# Two Computer Programs for Predicting Exponential Observables

by

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This note records and describes two computer programs used to evaluate quantities in Geisser (1981) and Geisser (1982). Specifically, the first program (Figure 1) gives values of $\Pr[\overline{Y} \geq \frac{r}{M}]$ when values of M, r, d, y, and $N\overline{x}$ are provided, and where the listed quantities M through $N\overline{x}$ are defined in Geisser (1981). The probability $\Pr[\overline{Y} = \frac{r}{M}]$ is computed using equation (4.3) of Geisser (1981). The second program (Figure 2) computes $\Pr[\overline{Y} \leq \frac{r}{M}|z]$ when $m < z$ using equation (2.24) of Geisser (1982). The program requests input of N, M, r, $\overline{x}$, z, d, and m, where these quantities are defined in Geisser (1982).

Both programs use the function COMB to compute the combinatorial quantity $\binom{M1}{M2}$ in a stable manner. This function is given in Figure 3.

Some cautionary notes are in order. It was necessary to use DOUBLE PRECISION for most of the calculations to avoid round-off error. As well, when these programs were run at the University of Minnesota, it was possible (in DOUBLE PRECISION) to use a 120 bit word length, yielding about 28 significant digits for calculating. Even at that, difficulties arising from round-off errors were noted when running the first program for large M (above 40) and for small r (roughly, $r < M/2$). The user is advised to check answers obtained from these programs against the approximations provided in (Geisser, 1981, Section 4) and (Geisser, 1982, Section 3).

Please note that this code is not protected against the entry of invalid parameters. It is up to the user to ensure that $0 < r < M$, $N\overline{x} \geq 0$, d is an integer, $y \geq 0$, and so on. Failure to do so will result in nonsensical results or fatal errors.

The programs listed here are written to conform to FORTRAN 77 standards. Users of a different version of FORTRAN may need to remove the structured IF statements from the function COMB.

Any questions regarding these programs may be addressed to Murray Clayton at the University of Guelph.

<u>FIGURE 1</u>

```
DOUBLE PRECISION YT, S, PAR, COMB, T, DUM
PRINT*, "INPUT   M, R, D, Y, AND N TIMES XBAR"
READ*, M, R, D, Y, SUM
YT = Y/SUM
SUMO = 0.0D + 0
DO 9000 K = R, M
SUMI = 0.0D + 0
DO 9001 IJ = 1, M - K + 1
J = IJ - 1
PAR = -1.0D + 0
IF((J/2)*2.EQ.J)PAR = 1.0D + 0
DUM = FLOAT(K+J)
SUMI = SUMI + COMB(M-K,J)*PAR/((1.0D+0+YT*DUM)**IFIX(D))
9001 CONTINUE
SUMO = SUMO + COMB(M,K)*SUMI
9000 CONTINUE
PRINT*, "PROBABILITY IS   ", S
STOP
END
```

FIGURE 2

```
 DOUBLE PRECISION  ZM, NXM, PAR, SUMI, SUMO, COMB, RPJ, NPRPJ
 INTERGER M, N, S, R
 REAL MIN
 PRINT*,"INPUT N,M(i.e. THE NUMBER OF FUTURE VALUES), R, XBAR, Z, D,
+     AND THE MINIMUM OF ALL VALUES IN THE SAMPLE (LOWER CASE M
+     IN GEISSER(1982))"
 READ*, N, M, R, XB, Z, D, MIN
 ZM = Z-MIN
 NXM = FLOAT(N)*(XBAR-MIN)
 SUMO = 0.0D + 0
 DO 9000 IK = 1, R + 1
 K = IK - 1
 SUMI = 0.0D + 0
 DO 9001 IJ = 1, M - K + 1
 J = IJ - 1
 RPJ = FLOAT(K+J)
 NPRPJ = FLOAT(K+J+N)
 PAR = -1.0D + 0
 IF ((J/2)*2.EQ.J)PAR = 1.0D + 0
 SUMI = SUMI + COMB(M-K,J)*PAR/(NPRPJ*(1.0D+0+RPJ*ZM/NXM)
      **(IFIX(D)-1))
 9001 CONTINUE
 SUMO = SUMO + FLOAT(N)*COMB(M,K)*SUMI
 9000 CONTINUE
 PRINT*, "PROBABILITY IS   ", SUMO
 STOP
 END
```

FIGURE 3

```
DOUBLE PRECISION FUNCTION COMB(M1,M2)
FUNCTION COMB(M1,M2)
DOUBLE PRECISON COMB, COMB1, COMB2, P
IF(M2.EQ.0)THEN
     COMB = 1.0
     RETURN
ENDIF
IF(M1.EQ.0)THEN
     COMB = 1.0
     RETURN
ENDIF
LCOMB1 = M1
LCOMB2 = M2
P = 1.0D + 0
1111 COMB1 = FLOAT(LCOMB1)
COMB2 = FLOAT(LCOMB2)
P = COMB1/COMB2*P
LCOMB1 = LCOMB1 - 1
LCOMB2 = LCOMB2 - 1
IF(LCOMB2.GE.1)GOTO 1111
COMB = P
RETURN
END
```

## REFERENCES

Geisser, S. (1981). Aspects of the Predictive and Estimative Approaches in the Determination of Probabilities. University of Minnesota Technical Report No. 385.

Geisser, S. (1982). Predicting Pareto and Exponential Observables. University of Minnesota Technical Report No. 408.