

## RUNS

### PURPOSE

Perform a runs test for randomness.

### DESCRIPTION

This distribution free test is designed to test the hypothesis that a sample has been drawn at random. The data is assumed to be in sequential order. A sequential difference table is computed (that is  $Y_i - Y_{i-1}$ ). Positive values in this table indicate an increasing value, negative values indicate a decreasing value, and zero indicates a tie. A run up is defined as a consecutive series of positive values in this table (zero values continue the run) while a run down is defined as a consecutive series of negative (or zero) values.

A table is printed that lists the number of runs of given length, the expected number of runs, the standard deviation of the number of runs, and a Z score for the number of runs. The Z score is a standardized value that can be compared against a standard normal distribution (e.g., values greater than 1.96 and less than -1.96 would be considered statistically significant at the 5% level). The table is constructed for runs of varying length and for the following 6 cases:

1. The number of runs up of length exactly I
2. The number of runs up of length I or more.
3. The number of runs down of length exactly I.
4. The number of runs down of length I or more.
5. The number of runs up and down of length exactly I.
6. The number of runs up and down of length I or more.

### SYNTAX

RUNS <x1> <SUBSET/EXCEPT/FOR qualification>  
 where <x1> is the variable for which the runs test is to be performed;  
 and where the <SUBSET/EXCEPT/FOR qualification> is optional.

### EXAMPLES

```
RUNS Y1
RUNS Y1 SUBSET TAG > 0
```

### DEFAULT

None

### SYNONYMS

None

### RELATED COMMANDS

PROBABILITY PLOT	=	Generates a probability plot.
LET	=	Computes data transformations.
RUN SEQUENCE PLOT	=	Generates a run sequence plot.

### APPLICATIONS

Testing for randomness

### IMPLEMENTATION DATE

Pre-1987

## PROGRAM

```
LET = Y1 NORMAL RANDOM NUMBERS FOR I= 1 1 100
RUNS Y1
```

The following output is generated.

```

                RUNS UP
STATISTIC = NUMBER OF RUNS UP
                OF LENGTH EXACTLY I
  I          STAT      EXP(STAT)      SD(STAT)      Z
  1          22.0      20.8750      4.5760        0.25
  2           9.0       9.0500      2.3563       -0.02
  3           1.0       2.5736      1.4309       -1.10
  4           1.0       0.5548      0.7208        0.62
  5           0.0       0.0969      0.3091       -0.31
  6           0.0       0.0143      0.1194       -0.12
  7           0.0       0.0018      0.0427       -0.04
  8           0.0       0.0002      0.0143       -0.01
  9           0.0       0.0000      0.0046        0.00
 10          0.0       0.0000      0.0014        0.00
STATISTIC = NUMBER OF RUNS UP
                OF LENGTH I OR MORE
  I          STAT      EXP(STAT)      SD(STAT)      Z
  1          33.0      33.1667      2.9543       -0.06
  2          11.0      12.2917      1.9820       -0.65
  3           2.0       3.2417      1.5208       -0.82
  4           1.0       0.6681      0.7835        0.42
  5           0.0       0.1133      0.3336       -0.34
  6           0.0       0.0163      0.1276       -0.13
  7           0.0       0.0021      0.0453       -0.05
  8           0.0       0.0002      0.0151       -0.02
  9           0.0       0.0000      0.0048        0.00
 10          0.0       0.0000      0.0014        0.00
                RUNS DOWN
STATISTIC = NUMBER OF RUNS DOWN
                OF LENGTH EXACTLY I
  I          STAT      EXP(STAT)      SD(STAT)      Z
  1          21.0      20.8750      4.5760        0.03
  2           5.0       9.0500      2.3563       -1.72
  3           4.0       2.5736      1.4309        1.00
  4           1.0       0.5548      0.7208        0.62
  5           1.0       0.0969      0.3091        2.92
  6           0.0       0.0143      0.1194       -0.12
  7           0.0       0.0018      0.0427       -0.04
  8           0.0       0.0002      0.0143       -0.01
  9           0.0       0.0000      0.0046        0.00
 10          0.0       0.0000      0.0014        0.00
STATISTIC = NUMBER OF RUNS DOWN
                OF LENGTH I OR MORE
  I          STAT      EXP(STAT)      SD(STAT)      Z
  1          32.0      33.1667      2.9543       -0.39
  2          11.0      12.2917      1.9820       -0.65

```

3	6.0	3.2417	1.5208	1.81
4	2.0	0.6681	0.7835	1.70
5	1.0	0.1133	0.3336	2.66
6	0.0	0.0163	0.1276	-0.13
7	0.0	0.0021	0.0453	-0.05
8	0.0	0.0002	0.0151	-0.02
9	0.0	0.0000	0.0048	0.00
10	0.0	0.0000	0.0014	0.00

RUNS TOTAL = RUNS UP + RUNS DOWN  
 STATISTIC = NUMBER OF RUNS TOTAL  
 OF LENGTH EXACTLY I

I	STAT	EXP(STAT)	SD(STAT)	Z
1	43.0	41.7500	6.4714	0.19
2	14.0	18.1000	3.3323	-1.23
3	5.0	5.1472	2.0236	-0.07
4	2.0	1.1095	1.0194	0.87
5	1.0	0.1939	0.4372	1.84
6	0.0	0.0286	0.1688	-0.17
7	0.0	0.0036	0.0604	-0.06
8	0.0	0.0004	0.0203	-0.02
9	0.0	0.0000	0.0064	-0.01
10	0.0	0.0000	0.0019	0.00

STATISTIC = NUMBER OF RUNS TOTAL  
 OF LENGTH I OR MORE

I	STAT	EXP(STAT)	SD(STAT)	Z
1	65.0	66.3333	4.1780	-0.32
2	22.0	24.5833	2.8030	-0.92
3	8.0	6.4833	2.1508	0.71
4	3.0	1.3361	1.1081	1.50
5	1.0	0.2266	0.4718	1.64
6	0.0	0.0327	0.1805	-0.18
7	0.0	0.0041	0.0641	-0.06
8	0.0	0.0005	0.0214	-0.02
9	0.0	0.0000	0.0068	-0.01
10	0.0	0.0000	0.0020	0.00

LENGTH OF THE LONGEST RUN UP = 4  
 LENGTH OF THE LONGEST RUN DOWN = 5  
 LENGTH OF THE LONGEST RUN UP OR DOWN = 5

NUMBER OF POSITIVE DIFFERENCES = 47  
 NUMBER OF NEGATIVE DIFFERENCES = 52  
 NUMBER OF ZERO DIFFERENCES = 0