



Tutorials and worked examples for simulation,
 curve fitting, statistical analysis, and plotting.
<http://www.simfit.org.uk>

In experimental design, especially with Latin square ANOVA, it is often required to use a randomly generated Latin square.

To make this clear, consider the SIMFIT test file ANOVA3.TF1 (shown in full and colored blue below) by choosing [View] from the SIMFIT main menu and browsing the test files.

Latin Square ANOVA Data ... see NAG routine G04ADF

```

10      5
 5      4      1      3      2
 2      5      4      1      3
 3      2      5      4      1
 1      3      2      5      4
 4      1      3      2      5
6.67  7.15  8.29  8.95  9.62
5.40  4.77  5.40  7.54  6.93
7.32  8.53  8.50  9.99  9.68
4.92  5.00  7.29  7.85  7.08
4.88  6.16  7.83  5.38  8.51
 7
  
```

- Line 1 title for this data set
- Line 2 number of rows then number of columns
- Line 3 first row of keys (using 1,2,3,... instead of A,B,C...)
- Line 7 last row of keys (using 1,2,3,... instead of A,B,C...)
- Line 8 first row of data values(corresponding to first row of keys)
- Line 12 last row of data values(corresponding to last row of keys)
- Line 13 number of rows of comments appended to data set

First of all note that there are two ways to represent Latin squares.

1. Using integers as in

```

 1  2  3
 2  3  1
 3  1  2.
  
```

2. Using characters as in

```

 A  B  C
 B  C  A
 C  A  B.
  
```

To create a SIMFIT data file for n by n Latin square ANOVA you first generate a n by n Latin square and save it to file. Then take the corresponding n by n data file, and copy and paste the Latin square (in integer format) into the data just before the first line of data. Finally you must change the dimension header from n into $2n$ n . For example, in the above test file the original line number two would have had 5 5 but, after pasting in the 5 by 5 Latin square, it would contain 10 5 to account for the doubling of the number of rows of data.

Theory

A Latin square is a n by n array of integers with the following properties.

1. Each row must contain the complete set of positive integers $1, 2, \dots, n$ in some order.
2. Each column must contain the complete set of positive integers $1, 2, \dots, n$ in some order.
3. No two rows can be identical and no two columns can be identical.

Sometimes characters or symbols are used, for instance alphabetical characters if $n \leq 26$ as in the following 4 by 4 standard cases.

A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
B	A	D	C	B	C	D	A	B	D	A	C	B	A	D	C
C	D	B	A	C	D	A	B	C	A	D	C	C	D	A	B
D	C	A	B	D	A	B	C	D	C	B	A	D	C	B	A

The way that SIMFIT generates a random Latin square is to start by generating the n by n formulation

$$\begin{pmatrix} 1 & 2 & 3 & 4 & \dots & n \\ n & 1 & 2 & 3 & \dots & n-1 \\ n-1 & n & 1 & \dots & \dots & n-2 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 2 & 3 & 4 & \dots & \dots & 1 \end{pmatrix}$$

with the indicated shifting. Then the rows and columns are shuffled and the option is provide to view or save the randomly generated Latin square. For $n \leq 26$ the alphabetical representation is also generated and appended to any examples that are written to files.

Rather surprisingly, there is no simple way to calculate the total number of permutations given n , but the following table will give some idea of the numbers involved.

n	Number
3	12
4	576
5	161250
6	812851200
7	61479419904000