Abstract

Most software systems are capable of generating random numbers to assist in simple random sampling. If a more complex sampling scheme is required, such as stratified randomization, a complicated program must be generated to accomplish this task.

SAS is able to simplify this task a great deal by combining various PROCedures with programming statements such as DO loops and IF-THEN-ELSE conditionals.

Methods and codes for obtaining numerous randomizations will be presented in this paper, but emphasis will be on Stratified Randomization schemes. Sample programs will be presented which can be developed by a SAS user, to satisfy a variety of randomization formats. Use of several PROCedures and functions, including UNIFORM, RANK, and SORT, will be discussed.

Introduction

Random sampling is required in all areas of research. A valid sampling procedure provides the basis for statistical inference, which is vital to research studies.

Below we have discussed randomization codes to perform simple sequencing, simple random selection with spares, simple stratification, and complex stratification. These categories were selected because they demonstrate techniques which are used in many common research designs.

Simple Sequencing

In the simplest case, a set of units is to be randomly ordered. While a table of random numbers may be used quite easily for small sample sizes, a short SAS program will prove to be a time saver in the long run. Given the same seed, these programs will generate the same randomization code at a later date, for verification.

Example: A drug study will be performed on 10 rats housed in cages in a laboratory. The cages are to be randomly ordered for dosing.

SAS Program:

```
1 DATA RATS;
2 ** SINCE CAGE NUMBERS ARE 1 TO 10, GENERATE *
3 ** IN A DO-LOOP, USE UNIFORM FUNCTION TO ****
4 ** ASSIGN A RANDOM NUMBER TO EACH CAGE. ****;
5 DO CAGE = 1 TO 10;
6 RANDOM = UNIFORM(75123);
7 OUTPUT;
8 END;
9 ** SORT BY RANDOM NUMBERS AND PRINT ORDER **;
10 PROC SORT; BY RANDOM;
11 DATA; SET;
12 ORDER=JY;
13 PROC PRINT; ID ORDER; VAR CAGE;
14 TITLE RANDOM ORDER OF CAGES FOR DOSING;
```

Since cage numbers are sequential, they are generated in a DO loop. Each cage number is paired with a randomly generated number. The file is then sorted by the random numbers so that the cages in the sorted file are randomly sequenced. SAS's internal counter, _Y_ corresponds to the new order of the cages. That is, the value of _Y_ for each cage is its dosing position (from 1 to 10), as shown in the output below:

SAS Output:

```
---------RANDOM ORDER OF CAGES FOR DOSING---------
ORDER CAGE
  1  4
  2  9
  3  2
  4  1
  5  3
  6  5
  7  8
  8  6
  9 10
 10  7
```

Simple Random Selection (Including Spares)

For an experiment on a sample population that contains spares - - i.e. there are more units than required - - the spares can be easily selected using OBS and FIRSTOBS options in a data step.

Example: An experiment is to be conducted to study yield difference of fertilizers containing 3 levels of nitrogen. Twenty-one plots of land (P1-P21) were allocated for this experiment. Six plots must be reserved as spares for possible further study. The remaining 15 plots must be randomly assigned to the 3 fertilizer groups, 5 per group, as shown in the SAS Program:
SAS Program:

1 PROC FORMAT;
2 VALUE FG .='SPARES'
3 0= '1'
4 1= '2'
5 2= '3';
6 DATA ONE;
7 ** SINCE PLOT NUMBERS ARE CONSECUTIVE, DO **
8 ** LOOP IS USED TO ASSIGN PLOT NUMBER. ***;
9 DO PLOTS=1 TO 21;
10 RANDOM=UNIFORM(0);
11 OUTPUT; END;
12 PROC SORT;
13 BY RANDOM;
14 DATA SPARE; SET ONE(OBS=6);
15 ** AFTER SORT, SPARES ARE SELECTED AS THE **
16 ** FIRST SIX PLOTS WITHIN THE SAMPLE *****;
17 ** POPULATION. **********************;
18 DATA REAL; SET ONE(FIRSTOBS=7);
19 ** SEPARATING THE REMAINDER OF PLOTS TO BE *
20 ** RANDOMLY ALLOCATED TO EACH FERTILIZER **;
21 PROC RANK OUT=RANKOUT GROUPS=3;
22 VAR RANDOM; RANKS FERTLZR;
23 DATA FINAL; SET RANKOUT SPARE;
24 PREFIX='P';
25 SUFFIX='PLTS';
26 PLOT=PREFIX! !SUFFIX;
27 KEEP FERTLZR PLOT;
28 PROC SORT;
29 BY FERTLZR PLOT;
30 PROC PRINT;
31 BY FERTLZR ID PLOT;
32 FORMAT FERTLZR FG.;
33 TITLE EXAMPLE OF SIMPLE RANDOMIZATION W/ SPARES;

As in the previous example, plot numbers are assigned using a DO loop. Each plot outputted will have a random number assigned to it by the UNIFORM function. The plots are then sorted by their respective random numbers.

On line 16, the spares selected are the 6 with the lowest random numbers. On line 18, the remaining 15 plots, beginning with the seventh observation, will be randomly assigned to 3 groups by PROC RANK as shown on line 21. Since each plot is identified by its plot number and a 'P' as prefix, DATA FINAL is set up to concatenate the prefix and plot number. The result is then sorted and printed:

SAS Output:
EXAMPLE OF SIMPLE RANDOMIZATION W/ SPARES

-------------FERTLZR=1-------------
<table>
<thead>
<tr>
<th>PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>P01</td>
</tr>
<tr>
<td>P02</td>
</tr>
<tr>
<td>P09</td>
</tr>
<tr>
<td>P12</td>
</tr>
<tr>
<td>P16</td>
</tr>
</tbody>
</table>

-------------FERTLZR=2-------------
<table>
<thead>
<tr>
<th>PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>P03</td>
</tr>
<tr>
<td>P05</td>
</tr>
<tr>
<td>P07</td>
</tr>
<tr>
<td>P08</td>
</tr>
<tr>
<td>P20</td>
</tr>
</tbody>
</table>

-------------FERTLZR=3-------------
<table>
<thead>
<tr>
<th>PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>P04</td>
</tr>
<tr>
<td>P06</td>
</tr>
<tr>
<td>P10</td>
</tr>
<tr>
<td>P11</td>
</tr>
<tr>
<td>P14</td>
</tr>
</tbody>
</table>

Stratification by Sex

Quite often the design used in the previous example will be complicated by classifications such as sex, as in this example:

Example: A dermatologist is conducting a study of 3 acne facial creams. He has 20 volunteers; numbers 1 through 10 are males, 11 through 20 are females. Volunteers are to be randomly assigned, such that they are evenly distributed by sex into 3 treatment groups, thus leaving 1 of each sex as spares.

SAS Program:

1 PROC FORMAT;
2 VALUE GRPF .='SPARES'
3 0= '1'
4 1= '2'
5 2= '3';
6 VALUE SEXF 1='MALE'
7 2='FEMALE';
8 DATA ONE;
9 DO SUBJECT=1 TO 20;
10 SEX=1; IF SUBJECT GT 10 THEN SEX=2;
11 RANDOM=UNIFORM(0);
12 OUTPUT; END;
13 PROC SORT;
14 BY SEX RANDOM;
15 DATA ONE SPARES; SET ONE;
16 BY SEX;
17 IF FIRST.SEX THEN OUTPUT SPARES;
18 ELSE OUTPUT ONE;
19 PROC RANK DATA=ONE GROUPS=3 OUT=RANKOUT;
20 BY SEX;
21 VAR RANDOM; RANKS GROUP;
22 DATA ALL; SET SPARES RANKOUT;
23 PROC SORT;
24 BY GROUP SUBJECT;
Aside from the sex stratification differences, the spares in this example were handled much like the spares in the previous example.

On line 8, DATA ONE generated the subject numbers and defined the first 10 subjects as male, the remaining 10 as female. On line 15, the spares were selected, then the remaining subjects were ranked and assigned to the treatment groups by PROC RANK (line 19). The output file RANKOUT from PROC RANK was then concatenated with SPARES (line 22). The output is shown below.

SAS Output:

Randomization with Spares and Classification

GROUPS=SPARES

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>SEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>MALE</td>
</tr>
<tr>
<td>15</td>
<td>FEMALE</td>
</tr>
</tbody>
</table>

GROUP=1

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>SEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MALE</td>
</tr>
<tr>
<td>5</td>
<td>MALE</td>
</tr>
<tr>
<td>7</td>
<td>MALE</td>
</tr>
<tr>
<td>12</td>
<td>FEMALE</td>
</tr>
<tr>
<td>14</td>
<td>FEMALE</td>
</tr>
<tr>
<td>19</td>
<td>FEMALE</td>
</tr>
</tbody>
</table>

GROUP=2

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>SEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>MALE</td>
</tr>
<tr>
<td>4</td>
<td>MALE</td>
</tr>
<tr>
<td>9</td>
<td>MALE</td>
</tr>
<tr>
<td>13</td>
<td>FEMALE</td>
</tr>
<tr>
<td>17</td>
<td>FEMALE</td>
</tr>
<tr>
<td>20</td>
<td>FEMALE</td>
</tr>
</tbody>
</table>

GROUP=3

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>SEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>MALE</td>
</tr>
<tr>
<td>6</td>
<td>MALE</td>
</tr>
<tr>
<td>8</td>
<td>MALE</td>
</tr>
<tr>
<td>11</td>
<td>FEMALE</td>
</tr>
<tr>
<td>16</td>
<td>FEMALE</td>
</tr>
</tbody>
</table>

Random Group Assignment

With Special Restriction

Sometimes a subset of the units in a sample has a characteristic for which some special provision must be made, as in the following:

Example: Twenty-five new cars will be used to test 5 different wax treatments. Five of the cars have metallic paint. The cars are to be randomly assigned to the five wax treatment groups, each consisting of five cars. In addition, one and only one car with metallic paint should appear in each treatment group.

Car Numbers *

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>105</td>
<td>109</td>
<td>113</td>
<td>117</td>
</tr>
<tr>
<td>102</td>
<td>106</td>
<td>110</td>
<td>114</td>
<td>118</td>
</tr>
<tr>
<td>103</td>
<td>107</td>
<td>111</td>
<td>115</td>
<td>119</td>
</tr>
<tr>
<td>104</td>
<td>108</td>
<td>112</td>
<td>116</td>
<td>1120</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* M indicates car with metallic paint.

SAS Program:

PROC FORMAT;
VALUE TRT;
  1=WAX TREATMENT #1
  2=WAX TREATMENT #2
  3=WAX TREATMENT #3
  4=WAX TREATMENT #4
  5=WAX TREATMENT #5;
** READ CARS INTO 2 DATA SETS -- METALLIC & *
** COLORED. CREATE RAND = RANDOM NUMBERS ***
** PAIRED WITH CARS. ****************************;**
DATA METALLIC COLOR;
  VALUE CAR $ @0;
  RAND=UNIFORM(0);
  IF SUBSTR(CAR.1.1)=M THEN OUTPUT METALLIC;
  ELSE OUTPUT COLORED;
  CARDS;
  101 106 111 116 121
  102 107 112 117 122
  103 108 113 118 1123
  104 109 114 119 124
  105 110 115 1120 125
** RANK EACH SET OF CARS BY THEIR ************
** CORRESPONDING SET OF RANDOM NUMBERS -- ***
** USE GROUPS OPTION TO ASSIGN FIVE GROUP ***
** VALUES TO DATA, BASED ON RANK QUANTILES **
PROC RANK DATA=METALLIC GROUPS=5;
  OUT=METALLIC; VAR RAND; RANKS GROUP;
PROC RANK DATA=COLORED GROUPS=5;
  OUT=COLORED; VAR RAND;
** CONCATENATE THE TWO RANKED DATA SETS.****
** EACH DATA SET WAS RANDOMIZED SEPARATELY TO **
** THE 5 GROUPS. ****************************;
PROC SORT; BY GROUP CAR;
PROC PRINT; ID CAR; BY GROUP;
PROC PRINT; ID CAR; BY GROUP;
TITLE1 RANDOM ASSIGNMENT OF CARS TO GROUPS;
In this example, cars were assigned random numbers, then placed in separate data files according to paint type. Each paint-type data file was evenly randomized to the 5 treatment groups. In this way, one and only one metallic car was assigned to each group. The data files with resulting group assignments were then combined, with the automatic group 0 recoded as group 5. The result is shown below.

SAS Output:

<table>
<thead>
<tr>
<th>RANDOM ASSIGNMENT OF CARS TO GROUPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>---------GROUP=WAX TREATMENT #1-------</td>
</tr>
<tr>
<td>CAR</td>
</tr>
<tr>
<td>M123</td>
</tr>
<tr>
<td>102</td>
</tr>
<tr>
<td>103</td>
</tr>
<tr>
<td>109</td>
</tr>
<tr>
<td>112</td>
</tr>
<tr>
<td>---------GROUP=WAX TREATMENT #2-------</td>
</tr>
<tr>
<td>CAR</td>
</tr>
<tr>
<td>M108</td>
</tr>
<tr>
<td>104</td>
</tr>
<tr>
<td>106</td>
</tr>
<tr>
<td>107</td>
</tr>
<tr>
<td>116</td>
</tr>
<tr>
<td>---------GROUP=WAX TREATMENT #3-------</td>
</tr>
<tr>
<td>CAR</td>
</tr>
<tr>
<td>M114</td>
</tr>
<tr>
<td>112</td>
</tr>
<tr>
<td>115</td>
</tr>
<tr>
<td>124</td>
</tr>
<tr>
<td>125</td>
</tr>
<tr>
<td>---------GROUP=WAX TREATMENT #4-------</td>
</tr>
<tr>
<td>CAR</td>
</tr>
<tr>
<td>M120</td>
</tr>
<tr>
<td>101</td>
</tr>
<tr>
<td>105</td>
</tr>
<tr>
<td>119</td>
</tr>
<tr>
<td>121</td>
</tr>
<tr>
<td>---------GROUP=WAX TREATMENT #5-------</td>
</tr>
<tr>
<td>CAR</td>
</tr>
<tr>
<td>M117</td>
</tr>
<tr>
<td>110</td>
</tr>
<tr>
<td>111</td>
</tr>
<tr>
<td>116</td>
</tr>
<tr>
<td>122</td>
</tr>
</tbody>
</table>

Complex Stratification for Factorial Designs
With Special Restriction

In the example given below, subjects must be randomly selected according to two factors, sex and grade. Subjects are simultaneously randomized to two treatment situations: reading group and follow-up. For one subject, a special restriction is made on group assignment, but not on follow-up.

Example: A school district plans to conduct a study of 3 reading programs. Eight children are to be randomly assigned to each group. Each group should contain 4 boys and 4 girls. Two age groups, 4th and 7th graders, should be evenly distributed among the groups. The principal's daughter, Sandy Lange, must be placed in reading group #3. In addition, two children per grade per group should be randomly selected for follow-up testing.

SAS Program:

```sas
1 *-----------------------------------------------*
2 ** RANDOMIZATION OF 4TH AND 7TH GRADERS ****
3 ** TO READING GROUPS, EVENLY DISTRIBUTING **
4 ** SEXES. ONE STUDENT IS FORCED INTO ******
5 ** GROUP THREE. TWO STUDENTS PER GROUP *****
6 ** PER GRADE ARE RANDOMLY SELECTED FOR *****
7 ** FOLLOW-UP TEST. ***********************
8 ** *****************************************
9 DATA READPROG;
10 INFILE ROSTER;
11 INPUT FNAM $ LNAME $10-19 SEX $ GRADE;
12 ** SET FULL NAME LENGTH ***************;
13 LENGTH NAME $ 25;
14 NAME=TRIM (LNAME)||*, ''||FNAM;
15 ** GENERATE RANDOM NUMBERS FOR RANDOMLY *****
16 ** SEQUENCING CHILDREN FOR SELECTION IN ****
17 ** STUDY, THEN FOR FOLLOW-UP TEST *********
18 ** SELECTION. *****************************;
19 RANDOM=UNIFORM(B3709);
20 RANDOMF=UNIFORM (0);
21 ** FORCE SANDY LANGE INTO GROUP 3 BY *****
22 ** ASSIGNING RANDOM=0 (CHILDREN AT THE TOP **
23 ** OF THE LIST (LOWEST RANDOM NUMBERS) WILL *
24 ** BE ASSIGNED TO GROUP O, WHICH IS RECODED *
25 ** AS GROUP 3 BELOW). ****************************************
26 IF NAME='LANGE, SANDY'
27 THEN RANDOM=0;
28 PROC SORT; BY GRADE SEX RANDOM;
29 ** AFTER RANDOM SORTING OF CHILDREN WITHIN **
30 ** EACH GRADE AND SEX, SELECT THE FIRST N ***
31 ** DESIRED, OF EACH GRADE AND SEX ***************;
32 ** (N=6 HERE). ****************************************
33 DATA READPROG;
34 SET READPROG; BY GRADE SEX;
35 IF FIRST.SEX THEN COUNT=0;
36 RETAIN COUNT;
37 COUNT=COUNT+1;
38 ** SELECT SEX & GRADE SAMPLE SIZE **********;
39 IF COUNT LE 6 THEN OUTPUT;
40 PROC PRINT;
41 PROC SORT; BY GRADE SEX RANDOM;
42 ***********************************************
43 ** USE PROC RANK WITH GROUPS OPTION AND *****
44 ** RANK STATEMENT TO AUTOMATICALLY ASSIGN ******
45 ** EQUAL NUMBERS OF CHILDREN WITHIN EACH ****
46 ** SEX & GRADE TO EACH GROUP. *************;
47 PROC RANK GROUPS=3
48 DATA=READPROG OUT=RANKREAD;
49 BY GRADE SEX;
50 RANKS GROUP; VAR RANDOM;
51 PROC SORT; BY GROUP GRADE RANDOM;
52 ** ASSIGN COUNTER TO RESORTED DATA. ********
53 ** RANDOMLY SELECT FIRST TWO CHILDREN IN ****
54 ** EACH GROUP AND GRADE, BASED ON RANDOMF ***
55 ** SEQUENCE FOR FOLLOW-UP TESTING. *********;
56 DATA RANKREAD;
57 SET RANKREAD;
58 BY GROUP GRADE;
```
IF FIRST-GRADE THEN COUNTER=0;
RETAIN COUNTER;
COUNTER= COUNTER+1;
IF (COUNTER=1 OR COUNTER=2)
THEN FOLLOW='YES';
ELSE FOLLOW='NO';
** RECODE AUTOMATIC GROUP 0 = GROUP 3 *****;
IF GROUP=0 THEN GROUP=3;
** OUTPUT FOR TEACHERS ***************;
PROC SORT; BY GRADE LNAME;
PROC PRINT PAGE; BY GRADE; ID NAME;
VAR SEX GROUP FOLLOW RAIlOOI'I;
TITLE1 ALPHABETIC LIST FOR EACH GRADE;
TITLE2 WITH GROUP ASSIGNMENTS;
** OUTPUT FOR READING INSTRUCTOR ***********;
PROC SORT; BY GROUP GRADE LNAME;
PROC PRINT; ID NAME;
VAR GRADE SEX FOLLOW;
TITLE1 ALPHABETIC LIST FOR EACH GROUP;
TITLE2 BY GRADE;

Data are read on line 9 using an INFILE statement. Each child is assigned two random numbers (RANDOM & RANDOMM) (lines 20 & 21). RANDOM is used to select 6 children per grade per sex (lines 33-39) and randomly assign them to reading groups (line 47). Sandy Lange was given RANDOM=0 (lines 26 & 27). Therefore she will automatically be selected and assigned to group 0 by PROC RANK (line 47). Group 0 is later recoded as group 3 (line 66). Data are resorted by RANDOMM (line 51). Two children per group per grade are selected for follow-up (lines 59-64).
Since Sandy Lange has a random value for RANDOM, she has an equal chance of being selected for follow-up within group 3. Two forms of output are printed as shown below (lines 70 & 76).

SAS Output for classroom teachers:

APhabetIC LIST FOR EACH GRADE
WITH GROUP ASSIGNMENTS
---------------------GRADE=4----------------------
NAME SEX GROUP FOLLOW
APGAR, MICHAEL BOY 2 YES
BARTLEY, BOB BOY 3 NO
BRADLEY, NANCY GIRL 3 YES
DU RN, HARY GIRL 1 YES
EGAN, JANET GIRL 2 YES
HANLEY, ELLEN GIRL 1 NO
KING, MARK BOY 1 YES
KLINGLER, DAVID GIRL 3 YES
LARGE, SANDY GIRL 3 NO
MILLER, ROBERT BOY 2 NO
O'NEIL, TIM BOY 1 NO
PLUM, TINA GIRL 2 NO

ALPHABETIC LIST FOR EACH GRADE
WITH GROUP ASSIGNMENTS
---------------------GRADE=7----------------------
NAME SEX GROUP FOLLOW
CALLAHAN, PETER BOY 3 YES
FURGESON, JIM BOY 2 YES
GRETCHEL, GLORIA GIRL 3 NO
IVES, RICHARD BOY 1 YES
LANGSTON, JODY GIRL 1 YES
LIVINGSTON, STEWART BOY 3 YES
MANNING, HARCIA GIRL 1 NO
QUILLAN, RODNEY BOY 1 NO
RICHARDS, EILEEN GIRL 3 NO
STONE, MARION GIRL 2 NO
UNDERHILL, BARBARA GIRL 2 NO
VIESER, RANDY BOY 2 YES

SAS Output for reading teacher:

ALPHABETIC LIST FOR EACH GROUP
BY GRADE
----------------------GROUP=1----------------------
NAME GRADE SEX FOLLOW
DUNN, MARY 4 GIRL YES
HANLEY, ELLEN 4 GIRL NO
KING, MARK 4 BOY YES
O'NEIL, TIM 4 BOY NO
IVES, RICHARD 7 BOY YES
LANGSTON, JODY 7 GIRL YES
MANNING, MARICA 7 GIRL NO
QUILLAN, RODNEY 7 BOY NO

ALPHABETIC LIST FOR EACH GROUP
BY GRADE
----------------------GROUP=2----------------------
NAME GRADE SEX FOLLOW
APGAR, MICHAEL 4 BOY YES
EGAN, JANET 4 GIRL YES
MILLER, ROBERT 4 BOY NO
PLUM, TINA 4 GIRL NO
FURGESON, JIM 7 BOY YES
STONE, MARION 7 GIRL NO
UNDERHILL, BARBARA 7 GIRL NO
VIESER, RANDY 7 BOY YES

ALPHABETIC LIST FOR EACH GROUP
BY GRADE
----------------------GROUP=3----------------------
NAME GRADE SEX FOLLOW
BARTLEY, BOB 4 BOY NO
BRADLEY, NANCY 4 GIRL YES
KLINGLER, DAVID 4 GIRL YES
LANGE, SANDY 4 GIRL NO
CALLAHAN, PETER 7 BOY YES
GRETCHEL, GLORIA 7 GIRL NO
LIVINGSTON, STEWART 7 BOY YES
RICHARDS, EILEEN 7 GIRL NO
Complex Stratification for Nested Designs

A nested design requiring randomization is illustrated in Hicks (1973, p.194). In this example 9 subjects were randomly selected from each of three physique classifications of men in the armed services. Men within each physique class were assigned to one of three teams. Each subject was then randomly assigned to one of 6 gun-test orders. Orders are the 6 possible permutations of testing 2 methods of gun loading, twice each.

SAS Program:

```sas
1 /* FORMAT THE 6 POSSIBLE ORDERS OF TESTING */;
PROC FORMAT;
2 VALUE ORDERF 1='1 1' 2='2 1' 3='2 2' 4='2 1' 5='1 2' 6='1 1';
3 DATA ONE;
4 INFILE DATANOME;
5 INPUT NAME $ PHYSIQUE;
6 OUTPUT;
7 TITLE SAMPLE RANDOMIZATION OF COMPLEX NESTED DESIGN;
8 ** PROC RANK IS FIRST USED TO RANDOMLY ASSIGN SUBJECTS TO ONE OF THE THREE TEAMS. **
9 ** EACH SUBJECT MUST BE ASSIGNED 1 OF THE 6 * 3=18 PERMUTATIONS OF ORDERS. **
10 ** ALL RANDOM NUMBERS ARE IN THE OUTPUT LISTED BELOW. **
11 ** ORDER IS THE RESULT OF 1-6 ASSIGNMENTS TO THE 3 TEAMS. **
```

A list of volunteers was input using an INFILE statement. Two sets of random numbers (RANDOM1 and RANDOM2) were generated. RANDOM1 was used to select and assign individuals to teams. RANDOM2 was used to randomly assign individuals to test order (double sequence of 2 gun-loading methods to be tested).

Each physique class consisted of 3 teams, and each team consisted of 3 members. These 9 members of each physique class were selected in DATA ONE. PROC RANK on line 33 used RANDOM to assign these 9 individuals to the 3 teams within their respective physique classes.

The second random number, RANDOM2, was used to assign an individual to a test order.

In the output listed below, each subject was randomly assigned one of six permutations of test orders, using RANDOM2. Since all six orders need not be selected, nor equally represented, PROC RANK was not used. Instead the actual random numbers were used. All random numbers falling within the first 1/6 of the uniform range are assigned to ORDER=1, the next 1/6 to ORDER=2, etc.

SAS Output:

```
OBS  NAME  PHYSIQUE  TEAM  ORDER
   1  CALLIS  SLIGHT  1  2  1  1  2
   2  CATANZA  SLIGHT  1  2  1  1  2
   3  GOBLE  SLIGHT  1  2  1  1  2
   4  BERK  SLIGHT  1  2  1  1  2
   5  FULCHER  SLIGHT  1  2  1  1  2
   6  GELSON  SLIGHT  1  2  1  1  2
   7  BIALY  SLIGHT  1  2  1  1  2
   8  SEE  SLIGHT  1  2  1  1  2
   9  GILLIAM  SLIGHT  1  2  1  1  2
  10  GOODSON  MEDIUM  1  2  1  1  2
  11  TOSUN  MEDIUM  1  2  1  1  2
  12  YOUNG  MEDIUM  1  2  1  1  2
  13  GORDON  MEDIUM  1  2  1  1  2
  14  HARRIS  MEDIUM  1  2  1  1  2
  15  TELLER  MEDIUM  1  2  1  1  2
  16  LYONS  MEDIUM  1  2  1  1  2
  17  TIZIO  MEDIUM  1  2  1  1  2
  18  UDALL  MEDIUM  1  2  1  1  2
  19  HUGHES  HEAVY  1  2  1  1  2
  20  HUSTAR  HEAVY  1  2  1  1  2
  21  LABRUZZA  HEAVY  1  2  1  1  2
  22  CACI  HEAVY  1  2  1  1  2
  23  CORCORAN  HEAVY  1  2  1  1  2
  24  LIVSEY  HEAVY  1  2  1  1  2
  25  BAUREIS  HEAVY  1  2  1  1  2
  26  KING  HEAVY  1  2  1  1  2
  27  KLEE  HEAVY  1  2  1  1  2
```