**SENSE: A program for calculating parametric
(d') and nonparametric (A' and Ag)
indexes of sensitivity**

ARTHUR D. FISK, WALTER SCHNEIDER,
and JOHN C. BURKHARD

Human Attention Research Laboratory
Department of Psychology, University of Illinois
Champaign, Illinois 61820

The present program provides the user with the capability of computing a parametric sensitivity measure, d' (and the corresponding criterion measure, β), in addition to the more distribution-free measures A' (see Craig, 1979; Norman, 1964) and Ag (see Pollack, Norman, & Galanter, 1964). The primary benefit of the program is that the sensitivity measures can be obtained singularly or all can be output in one run (for comparison). For a given sensitivity measure, the individual subjects' data are output with subjects being the slowest changing variable. That is, values are output for all experimental conditions (in ascending order) for the first subject, then the next, and so on. Following output of the individual subject data, marginal values (averages) are output for subjects and experimental conditions.

The calculation of d' is based on an algorithm presented by Emerson (1979) that uses Hastings' (1955) formula. The d' algorithm takes the input hit and false alarm (FA) values (for a given subject and experimental condition) and converts them to the corresponding Z scores. The β value is obtained by dividing the hit Z score by the FA Z score.

A' is given by the formula $A' = 1 - .25[P(FA)/P(HIT) + P(1 - HIT)/P(1 - FA)]$, and the Ag measure is based on the formula $Ag = [P(HIT) + P(1 - FA)]/2$. Note that A' can be calculated when hit is 1.0 and FA is 0 and Ag returns a value for any valid corresponding hit and FA values. The d' metric is, of course, indeterminate when either hit or FA probabilities are 1.0 or 0.

Input. The user must create a data file containing the percentage of hits and FAs for each subject and each condition. Each input data line must include the subject number, the experimental condition number, percent hit, and percent FA. The subject and experimental condition must be integer values, and the percentage hit and FA values must be decimal (real). The data line values are entered in free format. Although values on each data line must be in the prescribed order, the data lines need not be input in any specified order (e.g., Subject 3, Condition 10 may precede Subject 1, Condition 1).

When running the program, the user is asked to enter the name of the data file, the maximum subject number,

the experimental condition number used, and finally, the sensitivity measure(s) desired. There is no requirement for an equal number of subjects in each experimental condition, and the experimental conditions need not all occur (to the maximum specified).

If any input value is out of range (e.g., subject number greater than the maximum specified subject number, hit less than zero, etc.), the program prints an error message, specifies the line in which the error was encountered, and outputs the bad line. Program execution is terminated when an input error is encountered.

Output. The program outputs the desired sensitivity measures for each subject and each experimental condition. The marginal values for each subject and condition are also output, with the number of conditions or subjects on which each average is based. If a sensitivity measure cannot be calculated for a given subject (e.g., zero FA rate when d' is to be calculated), a -99 is output for that subject.

Limitations. The program size is primarily dependent on the product of the maximum subject $\times$ experimental conditions. Presently, the program is set to allow the subject $\times$ experimental condition product to be up to 400 and requires 10.37K words. However, this limitation can be easily modified by altering the dimension of the data array. Program documentation explains this change. Since the data array is dynamically allocated, there is no set limit on the number of subjects or experimental conditions, except that their product may not exceed the maximum dimension of the data array.

Language, Computers, and Availability. The program is written in RATFOR, FORTRAN, and BASIC. Versions of the program are available for DEC RT-11-based systems and CP/M 2.X with 44 KB minimum, as well as Apple II+ with 48 KB and one disk drive. Program listings and a sample run (input and output) are available from the second author. Please specify the language and machine version desired.

REFERENCES

- CRAIG, A. Nonparametric measures of sensory efficiency for sustained monitoring tasks. *Human Factors*, 1979, 21, 69-78.
EMERSON, P. L. Computer approximation of the inverse of the normal distribution function. *Behavior Research Methods & Instrumentation*, 1979, 11, 397-398.
HASTINGS, C. *Approximation for digital computers*. Princeton, N.J.: Princeton University Press, 1955.
NORMAN, D. A. A comparison of data obtained under different false-alarm rates. *Psychological Review*, 1964, 71, 243-246.
POLLACK, I., NORMAN, D. A., & GALANTER, E. An efficient nonparametric analysis of recognition memory. *Psychonomic Science*, 1964, 1, 327-328.

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