																							
<pre>prtm <- read.table(header = TRUE, text = ' sex internship enrollment count 1 boys yes yes 35 2 boys no yes 14 3 girls yes yes 32 4 girls no yes 53 5 boys yes NA 29 6 boys no no 27 7 girls yes no 10 8 girls no no 23 9 girls NA yes 25 10 girls NA no 29') res <- proc_freq(prtm, tables = v(internship), options = v(nlevels, missing))</pre>	<table border="1" style="margin: 10px auto;"> <thead> <tr> <th>Variable</th> <th>Levels</th> <th>Missing Levels</th> <th>Nonmissing Levels</th> </tr> </thead> <tbody> <tr> <td>internship</td> <td>3</td> <td>1</td> <td>2</td> </tr> </tbody> </table> <table border="1" style="margin: 10px auto;"> <thead> <tr> <th colspan="6">Table of internship</th> </tr> <tr> <th>internship</th> <th>N</th> <th>Frequency</th> <th>Percent</th> <th>Cumulative Frequency</th> <th>Cumulative Percent</th> </tr> </thead> <tbody> <tr> <td>.</td> <td>10</td> <td>2</td> <td>20.00</td> <td>2</td> <td>20.00</td> </tr> <tr> <td>no</td> <td>10</td> <td>4</td> <td>40.00</td> <td>6</td> <td>60.00</td> </tr> <tr> <td>yes</td> <td>10</td> <td>4</td> <td>40.00</td> <td>10</td> <td>100.00</td> </tr> </tbody> </table>	Variable	Levels	Missing Levels	Nonmissing Levels	internship	3	1	2	Table of internship						internship	N	Frequency	Percent	Cumulative Frequency	Cumulative Percent	.	10	2	20.00	2	20.00	no	10	4	40.00	6	60.00	yes	10	4	40.00	10	100.00
Variable	Levels	Missing Levels	Nonmissing Levels																																				
internship	3	1	2																																				
Table of internship																																							
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.	10	2	20.00	2	20.00																																		
no	10	4	40.00	6	60.00																																		
yes	10	4	40.00	10	100.00																																		
Comparison	Result																																						
Compare basic frequencies with nlevels and missing options.	Pass																																						

proc_freq-004

SAS Code and Output

```

data SummerSchool;
  input Gender $ Internship $ Enrollment $ Count
  @@;
  datalines;
boys yes yes 35 boys yes no 29
boys no yes 14 boys no no 27
girls yes yes 32 girls yes no 10
girls no yes 53 girls no no 23
;

proc freq data=SummerSchool order=data;
  tables Internship * Enrollment / out = Fork chisq;
  by Gender;
  weight Count;
run;
  
```

The FREQ Procedure

Gender=boys

Frequency
Percent
Row Pct
Col Pct

Table of Internship by Enrollment			
Internship	Enrollment		Total
	yes	no	
yes	35 33.33 54.69 71.43	29 27.62 45.31 51.79	64 60.95
no	14 13.33 34.15 28.57	27 25.71 65.85 48.21	41 39.05
Total	49 46.67	56 53.33	105 100.00

Statistics for Table of Internship by Enrollment

Statistic	DF	Value	Prob
Chi-Square	1	4.2366	0.0396
Likelihood Ratio Chi-Square	1	4.2903	0.0383
Continuity Adj. Chi-Square	1	3.4515	0.0632
Mantel-Haenszel Chi-Square	1	4.1983	0.0405
Phi Coefficient		0.2009	
Contingency Coefficient		0.1969	
Cramer's V		0.2009	

Fisher's Exact Test

Cell (1,1) Frequency (F)	35
Left-sided Pr <= F	0.9885
Right-sided Pr >= F	0.0311
Table Probability (P)	0.0196
Two-sided Pr <= P	0.0467

Sample Size = 105

The FREQ Procedure

Gender=girls

Frequency
Percent
Row Pct
Col Pct

Table of Internship by Enrollment			
Internship	Enrollment		Total
	yes	no	
yes	32 27.12 78.19 37.65	10 8.47 23.81 30.30	42 35.59
no	53 44.92 69.74 62.35	23 19.49 30.26 69.70	76 64.41
Total	85 72.03	33 27.97	118 100.00

Statistics for Table of Internship by Enrollment

Statistic	DF	Value	Prob
Chi-Square	1	0.5593	0.4546
Likelihood Ratio Chi-Square	1	0.5681	0.4510
Continuity Adj. Chi-Square	1	0.2848	0.5936
Mantel-Haenszel Chi-Square	1	0.5545	0.4565
Phi Coefficient		0.0688	
Contingency Coefficient		0.0687	
Cramer's V		0.0688	

Fisher's Exact Test

Cell (1,1) Frequency (F)	32
Left-sided Pr <= F	0.8317
Right-sided Pr >= F	0.2994
Table Probability (P)	0.1311
Two-sided Pr <= P	0.5245

Sample Size = 118

R Code and Output

```
prt <- read.table(header = TRUE, text = '
sex internship enrollment count
1 boys yes yes 35
2 boys no yes 14
3 girls yes yes 32
4 girls no yes 53
5 boys yes no 29
6 boys no no 27
7 girls yes no 10
8 girls no no 23')

prt$enrollment <- factor(prt$enrollment, c("yes",
"no"))
prt$internship <- factor(prt$internship, c("yes", "no"))

proc_freq(prt, tables = "internship * enrollment",
options = ChiSq,
by = "sex",
weight = "count")
```

sex=boys, Table of internship by enrollment				
		enrollment		
internship	Statistic	yes	no	Total
yes	Frequency	35	29	64
	Percent	33.33	27.62	60.95
	Row Pct	54.69	45.31	
no	Frequency	14	27	41
	Percent	13.33	25.71	39.05
	Row Pct	34.15	65.85	
Total	Frequency	49	56	105
	Percent	46.67	53.33	100.00

sex=boys, Chi-Square Test	
Measure	Value
Chi-Square	4.2366
DF	1
PR>ChiSq	0.0396

sex=girls, Table of internship by enrollment				
		enrollment		
internship	Statistic	yes	no	Total
yes	Frequency	32	10	42
	Percent	27.12	8.47	35.59
	Row Pct	76.19	23.81	
no	Frequency	53	23	76
	Percent	44.92	19.49	64.41
	Row Pct	69.74	30.26	
Total	Frequency	85	33	118
	Percent	72.03	27.97	100.00

sex=girls, Chi-Square Test	
Measure	Value
Chi-Square	0.5593
DF	1
PR>ChiSq	0.4546

Comparison

Compare two way with chisquare statistic.

Result

Pass.

proc_freq-005

SAS Code and Output

```

data SummerSchool;
  input Gender $ Internship $ Enrollment $ Count
  @@;
  datalines;
boys yes yes 35 boys yes no 29
boys no yes 14 boys no no 27
girls yes yes 32 girls yes no 10
girls no yes 53 girls no no 23
;

proc freq data=SummerSchool order=data;
  tables Internship * Enrollment / out = Fork chisq;
  by Gender;
  weight Count;
run;
  
```

The FREQ Procedure

Gender=boys

Frequency
Percent
Row Pct
Col Pct

Table of Internship by Enrollment			
Internship	Enrollment		Total
	yes	no	
yes	35	29	64
	33.33	27.62	60.95
	54.69	45.31	
	71.43	51.79	
no	14	27	41
	13.33	25.71	39.05
	34.15	65.85	
	28.57	48.21	
Total	49	56	105
	46.67	53.33	100.00

Statistics for Table of Internship by Enrollment

Statistic	DF	Value	Prob
Chi-Square	1	4.2366	0.0396
Likelihood Ratio Chi-Square	1	4.2903	0.0383
Continuity Adj. Chi-Square	1	3.4515	0.0632
Mantel-Haenszel Chi-Square	1	4.1983	0.0405
Phi Coefficient		0.2009	
Contingency Coefficient		0.1969	
Cramer's V		0.2009	

Fisher's Exact Test

Cell (1,1) Frequency (F)	35
Left-sided Pr <= F	0.9885
Right-sided Pr >= F	0.0311
Table Probability (P)	0.0196
Two-sided Pr <= P	0.0467

Sample Size = 105

The FREQ Procedure

Gender=girls

Frequency
Percent
Row Pct
Col Pct

Table of Internship by Enrollment			
Internship	Enrollment		Total
	yes	no	
yes	32	10	42
	27.12	8.47	35.59
	78.19	23.81	
	37.65	30.30	
no	53	23	76
	44.92	19.49	64.41
	69.74	30.26	
	62.35	69.70	
Total	85	33	118
	72.03	27.97	100.00

Statistics for Table of Internship by Enrollment

Statistic	DF	Value	Prob
Chi-Square	1	0.5593	0.4546
Likelihood Ratio Chi-Square	1	0.5681	0.4510
Continuity Adj. Chi-Square	1	0.2848	0.5936
Mantel-Haenszel Chi-Square	1	0.5545	0.4565
Phi Coefficient		0.0688	
Contingency Coefficient		0.0687	
Cramer's V		0.0688	

Fisher's Exact Test

Cell (1,1) Frequency (F)	32
Left-sided Pr <= F	0.8317
Right-sided Pr >= F	0.2994
Table Probability (P)	0.1311
Two-sided Pr <= P	0.5245

Sample Size = 118

R Code and Output

```
prt <- read.table(header = TRUE, text = '
sex internship enrollment count
1 boys yes yes 35
2 boys no yes 14
3 girls yes yes 32
4 girls no yes 53
5 boys yes no 29
6 boys no no 27
7 girls yes no 10
8 girls no no 23')

prt$enrollment <- factor(prt$enrollment, c("yes",
"no"))
prt$internship <- factor(prt$internship, c("yes", "no"))

proc_freq(prt, tables = "internship * enrollment",
options = Fisher,
by = "sex",
weight = "count")
```

internship	Statistic	enrollment		Total
		yes	no	
yes	Frequency	35	29	64
	Percent	33.33	27.62	60.95
	Row Pct	54.69	45.31	
	Col Pct	71.43	51.79	
no	Frequency	14	27	41
	Percent	13.33	25.71	39.05
	Row Pct	34.15	65.85	
	Col Pct	28.57	48.21	
Total	Frequency	49	56	105
	Percent	46.67	53.33	100.00

Measure	Value
Cell1.1	35.0000
Left.Sided	0.9885
Right.Sided	0.0311
Two.Sided	0.0467

internship	Statistic	enrollment		Total
		yes	no	
yes	Frequency	32	10	42
	Percent	27.12	8.47	35.59
	Row Pct	76.19	23.81	
	Col Pct	37.65	30.30	
no	Frequency	53	23	76
	Percent	44.92	19.49	64.41
	Row Pct	69.74	30.26	
	Col Pct	62.35	69.70	
Total	Frequency	85	33	118
	Percent	72.03	27.97	100.00

Measure	Value
Cell1.1	32.0000
Left.Sided	0.8317
Right.Sided	0.2994
Two.Sided	0.5245

Comparison

Compare two way with Fisher's Exact statistic.

Result

Pass.

Means Data

SAS	R
<pre> data cake; input LastName \$ 1-12 Age 13-14 PresentScore 16-17 TasteScore 19-20 Flavor \$ 23-32 Layers 34 ; datalines; Orlando 27 93 80 Vanilla 1 Ramey 32 84 72 Rum 2 Goldston 46 68 75 Vanilla 1 Roe 38 79 73 Vanilla 2 Larsen 23 77 84 Chocolate 3 Davis 51 86 91 Spice 3 Strickland 19 82 79 Chocolate 1 Nguyen 57 77 84 Vanilla 3 Hildenbrand 33 81 83 Chocolate 1 Byron 62 72 87 Vanilla 2 Sanders 26 56 79 Chocolate 1 Jaeger 43 66 74 1 Davis 28 69 75 Chocolate 2 Conrad 69 85 94 Vanilla 1 Walters 55 67 72 Chocolate 2 Rossburger 28 78 81 Spice 2 Matthew 42 81 92 Chocolate 2 Becker 36 62 83 Spice 2 Anderson 27 87 85 Chocolate 1 Merritt 62 73 84 Chocolate 1 ; </pre>	<pre> datm <- read.table(header = TRUE, text = ' LastName Age PresentScore TasteScore Flavor Layers Orlando 27 93 80 Vanilla 1 Ramey 32 84 72 Rum 2 Goldston 46 68 75 Vanilla 1 Roe 38 79 73 Vanilla 2 Larsen 23 77 84 Chocolate 3 Davis 51 86 91 Spice 3 Strickland 19 82 79 Chocolate 1 Nguyen 57 77 84 Vanilla 3 Hildenbrand 33 81 83 Chocolate 1 Byron 62 72 87 Vanilla 2 Sanders 26 56 79 Chocolate 1 Jaeger 43 66 74 NA 1 Davis 28 69 75 Chocolate 2 Conrad 69 85 94 Vanilla 1 Walters 55 67 72 Chocolate 2 Rossburger 28 78 81 Spice 2 Matthew 42 81 92 Chocolate 2 Becker 36 62 83 Spice 2 Anderson 27 87 85 Chocolate 1 Merritt 62 73 84 Chocolate 1 ') </pre>
<p>** Above input data will be used for all means comparisons unless data is provided in the script itself.</p>	

proc_means-001

SAS Code and Output																																				
<pre>proc means data=cake n mean median stddev min max maxdec=4; var Age PresentScore TasteScore layers; title 'Summary of Presentation and Taste Scores'; output out=outdata; run;</pre>	<div style="text-align: center;"> <p>Summary of Presentation and Taste Scores</p> <p>The MEANS Procedure</p> <table border="1"> <thead> <tr> <th>Variable</th> <th>N</th> <th>Mean</th> <th>Median</th> <th>Std Dev</th> <th>Minimum</th> <th>Maximum</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>20</td> <td>40.2000</td> <td>37.0000</td> <td>14.8274</td> <td>19.0000</td> <td>69.0000</td> </tr> <tr> <td>PresentScore</td> <td>20</td> <td>76.1500</td> <td>77.5000</td> <td>9.3768</td> <td>56.0000</td> <td>93.0000</td> </tr> <tr> <td>TasteScore</td> <td>20</td> <td>81.3500</td> <td>82.0000</td> <td>6.6116</td> <td>72.0000</td> <td>94.0000</td> </tr> <tr> <td>Layers</td> <td>20</td> <td>1.7000</td> <td>2.0000</td> <td>0.7327</td> <td>1.0000</td> <td>3.0000</td> </tr> </tbody> </table> </div>	Variable	N	Mean	Median	Std Dev	Minimum	Maximum	Age	20	40.2000	37.0000	14.8274	19.0000	69.0000	PresentScore	20	76.1500	77.5000	9.3768	56.0000	93.0000	TasteScore	20	81.3500	82.0000	6.6116	72.0000	94.0000	Layers	20	1.7000	2.0000	0.7327	1.0000	3.0000
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Simple Proc means on multiple variables.	Pass																																			

proc_means-002

<p>SAS Code and Output</p> <pre>proc means data=cake nmiss median mode lclm uclm stderr maxdec=4; var Age PresentScore TasteScore layers; title 'Summary of Presentation and Taste Scores'; output out=outdata; run;</pre>	<p style="text-align: center;">Summary of Presentation and Taste Scores</p> <p style="text-align: center;">The MEANS Procedure</p> <table border="1"> <thead> <tr> <th>Variable</th> <th>N Miss</th> <th>Median</th> <th>Mode</th> <th>Lower 95% CL for Mean</th> <th>Upper 95% CL for Mean</th> <th>Std Error</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>0</td> <td>37.0000</td> <td>27.0000</td> <td>33.2605</td> <td>47.1395</td> <td>3.3155</td> </tr> <tr> <td>PresentScore</td> <td>0</td> <td>77.5000</td> <td>77.0000</td> <td>71.7615</td> <td>80.5385</td> <td>2.0967</td> </tr> <tr> <td>TasteScore</td> <td>0</td> <td>82.0000</td> <td>84.0000</td> <td>78.2557</td> <td>84.4443</td> <td>1.4784</td> </tr> <tr> <td>Layers</td> <td>0</td> <td>2.0000</td> <td>1.0000</td> <td>1.3571</td> <td>2.0429</td> <td>0.1638</td> </tr> </tbody> </table>	Variable	N Miss	Median	Mode	Lower 95% CL for Mean	Upper 95% CL for Mean	Std Error	Age	0	37.0000	27.0000	33.2605	47.1395	3.3155	PresentScore	0	77.5000	77.0000	71.7615	80.5385	2.0967	TasteScore	0	82.0000	84.0000	78.2557	84.4443	1.4784	Layers	0	2.0000	1.0000	1.3571	2.0429	0.1638
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<p>Comparison</p>	<p>Result</p>																																			
<p>Comparison of more statistics options.</p>	<p>Pass</p>																																			

proc_means-003

```
SAS Code and Output  
proc sort data=cake out=cake2;  
by Layers;  
run;  
  
proc means data=cake2 n mean median stddev min max maxdec=4;  
var Age PresentScore TasteScore;  
title 'Summary of Presentation and Taste Scores';  
by Layers;  
output out=outdata;  
run;
```

R Code and Output

Summary of Presentation and Taste Scores
The MEANS Procedure

Layers=1

Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Age	9	39.1111	33.0000	17.2731	19.0000	69.0000
PresentScore	9	76.7778	81.0000	11.8298	56.0000	93.0000
TasteScore	9	81.4444	80.0000	6.0231	74.0000	94.0000

Layers=2

Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Age	8	40.1250	37.0000	12.4492	28.0000	62.0000
PresentScore	8	74.0000	75.0000	7.6718	62.0000	84.0000
TasteScore	8	79.3750	78.0000	7.5770	72.0000	92.0000

Layers=3

Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Age	3	43.6667	51.0000	18.1475	23.0000	57.0000
PresentScore	3	80.0000	77.0000	5.1962	77.0000	86.0000
TasteScore	3	86.3333	84.0000	4.0415	84.0000	91.0000

```
proc_means(datm, var = v(Age, PresentScore, TasteScore),
  stats = c("n", "mean", "median", "std", "min", "max"),
  by = "Layers",
  options = v(maxdec = 4),
  titles = "Summary of Presentation and Taste Scores")
```

Summary of Presentation and Taste Scores

Layers=1						
Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Age	9	39.1111	33	17.2731	19	69
PresentScore	9	76.7778	81	11.8298	56	93
TasteScore	9	81.4444	80	6.0231	74	94

Layers=2						
Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Age	8	40.1250	37.0000	12.4492	28	62
PresentScore	8	74.0000	75.0000	7.6718	62	84
TasteScore	8	79.3750	78.0000	7.5770	72	92

Layers=3						
Variable	N	Mean	Median	Std Dev	Minimum	Maximum
Age	3	43.6667	51	18.1475	23	57
PresentScore	3	80.0000	77	5.1962	77	86
TasteScore	3	86.3333	84	4.0415	84	91

Comparison

Comparison of by variable.

Result

Pass

proc_means-004

SAS Code and Output																																																																																	
<pre>proc sort data=cake out=cake2; by Layers; run; proc means data=cake2 n mean median stddev min max maxdec=4; var Age PresentScore TasteScore; title 'Summary of Presentation and Taste Scores'; class Layers; output out=outdata; run;</pre>	<p style="text-align: center;">Summary of Presentation and Taste Scores</p> <p style="text-align: center;">The MEANS Procedure</p> <table border="1"> <thead> <tr> <th>Layers</th> <th>N Obs</th> <th>Variable</th> <th>N</th> <th>Mean</th> <th>Median</th> <th>Std Dev</th> <th>Minimum</th> <th>Maximum</th> </tr> </thead> <tbody> <tr> <td rowspan="3">1</td> <td rowspan="3">9</td> <td>Age</td> <td>9</td> <td>39.1111</td> <td>33.0000</td> <td>17.2731</td> <td>19.0000</td> <td>69.0000</td> </tr> <tr> <td>PresentScore</td> <td>9</td> <td>76.7778</td> <td>81.0000</td> <td>11.8298</td> <td>56.0000</td> <td>93.0000</td> </tr> <tr> <td>TasteScore</td> <td>9</td> <td>81.4444</td> <td>80.0000</td> <td>6.0231</td> <td>74.0000</td> <td>94.0000</td> </tr> <tr> <td rowspan="3">2</td> <td rowspan="3">8</td> <td>Age</td> <td>8</td> <td>40.1250</td> <td>37.0000</td> <td>12.4492</td> <td>28.0000</td> <td>62.0000</td> </tr> <tr> <td>PresentScore</td> <td>8</td> <td>74.0000</td> <td>75.0000</td> <td>7.6718</td> <td>62.0000</td> <td>84.0000</td> </tr> <tr> <td>TasteScore</td> <td>8</td> <td>79.3750</td> <td>78.0000</td> <td>7.5770</td> <td>72.0000</td> <td>92.0000</td> </tr> <tr> <td rowspan="3">3</td> <td rowspan="3">3</td> <td>Age</td> <td>3</td> <td>43.6667</td> <td>51.0000</td> <td>18.1475</td> <td>23.0000</td> <td>57.0000</td> </tr> <tr> <td>PresentScore</td> <td>3</td> <td>80.0000</td> <td>77.0000</td> <td>5.1962</td> <td>77.0000</td> <td>86.0000</td> </tr> <tr> <td>TasteScore</td> <td>3</td> <td>86.3333</td> <td>84.0000</td> <td>4.0415</td> <td>84.0000</td> <td>91.0000</td> </tr> </tbody> </table>	Layers	N Obs	Variable	N	Mean	Median	Std Dev	Minimum	Maximum	1	9	Age	9	39.1111	33.0000	17.2731	19.0000	69.0000	PresentScore	9	76.7778	81.0000	11.8298	56.0000	93.0000	TasteScore	9	81.4444	80.0000	6.0231	74.0000	94.0000	2	8	Age	8	40.1250	37.0000	12.4492	28.0000	62.0000	PresentScore	8	74.0000	75.0000	7.6718	62.0000	84.0000	TasteScore	8	79.3750	78.0000	7.5770	72.0000	92.0000	3	3	Age	3	43.6667	51.0000	18.1475	23.0000	57.0000	PresentScore	3	80.0000	77.0000	5.1962	77.0000	86.0000	TasteScore	3	86.3333	84.0000	4.0415	84.0000	91.0000		
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proc_means-005

SAS Code and Output																												
<pre> data cake2; set cake; if (_n_ = 5) then do; PresentScore = .; end; run; proc means data=cake2 n nmiss mean median lclm uclm stddev maxdec=4; var PresentScore TasteScore; title 'Summary of Presentation and Taste Scores'; output out=outdata; run; </pre>	<div style="text-align: center;"> <p>Summary of Presentation and Taste Scores</p> <p>The MEANS Procedure</p> </div> <table border="1"> <thead> <tr> <th>Variable</th> <th>N</th> <th>N Miss</th> <th>Mean</th> <th>Median</th> <th>Lower 95% CL for Mean</th> <th>Upper 95% CL for Mean</th> <th>Std Dev</th> </tr> </thead> <tbody> <tr> <td>PresentScore</td> <td>19</td> <td>1</td> <td>76.1053</td> <td>78.0000</td> <td>71.4630</td> <td>80.7475</td> <td>9.6315</td> </tr> <tr> <td>TasteScore</td> <td>20</td> <td>0</td> <td>81.3500</td> <td>82.0000</td> <td>78.2557</td> <td>84.4443</td> <td>6.6116</td> </tr> </tbody> </table>	Variable	N	N Miss	Mean	Median	Lower 95% CL for Mean	Upper 95% CL for Mean	Std Dev	PresentScore	19	1	76.1053	78.0000	71.4630	80.7475	9.6315	TasteScore	20	0	81.3500	82.0000	78.2557	84.4443	6.6116			
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<pre> datm2 <- datm datm2[5, "PresentScore"] <- NA proc_means(datm2, var = c("PresentScore", "TasteScore"), stats = c("n", "nmiss", "mean", "median", "mode", "clm", "std"), titles = "My first title for Means", options = v(notype, nonobs, maxdec=4)) </pre>	<div style="text-align: center;"> <p>My first title for Means</p> </div> <table border="1"> <thead> <tr> <th>Variable</th> <th>N</th> <th>NMiss</th> <th>Mean</th> <th>Median</th> <th>Mode</th> <th>Lower Conf. Limit</th> <th>Upper Conf. Limit</th> <th>Std Dev</th> </tr> </thead> <tbody> <tr> <td>PresentScore</td> <td>19</td> <td>1</td> <td>76.1053</td> <td>78.0000</td> <td>81</td> <td>71.4630</td> <td>80.7475</td> <td>9.6315</td> </tr> <tr> <td>TasteScore</td> <td>20</td> <td>0</td> <td>81.3500</td> <td>82.0000</td> <td>84</td> <td>78.2557</td> <td>84.4443</td> <td>6.6116</td> </tr> </tbody> </table>	Variable	N	NMiss	Mean	Median	Mode	Lower Conf. Limit	Upper Conf. Limit	Std Dev	PresentScore	19	1	76.1053	78.0000	81	71.4630	80.7475	9.6315	TasteScore	20	0	81.3500	82.0000	84	78.2557	84.4443	6.6116
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proc_means-006

SAS Code and Output																															
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proc_means-007

SAS Code and Output																																														
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proc_means-008

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proc_means-009

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proc_means-010

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<pre>proc_means(dtm, var = v(PresentScore, TasteScore), stats = v(mean, clm), options = v(alpha = 0.1, maxdec=4), titles = "Summary of Presentation and Taste Scores")</pre>	<p>Summary of Presentation and Taste Scores</p> <table border="1"> <thead> <tr> <th>Variable</th> <th>Mean</th> <th>Lower 90% CL for Mean</th> <th>Upper 90% CL for Mean</th> </tr> </thead> <tbody> <tr> <td>PresentScore</td> <td>76.1500</td> <td>72.5245</td> <td>79.7755</td> </tr> <tr> <td>TasteScore</td> <td>81.3500</td> <td>78.7937</td> <td>83.9063</td> </tr> </tbody> </table>	Variable	Mean	Lower 90% CL for Mean	Upper 90% CL for Mean	PresentScore	76.1500	72.5245	79.7755	TasteScore	81.3500	78.7937	83.9063
Variable	Mean	Lower 90% CL for Mean	Upper 90% CL for Mean										
PresentScore	76.1500	72.5245	79.7755										
TasteScore	81.3500	78.7937	83.9063										
<p>Comparison</p>	<p>Result</p>												
<p>Comparison of 90% confidence limit with alpha option.</p>	<p>Pass</p>												

proc_means-011

SAS Code and Output													
<pre>DATA WEIGHT; INPUT WBEFORE WAFTER; * Calculate WLOSS in the DATA step *; WLOSS=WAFTER-WBEFORE; DATALINES; 200 190 175 154 188 176 198 193 197 198 310 240 245 204 202 178 ; run; PROC MEANS N MEAN T PRT; VAR WLOSS; TITLE 'Paired t-test example using PROC MEANS'; RUN;</pre>	<p style="text-align: center;">Paired t-test example using PROC MEANS</p> <p style="text-align: center;">The MEANS Procedure</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="4">Analysis Variable : WLOSS</th> </tr> <tr> <th>N</th> <th>Mean</th> <th>t Value</th> <th>Pr > t </th> </tr> </thead> <tbody> <tr> <td>8</td> <td>-22.7500000</td> <td>-2.79</td> <td>0.0270</td> </tr> </tbody> </table>	Analysis Variable : WLOSS				N	Mean	t Value	Pr > t	8	-22.7500000	-2.79	0.0270
Analysis Variable : WLOSS													
N	Mean	t Value	Pr > t										
8	-22.7500000	-2.79	0.0270										
R Code and Output													
<pre>datp <- read.table(header = TRUE, text = ' WBEFORE WAFTER 200 190 175 154 188 176 198 193 197 198 310 240 245 204 202 178') datp\$WLOSS <- datp\$WAFTER - datp\$WBEFORE res <- proc_means(datp, var = WLOSS, stats = v(n, mean, t, prt), titles = c("Paired t-test example"))</pre>	<p style="text-align: center;">Paired t-test example</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Variable</th> <th>N</th> <th>Mean</th> <th>t Value</th> <th>Pr > t </th> </tr> </thead> <tbody> <tr> <td>WLOSS</td> <td>8</td> <td>-22.7500000</td> <td>-2.7884739</td> <td>0.0269675</td> </tr> </tbody> </table>	Variable	N	Mean	t Value	Pr > t	WLOSS	8	-22.7500000	-2.7884739	0.0269675		
Variable	N	Mean	t Value	Pr > t									
WLOSS	8	-22.7500000	-2.7884739	0.0269675									
Comparison	Result												
Comparison of hypothesis tests.	Pass												

proc_means-012

SAS Code and Output																					
<pre>proc means data=cake n mean uss; var Age PresentScore TasteScore Layers; title 'Summary of Presentation and Taste Scores'; output out=outdata; run;</pre>	<p style="text-align: center;">Summary of Presentation and Taste Scores</p> <p style="text-align: center;">The MEANS Procedure</p> <table border="1"> <thead> <tr> <th>Variable</th> <th>N</th> <th>Mean</th> <th>Uncorrected SS</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>20</td> <td>40.2000000</td> <td>36498.00</td> </tr> <tr> <td>PresentScore</td> <td>20</td> <td>76.1500000</td> <td>117647.00</td> </tr> <tr> <td>TasteScore</td> <td>20</td> <td>81.3500000</td> <td>133187.00</td> </tr> <tr> <td>Layers</td> <td>20</td> <td>1.7000000</td> <td>68.0000000</td> </tr> </tbody> </table>	Variable	N	Mean	Uncorrected SS	Age	20	40.2000000	36498.00	PresentScore	20	76.1500000	117647.00	TasteScore	20	81.3500000	133187.00	Layers	20	1.7000000	68.0000000
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<pre>proc_means(datm, var = v(Age, PresentScore, TasteScore, Layers), stats = v(n, mean, uss), titles = c("Test"))</pre>	<p style="text-align: center;">Test</p> <table border="1"> <thead> <tr> <th>Variable</th> <th>N</th> <th>Mean</th> <th>Uncorrected SS</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>20</td> <td>40.2000000</td> <td>36498.0000000</td> </tr> <tr> <td>PresentScore</td> <td>20</td> <td>76.1500000</td> <td>117647.0000000</td> </tr> <tr> <td>TasteScore</td> <td>20</td> <td>81.3500000</td> <td>133187.0000000</td> </tr> <tr> <td>Layers</td> <td>20</td> <td>1.7000000</td> <td>68.0000000</td> </tr> </tbody> </table>	Variable	N	Mean	Uncorrected SS	Age	20	40.2000000	36498.0000000	PresentScore	20	76.1500000	117647.0000000	TasteScore	20	81.3500000	133187.0000000	Layers	20	1.7000000	68.0000000
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Layers	20	1.7000000	68.0000000																		
Comparison	Result																				
Test USS statistics.	Pass																				

proc_means-013

SAS Code and Output																										
<pre>proc means data=cake n mean skewness kurtosis maxdec = 8; var Age PresentScore TasteScore Layers; title 'Summary of Presentation and Taste Scores'; output out=outdata; run;</pre>	<p style="text-align: center;">Summary of Presentation and Taste Scores</p> <p style="text-align: center;">The MEANS Procedure</p> <table border="1"> <thead> <tr> <th>Variable</th> <th>N</th> <th>Mean</th> <th>Skewness</th> <th>Kurtosis</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>20</td> <td>40.20000000</td> <td>0.49070401</td> <td>-0.96131045</td> </tr> <tr> <td>PresentScore</td> <td>20</td> <td>76.15000000</td> <td>-0.36762986</td> <td>-0.30448351</td> </tr> <tr> <td>TasteScore</td> <td>20</td> <td>81.35000000</td> <td>0.25698724</td> <td>-0.70821594</td> </tr> <tr> <td>Layers</td> <td>20</td> <td>1.70000000</td> <td>0.55306602</td> <td>-0.83361603</td> </tr> </tbody> </table>	Variable	N	Mean	Skewness	Kurtosis	Age	20	40.20000000	0.49070401	-0.96131045	PresentScore	20	76.15000000	-0.36762986	-0.30448351	TasteScore	20	81.35000000	0.25698724	-0.70821594	Layers	20	1.70000000	0.55306602	-0.83361603
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R Code and Output																										
<pre>proc_means(datm, var = v(Age, PresentScore, TasteScore, Layers), stats = v(n, mean, skew, kurt), titles = c("Test"), options = c(maxdec = 8))</pre>	<p style="text-align: center;">Test</p> <table border="1"> <thead> <tr> <th>Variable</th> <th>N</th> <th>Mean</th> <th>Skewness</th> <th>Kurtosis</th> </tr> </thead> <tbody> <tr> <td>Age</td> <td>20</td> <td>40.20000000</td> <td>0.49070401</td> <td>-0.96131045</td> </tr> <tr> <td>PresentScore</td> <td>20</td> <td>76.15000000</td> <td>-0.36762986</td> <td>-0.30448351</td> </tr> <tr> <td>TasteScore</td> <td>20</td> <td>81.35000000</td> <td>0.25698724</td> <td>-0.70821594</td> </tr> <tr> <td>Layers</td> <td>20</td> <td>1.70000000</td> <td>0.55306602</td> <td>-0.83361603</td> </tr> </tbody> </table>	Variable	N	Mean	Skewness	Kurtosis	Age	20	40.20000000	0.49070401	-0.96131045	PresentScore	20	76.15000000	-0.36762986	-0.30448351	TasteScore	20	81.35000000	0.25698724	-0.70821594	Layers	20	1.70000000	0.55306602	-0.83361603
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Comparison	Result																									
Test Skewness and Kurtosis	Pass																									

proc_means-014

SAS Data	R Data
<pre> data cake2; input LastName \$ 1-12 Age 13-14 PresentScore 16-17 TasteScore 19-20 Flavor \$ 23-32 Layers 34 Region 36; datalines; Orlando 27 93 80 Vanilla 1 1 Ramey 32 84 72 Rum 2 1 Goldston 46 68 75 Vanilla 1 1 Roe 38 79 73 Vanilla 2 1 Larsen 23 77 84 Chocolate 3 1 Davis 51 86 91 Spice 3 1 Strickland 19 82 79 Chocolate 1 1 Nguyen 57 77 84 Vanilla 3 1 Hildenbrand 33 81 83 Chocolate 1 1 Byron 62 72 87 Vanilla 2 1 Sanders 26 56 79 Chocolate 1 2 Jaeger 43 66 74 1 2 Davis 28 69 75 Chocolate 2 2 Conrad 69 85 94 Vanilla 1 2 Walters 55 67 72 Chocolate 2 2 Rossburger 28 78 81 Spice 2 2 Matthew 42 81 92 Chocolate 2 2 Becker 36 62 83 Spice 2 2 Anderson 27 87 85 Chocolate 1 2 Merritt 62 73 84 Chocolate 1 2 ; </pre>	<pre> datmr <- read.table(header = TRUE, text = ' LastName Age PresentScore TasteScore Flavor Layers Region Orlando 27 93 80 Vanilla 1 1 Ramey 32 84 72 Rum 2 1 Goldston 46 68 75 Vanilla 1 1 Roe 38 79 73 Vanilla 2 1 Larsen 23 77 84 Chocolate 3 1 Davis 51 86 91 Spice 3 1 Strickland 19 82 79 Chocolate 1 1 Nguyen 57 77 84 Vanilla 3 1 Hildenbrand 33 81 83 Chocolate 1 1 Byron 62 72 87 Vanilla 2 1 Sanders 26 56 79 Chocolate 1 2 Jaeger 43 66 74 NA 1 2 Davis 28 69 75 Chocolate 2 2 Conrad 69 85 94 Vanilla 1 2 Walters 55 67 72 Chocolate 2 2 Rossburger 28 78 81 Spice 2 2 Matthew 42 81 92 Chocolate 2 2 Becker 36 62 83 Spice 2 2 Anderson 27 87 85 Chocolate 1 2 Merritt 62 73 84 Chocolate 1 2 ') </pre>
<p>SAS Code and Output</p>	

```
proc means data=cake2 n min max mean stddev maxdec=4;
  var Age PresentScore TasteScore;
  title 'Summary of Presentation and Taste Scores';
  class Region Layers;
  output out=mdata;
run;
```

Summary of Presentation and Taste Scores

The MEANS Procedure

Region	Layers	N Obs	Variable	N	Minimum	Maximum	Mean	Std Dev
1	1	4	Age	4	19.0000	46.0000	31.2500	11.3835
			PresentScore	4	68.0000	93.0000	81.0000	10.2307
			TasteScore	4	75.0000	83.0000	79.2500	3.3040
	2	3	Age	3	32.0000	62.0000	44.0000	15.8745
			PresentScore	3	72.0000	84.0000	78.3333	6.0277
			TasteScore	3	72.0000	87.0000	77.3333	8.3865
	3	3	Age	3	23.0000	57.0000	43.6667	18.1475
			PresentScore	3	77.0000	86.0000	80.0000	5.1962
			TasteScore	3	84.0000	91.0000	86.3333	4.0415
2	1	5	Age	5	26.0000	69.0000	45.4000	19.7053
			PresentScore	5	56.0000	87.0000	73.4000	13.0115
			TasteScore	5	74.0000	94.0000	83.2000	7.4632
	2	5	Age	5	28.0000	55.0000	37.8000	11.2783
			PresentScore	5	62.0000	81.0000	71.4000	7.8930
			TasteScore	5	72.0000	92.0000	80.6000	7.7653

R Code and Output

```
res <- proc_means(datmr,
  var = c("Age", "PresentScore", "TasteScore"),
  stats = c("n", "min", "max", "mean", "std"),
  output = c("all", "report"),
  class = c("Region", "Layers"),
  titles = "My first title for Means",
  options = c("long", maxdec = 4))
```

My first title for Means

Region	Layers	Variable	N	Minimum	Maximum	Mean	Std Dev
1	1	Age	4	19	46	31.2500	11.3835
1	1	PresentScore	4	68	93	81.0000	10.2307
1	1	TasteScore	4	75	83	79.2500	3.3040
1	2	Age	3	32	62	44.0000	15.8745
1	2	PresentScore	3	72	84	78.3333	6.0277
1	2	TasteScore	3	72	87	77.3333	8.3865
1	3	Age	3	23	57	43.6667	18.1475
1	3	PresentScore	3	77	86	80.0000	5.1962
1	3	TasteScore	3	84	91	86.3333	4.0415
2	1	Age	5	26	69	45.4000	19.7053
2	1	PresentScore	5	56	87	73.4000	13.0115
2	1	TasteScore	5	74	94	83.2000	7.4632
2	2	Age	5	28	55	37.8000	11.2783
2	2	PresentScore	5	62	81	71.4000	7.8930
2	2	TasteScore	5	72	92	80.6000	7.7653

Comparison

Test multiple class variables

Result

Pass

proc_means-015

SAS Data	R Data
<pre>data cake; input LastName \$ 1-12 Age 13-14 PresentScore 16-17 TasteScore 19-20 Flavor \$ 23-32 Layers 34 Region 36; datalines; Orlando 27 93 80 Vanilla 3 1 Ramey 32 84 72 Rum 2 1 Goldston 46 68 75 Vanilla 1 1 Roe 38 79 73 Vanilla 2 1 Larsen 23 77 84 Chocolate 3 1 Davis 51 86 91 Spice 3 1 Strickland 19 82 79 Chocolate 1 1 Nguyen 57 77 84 Vanilla 3 1 Hildenbrand 33 81 83 Chocolate 1 1 Byron 62 72 87 Vanilla 2 1 Sanders 26 56 79 Chocolate 1 1 Jaeger 43 66 74 1 2 Davis 28 69 75 Chocolate 2 2 Conrad 69 85 94 Vanilla 1 2 Walters 55 67 72 Chocolate 2 2 Rossburger 28 78 81 Spice 2 2 Matthew 42 81 92 Chocolate 2 2 Becker 36 62 83 Spice 2 2 Anderson 27 87 85 Chocolate 1 2 Merritt 62 73 84 Chocolate 1 2 ;</pre>	<pre>datasp <- datm datasp\$Layers[1] <- 3</pre>
SAS Code and Output	

```

proc sort data=cake out=cake2;
by Layers;
run;

proc means data=cake2 kurt skew cv clm maxdec = 8;
var Age PresentScore TasteScore;
title 'Summary of Presentation and Taste Scores';
by Layers;

output out=mdata;
run;

```

Summary of Presentation and Taste Scores

The MEANS Procedure

Layers=1

Variable	Kurtosis	Skewness	Coeff of Variation	Lower 95% CL for Mean	Upper 95% CL for Mean
Age	-0.95194732	0.55802418	43.85482852	25.73043112	55.51956888
PresentScore	-0.70369508	-0.60221998	14.51013940	65.68224186	83.81775814
TasteScore	0.98276993	0.85172466	7.85651169	76.26370010	86.98629990

Layers=2

Variable	Kurtosis	Skewness	Coeff of Variation	Lower 95% CL for Mean	Upper 95% CL for Mean
Age	-0.24886914	0.94617635	31.02599979	29.71722304	50.53277696
PresentScore	-1.23207654	-0.28347268	10.36735257	67.58618050	80.41381950
TasteScore	-1.06156373	0.59659254	9.54580892	73.04048132	85.70951868

Layers=3

Variable	Kurtosis	Skewness	Coeff of Variation	Lower 95% CL for Mean	Upper 95% CL for Mean
Age	-5.12632751	0.05902707	43.03797468	12.44920641	66.55079359
PresentScore	-2.34699816	0.65484802	9.32382865	70.89878690	95.60121310
TasteScore	2.00892049	0.94865417	5.39642979	77.47258189	92.02741811

R Code and Output

```

proc_means(datsp, var = c("Age", "PresentScore", "TasteScore"),
stats = c("kurtosis", "skew", "cv", "clm"),
output = all,
by = c("Layers"),
options = c(maxdec = 8)
)

```

Layers=1					
Variable	Kurtosis	Skewness	Coeff of Variation	Lower 95% CL for Mean	Upper 95% CL for Mean
Age	-0.95194732	0.55802418	43.85482852	25.73043112	55.51956888
PresentScore	-0.70369508	-0.60221998	14.51013940	65.68224186	83.81775814
TasteScore	0.98276993	0.85172466	7.85651169	76.26370010	86.98629990

Layers=2					
Variable	Kurtosis	Skewness	Coeff of Variation	Lower 95% CL for Mean	Upper 95% CL for Mean
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TasteScore	2.00892049	0.94865417	5.39642979	77.47258189	92.02741811

Comparison

Test more complicated statistics with by variables and low sample sizes.

Result

Pass

Transpose Data

SAS	R
<pre>data score; input Student \$9. +1 StudentID \$ Section \$ Test1 Test2 Final; datalines; Capalleti 0545 1 94 91 87 Dubose 1252 2 51 65 91 Engles 1167 1 95 97 97 Grant 1230 2 63 75 80 Krupski 2527 2 80 76 71 Lundsford 4860 1 92 40 86 McBane 0674 1 75 78 72 ;</pre>	<pre>score <- read.table(header = TRUE, colClasses = c(Student = "character", StudentID = "character", Section = "character"), text = ' Student StudentID Section Test1 Test2 Final Capalleti "0545" "1" 94 91 87 Dubose "1252" "2" 51 65 91 Engles "1167" "1" 95 97 97 Grant "1230" "2" 63 75 80 Krupski "2527" "2" 80 76 71 Lundsford "4860" "1" 92 40 86 McBane "0674" "1" 75 78 72 ', stringsAsFactors = FALSE)</pre>

proc_transpose-001

SAS Code and Output																																	
<pre>proc transpose data=score out=score_transposed name = Exam; id Student; run; proc print data=score_transposed noobs; title 'Student Test Scores in Variables'; run;</pre>	<p style="text-align: center;">Student Test Scores in Variables</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Exam</th> <th>Capalleti</th> <th>Dubose</th> <th>Engles</th> <th>Grant</th> <th>Krupski</th> <th>Lundsford</th> <th>McBane</th> </tr> </thead> <tbody> <tr> <td>Test1</td> <td>94</td> <td>51</td> <td>95</td> <td>63</td> <td>80</td> <td>92</td> <td>75</td> </tr> <tr> <td>Test2</td> <td>91</td> <td>65</td> <td>97</td> <td>75</td> <td>76</td> <td>40</td> <td>78</td> </tr> <tr> <td>Final</td> <td>87</td> <td>91</td> <td>97</td> <td>80</td> <td>71</td> <td>86</td> <td>72</td> </tr> </tbody> </table>	Exam	Capalleti	Dubose	Engles	Grant	Krupski	Lundsford	McBane	Test1	94	51	95	63	80	92	75	Test2	91	65	97	75	76	40	78	Final	87	91	97	80	71	86	72
Exam	Capalleti	Dubose	Engles	Grant	Krupski	Lundsford	McBane																										
Test1	94	51	95	63	80	92	75																										
Test2	91	65	97	75	76	40	78																										
Final	87	91	97	80	71	86	72																										
<p>R Code and Output</p> <pre>res <- proc_transpose(score, var = c("Test1", "Test2", "Final"), id = Student, name = "Exam") proc_print(res, titles = "Student Test Scores in Variables")</pre>	<p style="text-align: center;">Student Test Scores in Variables</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Exam</th> <th>Capalleti</th> <th>Dubose</th> <th>Engles</th> <th>Grant</th> <th>Krupski</th> <th>Lundsford</th> <th>McBane</th> </tr> </thead> <tbody> <tr> <td>Test1</td> <td>94</td> <td>51</td> <td>95</td> <td>63</td> <td>80</td> <td>92</td> <td>75</td> </tr> <tr> <td>Test2</td> <td>91</td> <td>65</td> <td>97</td> <td>75</td> <td>76</td> <td>40</td> <td>78</td> </tr> <tr> <td>Final</td> <td>87</td> <td>91</td> <td>97</td> <td>80</td> <td>71</td> <td>86</td> <td>72</td> </tr> </tbody> </table>	Exam	Capalleti	Dubose	Engles	Grant	Krupski	Lundsford	McBane	Test1	94	51	95	63	80	92	75	Test2	91	65	97	75	76	40	78	Final	87	91	97	80	71	86	72
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Final	87	91	97	80	71	86	72																										
<p>Comparison</p>	<p>Results</p>																																
<p>Perform basic transpose with ID variable and name.</p>	<p>Pass</p>																																

proc_transpose-002

<p>SAS Code and Output</p> <pre>proc transpose data=score out=score_transposed prefix = Student suffix= score name = Exam; run; proc print data=score_transposed noobs; title 'Student Test Scores in Variables'; run;</pre>	<p style="text-align: center;">Student Test Scores in Variables</p> <table border="1"> <thead> <tr> <th>Exam</th> <th>Student1score</th> <th>Student2score</th> <th>Student3score</th> <th>Student4score</th> <th>Student5score</th> <th>Student6score</th> <th>Student7score</th> </tr> </thead> <tbody> <tr> <td>Test1</td> <td>94</td> <td>51</td> <td>95</td> <td>63</td> <td>80</td> <td>92</td> <td>75</td> </tr> <tr> <td>Test2</td> <td>91</td> <td>65</td> <td>97</td> <td>75</td> <td>76</td> <td>40</td> <td>78</td> </tr> <tr> <td>Final</td> <td>87</td> <td>91</td> <td>97</td> <td>80</td> <td>71</td> <td>86</td> <td>72</td> </tr> </tbody> </table>	Exam	Student1score	Student2score	Student3score	Student4score	Student5score	Student6score	Student7score	Test1	94	51	95	63	80	92	75	Test2	91	65	97	75	76	40	78	Final	87	91	97	80	71	86	72
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<p>R Code and Output</p> <pre>res <- proc_transpose(score, var = c("Test1", "Test2", "Final"), name = "Exam", prefix = "Student", suffix = "score") proc_print(res, titles = "Student Test Scores in Variables")</pre>	<p style="text-align: center;">Student Test Scores in Variables</p> <table border="1"> <thead> <tr> <th>Exam</th> <th>Student1score</th> <th>Student2score</th> <th>Student3score</th> <th>Student4score</th> <th>Student5score</th> <th>Student6score</th> <th>Student7score</th> </tr> </thead> <tbody> <tr> <td>Test1</td> <td>94</td> <td>51</td> <td>95</td> <td>63</td> <td>80</td> <td>92</td> <td>75</td> </tr> <tr> <td>Test2</td> <td>91</td> <td>65</td> <td>97</td> <td>75</td> <td>76</td> <td>40</td> <td>78</td> </tr> <tr> <td>Final</td> <td>87</td> <td>91</td> <td>97</td> <td>80</td> <td>71</td> <td>86</td> <td>72</td> </tr> </tbody> </table>	Exam	Student1score	Student2score	Student3score	Student4score	Student5score	Student6score	Student7score	Test1	94	51	95	63	80	92	75	Test2	91	65	97	75	76	40	78	Final	87	91	97	80	71	86	72
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proc_transpose-003

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<pre>proc sort data = score out = score_sorted; by Section; run; proc transpose data=score_sorted out=score_transposed name = Exam; id Student; by Section; run; proc print data=score_transposed noobs; title 'Student Test Scores in Variables'; run;</pre>	<p style="text-align: center;">Student Test Scores in Variables</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Section</th> <th>Exam</th> <th>Capalleti</th> <th>Engles</th> <th>Lundsford</th> <th>McBane</th> <th>Dubose</th> <th>Grant</th> <th>Krupski</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Test1</td> <td>94</td> <td>95</td> <td>92</td> <td>75</td> <td>.</td> <td>.</td> <td>.</td> </tr> <tr> <td>1</td> <td>Test2</td> <td>91</td> <td>97</td> <td>40</td> <td>78</td> <td>.</td> <td>.</td> <td>.</td> </tr> <tr> <td>1</td> <td>Final</td> <td>87</td> <td>97</td> <td>86</td> <td>72</td> <td>.</td> <td>.</td> <td>.</td> </tr> <tr> <td>2</td> <td>Test1</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>51</td> <td>63</td> <td>80</td> </tr> <tr> <td>2</td> <td>Test2</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>65</td> <td>75</td> <td>76</td> </tr> <tr> <td>2</td> <td>Final</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>91</td> <td>80</td> <td>71</td> </tr> </tbody> </table>	Section	Exam	Capalleti	Engles	Lundsford	McBane	Dubose	Grant	Krupski	1	Test1	94	95	92	75	.	.	.	1	Test2	91	97	40	78	.	.	.	1	Final	87	97	86	72	.	.	.	2	Test1	51	63	80	2	Test2	65	75	76	2	Final	91	80	71
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proc_transpose-004

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<pre>proc means data = score nonobs; output out = stats; run; data score2 (keep = Group _STAT_ Test1 Test2 Final) ; set stats (drop = _TYPE_ _FREQ_); Group = "Group1"; run; proc print data=score2 noobs; title 'Student Test Scores in Variables'; run;</pre>	<div style="text-align: center;"> <p>Student Test Scores in Variables</p> <table border="1"> <thead> <tr> <th>_STAT_</th> <th>Test1</th> <th>Test2</th> <th>Final</th> <th>Group</th> </tr> </thead> <tbody> <tr> <td>N</td> <td>7.0000</td> <td>7.0000</td> <td>7.0000</td> <td>Group1</td> </tr> <tr> <td>MIN</td> <td>51.0000</td> <td>40.0000</td> <td>71.0000</td> <td>Group1</td> </tr> <tr> <td>MAX</td> <td>95.0000</td> <td>97.0000</td> <td>97.0000</td> <td>Group1</td> </tr> <tr> <td>MEAN</td> <td>78.5714</td> <td>74.5714</td> <td>83.4286</td> <td>Group1</td> </tr> <tr> <td>STD</td> <td>16.8608</td> <td>18.5908</td> <td>9.6412</td> <td>Group1</td> </tr> </tbody> </table> </div>	_STAT_	Test1	Test2	Final	Group	N	7.0000	7.0000	7.0000	Group1	MIN	51.0000	40.0000	71.0000	Group1	MAX	95.0000	97.0000	97.0000	Group1	MEAN	78.5714	74.5714	83.4286	Group1	STD	16.8608	18.5908	9.6412	Group1
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<p>R Code and Output</p> <pre>stats <- proc_means(score, options = v(notype, nonobs)) res1 <- data.frame(Group = "Group1", stats) res2 <- proc_transpose(res1, copy = "Group", name = "STAT", id = "VAR") proc_print(res2, titles = "Student Test Scores in Variables")</pre>	<div style="text-align: center;"> <p>Student Test Scores in Variables</p> <table border="1"> <thead> <tr> <th>Group</th> <th>STAT</th> <th>Test1</th> <th>Test2</th> <th>Final</th> </tr> </thead> <tbody> <tr> <td>Group1</td> <td>N</td> <td>7</td> <td>7</td> <td>7</td> </tr> <tr> <td>Group1</td> <td>MEAN</td> <td>78.5714285714286</td> <td>74.5714285714286</td> <td>83.4285714285714</td> </tr> <tr> <td>Group1</td> <td>STD</td> <td>16.8607744272235</td> <td>18.5908323541214</td> <td>9.64118151226192</td> </tr> <tr> <td>Group1</td> <td>MIN</td> <td>51</td> <td>40</td> <td>71</td> </tr> <tr> <td>Group1</td> <td>MAX</td> <td>95</td> <td>97</td> <td>97</td> </tr> </tbody> </table> </div>	Group	STAT	Test1	Test2	Final	Group1	N	7	7	7	Group1	MEAN	78.5714285714286	74.5714285714286	83.4285714285714	Group1	STD	16.8607744272235	18.5908323541214	9.64118151226192	Group1	MIN	51	40	71	Group1	MAX	95	97	97
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