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PSYCHOLOGY AND THE COMPUTER IN THE PHILIPPINES

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Much psychological research requires the analysis of a considerable body of data, and prior to the development of digital computers it was often true that the major task for the researcher was not the planning and execution of his investigation, but the analysis of the data. The purpose of this article is to summarize briefly a series of computer programmes which are available to psychologists and other researchers in the Philippines.

A knowledge of computer programming or computer technology is not required in order to use these programmes. All that is necessary is an understanding of the statistical technique required so that results can be readily interpreted.

A computer program consists of a series of statements written in some computer language which directs the computer to input data, make calculations, and output answers. The programs described below were written in Fortran IV, level E, and are available from the Computing Center, University of the Philippines, either in their Fortran form, or as object decks (a series of cards containing the instructions in a more basic machine language). As presently used, these programs consist of a series of punched cards which are read into the computer just prior to the data to be analyzed. Although these programmes were written for the IBM 360 installations at the University of the Philippines, they can be used on any computer with little, if any, modifications. The major modification which might be required is an adjustment to the dimensions for computers with less than 64,000 bytes of memory.

The descriptions to follow refer specifically to the purpose of each program, the information which is required by the computer to perform the analysis, and the way the data must be prepared. In general there are also other requirements needed to execute any computer program, but these are specific to the computer installation and not the program. As a rule, the order of input to the computer will be as follows:

EDITOR'S NOTE: While Dr. Gardner's article is not a scientific report, it was felt that the various computed programmes described in it would be of great interest to psychologists who have to work with data in a statistical form. It is for this reason that this article appears in the PJP.

The writer would like to express his appreciation to Mr. D. M. Taylor, International Exchange Graduate Student at the Language Study Center, for his assistance, and actual writing of some of the programs to Miss Emma H. Santos, a faculty member of the Philippine Normal College, for helping to make them functional, and to the many graduate students and faculty at PNC whose research needs dictated which programs should be written.

The programs were developed through a grant of Computer time provided by the University of the Philippines, and were run many times, with errors being eliminated, with the assistance of funds provided to the Language Study Center by the Ford Foundation. The writer is a Ford Foundation Consultant from the University of Western Ontario, London, Canada.

1. Control Cards
2. Program
3. Control Cards
4. Parameter Card
5. Data Cards
6. Control Cards

Items 1, 3, and 6 above will be determined by the computer installation being used. Item 2 is the program and can be obtained from the computing Center, University of the Philippines, or from the Language Study Center, Philippine Normal College. Items 4 and 5 are information which the user must supply in the form of punched IBM cards. The descriptions to follow indicate how this material should be prepared. A note of caution must be made here. Parameter and data card preparation must be exact, otherwise the program may not be executed, or worse still, the results may be in error. There is a computer adage, *garbage in, garbage out* (abbreviated, GINGO) which simply means that the meaningfulness and validity of the answers provided depend upon the meaningfulness and validity of the material fed into the computer.

Following are descriptions of a series of computed programs which will handle most statistical and data analysis problems required by psychologists and social scientists. It is important to note that because of limitations of memory capacity on the computer, these programs are written in fixed format. That is, all data are read in rigid card column specifications. Anyone familiar with programming can easily change these specifications by altering the format card associated with the data-read statement, but this should be done on a copy of existing programs and not the ones available in either the UP or PNC program library. Most of the programs have been written to do multiple jobs without the necessity of reading the program into the machine each time. In order to do extra jobs, it is necessary only to add data for subsequent jobs after the first set of data, beginning each time with the parameter cards.

CORRELATION PROGRAM — WITH MISSING OBSERVATIONS
CODE NAME — VOID R

General Description. This program computes Pearson product-moment correlation coefficients for all possible pairs of variables. A discussion of the Pearson product-moment correlation coefficient is available in most textbooks of statistics; one particularly good source is Ferguson (1966). The maximum number of variables (observations per subject) which can be analyzed is 51; the maximum number of subjects is 99,999. The program allows for missing observations in the calculation of the correlation coefficients so that the various correlation coefficients can be based on unequal sample sizes. The value to be used to signal a missing observation is read in on the parameter card (see below); when the machine finds this value for an observation, it ignores the subject concerned in the calculation of that coefficient. The program does multiple jobs, and always ends on an input (code IHC-2171) error.

Parameter Card. Five values (parameters) are required by the computer to execute this program. These parameters are punched on one card, and this card precedes the data cards. The parameters and their locations on the parameter card are as follows:

Columns 4-5: The number of variables (observations). The maximum value permitted is 51.

Columns 6-10: The number of subjects. A maximum number of 99,999 is permitted.

Columns 11-15: The value used to indicate missing observations in the data. It can take any value, as long as that value is used to indicate a missing observation in the data. For example, if "-1" were punched in Columns 14-15 of this card, this would result in all observations of "-1" to be considered missing observations. If columns 11-15 on this card are left blank, this would result in all observations with values of zero or blank to be considered as missing observations.

Columns 16-20: This number is used to indicate to the machine that some of the input data is to be written out, so that the user can check to make sure that the computer is calculating correlations on the correct data. The machine will print out the data for as many subjects as indicated by this value. If this value is left blank, none of the subjects' data will be printed; if its value is 1 the first subject's data will be printed; if 5, the first five subjects' data will be printed, and so on. If the value is the same as that indicated in columns 6-10, all subjects' data will be printed.

Column 25: This value is used to signal to the machine that the user does not want the matrix of correlation coefficient to be punched on cards. The matrix *will not be punched* if a "1" is punched in this column; if the matrix is required on cards (as it would be if it was intended to conduct a factor analysis), this column should be left blank.

Data Input. The data are input by subjects. That is, all the observations for the first subjects are read in, followed by all the observations for the second subject, and so on. The data must be punched for each subject:

Columns 1-8: These columns are used to identify the subject, and are not read by the computer.

Columns 9-14: Value for Variable 1.

Columns 15-20: Value for Variable 2.

Columns 21-26: Value for Variable 3. etc.

Columns 75-80: Value for Variable 12.

This same format would be followed for Variables 13-24, 25-36, 37-48, and 49-51. Thus, if for example there were 38 variables, each subject would have four cards containing his data, the last card ending in Column 20. It will be noted that the values are punched in six column fields. The machine assumes that these are whole numbers unless a decimal point is punched. Thus, to indicate a value of 172 in columns 9-14 of a data card, one would punch 1 7 2 in columns 12, 13 and 14. If a value like 36.4 were to be indicated this would be punched as 36.4 in columns 11, 12, 13, and 14.

Output. Before the results of the calculations are written out, the machine will print out the input data for as many subjects as indicated in columns 16-20 of the parameter card. These data will be printed 12 per line in ten-column fields, with two decimal places for each value. Following this, and beginning on a new page, the program will print out information concerning each possible pair of variables in one line. The information is labelled at the top of the first page of output as follows: Variables, Correlation, Mean 1, Variance 1, Mean 2, Variance 2, and *N*.

Unless the card output for the correlation matrix has been omitted (as indicated on the parameter card), the matrix of correlations will also be punched on cards in 10 seven-column fields per variable. The matrix will be punched as a square matrix (i.e., the correlations of each variable with every variable); the correlation of a variable with itself is indicated as 1.0000.

CORRELATION PROGRAM — WITH NO MISSING OBSERVATIONS CODE NAME: NO VDR

General Description. For a good discussion of correlation, see Ferguson (1966). This program performs the same function as that described above, *viz.*, the calculation of all possible Pearson product-moment correlation coefficients, except that it does not allow for the occurrence of missing observations. Since there are fewer calculations required, this program will permit up to 80 variables and 99,999 subjects. This program does multiple jobs and always terminates on an input (IHC-2171) error.

Parameter Card. Four values (parameters) are required for the execution of this program, and are specified in the parameter card as follows:

Columns 4-5: The number of variables (observations). This value must be greater than one and less than or equal to 80.

Columns 6-10: The number of subjects. The maximum value permitted is 99,999.

Columns 11-15: The number of subjects for which it is desired that the machine list the input data. A value of 1 will cause the machine to print out the data for the first subject; a value of 10, 10 subjects, and so on. A value of zero or blank will result in no input data being printed.

Column 20: Punch 1 if you do *not* want the correlation matrix punched on cards. Any other value including blank will cause the correlation matrix to be punched out. Ordinarily, the punch-out of the correlation matrix will be required if it is planned to carry out a factor analysis of the correlation matrix.

Data Input. The data input is the same as that described above for the VOID R program.

PRINCIPAL AXIS FACTOR ANALYSIS CODE NAME: FAST

General Description. The Principal Axis factor analysis is discussed in detail in any book concerned with factor analysis (see Harmon, 1966). This program, adapted from Horst (1966), performs a factor analysis of a correlation matrix, using a Jacobi-Kelly transformation, which extracts factors successively until a given criterion (based on the minimum squared eigenvalue) has been achieved. The program starts with a correlation matrix (which

Columns 1-8: This number is read in F8.6 format (eight digits, the last six of which are decimal values), and represents the lowest eigenvalue for which factors are desired. In much research, the lowest eigenvalue considered acceptable is 1.000000 which here would be represented as a 1 in Column 2 and zeroes in columns 3-8. The program is written so that one factor more than that indicated by this value is calculated and output. This value must be positive.

Columns 11-12: The number of variables in the correlation matrix. The number cannot exceed 60.

Column 16: This number is used to indicate the communality estimate (diagonal elements in the correlation matrix) to be used. There are three possibilities as indicated by the following three numbers punched in this column:

0. The highest absolute correlation in any row will be selected by the computer as the communality estimate.
1. The computer will insert ones as the communality estimates.
2. The computer will use the diagonal elements (i.e., the correlation of each variable with itself) as the communality estimate.

Data Input. The data cards contain a square matrix of correlation coefficients, punched by variable, seven coefficients per card in ten-column fields. This, it should be noted, is identical with the way in which the correlation matrix is punched out by the Correlation Matrix programs.

Output. The printed output consists of the following:

a. Correlation Matrix. This matrix will be the same as that read in, except that the values are written only to two significant digits. Also, the diagonal values will be the communality estimates as indicated on the parameter card.

is typically an output from either of the correlation matrix programs) and computes a principal axis factor matrix. Generally in psychology, this factor matrix is not the one which is interpreted, and is considered only as an intermediate calculation which must be used in obtaining a matrix following rotation by means of the Varimax solution. Consequently, the factor matrix computed by this program is punched on cards to be used as input to the Varimax Rotation Program. The maximum number of variables permitted in this program is 60.

Parameter Card. The parameters for any given run are punched on one card in the following columns, right adjusted.

b. Sum of the eigenvalues.

c. Principal Axis Factor Matrix. Following the heading, the eigenvalues for the first twelve factors are written, under which are the number of iterations required to define each factor. Below this is written the factor numbers followed by a series of print lines containing the variable numbers and the factor loadings. If there are more than 12 factors, the whole procedure starting with the eigenvalues will be repeated for each new set of 12 factors or less.

The punched output consists of the factor loadings punched out by variable 12 per card in six-column fields. These cards are used as input to the Varimax Rotation Program.

VARIMAX ROTATION PROGRAM CODE NAME: VARMAX

General Description. For a complete discussion of the varimax rotation solution, see Harmon. This program performs an orthogonal rotation of the axes of a factor matrix according to the specifications outlined by Kaiser (1958), and described in Harmon (1966). This type of rotational system is most common in factor analytic research and has as its major criterion the rotation of axes so that the sum of the variances of the squared factor loadings on each factor is a maximum. The restriction of orthogonality (i.e., the independence of the axes or factors) is maintained throughout. the maximum number of variables permitted is 60; the maximum number of factors is 60.

Parameter Card. Four parameters are punched on one card in the following columns, right adjusted.

Columns 2-3: The number of variables in the matrix. The maximum number is 60.

Columns 5-6: The number of factors in the matrix. The maximum number permitted is 60, though usually the number of factors is much less than the number of variables.

Column 9: This is a control parameter used to indicate whether a varimax or normalized varimax solution is required. Punch 0 (zero) if a normalized varimax solution is required. This is the solution most often used in psychological research, and is now commonly referred to as the Varimax solution. Punch 1 if a non-normalized varimax solution is required. This is not commonly used (see Kaiser, 1958).

Columns 10-19: This value is read in F10.6 format and indicates the amount of tolerance allowed in the increase in the variance of the squared factor loadings which will be considered as no appreciable increase. Typically this is punched as 100 in columns 17-19. This results in a tolerance level of .0001 and is interpreted by the machine as indicating that when the variance of squared factor loadings increases by .0001 or less, a satisfactory solution has been achieved.

Column 20: This parameter is used to signal to the machine whether or not the rotated factor matrix should be punched on cards. Punch 0 if the punched rotated factor matrix is required, otherwise, punch 1. Generally the punched rotated factor matrix will *not* be required unless the researcher wants to use the matrix in the factor matching program (see below) to assess the similarity of two factor matrices.

Data Input. The data cards contain the factor matrix punched by variable, twelve factor loadings per card in six column fields. This, it should be noted, is identical to the output from the Principal Axis Factor Analysis Program.

Output. The programs print out the following information:

a. Original matrix. This is the factor matrix which was read in, and is printed by variable for the number of factors specified on the parameter card. It is important to check this matrix to ensure that it is identical to the factor matrix which was to have been rotated.

b. Criteria for each iteration. The criteria for each iteration are printed beginning with the second complete rotation. These criteria are the variances of squared factor loadings for the present rotation, the previous one and the test, which is the sum of the previous criterion plus the tolerance level indicated on the parameter card. Rotations are stopped when the present variance (criterion) is equal to or greater than the test criterion.

c. Communalities. The communalities (sum of the squared factor loadings for each variable) for both the original factor matrix and the rotated matrix, and the difference between these two, are written. These values should be checked to ensure that no communality exceeds 1.000, and that each difference is zero or near zero. If either condition is not satisfied, it is indicative of either a machine error, a program error, or a fault in the reading of the original matrix. It is possible that if a communality exceeds 1.00 that too many factors have been rotated, or possibly that there is an error in either the correlation matrix (values exceed 1.00) or the principal axis factor matrix.

d. Varimax Matrix. This is the matrix of rotated factor loadings which would normally be interpreted. This matrix is output by variable, with up to 12 factors per line. The number of each factor appears above the column of factor loadings. If more than 12 factors are being rotated, subsequent sets of up to 12 factors each will be printed out following the first set of factor loadings, with the factor numbers appearing above each set.

The factor matrix will also be punched on cards if this is indicated on the parameter card.

FACTOR MATCHING
CODE NAME: MATCH

General Description. This program computes indices of factor similarity between two factor matrices using the method of Wrigley and Neuhaus (1955) as described in Harmon (1967, p. 270). The data input consists of two factor matrices with the same variables in each, but the number of factors in each matrix may differ. In each matrix, the maximum number of variables permitted is 60, the maximum number of factors is 20.

Parameter Card. Three parameters are required to execute this program. They are as follows:

Columns 4-5: The number of variables in each factor matrix. This must be equal for the two matrices and cannot exceed 60.

Columns 9-10: The number of factors in the first factor matrix read in. This value cannot exceed 20.

Columns 14-15: The number of factors in the second factor matrix read in. This value cannot exceed 20.

Data Input. All factor loadings are read in for the first factor matrix followed by all loadings for the second factor matrix. For each matrix, the factor loadings are read in by variable in 12 six-column fields per card. This format is identical to that which is output by the Varimax Rotation Program.

Output. The program writes out the title Factor A, Factor B, and *Phi* followed by a series of print lines. Each print line contains the factor number of the first factor matrix, the factor number of the second factor matrix, and the Wrigley-Neuhaus index of factor similarity (*phi*) for that pair.

GENERAL DESCRIPTIVE STATISTICS CODE NAME: STATS

General Description. This program computes four basic statistics which describe a set of observations. These four statistics are the mean, standard deviation, skewness and kurtosis. Definitions and descriptions of their usefulness are contained in most statistics books (see, for example, Ferguson, 1966). This program computes such statistics for up to 500 variables at one pass. There is no limit on the number of observations for each variable, since the number of observations is limited by a termination card which follows the data.

Parameter Card. Three parameters are required for the execution of this program. They are as follows:

Columns 3-5: The number of variables to be read in for each subject.

Columns 6-11: The value used to signal a missing observation. If these columns are left blank all variables with values of zero (or blank) will be treated as missing observations. The value punched in these columns must also be punched in the data fields for which there are missing observations.

Columns 12-17: The value used to indicate the end of the data. This value must be one which is not contained as a value for the first variable for any subject, otherwise the machine will stop when it reads this subject's data. In the following section, this is referred to as the *termination value.*

Data Input. The data are read in by subject with the data for each subject punched as follows:

Columns 1-8: Subject Identification

Columns 9-14: Variable 1

Columns 15-20: Variable 2
etc.

Columns 75-80: Variable 12.

Data for Variables 13-24, 25-36, etc. would be punched similarly.

Following the last subject's data, it is necessary to punch data for a "fictitious subject." This fictitious subject must have as many cards as a real subject, except that all that will be punched is the *termination value* (see Columns 12-17 in the parameter card) in the field for Variable 1 (i.e., columns 9-14).

Output. The program prints the title, Variable, Mean, Standard Deviation, Skewness, Kurtosis, and *N*. On the following lines the program prints the various statistics for that variable under the appropriate heading. If, for any variable, *N* is 0, or the variance is 0, or the variance is 0, the program prints the message, INSUFFICIENT DATA, followed by the values of the mean and the sample size.

T-TEST FOR INDEPENDENT GROUPS CODE NAME: IND-T

General Descriptions. This program computes *t*-tests for independent samples (See Ferguson, 1966) for up to 150 variables on any given pass. The maximum number of subjects permitted in each sample is 99,999. The sample sizes need not be equal.

There is one failure of this program which increases its general usefulness. The variables for the two groups do not have to be read in, in the same order. An order card indicates to the machine the order of the variables in the second group relative to the first one. Moreover, a variable in the second group can even be a reflection of the corresponding one in the first group. This feature is particularly beneficial for data consisting of semantic differential ratings in which, for example, one group rates a concept on the scale good (1) — bad (7), while the second group rates it on the scale bad (1) — good (7). A parameter (see Second Parameter Card, Columns 16-20) can be read into the computer, allowing it to reflect (i.e., turn around) the rating on the second group so that direct comparisons can be made.

This program performs multiple jobs. That is, having completed the analysis of the first two groups, two further groups can be analyzed by including their data beginning with the parameter cards immediately after the data for the first two groups. This can be repeated as many times as necessary. The program always ends on an input (code IHC2171) error.

Parameter Cards. There are three parameter cards required by this program. They are read in as follows:

First Parameter Card. This card is merely a label card to identify the output. Any descriptive label can be punched in Columns 1-50.

Second Parameter Card. Four parameters are read in the following columns:

Columns 1-5: The number of variables. This value cannot exceed 150.

Columns 6-10: The number of subjects in the first group. This value cannot exceed 99,999.

Columns 11-15: The number of subjects in the second group. This value cannot exceed 99,999.

Columns 16-21: This number is used in reflecting variables, as when for example semantic differential ratings are being analyzed and some scales for group two are scored oppositely to the corresponding ones in group one. The value punched here would be one greater than the highest possible value for a variable. For semantic differential ratings, for example, the maximum score is 7, so that the value punched here would be 8.

Columns 22-27: The value punched here indicates which number is used to indicate missing observations in the data. If this field is left blank, all blank or zero values for a subject will be considered as missing observations.

Third Parameter Card. This card (or cards) indicates the order of the variables in the second group relative to the first group. Even if the order of the variables in the two groups are the same, the orders must be indicated. In this instance, the orders would be punched as 1, 2, 3, and so on, to the number of variables. Where the variables are in different orders in the two groups, the ordinal positions of the variables in the first group would be punched in the order they appear in the second. For example, if the first three variables for the second group corresponded to variables 1, 42, and 26 in the first group, the numbers 1, 42, and 26 would be the first three numbers punched on this card. Subsequent values would be determined by the ordinal positions of variables 4, 5, and so on, in the second group as they appear in the first group.

These values must be punched in four column fields, right adjusted. Therefore there will be one card for each 20 variables or part thereof.

If a variable is to be reflected as described in the General Description, this is indicated by preceding the ordinal position by a minus sign.

Data Input. Data are input by groups. The data for group 1 are input first by subject followed by the data for group 2. The data for each subject must be punched as indicated in the description of the Data Input for the CORRELATION PROGRAM WITH MISSING OBSERVATIONS.

Output. The output is preceded by the label as indicated on the First Parameter Card. This is followed by a line consisting of the following headings, Scale, Mean 1, Mean 2, Variance 1, Variance 2, N1, N2, and *t*. The results of the computations follow under the appropriate headings one line for each variable. Mean 1 and Mean 2 refer to the means of groups 1 and 2 respectively.

T-TEST FOR CORRELATED OBSERVATIONS
CODE NAME: COR-T

General Description. This program computes *t*-tests for up to 200 variables and up to 99,999 subjects where the data are based on correlated observations, as when measures are taken on the same subjects twice (see Ferguson, 1966). The data are read in by subject, but it is necessary that the values for the first set of observations (e.g., the X's) are punched on a separate card from the second set (e.g., the Y's). It is not necessary however that the Ys' be punched in the same order as the X's. The program rearranges the Y's (if necessary) to correspond to the order of the X's. The program also allows for the reflection (i.e., turning around) of the Y's if this is required. This particular problem can arise when the data being analyzed are for example semantic differential ratings and the scale in question used in the second testing is the mirror image of the scale in the first (see General Description of the previous program). This program performs multiple jobs. To do more than one job, the data for subsequent ones should be added immediately after all the data for the first job. Each job must start with all the necessary parameters. This program terminates on an input (IHC2171) error.

Parameter Card. Two parameter cards are required for the execution of this program.

First Parameter Card.

Columns 3-5: The number of variables to be analyzed. The maximum value is 200.

Columns 6-10: The number of subjects.

Columns 11-16: This parameter is used when it is necessary to reflect scores in the second set of observations to correspond with those in the first. A complete discussion of this parameter has already been given in the previous program, second parameter card, columns 16-21.

Columns 17-22: The value used to indicate a missing observation in the data is punched here. If for example, a subject did not have a score on a particular variable and a "-1" were punched (in the appropriate columns) on his data card to indicate this, a -1 punched in Columns 21-22 of the present card would result in the machine ignoring the missing observation for the subject. If Columns 17-22 of this card are left blank, all blank fields, or zero scores in subjects' data, will be considered as missing observations.

Second Parameter Card. This card (or cards) is described in detail in the previous program. It is identical with the Third Parameter Card described for that program. Its purpose is to indicate the order of the variables in the second group relative to the first.

Data Input. Data are input by subject, the first set of variables preceding the second set for each subject. For example, if correlated *t*-tests were to be performed for each of 20 variables, the 20 variate values for subject 1 would be read in for the first set of observations, followed immediately by the 20 variate values for subject 1 for the second set of observations. This would be repeated for subject 2 and so on. The second set of observations must always begin on a new card. Data are punched as follows:

Columns 1-8: These columns are to be used for subject identification. They are not read by the computer. Note: This means that the computer does not check the subject numbers to ensure that appropriate subject's data are paired.

Columns 9-14: Value for Variable 1. A more complete description is provided in the Correlation program with missing observations.

Columns 15-20: Value for Variable 2. etc.

Columns 75-80: Value for Variable 12.

This same pattern must be followed for Variables 13-24, 25-36 and so on. Furthermore, the second set of observations for each subject must be punched in the same way. Missing observations should be coded consistently and this code should be indicated as directed on the parameter card.

Output. The program prints the title, Item No., *t*, *N*, Mean 1, Mean 2, Mean Difference, Variance 1, Variance 2, Standard Error. Following this, the program writes a series of print lines. Each print line gives the number of the variable (in terms of the first group), the *t*-statistic, the number of pairs of observations, the mean for the first set of observations, the mean for the second set, the variances respectively for the first and second set, and the standard error of the mean difference.

POLARITY ANALYSIS CODE NAME: POLAR

General Description. This program was designed primarily to assess the degree of polarization of ratings on semantic differential scales, but is appropriate to any situation where it is desired to test the significance of the deviation of a sample mean from an assumed population mean.

The program makes use of the statistic:

$$t = \frac{x - u}{s/\sqrt{N}}$$

where: x is the sample mean
u is the assumed population mean
s is the unbiased estimate of the population standard deviation
N is the sample size.

This statistics has been used to assess ethnic stereotypes (Gardner, Wonnacott & Taylor, 1968), and the program was written primarily for this purpose. For that reason, the data input for this program is different from most other programs beginning with raw data. In order to use this program with other than input data with values ranging from one to seven (or less), modifications would have to be made in the input format statement (Number 1), the statement concerned with writing out the results (since each print line contains a frequency distribution of the ratings 1—7), and the frequency distribution calculation section.

As written, the program will compute polarity analyses for up to eight concepts and 49 scales. Moreover, multiple jobs are permitted by including the data (with the appropriate parameter card) for subsequent jobs after the first. The program always ends on an input (code IHC217I) error.

Parameter Card. Two parameters are required for the execution of this program and are punched as follows:

Columns 4-5: The number of scales (variables) for each concept. This value cannot exceed 49.

Column 10: The number of concepts. This value cannot exceed 8.

Data Input. Data are input by subject by concept. The semantic differential ratings of subject 1 for concepts 1, 2, 3 and so on to the value indicated in Column 10 of the parameter card, are read in followed by the ratings for subject 2, and so on. For each subject, the first concept number must be 1, though the order for the remaining concepts can vary. No concept number can be greater than 8. The ratings for each concept must be punched on a separate card as follows:

Columns 1-5: Subject number.

Columns 6-9: Any other identifying information.

Column 10: Concept number. This value must range from 1 to 8.

Columns 11-59: The semantic differential ratings. These are punched in one column fields, and no value can exceed 7. Missing observations are punched as zeroes.

Following the last subject, the first card for a "fictitious" subject must be included which contains a subject number of -9 (punched in Columes 4-5), and a concept number of 1 (punched in Column 10).

Output . The computer prints out the data for each subject. If the subject numbers do not agree for all the data for a subject, or if more than one card for a subject has the same concept number punched on it, the computer will not analyze the data for this subject. A message to this effect is written immediately after the data for that subject.

Following the listing of the subjects' data, the program writes the statement "Analysis of Results," below which is the line "Concept" (with the concept number specified), Mean, Standard Deviation, *t*, *N*, 1, 2, 3, 4, 5, 6, 7, 8. Below this, in the appropriate columns, are the statistics calculated for each scale. Below the numbers 1, 2, etc. are the frequency of ratings with those values. The column labelled "8," gives the number of subjects for which a value of zero or blank was punched as their rating on that scale. These values are not included in the other statistics.

ANALYSIS OF VARIANCE — ONE WAY CLASSIFICATION
CODE NAME: ANOVA1

General Description. The program performs an analysis of variance of a single factor experiment based on independent groups (see Ferguson, 1966, or Winer, 1962). Up to 100 analyses can be performed in any given pass. The maximum number of groups (treatments) is 20. The groups can be based on unequal sample sizes but no group can contain more than 999 subjects.

Parameter Cards. There are two parameter cards, one indicating the number of groups, the number of analyses and the value used to indicate a missing observation, and the other specifying the number of subjects in each group.

First Parameter Card. Three values are required as follows:

Columns 4-5: This is the number of independent groups (treatments) forming the basis of classification. This value cannot exceed 20.

Columns 8-10: This is the number of analyses of variance (or dependent variables) to be performed. It cannot exceed 100.

Columns 11-16: This value is used to signal a missing observation. The value punched here must also be used in the data represent a missing observation. If this field is left blank, data punched as zero or blank will be interpreted by the machine as missing observations.

Second Parameter Card. This card is used to indicate to the machine the number of subjects in each group. The numbers are read in three column fields, right adjusted. That is, the number of subjects in group 1 is punched in Columns 1-3, the number in group 2, in Columns 4-6, and so on for as many groups as indicated in Columns 4-5 of the First Parameter Card.

Data Input. The data are read in by subject for each group separately. All subjects for group 1 are read in, followed by all subjects for group 2, and so on for as many groups as indicated on the First Parameter Card. For each subject, the cards must be punched as follows:

Columns 1-8: Subject identification. These columns are not read by the computer.

Columns 9-14: Value for Variable 1 (the scores for the first analysis of variance).

Columns 15-20: Value for Variable 2 (scores for the second analysis of variance).

Etc.

Columns 75-80: Value for Variable 12.

This same scheme is followed for Variables 13-24, 25-36, and so on. A more complete description is presented in the data input section for the Correlation Program With Missing Observations.

Output. The output consists of a summary table indicating source, sum of squares, degrees of freedom, mean square and *F* ratio for each analysis. Immediately following the summary table for each analysis are printed the means, variances, and sample sizes for each group.

Analysis Of Variance—Multiple Factors

Code Name: anova2

General Description. This program performs a factorial design analysis of variance for two (AB), three (ABC) or four (ABCD) factors, all based on independent groups. The number of subjects in each cell must be equal. The program allows up to 10 levels of each of the factors A, B, and C, but only 2 levels of factor D. Only one analysis of variance can be performed on any one pass; but multiple jobs can be processed by adding subsequent jobs complete with the parameter card after each set of data.

The analysis of variance for more than one factor is discussed by Ferguson (1966) and Winer (1962).

Parameter Card. Five parameters are read in as follows:

Columns 4-5: The number of levels for factor A. The maximum value is 10.

Columns 9-10: The number of levels for factor B. The maximum value is 10.

Columns 14-15: The number of levels for factor C. The maximum value is 10, but if only a two factor analysis of variance is being performed this value must be 1.

Column 20: The number of levels for factor D. The maximum value is 2, but if only a three factor analysis of variance is being performed, this value must be 1.

Columns 21-25: The number of subjects in any cell (i.e., any ABCD group).

Data Input. The data are input by subject with one observation per card as follows:

Columns 1-8: Subject identification

Columns 9-14: The data to be analyzed. This number is read by the computer as a six digit whole number, but decimal values can be indicated by punching the number with the decimal point.

The data must be read into the computer with all subjects in each group being read in the following order:

All subjects in A1B1C1D1
All subjects in A1B1C1D2
All subjects in A1B1C2D1
etc. (varying on C to the number of levels of C)

Then:

A1B1C1D1
A1B2C1D2
A1B2C2D1

etc. (varying on B to the number of levels of B)

This would then be repeated for the second level of A and so on.

For example, if there were two levels of A, 2 levels of B, three levels of C, and two levels of D, with five subjects in each group, the data would be read with five cards in each group in the following order:

A1B1C1D1, A1B1C1D2, A1B1C2D1, A1B1C2D2,
A1B1C3D1, A1B1C3D2, A1B2C1D1, A1B2C1D2,
A1B2C2D1, A1B2C2D2, A1B2C3D1, A1B2C3D2,
A2B1C1D1, A2B1C1D2, A2B1C2D1, A2B1C2D2,
A2B1C3D1, A2B1C3D2, A2B2C1D1, A2B2C1D2,
A2B2C2D1, A2B2C2D2, A2B2C3D1, A2B2C3D2.

For a three factor analysis of variance, the variation in the subscripts of D would be ignored; for a two factor analysis, the variation in the subscripts of C would also be ignored.

Output. The program prints out the summary table for the analysis of variance for either the four, three or two factor analysis of variance. Following this the means for each cell are printed with appropriate labels.

ANALYSIS OF VARIANCE PROGRAM FOUR FACTORS WITH REPEATED MEASURES ON TWO CODE NAME: ANOVA3

General Description. This program computes an analysis of variance for the following types of designs AB[CD], AB [C] where the factors within the brackets are based on repeated measures (see Winer, 1962). The program assumes that there are an equal number of observations in each cell. Multiple jobs can be performed by including the data for subsequent jobs, complete with the appropriate parameter card, immediately after the first set of data. The program always terminates on an input (IHC2171) error.

Parameter Card. Four parameters are required for execution of this program:

Columns 4-5: The number of levels of Factor A. This value cannot exceed 10.

Columns 9-10: The number of levels of Factor B. This value cannot exceed 10.

Columns 14-15: The number of levels of Factor C. This value cannot exceed 10.

Column 20: The number of levels of Factor D. This value cannot exceed 2. If only the three factor analysis, AB[C], is wanted, this value must be 1.

Columns 21-25: The number of subjects in any AB group. This value must be constant for all groups and cannot exceed 99,999.

Data Input. Data are input by subject. All subjects in group A1B1 are followed by all subjects in group A1B2, etc. to all levels of B (see columns 9-10 in parameter card). This same pattern is repeated for the second level of factor A, then the third level and so on till all levels of factor A have been exhausted. For each subject, the data are read in the order C1D1, C2D1, etc. to the number of levels of C, then this is repeated for the second level of D. If only the AB[D] design is wanted, this second level of D will, of course, not be punched. The column specifications are:

Columns 1-8: Subject identification.

Columns 9-14: The observation for C1D1

Columns 15-20: The observation for C2D1

and so on in six column fields. The data for C1D2, C2D2, etc. are begun in the data field immediately following the last CD1 observation. If more than one card is required for each subject, the data is continued in the same data fields.

The program assumes that each observation is a whole number. If decimal values are involved the decimal point must be punched.

Output. The program prints out the summary table of the analysis of variance followed by a table of ABCD cell means. The cell means are labelled appropriately.

REFERENCES

FERGUSON, G. A. *Statistical analysis in Psychology and Education* (Second edition). New York: McGraw-Hill, 1966.

GARDNER, R. C., WONNACOTT, E. JOY, & TAYLOR, D. M. Ethnic stereotypes: a factor analytic investigation. *Canadian Journal of Psychology,* 1968, 22, 35-44.

HARMON, H. H. Modern factor analysis (second revised edition). Chicago, University Chicago Press, 1967.

HORST, P. Factor analysis of data matrices. Holt, Rinehart and Winston, New York: 1965.

WINER, B. J. *Statistical principles in experimental design.* New York: McGraw-Hill, 1962.

KRIGLEY, C. F., & NEUHAUS, J. E., The matching of two sets of factors. *American Psychologist.* 1955, 10, 418-419.