The calculation of the significance level of F, t, and r on the Apple II

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The program FSIG was written for use with the Apple II to compute the significance level of F ratios. The program can also be used to compute the significance levels of the results of t tests (t) and correlations (r) using the relationships of $F_{1,df} = t^2_{df}$ for t and $F_{1,df} = [(r\sqrt{df})/\sqrt{1-r^2}]^2$ for r.

Description. The BASIC program presented in Figure 1 is a translation and modification of FORTRAN

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10 PRINT "F, T & CORRELATION": PRINT "SIGNIFICANCE LEVEL CALCU
LATOR": PRINT
20 RR = 0: FF = 0: TT = 0: INPUT "F, T OR R-->": AN$
27 REM
28 REM SELECT RATIO TYPE TO BE
29 REM EVALUATED BY FSIG
30 IF AN$ = "T" THEN TT = 1
40 IF AN$ = "R" THEN RR = 1
50 IF AN$ = "F" THEN FF = 1
57 REM
58 REM CHECK FOR INCORRECT
59 REM SELECTION
60 IF TT = 0 AND RR = 0 AND FF = 0 THEN PRINT "PLEASE ANSWER
CORRECTLY--F, T OR R": GOTO 20
67 REM
68 REM IF T OR R THEN SET
69 REM NUMERATOR TO 1
70 IF (TT) OR (RR) THEN PRINT "NUMERATOR SET TO 1": DA = 1
77 REM
78 REM IF F-RATIO, THE GET
79 REM VALUE FOR NUMERATOR
80 IF FF THEN INPUT "ENTER NUMERATOR DF-->": DA
87 REM
89 REM GET DENOMINATOR & RATIO
90 INPUT "ENTER DENOMINATOR DF-->": DB
100 INPUT "ENTER RATIO TO BE EVALUATED-->": FR
107 REM
108 REM CHECK FOR INVALID ENTRY
109 REM FOR CORRELATION (R)
110 IF RR AND (FR < -1 OR FR > 1) THEN PRINT "CORRELATION
CANNOT EXCEED +-1": GOTO 100
118 REM
119 REM CONVERT T TO F
120 IF TT THEN FR = FR * FR
128 REM
129 REM CONVERT R TO F
130 IF RR THEN FR = (FR * SQR (DB)) / SQR (1 - FR * FR): FR
= FR * FR
137 REM
138 REM CALCULATE SIGNIFICANCE
139 REM & PRINT THE RESULT
140 GOSUB 500
150 PRINT "SIG OF "AN$;"="PRBF
160 PRINT: INPUT "MORE?"AN$: IF LEFT$(AN$,1) < "N" GOT
O 20
170 END
489 REM
490 REM F PROB FUNCTION
491 REM DA=NUMERATOR DF
492 REM DB=DENOMINATOR DF
493 REM PRBF=F-RATIO
494 REM
500 PRBF = 1: IF DA * DB * FR = 0 THEN RETURN
510 A = DA: B = DB: F = FR
520 IF FR < 1 THEN A = DB: B = DA: F = 1 / FR
530 AA = 2 / (9 * A): BB = 2 / (9 * B)
540 Z = ABS (((1 - BB) * F + (1 / 3)) - 1 + AA) / SQR ((BB
* F + (2 / 3)) + AA)
550 IF B < 4 THEN Z = Z * (1 + .08 * (Z * Z * Z * Z) / (B * B
* B))
560 PR = .5 / (1 + Z * (.196854 + Z * (.115194 + Z * (.000344
+ Z * (.019527)))) + 4
570 IF FR < 1 THEN PRBF = 1 - PRBF
580 RETURN
1000 REM BY TODD OGASAWARA
```

Figure 1. FSIG implemented in APPLESOFT BASIC. This listing contains instructions common to all versions of MICROSOFT BASIC 4.51 and up. Note that APPLESOFT BASIC calculates with nine digits of precision, whereas Z-80 versions of MICROSOFT BASIC have a default precision of six digits.

Table 1
Accuracy of FSIG

df ₁	df ₂	F Value	Tabled Value	SAS FPROB	FSIG
1	11	19.69	.001	.00099	.00128
2	6	27.00	.001	.00100	.00158
2	20	6.99	.005	.00490	.00522
3	3	141.00	.001	.00100	.00111
3	9	13.90	.001	.00100	.00138
3	13	10.21	.001	.00100	.00130
3	16	4.08	.025	.02493	.02460
8	18	3.71	.01	.00994	.01007
12	3	14.30	.025	.02509	.02562
12	9	9.57	.001	.00100	.00148
12	25	2.51	.025	.02524	.02507
20	5	1.88	.25	.25040	.24865
24	15	5.10	.001	.00100	.00134
24	26	1.95	.05	.04954	.04938
24	120	2.09	.005	.00498	.00517
40	50	1.59	.05	.05098	.05079
120	120	1.61	.005	.00479	.00497

functions presented by Jaspens (1965) and Veldman (1967). It is a stand-alone program. However, the subroutine beginning at Line 500 may be used in other programs. Before going to the subroutine, DA should contain the degrees of freedom in the numerator, DB should contain the degrees of freedom in the denominator, and FR should contain the F ratio (or transformed t or r) to be evaluated. The significance level will be returned in the variable PRBF.

Accuracy. The accuracy of the significance levels obtained from the program was checked by comparing a random sampling of tabled critical values of the F distribution (Rohlf & Sokal, 1969) and the results of the PROBF function in SAS (Helwig & Council, 1979) running on an IBM 370/158 at the University of Hawaii Computing Center with the results of the program FSIG. Table 1 presents a few of the comparisons. Due to the way floating-point numbers are represented internally in the Apple II and other microcomputers, the precision of the result of calculation is not at any single fixed decimal place. Rather, for this particular series of calculations, the result is accurate to the decimal place following the last of the series of zeros to the right of the decimal. For most results, this translates to an accuracy to the third or fourth decimal place.

Language and Computer. The program is written in APPLESOFT BASIC, a variant of MICROSOFT BASIC, on an Apple II. However, any computer MICROSOFT BASIC or any other BASIC with floating-point arithmetic (e.g., the TRS-80 Model I or Model III) can use the program without modifications. Further, due to the avoidance of GOTOs in the subroutine that calculates the significance level, the subroutine may be renumbered for use in another program without any changes. The program (less REMarks) occupies 843 bytes; the subroutine alone occupies 281 bytes.

REFERENCES

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- JASPEN, N. The calculation of probabilities corresponding to values of z, t, F, and chi-square. *Educational and Psychological Measurement*, 1965, **25**, 877-880.
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- VELDMAN, D. J. *FORTTRAN programming for the behavioral sciences*. New York: Holt, Rinehart & Winston, 1967.

(Accepted for publication August 7, 1982.)