Determining the significance of an observed F using a pocket calculator

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The F test is the procedure for determining the significance of differences among samples of populations which is perhaps the most frequently used by behavioral scientists, and tables of critical values for this test are widely available. However, occasionally an investigator may find the tabled values inadequate for his or her purposes. If an observed F is marginally significant, an investigator may have to interpolate among tabled values to conduct the test precisely. Furthermore, multivariate procedures may yield F statistics with noninteger degrees of freedom, which are rarely tabled. Finally, when calculating the power of an F test, it is necessary to determine the probability density function of a noncentral F, yet the available tables of noncentral F distributions (e.g., Tiku, 1967) are limited in scope.

The availability of sophisticated pocket calculators at a reasonable cost has made it possible for researchers to readily determine the significance of an observed F, in these cases and in others, with a high degree of precision. The keystroke program presented below yields a unit normal value with a significance equivalent to the observed F, given the numerator and denominator degrees of freedom, and the noncentrality parameter, λ . (In the case of the central F, the program is used with $\lambda = 0$.) The program is based on National Bureau of Standards approximation formulas (Abramowitz & Stegun, 1966, Formulas 26.6.15 and 26.6.26), which yield a maximum error in the significance level of .0005 in the case of the central F, and an error generally less than .005 in the noncentral case. The z value that results from the program may be entered into programs for calculating the corresponding probability, generally supplied with such calculators (e.g., Hewlett-Packard, 1975), or compared to the critical values for z. (The two or three commonly used critical z values may be committed to memory, eliminating reliance on tables.)

The program is presented in Table 1. Although it was developed on a Hewlett-Packard HP-25 programmable calculator, it may also be used with nonprogrammable calculators that use Reverse Polish Notation and have at least four memory locations and the necessary data-handling capabilities by following the keystroke routine manually.

The program is used as follows: (1) With the calculator in the program mode, enter the program. (2) Switch to the run mode and enter the observed F statistic, the numerator degrees of freedom, the denominator degrees of freedom, and the noncentrality parameter into Memory Locations 1, 2, 3, and 4,

Table 1
Program to Determine the Significance of an Observed F

Step	Key-strokes	Step	Key-strokes	Step	Key-strokes
01	RCL 2	17	STO 3	33	1
02	STO $\times$ 1	18	1	34	—
03	RCL 4	19	$x \leftrightarrow y$	35	+
04	+	20	—	36	RCL 1
05	STO $\div$ 1	21	RCL 1	37	2
06	STO 2	22	3	38	ENTER $\uparrow$
07	STO $\times$ 2	23	1/x	39	3
08	RCL 4	24	y^x	40	$\div$
09	+	25	x	41	y^x
10	STO $\div$ 2	26	RCL 2	42	RCL 3
11	RCL 3	27	9	43	x
12	9	28	x	44	RCL 2
13	x	29	2	45	+
14	2	30	$x \leftrightarrow y$	46	$\sqrt{x}$
15	$x \leftrightarrow y$	31	$\div$	47	$\div$
16	$\div$	32	STO 2		

respectively. To use the central F distribution, be sure that zero is stored in Location 4, and that data from a previous problem does not remain there instead. (3) Run the program. At the end of execution, the display contains a z score with a probability equivalent to the observed F. To verify the answer or solve additional problems, return to Step 2 above. The program will accept any positive values for the observed F and the degrees of freedom, and any nonnegative value for λ .

Example 1. What is the significance of $F(1.5, 4.25) = 7.035$?

To solve this problem, data values are stored in the calculator memory locations as follows (1) 7.035, (2) 1.5, (3) 4.25, (4) 0.00. At the end of program execution, the display contains 1.653076322. This z statistic exceeds the critical z value of 1.645, and hence is significant at the .05 level. The actual probability associated with the obtained z statistic is .04916. It should be noted that even assuming the maximum error in significance of .0005, the significance level is still less than .05. In contrast, interpolation among the commonly tabled critical F values yields a critical F statistic of 7.04 at the .05 level, which would result in the decision that the observed F is nonsignificant, with α set at .05.

Example 2. Using the noncentral F distribution defined by 3 and 10 degrees of freedom and $\lambda = 4$, what is the area under the right tail beyond $F = 3.708$?

Data values for this problem are stored in the memory locations as follows: (1) 3.708, (2) 3.0, (3) 10.0, (4) 4.0. The resulting display value is 0.674342506. From a table of the unit normal distribution, an estimate of the right-tail area of .251 may be obtained. This is a close approximation to the exact solution, which is .254.

REFERENCES

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