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CHOICE: 36 BAND FEATURE SELECTION SOFTWARE WITH APPLICATIONS TO MULTISPECTRAL PATTERN RECOGNITION

BY: W.C. JONES

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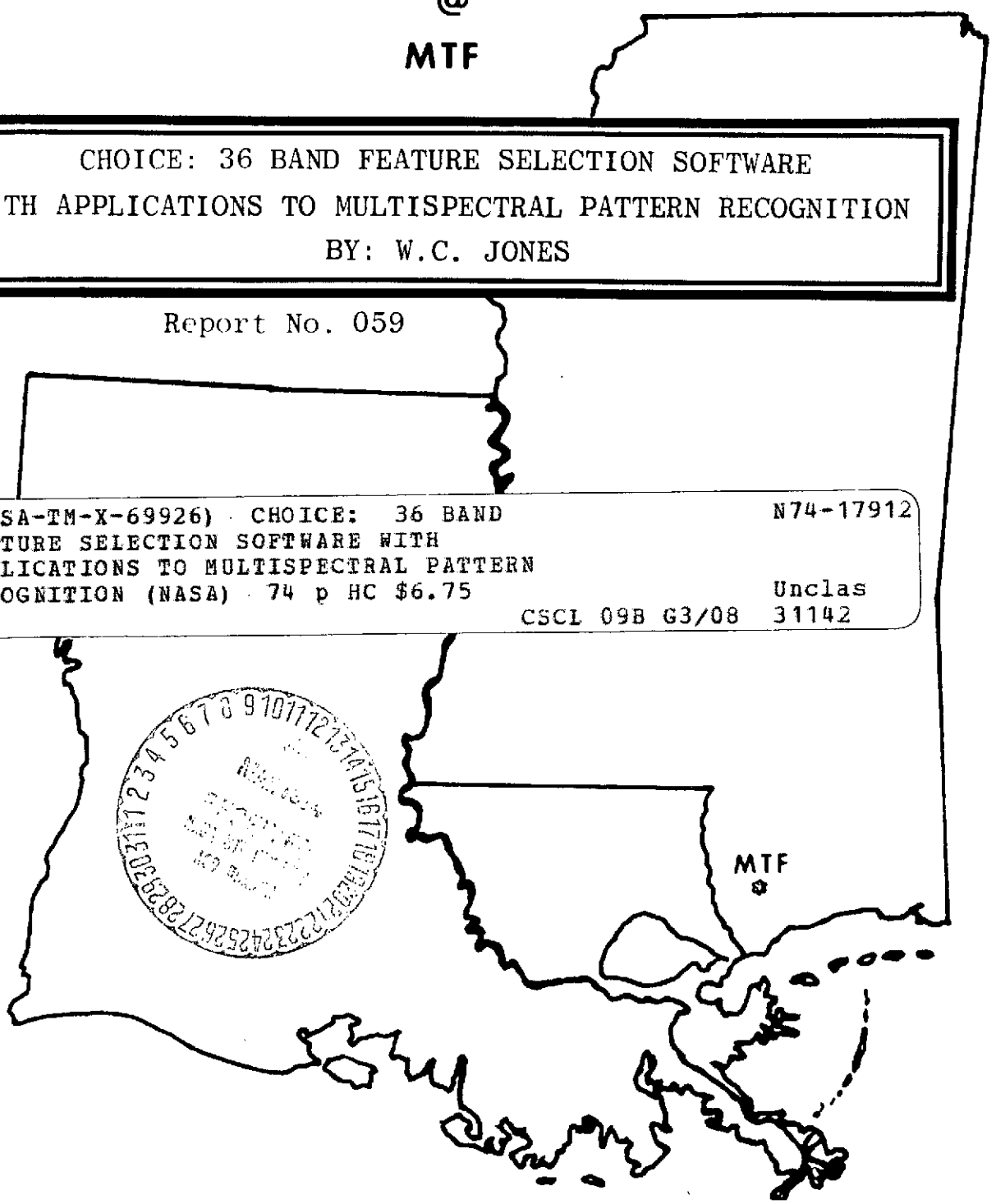

LYNDON B. JOHNSON SPACE CENTER

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with Applications to Multispectral Pattern Recognition

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ABSTRACT

Often a pattern recognition system is broken into two parts - feature selection and classification. This note deals with feature selection. In 1971, the Earth Resources Laboratory (ERL) received a version of the Purdue pattern recognition software (LARSYSAA). ERL was preparing to process the very large quantities of data as output by the Bendix 24 channel scanner. Eppler's Digital Table Look-up Classifier (DTL) was being implemented at ERL primarily because of its speed advantage. The Purdue feature selection program was quite useful but was limited to twelve features (or channels) and did not select channel subsets in a manner suggested by Eppler to be used with his table look-up classifier. He suggested using a different subset of channels for each material (class), i.e., the subset which is best suited for detecting a particular material.

Feature selection software has been developed at ERL that is capable of inputting up to 36 channels and selecting channel subsets according to several criteria based on divergence. One of the criterion used is compatible with the table look-up classifier requirements. The software indicates which channel subset best "separates" (based on average divergence) each class from all other classes. The software employs an exhaustive search technique, and designing the software such that computer time did not become prohibitive was a major goal. A typical task to select the "best" 4 of 22 channels for 12 classes takes 9 minutes on a Univac 1108 computer.

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INTRODUCTION

A pattern recognition system is often broken into two parts - feature selection and classification. This note deals with feature selection. (For a much more detailed discussion of pattern recognition and feature selection, see [1, 11, 12].) In 1971, the Earth Resources Laboratory (ERL) received a version of the pattern recognition software LARSYSAA. This software was originally developed by the Laboratory for Application of Remote Sensing (LARS) at Purdue University. The system is well-known and is described by Landgrebe [8] and Ratcliff [16].

ERL was preparing to process the very large quantities of data as output by the Bendix 24 channel scanner [19]. Eppler's Digital Table Look-up Classifier (DTL) was being implemented at ERL primarily because of its speed advantage [4]. The LARSYSAA feature selection program ($SELECT) was quite useful, but it was limited to 12 channels and did not rank the channel subsets in a manner suggested by Eppler, i.e., by the four channels which were best suited for detecting a particular material (class). It was necessary to develop feature selection software which would handle more than 12 channels and would rank them in a manner more compatible with the DTL. This software- CHOICE - is coded completely in Fortran V and runs on a Univac 1108 computer. The maximum number of classes and channels are currently set at 32 and 24 respectively and the program uses less than 32K, i.e., 32,000 Univac 1108 computer words. These limits are not fixed. More details can be found in the discussions under Computation Time and Core.

FEATURE SELECTION

A brief description of the notions of pattern recognition and feature selection as they are often applied in processing multispectral scanner data follows.

A series of n measurements are made on an object. This series could be composed of measurements of intensity of spectral radiation in n bands (channels) of a multispectral scanner. A series of measurements on an object can be considered an n-dimensional observation vector. Given m multivariate normal populations (classes), we are to decide to which class the observation vector most likely belongs. In general, it is not practical to use all n measurements in making this decision (classification) because of computer time constraints. We want to select some subset k of n channels which will enable us to classify the data in an accurate manner. Often there are many subsets to choose from. For example, the DTL requires that k=4 and in working with 24 channel scanner data, there are more than 10,000 possible channel subsets - $\binom{24}{4}$. We use divergence to help us choose a channel subset.

DIVERGENCE

All of the criteria used by CHOICE are based on divergence. The application of divergence to feature selection was proposed by Marill and Green [10], and an interesting discussion on the subject is given by Fu [11]. Divergence is given a very general definition by Kullback [7] and is based on considerations from information theory. Kullback argues that divergence is an appropriate "distance" between arbitrary distributions and asserts it to be "a measurement of the difficulty of discriminating" between two distributions [7, 10]. In the case of two multivariate normal populations with

equal covariance matrices, it can be shown that the probability of classification error is a monotonically decreasing function of divergence [11]. In the less restricted case of more than two populations with unequal covariance matrices, there is experimental support for using divergence [10].

Criteria based on divergence have come under attack because they have not been explicitly expressed in terms of probability of error in the more general cases. Further, specific examples can be cited where the average pairwise divergence criterion does not yield the minimum probability of error [6, 15]. Although these criticisms are valid, criteria based on divergence have proved to be a useful guide in working with multispectral scanner data and in attempting to improve classification results.

In the case of several multivariate normal populations (classes), the pairwise divergence between class i and class j reduces to:

$$J_{ij} = \tfrac{1}{2}\,\mathrm{tr}\left\{(K_i - K_j)(K_j^{-1} - K_i^{-1})\right\} + \tfrac{1}{2}\,\mathrm{tr}\,(u_i - u_j)^T (K_i^{-1} + K_j^{-1})(u_i - u_j) \quad (1)$$

where:

tr - trace

T - transpose

u_i - kxl mean vector of class i

K_i - kxk covariance matrix of class i

K_i^{-1} - inverse of the covariance matrix of class i

CHOICE actually computes the quantity D_{ij}, where $D_{ij} = 2(J_{ij})$.

Figure 1 illustrates some simple examples of class pairs and their associated divergences. The data from which these statistics were calculated were acquired by an aircraft borne 12 channel multispectral scanner.

$$f_i(x) = \frac{1}{\sqrt{2\pi}\,\sigma_i}\; e^{-\frac{1}{2}\left(\frac{x-\mu_i}{\sigma_i}\right)^2}$$

Class	S	Y	A	R
μ_i –mean response	170.0	174.9	177.8	182.3
σ_i –std.deviation	2.6	2.2	1.8	2.1

Pairwise Divergences

pair	Dij	pair	Dij
SY	9.2	YA	3.1
SA	28.3	YR	23.8
SR	56.9	AR	10.9

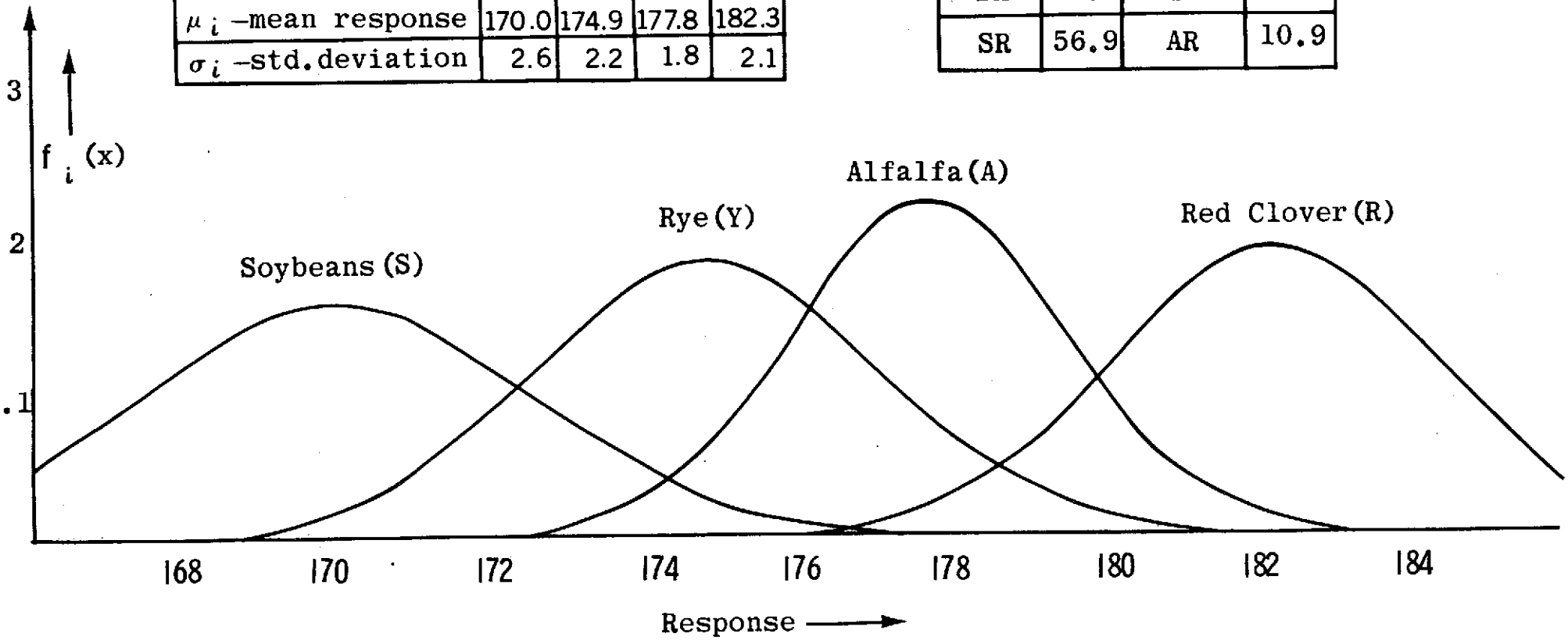


Figure 1. Statistics calculated from actual data (flight line C-1). Note the relation between a large value of pairwise divergence and good separability.

This flight line (Flight line C-1) was flown June 28, 1966 for LARS and has been widely reported on [2, 9]. In Figure 1, probability density functions $[f_i(x)]$ are plotted for four classes in the single channel case (channel 1). The mean response of channel 1 for soybeans (170.0) is the average reading of this channel as it "looked at" those soybean fields which were used in training the pattern recognition algorithm. The channel readings for a class are usually assumed to be normally distributed about the class's mean response. Thus, given the mean response and the standard deviation of these responses for soybean training fields, the probability density function for soybeans can be graphed. Figure 1 illustrates, and the pairwise divergence (YA = 3.1) indicates, that channel 1 would not be a "good" channel to discriminate rye from alfalfa. However, it would be a "good" channel to separate soybeans from red clover as evidenced by the figure and by SR=56.9.

CRITERIA

Assume that we are given n channels and are asked to choose a subset k of these, where k<n, by some criterion. CHOICE ranks the channel subsets by five separate criteria. The first two of these are the same as those available with $SELECT. Unfortunately, there is no one criterion that is always "best". Thus, the software presents several rankings to the investigator. An example of these channel subset rankings with k=4 for each criterion is given in the Appendix under Example of Output. Data from Flight Line C-1 was used in producing this output and is also listed in the Appendix under Example of Input Data. Following is a description of the five criteria used by CHOICE:

Criterion 1: Maximizing the arithmetic mean of the pairwise divergences. The average pairwise divergence for a given channel set can be computed by

$$Div_{avg} = \frac{1}{m(m-1)} \sum_{j=1}^{m-1} \sum_{i=j+1}^{m} D_{ij}, \text{ where m is the number of classes}$$

This average is computed for all $\binom{n}{k}$ possible subsets. The channel subsets which yield the largest averages are saved and printed.

Criterion 2. Maximizing the minimum pairwise divergence.

The minimum pairwise divergence for a given channel set is given by

$$Div_{min} = \min \{D_{ij}\}, \quad i=1, m-1; \; j=i+1, m$$

The minimum is computed for all $\binom{n}{k}$ subsets. Those subsets which produce the largest minimums are saved and printed.

Criterion 3. Maximizing the average divergence by class.

This is the criterion used at ERL most often in conjunction with the table look-up. Since the DTL can be run with a different set of channels for each class, this criterion is used to help decide which subset of channels best separates a class from all other classes. The average divergence for class j for a given channel set is computed by

$$Div_{avg\ (class\ j)} = \frac{1}{m-1} \sum_{i=1}^{m} D_{ij}, \; i \neq j.$$

The class average is computed for all classes for each channel set. This is repeated for all possible channel sets. The channel subset which yields the largest average for each class is saved and printed.

Criterion 4. Maximizing the geometric mean of the pairwise divergences.

It seems reasonable to expect the difference between a divergence of 10 and 30 to be more important than the difference between a divergence of 50 and 70 even though the delta in both cases is 20. For example, in the one-dimensional two-class case with variances equal to one, we get the following:

D_{ij}	Average Probability of Classification Error
10	13.14%
30	2.62
50	.62
70	.15

Criterion 4 gives more weight for an improvement in separation from 10 to 30 than for an improvement from 50 to 70. The more widely available criterion 1 considers these improvements of equal value. The geometric mean is computed for each channel subset as follows:

$$Div_{geo} = \frac{1}{m(m-1)} \prod_{j=1}^{m-1} \prod_{i=j+1}^{m} D_{ij}$$

This mean is computed for all possible subsets - $\binom{n}{k}$ - and those channel subsets which yield the largest geometric means are saved and printed.

Criterion 5. Maximizing the pairwise divergence for each class pair. D_{ij} is computed for each $\binom{n}{k}$ subset of channels. That channel set which yields the maximum divergence for each class pair is saved and printed. This is most useful in working with hard-to-separate classes. In the worst case, it will indicate to the investigator that no matter which channel set is selected, it will not be possible to separate the two classes. In less severe cases, it will indicate the most separability to be expected and which channel set will provide it. (This assumes that the channels will not be transformed. See discussion under Uses and [14].)

COMPUTATION TIME

There has been some discussion that it is not feasible to do an exhaustive search when the number of channels is large [2, 17]. By incorporating some efficiences, we have found we can routinely process 24

channel scanner data using the exhaustive search technique. A typical task to select the "best" 4 of 22 channels for 12 classes takes 9 minutes on a Univac 1108 computer.

In order to handle more than 12 channels in a timely manner, we decided it would be necessary to rewrite the feature selection software and not just modify LARSYSAA. There were two key changes which accounted for considerable time-savings.

1. Input/Output

No input/output (I/O) is done during the exhaustive search loop. Because of their generality, Fortran formated read and write commands are quite expensive in both throughput and in execution time. CHOICE circumvents doing an I/O after each set of divergence calculations by immediately testing whether this channel set ranks in the top group of channel sets for each criterion. Each group is made up of those sets which have exceeded all the preceeding channel sets in maximizing a particular criterion. if the set is not ranked in any top group, it is discarded. If it is top-ranked, then the channel set is saved using a bit manipulation function. With this technique only one 36 bit Univac 1108 word is required to store a channel set. (Hence the limitation of 36 channels.) At this point the pairwise divergences are discarded in order to conserve core. The search is continued until all possible subsets have been considered. At the completion of the search, the divergences for those top-ranked channel sets (which usually number less than 50) are recomputed and printed.

2. Matrix Inversion

In a case where we have 12 classes and are asked to select the best 4 of 22 channels, we must perform over 85,000 matrix inversions, and these comprise a significant portion of the total computation time. A procedure

based on the bordering technique [5] was incorporated into CHOICE to invert the lower triangular matrices. This procedure takes advantage of the fact that the matrices are symmetric. In a test, this procedure was about five times as fast as the more general and widely used matrix routine MINV. MINV uses the Gauss-Jordan reduction technique and does not capitalize on the symmetry of the matrices.

An empirical formula which can be used to roughly estimate the computation (CPU) time of CHOICE in minutes is:

$$\text{time} = \frac{\binom{n}{k}\binom{m}{2}}{50{,}000}$$

where n - total number of channels

k - number of channels in subset to be chosen

m - number of classes

Take, for example, the theoretically important two-class case. Let us estimate the time to choose the best 4 of 36 measurements.

$$\text{time} = \frac{\binom{36}{4}\binom{2}{2}}{50{,}000}$$

time = 1.2 minutes

CORE

CHOICE was written such that its core allocation can be easily changed for different applications by changing parameter cards.

Parameter	Meaning	Current Setting
m	maximum number of classes	32
n	maximum number of channels	24
k	maximum size of best subset	12

Parameter	Meaning	Current Setting
s	maximum number of show requests[1]	10
p_1	maximum number of top-ranked sets to print for criteria 1 and 2	20
p_2	maximum number of top-ranked sets to print for criteria 3	10

The following formula can be used to calculate the amount of core required (in U1108 words).

$$\text{Core} = 10{,}500+m[n+n(n+1)/2+k+k(k+1)/2+4]+k(s+1)+n(n-1)(p_1+4)/2+4p_2$$

All parameters must be greater than or equal to one. The number of channels must be less than or equal to 36, and the number of classes must be greater than or equal to 2.

USES

Just as with the LARSYSAA separability processor, there are several areas in which the investigator may find CHOICE useful in processing multispectral data.

1) The primary purpose of the program is to indicate which subset of measurements might best be used in deciding to which of several classes an unknown element belongs.
2) The program can indicate those classes which cannot be separated with the given set of measurements, no matter which subset we choose. For example, CHOICE may indicate that white sand and concrete look spectrally very similar when observed from space under certain illumination conditions. The investigator must decide whether to group

[1] A show request refers to a request by an investigator to see the pairwise divergence printed for a channel set of interest--one that is not necessarily top-ranked.

these materials into one class or to drop the materials from the classification.

3) Training fields for the same class can often be quite different spectrally. A decision must be made as to which training fields can be pooled into one population and which cannot. CHOICE can aid in this decision by indicating whether the two training fields are spectrally "close" or not. "Closeness" would be indicated by relatively low pairwise divergences.

4) Recently there has been developed a feature selection technique that seems very promising [13, 14]. Basically this technique determines a linear transformation Bx which can be used to reduce the dimension of the data from n to k where n is greater than k. This technique determines a k by n matrix B which maximizes the so called B-average divergence. (One disadvantage of this technique is that it is currently limited to 9 classes.) It is recommended that the best k of n channels be chosen as the initial guess for the B matrix [3]. This is done in order to increase the probability that the maximum found iteratively will be the global maximum. It seems that CHOICE could be quite useful in initializing B, especially when n is greater than 12.

SUMMARY

In this note, feature selection software (CHOICE) was described. CHOICE was developed mainly to enable processing 24 channel scanner data and to rank the channel subsets in a manner more compatible with the table look-up

classifier. A brief justification of the use of divergence was given. The criteria used by CHOICE in ranking the various channel subsets were described. Computer time and core allocation were discussed. Finally, some of the ways the program has been used at ERL were given. The appendix gives an example of a CHOICE computer run with real data. It also provides a description of the software including logic flow and Fortran listings.

References

1. Anderson, T.W., 1958: Introduction to Multivariate Statistical Analysis. John Wiley and Sons, Inc. New York.
2. Chang, C.Y., November 1971: "Dynamic Programming as Applied to Feature Subset Selection in a Pattern Recognition System", Technical Report LEC/HASD No. 640-TR-046, Lockheed Electronics Company, Houston.
3. Detchmendy, D.M., et. al., May 1973. "Users Guide and Software Documentation for the Algorithm Simulation Test and Evaluation Program (ASTEP)". JSC Internal Note No. 73-FM-71. Mission Planning and Analysis Division, JSC, Houston.
4. Eppler, W.G., C.A. Helmke, and R.H. Evans, 1971. "Table Look-up Approach to Pattern Recognition." Proceedings of the Seventh International Symposium on Remote Sensing of Environment. WRL, University of Michigan, Ann Arbor.
5. Hemmerle, W.J., 1967. Statistical Computations on a Digital Computer. Blaisdell Publishing Co., Waltham, Mass.
6. Hinkkannen, D.W., December, 1971. "Evaluation of Classification Probabilities". Report 1-7380-2-DWH. NASA J.O. 173, Lockheed Electronics Co., Bay St. Louis, MS.
7. Kullback, S., 1959. Information Theory and Statistics. John Wiley and Sons, Inc. New York.
8. Landgrebe, D.A. and staff. LARS Information note 091968, "LARSYSAA, A Processing System for Airborne Earth Resources Data", Purdue University, Lafayette, Indiana.
9. LARS Research Bulletin, Setp. 1968. "Remote Multispectral Sensing in Agriculture," Lafayette, Indiana.

10. Marill, T. and D.M. Green, January 1963. "On the Effectiveness of Receptors in Recognition Systems". IEEE Transactions on Information Theory. New York.

11. Mendel, J.M. and Fu, K.S., 1970. Adaptive, Learning and Pattern Recognition Systems. Academic Press. New York.

12. Nilsson, N.J., 1965. Learning Machines. McGraw Hill Book Co., New York.

13. Quirien, J. A., November 1972. "Divergence - Some Necessary Conditions for an Extremum." University of Houston Mathematics Department.

14. ----------, December 1972. "An Interactive Approach to the Feature Selection Classification Program". TRW Technical Note 99900-H019-RO-oo TRW Systems. Houston.

15. ----------, 1972. "Divergence Considerations." NASA Contract: NAS9-12777. University of Houston Mathematics Dept.

16. Ratcliff, M.L., 1970. "Description and User's Guide for a Processing System for Airborne Multispectral Scanner Data". I.S.D. Internal Note. Lockheed Electronics Co., Houston.

17. ----------, June 1972. "Implementation of Feature Selection via Dynamic Programming." Technical Report LEC/HASD No. 640-TR-122, Lockheed Electronics Co., Houston.

18. Skipworth, J.R., Jones, W.C., Pooley, J.C., Ramsey, J.A., Stone, W.T., 1972. "ERL Configuration III - Pattern Recognition". NASA/LEC Report NASA J.O. 134. Earth Resources Laboratory, Bay St. Louis, MS.

19. Zaitzeff, Korb, Wilson, July 1971. "MSDS: An Experimental 24-channel Multispectral Scanner System." IEEE Transactions on Geoscience Electronics. New York.

APPENDIX

Examples of Output

Task: Select the "best" 4 of 12 channels for 9 classes.
(data is from flight line C-1)

Computation time: 35 seconds

Criterion 1: Maximizing the arithmetic mean of the pairwise divergences. (top two sets).

DISPLAY OF CHANNELS RANKED ACCORDING TO AVERAGE PAIR-WISE DIVERGENCE.

CHANNELS= 1 9 11 12
AVERAGE PAIR-WISE DIVERGENCE= 443.0

MINIMUM PAIR-WISE DIVERGENCE= 25.8

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION= .33

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S = 173.702
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C = 268.075
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O = 180.312
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W = 303.635
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R = 654.247
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A = 696.094
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y = 206.235
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X = 1165.065
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E = 339.305

PAIR-WISE DIVERGENCE

CS=	26.1	OS=	78.4	OC=	76.6	WS=	202.4	WC=	324.5	WO=	110.9	RS=	209.5	RC=	100.3	RO=	90.3	RW=	674.6
AS=	188.7	AC=	82.2	AO=	92.2	AW=	733.0	AR=	25.8	YS=	117.5	YC=	204.3	YO=	37.9	YW=	52.6	YR=	423.3
YA=	439.3	XS=	346.8	XC=	921.4	XO=	804.1	XW=	299.6	XR=	2962.8	XA=	3281.7	XY=	325.5	ES=	220.2	EC=	409.2
EO=	152.0	EW=	31.5	ER=	747.5	EA=	725.9	EY=	49.6	EX=	378.6								

CHANNELS= 6 9 11 12
AVERAGE PAIR-WISE DIVERGENCE= 429.7

MINIMUM PAIR-WISE DIVERGENCE= 24.6

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION= .38

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S = 157.740
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C = 259.006
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O = 171.964
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W = 330.007
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R = 647.225
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A = 689.260
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y = 199.801
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X = 1087.277
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E = 325.354

PAIR-WISE DIVERGENCE

CS=	27.4	OS=	64.9	OC=	75.5	WS=	188.8	WC=	391.3	WO=	121.4	RS=	225.2	RC=	82.4	RO=	96.0	RW=	700.0
AS=	219.7	AC=	75.0	AO=	96.4	AW=	752.3	AR=	24.6	YS=	50.1	YC=	133.0	YO=	67.5	YW=	205.0	YR=	439.8
YA=	414.2	XS=	340.3	XC=	929.8	XO=	701.0	XW=	190.2	XR=	2831.5	XA=	3190.8	XY=	233.4	ES=	145.6	EC=	357.7
EO=	152.8	EW=	90.9	ER=	778.3	EA=	741.0	EY=	55.4	EX=	281.1								

Criterion 2: Maximizing the minimum pairwise divergence.
(top two sets)

DISPLAY OF CHANNEL COMBINATIONS RANKED ACCORDING TO MINIMUM PAIR-WISE DIVERGENCE

CHANNELS= 1 6 10 11
AVERAGE PAIR-WISE DIVERGENCE= 304.4

MINIMUM PAIR-WISE DIVERGENCE= 35.6

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION= .22

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S = 150.230
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C = 231.255
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O = 140.843
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W = 314.447
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R = 391.805
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A = 423.808
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y = 190.141
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X = 576.936
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E = 320.109

PAIR-WISE DIVERGENCE

CS=	35.6 OS=	93.1 OC=	122.3 WS=	231.8 WC=	387.2 WO=	89.1 RS=	184.2 RC=	139.7 RO=	87.8 RW=	541.8
AS=	171.6 AC=	111.8 AO=	110.6 AW=	665.9 AR=	38.2 YS=	121.1 YC=	215.0 YO=	63.3 YW=	181.5 YR=	299.6
YA=	310.0 XS=	152.0 XC=	455.1 XO=	416.6 XW=	331.6 XR=	1233.8 XA=	1333.9 XY=	272.9 ES=	212.4 EC=	383.3
EO=	143.9 EW=	86.5 ER=	609.2 EA=	648.5 EY=	57.7 EX=	419.5				

CHANNELS= 1 6 10 12
AVERAGE PAIR-WISE DIVERGENCE= 295.2

MINIMUM PAIR-WISE DIVERGENCE= 34.1

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION= .15

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S = 152.510
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C = 221.552
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O = 133.666
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W = 305.257
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R = 395.266
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A = 400.699
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y = 198.005
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X = 546.560
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E = 303.221

PAIR-WISE DIVERGENCE

CS=	35.0 OS=	89.7 OC=	122.3 WS=	228.1 WC=	364.5 WO=	86.6 RS=	215.6 RC=	157.2 RO=	82.4 RW=	529.6
AS=	188.5 AC=	125.1 AO=	99.2 AW=	612.5 AR=	34.1 YS=	124.3 YC=	211.6 YO=	69.1 YW=	181.4 YR=	342.4
YA=	330.7 XS=	130.8 XC=	394.9 XO=	382.0 XW=	338.3 XR=	1229.5 XA=	1232.0 XY=	263.9 ES=	208.1 EC=	361.9
EO=	136.2 EW=	101.1 ER=	571.2 EA=	583.7 EY=	60.6 EX=	401.0				

Criterion 3: Maximizing the average divergence by class

1. Summary print. For example, channel set (1, 8, 11, 12) yields the largest average divergence for class Rye (Y)-223. Also, if this set is used, Bare Soil (X) has an average divergence of 924 from all other classes.

2. Expanded print. The first set is (1, 8, 11, 12); the "best" set for detecting Rye. The second set is (1, 9, 11, 12); the "best" set for detecting bare soil.

MATRIX OF DIVERGENCES FOR CHANNEL SET YIELDING THE MAXIMUM SEPARATION OF A CLASS FROM ALL OTHER CLASSES

	FEATURES	S	C	O	W	R	A	Y	X	E
1	9 11 12 S	174.	268.	180.	304.	654.	696.	206.	1165.	339.
1	9 11 12 C	174.	268.	180.	304.	654.	696.	206.	1165.	339.
1	9 11 12 O	174.	268.	180.	304.	654.	696.	206.	1165.	339.
1	6 9 11 W	163.	247.	152.	346.	489.	518.	204.	743.	347.
1	9 11 12 R	174.	268.	180.	304.	654.	696.	206.	1165.	339.
8	9 11 12 A	127.	228.	157.	243.	649.	706.	182.	1133.	323.
1	8 11 12 Y	165.	235.	166.	281.	559.	607.	223.	924.	363.
1	9 11 12 X	174.	268.	180.	304.	654.	696.	206.	1165.	339.
1	8 9 11 E	160.	244.	146.	287.	489.	517.	203.	751.	367.
DIAGONAL		174.	268.	180.	346.	654.	706.	223.	1165.	367.

```
CHANNELS=  1  6 11 12
AVERAGE PAIR-WISE DIVERGENCE=   391.4

MINIMUM PAIR-WISE DIVERGENCE=    23.7

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION=   .24

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S =    164.967
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C =    235.160
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O =    165.692
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W =    281.203
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R =    558.932
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A =    606.938
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y =    222.906
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X =    923.967
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E =    362.898

 PAIR-WISE DIVERGENCE
 CS=    23.7 OS=    87.7 OC=    85.7 WS=   172.1 WC=   270.6 WO=    96.3 RS=   207.2 RC=   100.4 RO=    76.1 RW=   612.7
AS=   193.7 AC=    85.3 AO=    83.6 AW=   698.2 AR=    24.9 YS=   156.0 YC=   248.8 YO=    52.6 YW=    50.5 YR=   422.1
YA=   458.6 XS=   238.3 XC=   620.5 XO=   660.0 XW=   295.3 XR=  2301.1 XA=  2521.6 XY=   344.0 ES=   241.0 EC=   446.2
EO=   183.7 EW=    54.0 ER=   727.1 EA=   789.6 EY=    50.7 EX=   410.9



CHANNELS=  1  9 11 12
AVERAGE PAIR-WISE DIVERGENCE=   443.0

MINIMUM PAIR-WISE DIVERGENCE=    25.8

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION=   .33

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S =    173.702
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C =    268.075
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O =    180.312
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W =    303.635
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R =    654.247
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A =    696.094
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y =    206.235
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X =   1165.065
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E =    339.305

 PAIR-WISE DIVERGENCE
 CS=    26.1 OS=    78.4 OC=    76.6 WS=   202.4 WC=   324.5 WO=   110.9 RS=   209.5 RC=   100.3 RO=    90.3 RW=   674.6
AS=   188.7 AC=    82.2 AO=    92.2 AW=   733.0 AR=    25.8 YS=   117.5 YC=   204.3 YO=    37.9 YW=    52.6 YR=   423.3
YA=   439.3 XS=   346.8 XC=   921.4 XO=   804.1 XW=   299.6 XR=  2962.8 XA=  3281.7 XY=   325.5 ES=   220.2 EC=   409.2
EO=   152.0 EW=    31.5 ER=   747.5 EA=   725.9 EY=    49.6 EX=   376.6
```

Criterion 4: Maximizing the geometric mean of the pairwise divergences. This criterion is also referred to as "per cent separation".

DISPLAY OF CHANNEL COMBINATIONS RANKED ACCORDING TO MAXIMUM PERCENT SEPARATION.

CHANNELS= 1 6 9 12
AVERAGE PAIR-WISE DIVERGENCE= 355.5

MINIMUM PAIR-WISE DIVERGENCE= 27.9

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION= 1.00

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S = 165.568
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C = 241.099
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O = 148.228
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W = 343.142
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R = 506.152
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A = 508.696
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y = 208.093
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X = 760.826
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E = 317.945

PAIR-WISE DIVERGENCE

CS=	27.9 OS=	74.6 OC=	86.4 WS=	246.1 WC=	404.3 WO=	111.7 RS=	214.0 RC=	109.2 RO=	88.2 RW=	646.8
AS=	187.4 AC=	76.4 AO=	103.3 AW=	742.2 AR=	37.8 YS=	120.2 YC=	196.6 YO=	71.7 YW=	204.2 YR=	396.7
YA=	356.7 XS=	244.3 XC=	650.9 XO=	502.3 XW=	290.4 XR=	1845.9 XA=	1956.9 XY=	262.2 ES=	210.1 EC=	377.1
EO=	147.6 EW=	99.4 ER=	710.6 EA=	608.7 EY=	56.4 EX=	333.7				

CHANNELS= 1 6 9 11
AVERAGE PAIR-WISE DIVERGENCE= 356.5

MINIMUM PAIR-WISE DIVERGENCE= 27.6

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION= .89

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S = 162.926
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C = 246.966
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O = 151.837
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W = 346.474
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R = 489.120
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A = 517.510
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y = 203.546
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X = 742.910
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E = 347.346

PAIR-WISE DIVERGENCE

CS=	27.6 OS=	81.2 OC=	91.2 WS=	249.8 WC=	420.7 WO=	110.3 RS=	187.0 RC=	90.6 RO=	96.2 RW=	655.7
AS=	171.7 AC=	69.0 AO=	112.3 AW=	772.5 AR=	38.1 YS=	117.5 YC=	203.0 YO=	64.8 YW=	196.7 YR=	364.3
YA=	357.0 XS=	245.1 XC=	654.2 XO=	502.4 XW=	285.7 XR=	1721.5 XA=	1897.6 XY=	272.0 ES=	223.4 EC=	419.4
EO=	156.2 EW=	80.4 ER=	759.6 EA=	721.9 EY=	53.1 EX=	364.8				

Criterion 5: Maximizing the pairwise divergence for each class pair.

DISPLAY OF CHANNEL COMBINATIONS YIELDING MAXIMUM PAIR-WISE DIVERGENCE.

CLASS PAIR	MAX DIJ	AVG DIJ	CHANNELS
CS	36.5	332.2	6 9 10 11
CO	93.1	304.4	1 6 10 11
CC	122.3	304.4	1 6 10 11
WS	265.6	242.2	1 6 9 10
WC	441.0	332.2	6 9 10 11
WO	121.4	429.7	6 9 11 12
RS	226.8	282.9	1 6 11 12
RC	157.2	295.2	1 6 10 12
RO	106.7	332.2	6 9 10 11
RW	700.0	429.7	6 9 11 12
AS	219.7	429.7	6 9 11 12
AC	125.1	295.2	1 6 10 12
AO	115.2	228.2	2 6 9 10
AW	778.4	337.3	2 6 9 11
AR	38.2	304.4	1 6 10 11
YS	173.2	160.5	1 2 7 8
YC	273.6	177.2	1 2 8 10
YO	71.7	355.5	1 6 9 12
YW	233.8	202.5	6 7 9 10
YR	439.8	429.7	6 9 11 12
YA	458.6	391.4	1 8 11 12
XS	361.3	416.6	8 9 11 12
XC	983.3	403.7	9 10 11 12
XO	604.1	443.0	1 9 11 12
XW	338.3	295.2	1 6 10 12
XR	3008.5	416.6	8 9 11 12
XA	3378.3	416.6	8 9 11 12
XY	344.0	391.4	1 8 11 12
ES	265.2	307.4	1 2 8 11
EC	469.5	351.4	1 8 9 11
EO	183.7	391.4	1 8 11 12
EW	105.1	264.4	6 7 10 12
ER	818.2	332.9	2 7 9 11
EA	826.5	333.3	2 8 9 11
EY	62.4	282.1	2 6 10 12
EX	453.2	319.1	1 8 10 11

Show Requests

DISPLAY OF CHANNEL COMBINATIONS REQUESTED BY *SHOW* CARDS.

CHANNELS= 1 9 11 12
AVERAGE PAIR-WISE DIVERGENCE= 443.0

MINIMUM PAIR-WISE DIVERGENCE= 25.8

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION= .33

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S = 173.702
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C = 268.075
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O = 180.312
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W = 303.635
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R = 654.247
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A = 696.094
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y = 206.235
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X = 1165.065
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E = 339.305

PAIR-WISE DIVERGENCE

CS=	26.1	OS=	78.4	OC=	76.6	WS=	202.4	WC=	324.5	WO=	110.9	RS=	209.5
RC=	100.3	RO=	90.3	RW=	674.6	AS=	188.7	AC=	82.2	AO=	92.2	AW=	733.0
AR=	25.8	YS=	117.5	YC=	204.3	YO=	37.9	YW=	52.6	YR=	423.3	YA=	439.3
XS=	346.8	XC=	921.4	XO=	804.1	XW=	299.6	XR=	2962.8	XA=	3281.7	XY=	325.5
ES=	220.2	EC=	409.2	EO=	152.0	EW=	31.5	ER=	747.5	EA=	725.9	EY=	49.6
EX=	378.6												

CHANNELS= 6 9 10 11
AVERAGE PAIR-WISE DIVERGENCE= 332.2

MINIMUM PAIR-WISE DIVERGENCE= 26.2

RATIO OF THIS CHANNEL SET WITH CHANNEL SET YIELDING MAXIMUM PERCENT SEPARATION= .04

AVERAGE DIVERGENCE BY CLASS...
AVERAGE INTERCLASS DIVERGENCE FOR CLASS S = 136.941
AVERAGE INTERCLASS DIVERGENCE FOR CLASS C = 254.047
AVERAGE INTERCLASS DIVERGENCE FOR CLASS O = 133.205
AVERAGE INTERCLASS DIVERGENCE FOR CLASS W = 332.184
AVERAGE INTERCLASS DIVERGENCE FOR CLASS R = 471.094
AVERAGE INTERCLASS DIVERGENCE FOR CLASS A = 503.224
AVERAGE INTERCLASS DIVERGENCE FOR CLASS Y = 173.453
AVERAGE INTERCLASS DIVERGENCE FOR CLASS X = 653.091
AVERAGE INTERCLASS DIVERGENCE FOR CLASS E = 332.827

PAIR-WISE DIVERGENCE

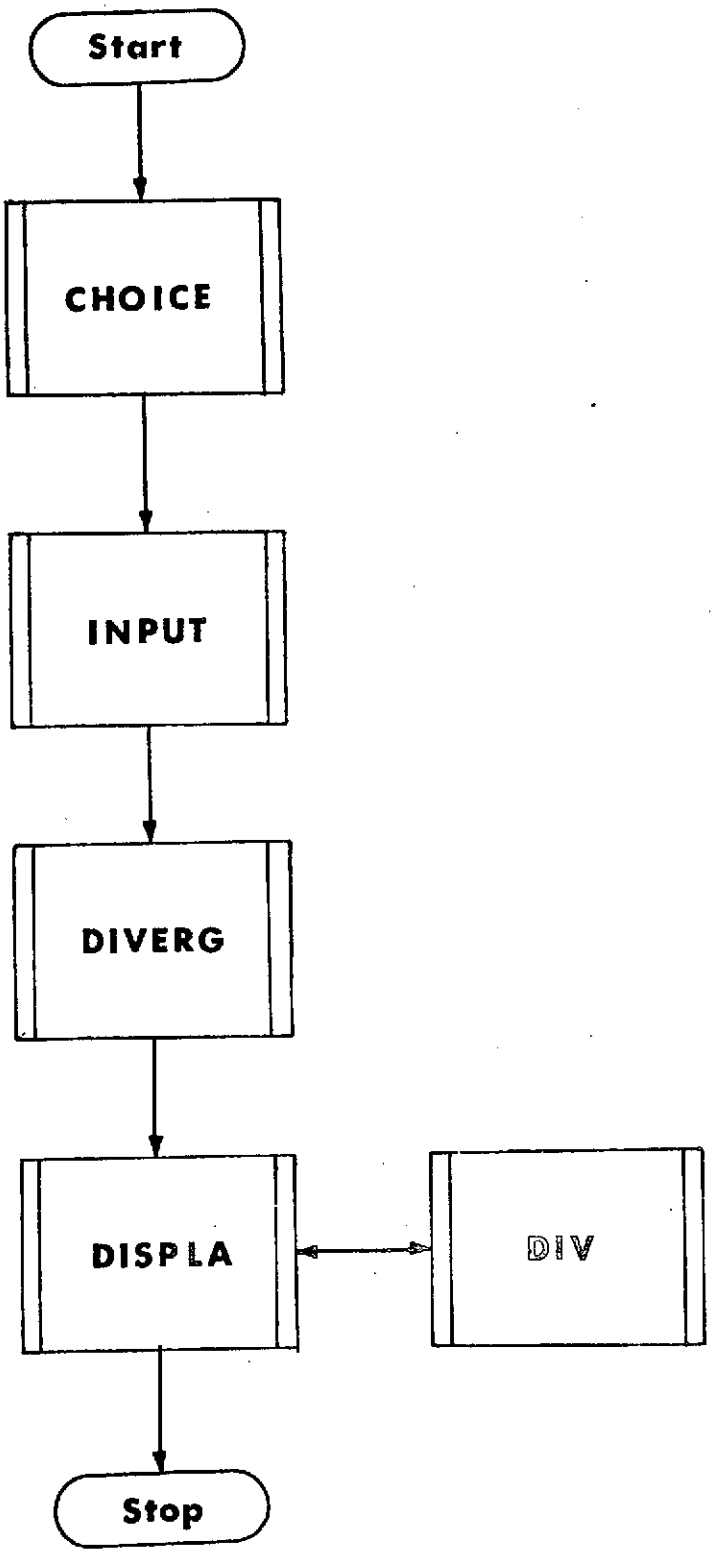
CS=	36.5	OS=	61.3	OC=	105.8	WS=	208.8	WC=	441.0	WO=	112.4	RS=	167.0
RC=	104.8	RO=	106.7	RW=	684.0	AS=	169.3	AC=	102.8	AO=	109.9	AW=	753.5
AR=	26.2	YS=	93.7	YC=	164.4	YO=	58.9	YW=	206.6	YR=	359.3	YA=	339.7
XS=	233.1	XC=	675.8	XO=	578.7	XW=	172.9	XR=	1550.2	XA=	1764.8	XY=	149.6
ES=	165.8	EC=	401.2	EO=	131.9	EW=	78.2	ER=	770.6	EA=	759.6	EY=	55.6
EX=	299.7												

Software Description

Overview

Routine	Function
CHOICE	Main program. Coordinates subroutine calls.
INPUT	Inputs and lists data cards.
DIVERG	Computes divergences, does exhaustive search, and saves top-ranked sets.
DISPLA	Displays top channel sets.
DIV	Recomputes pairwise divergences for those top-ranked sets to be displayed.

LOGIC FLOW



Univac 1108 Exec 8 Stream

```
@RUN,P    RUNID,ACCOUNTNO,PROJECTID,3,100
@ASG,T    CHOICE,T,11848     . MAGNETIC TAPE CONTAINING PROGRAM FILE
@COPIN    CHOICE.            . TRANSFER PROGRAM FILE TO DRUM
@FREE     CHOICE.            . RELEASE TAPE
@XQT      TL0003             . EXECUTE CHOICE'S ABSOLUTE ELEMENT
   data cards                  See:  Example of Input Data
@FIN                         . RUN COMPLETED
```

Fortran Listing

CHOICE

```
FOR,S CHOICE,CHOICE
FOR 94L-06/12-08'42 (2,0)


   MAIN PROGRAM

   STORAGE USED' CODE(1) 000026  DATA(0) 000011  BLANK COMMON(2) 000000

    COMMON BLOCKS'

    0003   UNITS  000002
    0004   MAX    000005
    0005   INP    025416
    0006   INV    005514
    0007   YDIJ   015735

   EXTERNAL REFERENCES (BLOCK, NAME)

    0010   INPUT
    0011   DIVERG
    0012   DISPLA
    0013   NINTR$
    0014   NADU$
    0015   NIO1$
    0016   NICP$
    0017   NSTOP$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0000   000002 100F      0001   000010 153G      0003 I 000000 CARD      0005   024203 CHAR      0005   024436 DIJ
    0004   000001 MAXCLS    0004   000002 MBEST     0005   024244 MDIJ      0004   000004 MFRNT     0004   000003 MSHO
    0004   000000 MXMSMT    0005   024202 NBEST     0005   024201 NCL       0005   024200 NM        0005   024243 NPRT
    0005   024245 NSHOW     0003 I 000001 PRINT     0005   024246 SHOW      0006   005500 VEC       0000 I 000000 VERS
    0007   015733 ZAVG      0007   015672 ZCAVG     0005   001400 ZCOV      0007   000000 ZDIJ      0006   000000 ZINV
    0007   004000 ZMADIJ    0007   003700 ZMCDIJ    0007   000760 ZMDIJ     0005   000000 ZMEAN     0007   015734 ZMIN
    0007   004050 ZMMDIJ    0007   004120 ZMPDIJ    0007   015732 ZPCT      0006   004700 ZV

                                                                                    C. JONES  NASA/ERL
00100    1*  C
00101    2*        INCLUDE SPEC,LIST    PARAMETERS,DIMENSIONS,COMMON
                                                                                                  JONES
00101    2*  C
00103    2*        IMPLICIT INTEGER(A-Y)     ALL INTEGER EXCEPT Z
00104    2*        PARAMETER MAXCLA=32    MAX. NO. OF CLASSES. CAN
00104    2*  C  INCREASE IF NEEDED.
00105    2*        PARAMETER MXMSMA=24     MAX NO. OF MEASUREMENTS (CHANNELS). CAN INCREASE.
00106    2*        PARAMETER MBESTA=12     MAX. NO. OF MEASUREMENTS IN "BEST" SUBSET
00107    2*        PARAMETER RSUMA=(MBESTA+1)*MBESTA/2     SUM OF 1,2,...,NO. IN "BEST" SUBSET
00110    2*        PARAMETER SUMA=(MXMSMA+1)*MXMSMA/2     SUM OF 1,2,...,MAX NO. MEASUREMENTS
00111    2*        COMMON/UNITS/CARD,PRINT     I/O UNITS-CARD READER, PRINTER
00112    2*        COMMON /MAX/MXMSMT,MAXCLS,MBEST,MSHO,MFRNT     MAXIMUMS
00113    2*        COMMON /INP/ ZMEAN,ZCOV,NM,NCL,
00113    2*       *NBEST,CHAR,NPRT,MDIJ,NSHOW,SHOW,DIJ     INPUT
00114    2*        DIMENSION ZMEAN(MXMSMA,MAXCLA)     HOLDS MEANS FOR EACH MEASUREMENT, CLASS
```

```
00115    2*        DIMENSION ZCOV(SUMA,MAXCLA)     HOLDS COVARIANCES (LOWER TRIANGLE)
00115    2*  C                                       FOR EACH CLASS.
00116    2*        PARAMETER PCTPRT=10     NO. OF COMBO'S RANKED BY PERCENT TO BE PRINTED
00117    2*        DIMENSION VEC(MBESTA)     HOLDS UNIQUE COMBINATION OF FEATURES (CHANNELS)
00120    2*        COMMON /INV/ZINV,ZV,VEC     INVERSION ARRAYS
00121    2*        DIMENSION ZINV(RSUMA,MAXCLA)     HOLDS INVERSE COVARIANCE MATRICES
00121    2*  C                                         FOR EACH CLASS
00122    2*        DIMENSION ZV(MBESTA,MAXCLA)     WORKING ARRAY USED WHEN COMPUTING
00122    2*  C                                         INVERSE BY BORDERING METHOD.
00123    2*        PARAMETER DSUM=(MAXCLA-1)*MAXCLA/2     "MAXCLA" COMBO'S TAKEN TWO AT A TIME
00124    2*        DIMENSION ZDIJ(DSUM)     WORKING BUFFER FOR INTERCLASS DIVERGENCE
00125    2*        DIMENSION CHAR(MAXCLA)     HOLDS CHARACTER REPRESENTATION OF CLASSES
00126    2*        COMMON /YDIJ/ ZDIJ,ZMDIJ,ZMCDIJ,ZMADIJ,
00126    2*       *ZMMDIJ,ZMFDIJ,ZCAVG,ZPCT,ZAVG,ZMIN     FOR DIJ
00127    2*        PARAMETER MSHOW=10     MAXIMUM NO. OF SHOW REQUESTS HONORED
00130    2*        DIMENSION SHOW (MBESTA,MSHOW)     HOLDS CHANNEL COMBO'S REQUESTED
00131    2*        PARAMETER MPRINT=20     MAXIMUM NO. OF PRINT REQUESTS TO BE HONORED
00132    2*        DIMENSION ZMDIJ(DSUM,3)     HOLDS MAX. DIJ,AVG. DIJ,PACKED CHANNEL WORD(PCW)
00133    2*        DIMENSION ZMCDIJ(MAXCLA,2)     HOLDS MAX. DIJ FOR CLASS,PCW
00134    2*        DIMENSION ZMADIJ(MPRINT,2)     HOLDS MAX. AVG. DIJ,PCW FOR NO. PRINT REQUEST
00135    2*        DIMENSION ZMMDIJ(MPRINT,2)     HOLDS MAX. MIN. DIJ,PCW FOR NO. PRINT REQUEST
00136    2*        PARAMETER DSUM1=DSUM+1     CLASSES TAKEN 2 AT A TIME + 1 WORD
00137    2*        DIMENSION ZMFDIJ(DSUM1,PCTPRT)     DIJ'S RANKED BY PERCENT,PCW
00140    2*        DIMENSION ZCAVG(MAXCLA)     WORK ARRAY USED TO FIND LARGEST CLASS AVG. DIJ
00141    2*        DIMENSION DIJ(DSUM)     HOLDS CHARACTER COMBO'S FOR DIJ PAIRS
00141    2*     END
00142    3*        DIMENSION VERS(2)     LAST TIME ANY CHANGE TO PROGRAM
00143    4*        DATA VERS/"APR  4",", 1973"/
00145    5*        DATA CARD/5/     CARD READER UNIT
00147    6*        DATA PRINT/6/     PRINTER UNIT
00151    7*        WRITE(PRINT,100) VERS     PRINT VERSION NO.
00157    8*  100   FORMAT("0",2A6,/,"0")
00160    9*        CALL INPUT     GET MEANS,COVARIANCES,NO. OF MEASUREMENTS (CHANNELS),
00160   10*  C           NO. OF CLASSES,DIMENSION OF "BEST" SUBSET, DISPLAY INFO.
00161   11*        CALL DIVERG     COMPUTE DIVERGENCE FOR ALL COMBINATIONS AND SAVE
00161   12*  C             THOSE OF INTEREST
00162   13*        CALL DISPLA     OUTPUT SEPARATIONS
00163   14*        STOP
00164   15*        END

      END OF COMPILATION'        NO  DIAGNOSTICS.
```

INPUT

```
FOR,S INPUT,INPUT
FOR 9#L-06/12-06'44 (2,0)

   SUBROUTINE INPUT      ENTRY POINT 000520

   STORAGE USED' CODE(1) 000534  DATA(0) 000264  BLANK COMMON(2) 000000

    COMMON BLOCKS'

    0003   UNITS  000002
    0004   MAX    000005
    0005   INP    025416
    0006   INV    005514
    0007   YDIJ   015735

   EXTERNAL REFERENCES (BLOCK, NAME)

    0010   NRDU$
    0011   NIO2$
    0012   NWDU$
    0013   NERR6$
    0014   NIO1$
    0015   NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0000   000007 10F      0000   000146 100F     0000   000155 110F     0000   000166 115F     0000   000172 125F
    0000   000174 126F     0000   000200 135F     0000   000202 136F     0000   000210 150F     0000   000221 160F
    0001   000103 175G     0000   000013 20F      0001   000110 201G     0001   000134 211G     0001   000141 215G
    0001   000157 224G     0001   000167 233G     0001   000176 237G     0001   000065 30L      0001   000273 301G
    0001   000300 305G     0001   000353 331G     0001   000360 335G     0001   000412 350G     0001   000417 354G
    0001   000435 364G     0001   000462 402G     0001   000467 406G     0000   000064 50F      0000   000066 70F
    0000   000071 80F      0001   000240 90L      0000   000075 91F      0001   000257 92L      0000   000120 93F
    0000   000143 95F      0001   000310 99L      0003 I 000000 CARD     0005 I 024203 CHAR     0005 I 024436 DIJ
    0000 I 000006 I        0000   000233 INJP$    0000 I 000002 J        0000 I 000003 K        0004 I 000001 MAXCLS
    0004 I 000002 MBEST    0005 I 024244 MDIJ     0000 I 000005 MM       0004 I 000004 MPRNT    0004 I 000003 MSHO
    0004 I 000000 MOHSHT   0005 I 024202 NBEST    0005 I 024201 NCL      0005 I 024200 NM       0005 I 024243 NPRT
    0005 I 024245 NSHOW    0003 I 000001 PRINT    0000 I 000004 PTS      0000 I 000001 RSUM     0005 I 024246 SHOW
    0000 I 000000 SUM      0006   005500 VEC      0007   015733 ZAVG     0007   015672 ZCAVG    0005 R 001400 ZCOV
    0007   000000 ZDIJ     0006   000000 ZINV     0007   004000 ZMADIJ   0007   003700 ZMCDIJ   0007   000760 ZMDIJ
    0005 R 000000 ZMEAN    0007   015734 ZMIN     0007   004050 ZMMDIJ   0007   004120 ZMPDIJ   0007   015732 ZPCT
    0006   004700 ZV

00101    1*          SUBROUTINE INPUT                                                    JONES
00101    2*    C
00103    3*          INCLUDE SPEC,LIST    PARAMETERS,DIMENSIONS,COMMON                   JONES
00103    3*    C
00104    3*          IMPLICIT INTEGER(A-Y)    ALL INTEGER EXCEPT Z
00105    3*          PARAMETER MAXCLA=32   MAX. NO. OF CLASSES. CAN
00105    3*    C  INCREASE IF NEEDED.
```

```
00106    3*        PARAMETER MXMSMA=24     MAX NO. OF MEASUREMENTS (CHANNELS). CAN INCREASE.
00107    3*        PARAMETER MBESTA=12     MAX. NO. OF MEASUREMENTS IN "BEST" SUBSET
00110    3*        PARAMETER RSUMA=(MBESTA+1)*MBESTA/2     SUM OF 1,2,...,NO. IN "BEST" SUBSET
00111    3*        PARAMETER SUMA=(MXMSMA+1)*MXMSMA/2     SUM OF 1,2,...,MAX NO. MEASUREMENTS
00112    3*        COMMON/UNITS/CARD,PRINT     I/O UNITS-CARD READER, PRINTER
00113    3*        COMMON /MAX/MXMSMT,MAXCLS,MBEST,MSHO,MPRNT     MAXIMUMS
00114    3*        COMMON /INF/ ZMEAN,ZCOV,NM,NCL,
00114    3*       *NBEST,CHAR,MPRT,MDIJ,NSHOW,SHOW,DIJ     INPUT
00115    3*        DIMENSION ZMEAN(MXMSMA,MAXCLA)     HOLDS MEANS FOR EACH MEASUREMENT, CLASS
00116    3*        DIMENSION ZCOV(SUMA,MAXCLA)     HOLDS COVARIANCES (LOWER TRIANGLE)
00116    3*  C                                       FOR EACH CLASS.
00117    3*        PARAMETER PCTPRT=10     NO. OF COMBO"S RANKED BY PERCENT TO BE PRINTED
00120    3*        DIMENSION VEC(MBESTA)     HOLDS UNIQUE COMBINATION OF FEATURES (CHANNELS)
00121    3*        COMMON /INV/ZINV,ZV,VEC     INVERSION ARRAYS
00122    3*        DIMENSION ZINV(RSUMA,MAXCLA)     HOLDS INVERSE COVARIANCE MATRICES
00122    3*  C                                          FOR EACH CLASS
00123    3*        DIMENSION ZV(MBESTA,MAXCLA)     WORKING ARRAY USED WHEN COMPUTING
00123    3*  C                                          INVERSE BY BORDERING METHOD.
00124    3*        PARAMETER DSUM=(MAXCLA-1)*MAXCLA/2     "MAXCLA" COMBO"S TAKEN TWO AT A TIME
00125    3*        DIMENSION ZDIJ(DSUM)     WORKING BUFFER FOR INTERCLASS DIVERGENCE
00126    3*        DIMENSION CHAR(MAXCLA)     HOLDS CHARACTER REPRESENTATION OF CLASSES
00127    3*        COMMON /YDIJ/ ZDIJ,ZMDIJ,ZMCDIJ,ZMADIJ,
00127    3*       *ZMMDIJ,ZMPDIJ,ZCAVG,ZPCT,ZAVG,ZMIN     FOR DIJ
00130    3*        PARAMETER MSHOW=10     MAXIMUM NO. OF SHOW REQUESTS HONORED
00131    3*        DIMENSION SHOW (MBESTA,MSHOW)     HOLDS CHANNEL COMBO"S REQUESTED
00132    3*        PARAMETER MPRINT=20     MAXIMUM NO. OF PRINT REQUESTS TO BE HONORED
00133    3*        DIMENSION ZMDIJ(DSUM,3)     HOLDS MAX. DIJ,AVG. DIJ,PACKED CHANNEL WORD(PCW)
00134    3*        DIMENSION ZMCDIJ(MAXCLA,2)     HOLDS MAX. DIJ FOR CLASS,PCW
00135    3*        DIMENSION ZMADIJ(MPRINT,2)     HOLDS MAX. AVG. DIJ,PCW FOR NO. PRINT REQUEST
00136    3*        DIMENSION ZMMDIJ(MPRINT,2)     HOLDS MAX. MIN. DIJ,PCW FOR NO. PRINT REQUEST
00137    3*        PARAMETER DSUM1=DSUM+1     CLASSES TAKEN 2 AT A TIME + 1 WORD
00140    3*        DIMENSION ZMPDIJ(DSUM1,PCTPRT)     DIJ"S RANKED BY PERCENT,PCW
00141    3*        DIMENSION ZCAVG(MAXCLA)     WORK ARRAY USED TO FIND LARGEST CLASS AVG. DIJ
00142    3*        DIMENSION DIJ(DSUM)     HOLDS CHARACTER COMBO"S FOR DIJ PAIRS
00142    3*   END
00143    4*        READ(CARD,10) NM,NCL,NBEST     NO. MEASUREMENTS,NO. CLASSES,SUBSET RANK
00150    5*  10    FORMAT(9X,I2,9X,I2,6X,I2)     CHANNELS=XX CLASSES=XX BEST=XX
00151    6*        MAXCLS=MAXCLA     GET MAX. CLASSES FROM PARAMETER STATEMENT
00152    7*        MXMSMT=MXMSMA     DITTO FOR MAX. NO. MEASUREMENTS
00153    8*        SUM=SUMA     DITTO FOR SUM OF 1,...,MAX. NO. MEASUREMENTS
00154    9*        MBEST=MBESTA     DITTO FOR NO. OF MEANS IN "BEST"
00155   10*        MSHO=MSHOW     DITTO FOR MAX. SHOW REQUESTS
00156   11*        MPRNT=MPRINT     DITTO FOR MAX. PRINT REQUESTS
00157   12*        RSUM=RSUMA     DITTO FOR SUM OF 1,2,...,NO. IN "BEST"
00160   13*        IF(MXMSMT.GE.NM.AND.MAXCLS.GE.NCL.AND.MBEST.GE.NBEST)GO TO 30     DIMS OK
00162   14*        WRITE(PRINT,20) MXMSMT,NM,MAXCLS,NCL,MBEST,NBEST     NO, ERROR
00172   15*  20    FORMAT(" MAXIMUMS EXCEEDED. CHECK CARD COLUMNS OF INPUT.",/,
00172   16*       *" NO. MEASUREMENTS ALLOWED=",I3," ATTEMPTED INPUT (OCTAL)=",O13,/,
00172   17*       *" NO. CLASSES ALLOWED=",I3," ATTEMPTED INPUT=",O13,/,
00172   18*       *" MAX. RANK SUBSET ALLOWED=",I3," ATTEMPTED INPUT=",O13)
00173   19*        RETURN 0     ERROR EXIT
00174   20*  30    DO 40 J=1,NCL     INDEX THRU CLASSES, READ MEANS
00177   21*  40    READ(CARD,50) (ZMEAN(K,J),K=1,NM)     READ MEANS
00206   22*  50    FORMAT(5X,5E15.8)
00207   23*        PTS=(NM+1)*NM/2     NO. POINTS IN LOWER TRIANGLE COV. MATRIX.SUM 1,2,...,NM
00210   24*        DO 60 J=1,NCL     INDEX THRU CLASSES. READ COVARIANCES.
00213   25*  60    READ(CARD,50) (ZCOV(K,J),K=1,PTS)     READ LOWER TRIANGLE COV.
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00213   26*   C  READ IN CHARACTER REPRESENTATIONS OF CLASSES
00222   27*        READ (CARD,70) (CHAR(J),J=1,NCL)     CLASSES=C,O,...
00230   28*   70   FORMAT(7X,36(1X,A1))
00231   29*        MM=1     INITIALIZE INDEX FOR DIJ CHARACTER PAIR
00232   30*        DO 55 I=2,NCL     THE I OF DIJ
00235   31*        K=I-1     THE J IS ALWAYS SMALLER THAN THE I
00236   32*        DO 55 J=1,K     THE J OF DIJ
00241   33*        DIJ(MM)=CHAR(I)     GET FIRST CHAR OF CLASS PAIR
00242   34*        FLD(6,6,DIJ(MM))=FLD(0,6,CHAR(J))     GET AND PACK 2ND CHAR. IN CLASS PAIR
00243   35*   55   MM=MM+1     BUMP PAIR INDEX
00246   36*        READ(CARD,80) NPRT,MDIJ,NSHOW     PRINT=XX,MAX DIJ=XXXXX,NO. SHOW=XX
00253   37*   80   FORMAT(6X,I2,9X,I5,1DX,I2)     NO. OF COMBO'S TO PRINT, MAXIMUM INTERCLASS
00253   38*   C                                          DIVERGENCE ALLOWED, NO. OF SPECIAL SHOW
00253   39*   C                                          COMBINATIONS REQUESTED.
00253   40*   C  CHECK NO. OF PRINT AND SHOW REQUESTS
00254   41*        IF(NPRT.LE. MPRNT) GO TO 90     NO. OF PRINT REQUESTS EXCEEDED MAX.
00256   42*        WRITE(PRINT,91) NPRT,MPRT,MPRNT     YES, PRINT WARNING
00263   43*   91   FORMAT("0 NO. OF PRINT REQUESTS=",I5,O14," TOO LARGE, MAXIMUM"
00263   44*       *" ALLOWED IS=",I3," PRINT REQUESTS SET TO MAX.")
00264   45*        NPRT=MPRNT     SET PRINT REQUESTS TO MAXIMUM
00265   46*   90   IF(NSHOW.LE.MSHO) GO TO 92     NO. OF SHOW REQUESTS EXCEEDED MAX.
00267   47*        WRITE(PRINT,93) NSHOW,NSHOW,MSHO     YES, PRINT WARNING
00274   48*   93   FORMAT("0 NO. OF SHOW REQUESTS=",I5,O14," TOO LARGE, MAXIMUM"
00274   49*       *" ALLOWED IS=",I3," SHOW REQUESTS SET TO MAX.")
00275   50*        NSHOW=MSHO     SET SHOW REQUESTS TO MAXIMUM
00276   51*   92   IF(NSHOW.EQ.0) GO TO 99     ANY SHOW CARDS
00300   52*        DO 94 J=1,NSHOW     INDEX THRU SHOW CARDS
00303   53*        READ(CARD,95) (SHOW(I,J),I=1,NBEST)     CHANNELS=01,03,10,...
00311   54*   95   FORMAT(8X,24(1X,I2))
00312   55*   94   CONTINUE
00314   56*   99   WRITE(PRINT,100)
00316   57*   100  FORMAT(1H1," INTERPRETATION OF CARD INPUT")
00316   58*   C  PRINT CHANNELS,CLASSES,BEST CHANNELS
00317   59*        WRITE(PRINT,110)NM,NCL,NBEST
00324   60*   110  FORMAT("0 CHANNELS=",I2," CLASSES=",I2," BEST=",I2)
00325   61*        WRITE(PRINT,115)
00327   62*   115  FORMAT("0 INPUT MEANS")
00330   63*        DO 120 J=1,NCL     INDEX THRU CLASSES
00333   64*   120  WRITE(PRINT,125) (ZMEAN(K,J),K=1,NM)     PRINT MEANS
00342   65*   125  FORMAT(5X,5E15.8)
00343   66*        PTS=(NM+1)*NM/2     NO. POINTS IN LOWER TRIANGLE COV. MATRIX
00344   67*        WRITE(PRINT,126)
00346   68*   126  FORMAT("0 INPUT COVARIANCE")
00347   69*        DO 130 J=1,NCL     INDEX THRU CLASSES
00352   70*   130  WRITE(PRINT,135) (ZCOV(K,J),K=1,PTS)     PRINT LOWER TRIANGLE COV.
00361   71*   135  FORMAT(5X,5E15.8)
00362   72*        WRITE(PRINT,136) (CHAR(J),J=1,NCL)     PRINT CLASSES
00370   73*   136  FORMAT("0 INPUT CLASSES ",36(1X,A1))
00371   74*        WRITE(PRINT,150)NPRT,MDIJ,NSHOW     PRINT=XX MAX. DIJ=XX NO. SHOW=XX
00376   75*   150  FORMAT("0 PRINT=",I2," MAX DIJ=",I5," NO. SHOW=",I2)
00377   76*        IF(NSHOW.EQ.0) RETURN     ANY SHOW CARDS
00401   77*        DO 155 J=1,NSHOW     INDEX THRU SHOW CARDS
00404   78*   155  WRITE(PRINT,160) (SHOW(I,J),I=1,NBEST)     BEST CHANNELS
00413   79*   160  FORMAT("0 SHOW CHANNELS=",24(1X,I2))
00414   80*        RETURN
00415   81*        END
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DIVERG

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FOR,S DIVERG,DIVERG
FOR 94L-06/12-08'44  (1,0)

   SUBROUTINE DIVERG     ENTRY POINT 001747

   STORAGE USED' CODE(1) 001774  DATA(0) 000520  BLANK COMMON(2) 000000

    COMMON BLOCKS'

    0003   UNITS  000002
    0004   MAX    000005
    0005   INP    025416
    0006   INV    005514
    0007   YDIJ   015735

   EXTERNAL REFERENCES (BLOCK, NAME)

    0010   N4DU$
    0011   NIO2$
    0012   NIO1$
    0013   NERR6$
    0014   NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0001   000026 146G     0001   000040 154G     0001   000064 164G     0001   000104 200G     0001   000334 203L
    0001   000116 204G     0001   000132 210G     0001   000160 222G     0001   000503 230L     0000   000206 231F
    0001   000211 231G     0000   000225 232F     0000   000243 233F     0001   000233 234G     0000   000245 236F
    0000   000247 237F     0000   000256 238F     0000   000266 239F     0001   050710 240L     0000   000303 241F
    0001   000243 242G     0000   000322 243F     0000   000327 244F     0001   000256 245G     0001   000310 260G
    0001   000346 271G     0001   001146 300L     0001   000407 304G     0001   000424 307G     0000   000331 310F
    0000   000354 311F     0000   000362 312F     0000   000400 313F     0001   000456 317G     0001   000531 341G
    0001   000540 350G     0001   000554 354G     0001   000600 366G     0001   000070 40L      0001   000660 417G
    0001   000702 427G     0001   000720 441G     0001   000740 445G     0001   000762 453G     0001   000775 456G
    0001   000102 50L      0001   001123 504G     0001   001164 532G     0001   001243 551G     0001   001274 563G
    0001   001313 575G     0001   001350 604G     0001   001343 612G     0001   001356 621G     0001   001365 625G
    0001   001404 635G     0001   001411 642G     0001   001434 655G     0001   001451 663G     0001   001474 700G
    0001   001511 706G     0001   001550 723G     0001   001602 737G     0001   001626 750G     0001   001637 754G
    0001   001665 765G     0001   001666 770G     0001   001701 776G     0001   001227 82L      0001   001231 83L
    0001   001307 85L      0001   001423 89L      0001   001465 90L      0001   001463 91L      0001   001525 93L
    0001   001523 94L      0001   000036 96L      0001   001707 99L      0003   000000 CARD     0005 I 024203 CHAR
    0005   024436 DIJ      0000 I 000000 ELE      0000 I 000202 I        0000 I 000205 II       0000   000424 INJP$
    0000 I 000132 J        0000 I 000135 JJ       0000 I 000204 JJJ      0000 I 000133 J2       0000 I 000134 J3
    0000 I 000176 L        0000 I 000200 LOW      0004   000001 MAXCLS   0004   000002 MBEST    0005 I 024244 MDIJ
    0000 I 000201 MM       0004   000004 MFRNT    0004   000003 MSHO     0004   000000 MXMSMT   0005 I 024202 NBEST
    0005 I 024201 NCL      0005 I 024200 NI       0005 I 024243 NPRT     0005   024245 NSHOW    0000 I 000174 PAIRS
    0003 I 000001 PRINT    0005   024246 SHOW     0000 I 000203 UP       0006 I 005500 VEC      0000 I 000160 WA
    0000 I 000162 WB       0000 I 000157 WC       0000 I 000164 WI       0000 I 000171 WIJ      0000 I 000165 WJ
    0000 I 000166 WK       0000 I 000170 WKL      0000 I 000167 WL       0000 I 000173 WM       0000 I 000161 WUP
    0000 I 000140 XC       0000 I 000136 XCL      0000 I 000137 XCT      0000 I 000142 XD       0000 I 000145 XF
    0000 I 000141 XI       0000 I 000150 XIJ      0000 I 000144 XIND     0000 I 000143 XJ       0000 I 000153 XJI
    0000 I 000146 XK       0000 I 000155 XKI      0000 I 000151 XKJ      0000 I 000154 XKK      0000 I 000152 XL
    0000 I 000147 XM       0000 I 000156 XPTS     0000 R 000172 Z        0007 R 015735 ZAVG     0007 R 015672 ZCAVG
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0005 R 001400 ZCOV      0000 R 000163 ZD        0007 R 000000 ZDIJ      0006 R 000000 ZINV      0000 R 000177 ZN
0007 R 004000 ZMADIJ    0007 R 003700 ZMCDIJ    0007 R 000760 ZMDIJ     0005 R 000000 ZMEAN     0007 R 015734 ZMIN
0007 R 004050 ZMMDIJ    0007 R 004120 ZMPDIJ    0007 R 015732 ZPCT      0000 R 000175 ZPCW      0000 R 000116 ZPRNT
0006 R 004700 ZV
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00101    1*          SUBROUTINE DIVERG                                                    JONES
00101    2*    C
00103    3*          INCLUDE SPEC,LIST    PARAMETERS,DIMENSIONS,COMMON
00103    4*    C  INITIALIZE "VEC" FOR UNIQUE INTEGER COMBINATION ALGORITHM              JONES
00103    4*    C
00104    4*          IMPLICIT INTEGER(A-Y)    ALL INTEGER EXCEPT Z
00105    4*          PARAMETER MAXCLA=32   MAX. NO. OF CLASSES. CAN
00105    4*    C  INCREASE IF NEEDED.
00106    4*          PARAMETER MXMSMA=24    MAX NO. OF MEASUREMENTS (CHANNELS). CAN INCREASE.
00107    4*          PARAMETER MBESTA=12    MAX. NO. OF MEASUREMENTS IN "BEST" SUBSET
00110    4*          PARAMETER RSUMA=(MBESTA+1)*MBESTA/2    SUM OF 1,2,...,NO. IN "BEST" SUBSET
00111    4*          PARAMETER SUMA=(MXMSMA+1)*MXMSMA/2    SUM OF 1,2,...,MAX NO. MEASUREMENTS
00112    4*          COMMON/UNITS/CARD,PRINT    I/O UNITS-CARD READER, PRINTER
00113    4*          COMMON /MAX/MXMSMT,MAXCLS,MBEST,MSHO,MPRNT    MAXIMUMS
00114    4*          COMMON /INP/ ZMEAN,ZCOV,NM,NCL,
00114    4*         *NBEST,CHAR,NPRT,MDIJ,NSHOW,SHOW,DIJ    INPUT
00115    4*          DIMENSION ZMEAN(MXMSMA,MAXCLA)    HOLDS MEANS FOR EACH MEASUREMENT, CLASS
00116    4*          DIMENSION ZCOV(SUMA,MAXCLA)    HOLDS COVARIANCES (LOWER TRIANGLE)
00116    4*    C                                      FOR EACH CLASS.
00117    4*          PARAMETER PCTPRT=10    NO. OF COMBO'S RANKED BY PERCENT TO BE PRINTED
00120    4*          DIMENSION VEC(MBESTA)    HOLDS UNIQUE COMBINATION OF FEATURES (CHANNELS)
00121    4*          COMMON /INV/ZINV,ZV,VEC    INVERSION ARRAYS
00122    4*          DIMENSION ZINV(RSUMA,MAXCLA)    HOLDS INVERSE COVARIANCE MATRICES
00122    4*    C                                      FOR EACH CLASS
00123    4*          DIMENSION ZV(MBESTA,MAXCLA)    WORKING ARRAY USED WHEN COMPUTING
00123    4*    C                                      INVERSE BY BORDERING METHOD.
00124    4*          PARAMETER DSUM=(MAXCLA-1)*MAXCLA/2    "MAXCLA" COMBO'S TAKEN TWO AT A TIME
00125    4*          DIMENSION ZDIJ(DSUM)    WORKING BUFFER FOR INTERCLASS DIVERGENCE
00126    4*          DIMENSION CHAR(MAXCLA)    HOLDS CHARACTER REPRESENTATION OF CLASSES
00127    4*          COMMON /YDIJ/ ZDIJ,ZMDIJ,ZMCDIJ,ZMADIJ,
00127    4*         *ZMMDIJ,ZMPDIJ,ZCAVG,ZPCT,ZAVG,ZMIN    FOR DIJ
00130    4*          PARAMETER MSHOW=10    MAXIMUM NO. OF SHOW REQUESTS HONORED
00131    4*          DIMENSION SHOW (MBESTA,MSHOW)    HOLDS CHANNEL COMBO'S REQUESTED
00132    4*          PARAMETER MPRINT=20    MAXIMUM NO. OF PRINT REQUESTS TO BE HONORED
00133    4*          DIMENSION ZMDIJ(DSUM,3)    HOLDS MAX. DIJ,AVG. DIJ,PACKED CHANNEL WORD(PCW)
00134    4*          DIMENSION ZMCDIJ(MAXCLA,2)    HOLDS MAX. DIJ FOR CLASS,PCW
00135    4*          DIMENSION ZMADIJ(MPRINT,2)    HOLDS MAX. AVG. DIJ,PCW FOR NO. PRINT REQUEST
00136    4*          DIMENSION ZMMDIJ(MPRINT,2)    HOLDS MAX. MIN. DIJ,PCW FOR NO. PRINT REQUEST
00137    4*          PARAMETER DSUM1=DSUM+1    CLASSES TAKEN 2 AT A TIME + 1 WORD
00140    4*          DIMENSION ZMPDIJ(DSUM1,PCTPRT)    DIJ'S RANKED BY PERCENT,PCW
00141    4*          DIMENSION ZCAVG(MAXCLA)    WORK ARRAY USED TO FIND LARGEST CLASS AVG. DIJ
00142    4*          DIMENSION DIJ(DSUM)    HOLDS CHARACTER COMBO'S FOR DIJ PAIRS
00142    4*        END
00143    5*          DIMENSION ELE(RSUMA)    PRINT BUFFER. HOLDS ELEMENTS OF
00143    6*    C  COVARIANCE MATRIX ON ERROR.
00144    7*          DIMENSION ZPRNT(MBESTA)    PRINT BUFFER. HOLDS ROW
00144    8*    C  OF COVARIANCE MATRIX ON ERROR.
00145    9*          DO 10 J=1,NBEST    DIMENSION IS "BEST"
00150   10*    10     VEC(J)=J    SET TO  FIRST UNIQUE SET
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00152   11*         VEC(NBEST)=VEC(NBEST)-1     EXCEPT FOR LAST COMPONENT
00152   12*   C  ALGORITHM FOR NEXT UNIQUE INTEGER COMBINATION
00153   13*   96    DO 20 J=1,NBEST      GIVE ME NEXT UNIQUE COMBINATION
00156   14*         J2=NBEST-J+1      INCREMENT NBEST*TH COMPONENT MOST OFTEN
00157   15*         J3=J2+1     TELLS ME IF I INCREMENTED THE NBEST*TH COMPONENT LAST
00160   16*         VEC(J2)=VEC(J2)+1      INCREMENT J2*TH COMPONENT
00161   17*         IF(J3.GT.NBEST) GO TO 40     IS THIS NBEST*TH COMPONENT
00163   18*         DO 30 JJ=J3,NBEST     NO,INITIALIZE NEXT LEVEL
00166   19*   30    VEC(JJ)=VEC(JJ-1)+1      SET HIGHER ORDER TO LOWER ORDER COMP. +1
00170   20*   40    IF(VEC(NBEST).LE.NM) GO TO 50     IS THIS LEGAL COMBO.
00172   21*   20    CONTINUE      NO, INCREMENT THE NEXT LOWER COMPONENT.
00174   22*         RETURN     UNIQUE COMBINATIONS HAVE BEEN EXHAUSTED
00175   23*   50    CONTINUE      CONNECTOR, I HAVE A UNIQUE SUBSET
00176   24*         INCLUDE INVR,LIST     MATRIX INVERSION CODE                    JONES
00176   24*   C
00176   24*   C  COMPUTES INVERSE FOR "NCL" MATRICES BY BORDERING TECHNIQUE
00176   24*   C
00176   24*   C  THIS ALGORITHM PERFORMS MATRIX INVERSION ON A SYMMETRIC MATRIX.
00176   24*   C SEE "STATISTICAL COMPUTATIONS ON A DIGITAL COMPUTER" BY HEMMERLE. PG 73
00176   24*   C THE INPUT MATRIX IS "ZCOV" IN LOWER TRIANGLE FORM
00176   24*   C THE INVERSE OF "ZCOV" IS STORED IN"ZINV" IN LOWER TRIANGLE FORM.
00176   24*   C  THIS PROCEDURE RESTRICTS ITSELF TO THE 200 SERIES
00176   24*   C AND TO INTERNAL FLAGS STARTING WITH "X"
00177   24*   211   DO 221 XCL=1,NCL     REDUCE COV. MATRIX FOR EACH CLASS
00202   24*         XCT=0     COUNTS WHERE I AM IN REDUCED COV. MATRIX
00203   24*         DO 221 XC=1,NBEST     REDUCED MATRIX OF RANK *NBEST*
00206   24*         XI=VEC(XC)     RETRIEVE LOGICAL ROW INDEX
00207   24*         DO 221 XD=1,XC      COLUMN INDEX FOR REDUCED LOWER TRIANGLE MATRIX
00212   24*         XJ=VEC(XD)     RETRIEVE LOGICAL COLUMN INDEX
00213   24*         XIND=XI*(XI-1)/2+XJ     CONVERT TO LOWER TRIANGLE INDEXING SCHEME
00214   24*         XCT=XCT+1     BUMP POINTER IN REDUCED COVARIANCE ARRAY
00215   24*   221   ZINV(XCT,XCL)=ZCOV(XIND,XCL)     REDUCE COVARIANCE MATRIX FOR EACH CLASS
00215   24*   C  NOW COMPUTE INVERSE
00221   24*         DO 222 XCL=1,NCL     COMPUTE INVERSE FOR EACH CLASS
00224   24*         XF=1    FLAGS FIRST ROW ERROR
00225   24*         IF(ABS(ZINV(1,XCL)).LT. .00001) GO TO 230    WILL I BE
00225   24*   C  DIVIDING BY ZERO
00227   24*         ZINV(1,XCL)=1.0/ZINV(1,XCL)     NO, TAKE RECIPROCAL
00230   24*         DO 201   XK=2,NBEST     INDEX THRU ROWS
00233   24*         DO 202   XI=1,XK     INITIALIZE WORK ARRAY TO ZERO
00236   24*   202    ZV(XI,XCL)=0
00240   24*         XM=XK-1     UPPER ROW LIMIT
00241   24*         DO 203 XI=1,XM     INDEX THRU ROWS
00244   24*         DO 204 XJ=1,XI     INDEX THRU COLUMNS
00247   24*         XIJ=(XI-1)*XI/2+XJ     COMPUTE LOWER TRIANGLE INDEX FOR (I,J)
00250   24*         XKJ=(XK-1)*XK/2+XJ     DITTO FOR (K,J)
00251   24*   204    ZV(XI,XCL)=ZV(XI,XCL)+ZINV(XIJ,XCL)*ZINV(XKJ,XCL)    COLUMN WORK VECTOR
00253   24*         IF(XI-XM) 205,206,205     AM I THRU COMPUTING WORK VECTOR
00256   24*   205   XL=XI+1     NO, COMPUTE LOWER LIMIT AND CONTINUE
00257   24*         DO 208 XJ=XL,XM     MULTIPLY THE XK*TH ROW BY THE XJ*TH COLUMN
00262   24*         XKJ=(XK-1)*XK/2+XJ     COMPUTE LOWER TRIANGLE INDEX FOR (K,J)
00263   24*         XJI=(XJ-1)*XJ/2+XI     DITTO FOR (J,I)
00264   24*   208    ZV(XI,XCL)=ZV(XI,XCL)+ZINV(XKJ,XCL)*ZINV(XJI,XCL)    COLUMN WORK VECTOR
00266   24*   203   CONTINUE     GO TO NEXT ROW
00270   24*         DO 206 XJ=1,XM     GO THRU XJ*TH COLUMN OF THE XK*TH ROW
00273   24*         XKJ=(XK-1)*XK/2+XJ     COMPUTE LOWER TRIANGLE INDEX (LTI) FOR (K,J)
00274   24*   206   ZV(XK,XCL)=ZV(XK,XCL)+ZINV(XKJ,XCL)*ZV(XJ,XCL)    XK*TH ROW OF COLUMN VECTR
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00276   24*         XKK=(XK+1)*XK/2    LTI FOR (K,K)
00277   24*         XF=2   FLAGS ERROR OCCURRED ON OTHER THAN FIRST ROW
00300   24*         IF(ABS(ZINV(XKK,XCL)-ZV(XK,XCL)).LT. .00001) GO TO 230   WILL I
00300   24*   C  BE DIVIDING BY ZERO
00302   24*         ZINV(XKK,XCL)=1.0/(ZINV(XKK,XCL)-ZV(XK,XCL))    INVERSE OF ELEMENT (K,K)
00303   24*         DO 207 XJ=1,XM     INDEX THRU ROWS
00306   24*         DO 207 XI=1,XJ     INDEX THRU COLUMNS
00311   24*         XJI=(XJ-1)*XJ/2+XI     LTI FOR (J,I)
00312   24*         XKK=(XK+1)*XK/2    LTI FOR (K,K)
00313   24*   207   ZINV(XJI,XCL)=ZINV(XJI,XCL)+ZINV(XKK,XCL)*ZV(XI,XCL)*ZV(XJ,XCL)   (J,I) INV
00316   24*         DO 209 XI=1,XM     INVERSE OF THE XK*TH ROW AND XI*TH COLUMNS
00321   24*         XKI=(XK-1)*XK/2+XI     LTI FOR (K,I)
00322   24*   209   ZINV(XKI,XCL)=-ZINV(XKK,XCL)*ZV(XI,XCL)     (K,I) INVERSE
00324   24*   201   CONTINUE     GO TO NEXT ROW
00326   24*   222   CONTINUE     GO TO NEXT CLASS
00330   24*         GO TO 240    SKIP ERROR PRINT
00330   24*   C
00330   24*   C  PROBLEMS ON ATTEMPTING TO INVERT MATRIX
00330   24*   C
00331   24*   230   WRITE(PRINT,231)
00333   24*   231   FORMAT(1H1,"***ERROR*** ON ATTEMPT TO COMPUTE INVERSE",
00333   24*        *" OF THE FOLLOWING SUB-MATRIX",//)
00334   24*         WRITE(PRINT,232)
00336   24*   232   FORMAT(" THE DIAGONAL ELEMENTS CANNOT BE ZERO.",/,
00336   24*        *" NO TWO ROWS CAN BE THE SAME.",//)
00337   24*         WRITE(PRINT,233)   (VEC(XC),XC=1,NBEST)    PRINT FEATURES
00345   24*   233   FORMAT(1X,I8,7I15)
00346   24*         XL=0    COUNTS ELEMENTS IN LOWER TRIANGLE MATRIX
00347   24*         DO 234 XC=1,NBEST    INDEX THRU NO. CHANNELS IN SUBSET
00352   24*         XI=VEC(XC)    GET ROW INDEX IN BIG COV. MATRIX
00353   24*         DO 235 XD=1,XC    INDEX THRU COLUMNS
00356   24*         XJ=VEC(XD)    GET COL. INDEX IN BIG COV. MATRIX
00357   24*         XIND=XI*(XI-1)/2+XJ    COMPUTE WHERE ROW,COL. ARE IN LOWER TRIANGLE
00360   24*         XL=XL+1    BUMP COUNTER FOR NO. ELEMENTS IN LOWER TRIANGLE
00361   24*         ELE(XL)=XIND    SAVE LOWER TRIANGLE INDEX
00362   24*   235   ZPRNT(XD)=ZCOV(XIND,XCL)    RETRIEVE NEXT
00362   24*   C  ELEMENT IN ROW FROM BIG MATRIX
00364   24*         WRITE(PRINT,236)   (ZPRNT(XM),XM=1,XC)    PRINT THE ROW
00372   24*   236   FORMAT(1X,8E15.8)
00373   24*   234   CONTINUE    GO PRINT NEXT ROW
00375   24*         IF(XF.EQ.1) WRITE(PRINT,237)    TEST ERROR FLAG
00400   24*   237   FORMAT("0 ERROR OCCURRED ON FIRST ROW",//)
00401   24*         IF(XF.EQ.2) WRITE(PRINT,238)    TEST ERROR FLAG
00404   24*   238   FORMAT("0 ERROR DID NOT OCCUR ON FIRST ROW",//)
00405   24*         WRITE(PRINT,239)XCL
00410   24*   239   FORMAT(" THIS SUB-MATRIX IS LOCATED IN THE",I3,3H*TH,
00410   24*        *" COVARIANCE MATRIX.")
00411   24*         WRITE(PRINT,241) CHAR(XCL)
00414   24*   241   FORMAT(" THIS COVARIANCE MATRIX IS FOR CLASS ",A2,
00414   24*        *" AND IS PRINTED AS IT WAS INPUT.",/)
00415   24*         WRITE(PRINT,243)   (ELE(XM),XM=1,XL)    PRINT LOWER
00415   24*   C  TRIANGLE INDEXES
00423   24*   243   FORMAT(" CHECK ELEMENTS-",25I4)
00424   24*         XPTS=(NM+1)*NM/2    NO. PTS IN BIG MATRIX
00425   24*         WRITE(PRINT,244)   (ZCOV(XM,XCL),XM=1,XPTS)    PRINT BIG MATRIX
00433   24*   244   FORMAT(6X,5E15.8)
00434   24*         RETURN 0    FATAL ERROR. GET DUMP.
```

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00435   24*  240   CONTINUE   CONNECTOR TO SKIP ERROR PRINT
00435   24*   END
00436   25*         INCLUDE DIJ,LIST
00436   26*  C  NOW SEE IF THIS IS A COMBINATION THAT SHOULD BE SAVED                    JONES
00436   26*  C
00436   26*  C  THIS PROCEDURE COMPUTES INTERCLASS DIVERGENCE AS FOLLOWS...
00436   26*  C   IM-MEAN VECTOR OF I"TH CLASS
00436   26*  C   DIJ-INTERCLASS DIVERGENCE BETWEEN CLASSSES I AND J
00436   26*  C   TR-TRACE. IE. SUM OF DIAGONAL ELEMENTS
00436   26*  C   IK-COVARIANCE MATRIX OF I"TH CLASS
00436   26*  C   JKIN-INVERSE COVARIANCE MATRIX OF J"TH CLASS
00436   26*  C   N-RANK OF MATRIX
00436   26*  C DIJ=TR(IK*JKIN + JK*IKIN) -2*N +TR((IKIN+JKIN)*(IM-JM)*(IM-JM))
00436   26*  C  THIS PROCEDURE RESTRICTS ITSELF TO STATEMENTS IN THE 300 SERIES
00436   26*  C  AND TO INTERNAL VARIABLES STARTING WITH W.
00437   26*        WC=0    POINTS TO WHERE I AM IN INTERCLASS DIVERGENCE ARRAY
00440   26*        DO 300 WA=2,NCL    THE "I" OF THE DIJ CALC. IE. CLASS I.
00443   26*        WUP=WA-1    UPPER LIMIT ON LOOP
00444   26*        DO 300 WB=1,WUP    THE "J" OF THE DIJ CALC. IE. CLASS J.
00447   26*        WC=WC+1    READY FOR NEXT DIJ CALC.
00450   26*        ZDIJ(WC)=0    INITIALIZE SUM
00451   26*        ZD=0    WORK CELL TO SUM UP ONE INTERCLASS DIVERGENCE
00452   26*        DO 301 WI=1,NBEST    LOGICAL ROWS OF COV. AND INVERSE COV. MATRIX
00455   26*        DO 301 WJ=1,WI    LOGICAL COLUMNS
00460   26*        WK=VEC(WI)    GET ROW INDEX IN BIG MATRIX
00461   26*        WL=VEC(WJ)    GET COLUMN INDEX
00462   26*        WKL=(WK-1)*WK/2+WL    INDEX IN COVARIANCE MATRIX (NOT REDUCED)
00463   26*        WIJ=(WI-1)*WI/2+WJ    INDEX IN INVERSE MATRIX (REDUCED)
00464   26*        Z=2    ALL OFF DIAGONAL TERMS ARE ADDED TWICE
00465   26*        IF(WI.EQ.WJ) Z=1.0    ON DIAGONAL TERMS ARE ADDED ONCE
00467   26*        ZD=ZD+Z*ZCOV(WKL,WA)*ZINV(WIJ,WB)    TR(IK*JKIN)
00470   26*        ZD=ZD+Z*ZCOV(WKL,WB)*ZINV(WIJ,WA)    TR(JK*IKIN)
00471   26*  301   ZD=ZD+Z*(ZINV(WIJ,WA)+ZINV(WIJ,WB))
00471   26*       1*(ZMEAN(WK,WA)-ZMEAN(WK,WB))
00471   26*       2*(ZMEAN(WL,WA)-ZMEAN(WL,WB))    TR((IKIN+JKIN)*(IM-JM)*(IM-JM))
00474   26*        ZDIJ(WC)=ZD-2*NBEST    -2N
00475   26*        IF(ZDIJ(WC).GT.0) GO TO 300    IS DIVERGENCE POSITIVE
00477   26*        WRITE(PRINT,310)    NO, WE HAVE ILLEGAL VALUE
00501   26*  310   FORMAT(1H1,"***ERROR*** HAVE COMPUTED AN ILLEGAL VALUE",
00501   26*       *" FOR INTERCLASS DIVERGENCE--EITHER NEGATIVE OR ZERO.",/)
00502   26*        WRITE(PRINT,311)  (VEC(WM),WM=1,NBEST)    PRINT CHANNELS
00510   26*  311   FORMAT(" USING FEATURE SUBSET=",1213,/)
00511   26*        WRITE(PRINT,312) CHAR(WA),CHAR(WB),ZDIJ(WC)    PRINT CLASS
00511   26*  C  PAIR AND DIJ
00516   26*  312   FORMAT(" THE INTERCLASS DIVERGENCE COMPUTED FOR",
00516   26*       *" CLASS PAIR ",2A1," IS",E15.8,/)
00517   26*        WRITE(PRINT,313)
00521   26*  313   FORMAT(" PLEASE CHECK THE INPUT STATISTICS FOR THESE CLASSES.")
00522   26*        RETURN 0    FATAL ERROR. GET DUMP.
00523   26*  300   CONTINUE    GO COMPUTE DIJ FOR NEXT COMBINATION OF CLASSES
00523   26*   END
00526   27*        PAIRS=(NCL-1)*NCL/2    NO. OF UNIQUE PAIRS
00527   28*        ZPCW=0    INITIALIZE PACKED CHANNEL WORD
00530   29*        L=1    INDEX THRU CHANNEL SET
00531   30*        DO 82 J=1,NM    INDEX THRU TOTAL NO. OF CHANNELS
00534   31*        JJ=IABS(J-1)    POINTS TO BIT POSITION IN ZPCW. INSURE AGAINST -0.
00535   32*        IF(J.LT.VEC(L)) GO TO 82    IS THIS CHANNEL NOT IN THIS COMBO.
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00537   33*          IF(J.EQ.VEC(L)) FLD(JJ,1,ZPCW)=1   NO, TURN ON BIT
00541   34*          L=L+1     LOOK AT NEXT CHANNEL IN SET
00542   35*          IF(L.GT.NBEST) GO TO 83     HAVE I SET FLAG FOR ALL CHANNELS IN SET
00544   36*   82     CONTINUE     NO, GO TO NEXT CHANNEL
00544   37*   C  COMPUTE CAPPED AVERAGE DIVERGENCE
00546   38*   83     ZAVG=0     INITIALIZE AVG. DIVERGENCE
00547   39*          ZM=MDIJ     GET MAX. DIJ ALLOWED IN AVG. COMPUTATION
00550   40*          DO 110 J=1,PAIRS    INDEX THRU CLASS PAIRS
00553   41*          IF(ZDIJ(J).LT. ZM) ZAVG=ZAVG+ZDIJ(J)     DIJ .LT. MAX
00555   42*          IF(ZDIJ(J).GE. ZM) ZAVG=ZAVG+ZM     DIJ .GE. TO MAX DIJ
00557   43*   110    CONTINUE     GO ADD NEXT DIVERGENCE
00561   44*          ZAVG=ZAVG/PAIRS    COMPUTE AVG. DIJ
00561   45*   C  NOW SEE IF THIS COMBO. YIELDS THE LARGEST DIJ YET FOUND
00562   46*          DO 85 J=1,PAIRS    INDEX THRU THE POSSIBLE DIJ"S
00565   47*          IF(ZDIJ(J).LE.ZMDIJ(J,1)) GO TO 85    IS THIS BIGGEST
00565   48*   C  DIJ I"VE FOUND
00567   49*          ZMDIJ(J,1)=ZDIJ(J)    YES, SAVE IT
00570   50*          ZMDIJ(J,2)=ZAVG    SAVE ASSOCIATED AVERAGE DIVERGENCE
00571   51*          ZMDIJ(J,3)=ZPCW    SAVE CHANNEL COMBO. YIELDING THIS
00572   52*   85     CONTINUE    TRY NEXT DIJ
00574   53*          DO 81 J=1,PAIRS     INDEX THRU CLASS PAIRS
00577   54*   81     IF(ZDIJ(J).GE.MDIJ) ZDIJ(J)=MDIJ    MAX. DIJ ALLOWED IN AVG. COMPUTATION
00602   55*          ZMIN=10000.     INITIALIZE TO LARGE NO. IN SEARCH FOR MIN. DIJ
00603   56*          DO 84 J=1,PAIRS     INDEX THRU CLASS PAIRS
00606   57*   84     IF(ZDIJ(J).LT.ZMIN) ZMIN=ZDIJ(J)     SEARCH FOR MINIMUM
00606   58*   C  O.K., NOW COMPUTE AVERAGE BY CLASS
00611   59*          DO 86 J=1,NCL     THRU CLASSES
00614   60*   86     ZCAVG(J)=0     INITIALIZE FOR AVG. COMP.
00616   61*          LOW=NCL-1     NO. OF PAIRS TO SUM FOR EACH CLASS
00617   62*          MM=0     INDEX THRU DIJ"S FOR THIS CHANNEL COMBO.
00620   63*          DO 87 I=2,NCL     THE I OF THE DIJ
00623   64*          UP =I-1     UPPER LIMIT ON J
00624   65*          DO 87 J=1,UP     THE J OF THE DIJ
00627   66*          MM=MM+1     GO TO NEXT DIJ
00630   67*          ZCAVG(I)=ZCAVG(I)+ZDIJ(MM)     COMPUTE SUM FOR I"TH CLASS
00631   68*   87     ZCAVG(J)=ZCAVG(J)+ZDIJ(MM)     COMPUTE SUM FOR J"TH CLASS
00634   69*          DO 88 J=1,NCL     THRU CLASSES
00637   70*   88     ZCAVG(J)=ZCAVG(J)/LOW     COMPUTE AVG. DIJ FOR CLASS
00641   71*          DO 89 J=1,NCL     INDEX THRU CLASSES
00644   72*          IF(ZCAVG(J).LT.ZMCDIJ(J,1)) GO TO 89     IS THIS CLASS AVG. DIJ MAX. FOUND
00646   73*          ZMCDIJ(J,1)=ZCAVG(J)     YES, SAVE IT
00647   74*          ZMCDIJ(J,2)=ZPCW    ALSO SAVE COMBINATION OF CHANNELS THAT PRODUCED IT
00650   75*   89     CONTINUE     GO CHECK NEXT CLASS AVG.
00650   76*   C  CHECK IF THIS COMBO. IS IN THE TOP "NPRT" POSITIONS AS RANKED BY
00650   77*   C  MAXIMUM AVERAGE DIVERGENCE AND BY MAXIMUM MINIMUM INTERCLASS DIVERGENCE
00652   78*          IF(ZAVG.LE.ZMADIJ(NPRT,1)) GO TO 90     IS AVG. DIJ IN  TOP "NPRT"
00654   79*          DO 91 J=1,NPRT     YES, RANK IT AND SAVE IT
00657   80*          IF(ZAVG.LE.ZMADIJ(J,1)) GO TO 91     IS THIS AVG. DIJ .GT. J"TH SAVED AVG.
00661   81*          JJ=J+1     YES, COPY ALL J POSITIONS TO J+1 POSITION
00662   82*          DO 92 I=NPRT,JJ,-1     INDEX THRU MAX. DIJ"S THAT ARE SMALLER THAN ZAVG
00665   83*          ZMADIJ(I,1)=ZMADIJ(I-1,1)     MOVE SMALLER MAX. DIJ"S DOWN IN RANK
00666   84*   92     ZMADIJ(I,2)=ZMADIJ(I-1,2)     ALONG WITH THEIR CHANNEL WORDS
00670   85*          ZMADIJ(J,1)=ZAVG     INSERT NEW MAX. AVG. DIJ AT J"TH POSITION
00671   86*          ZMADIJ(J,2)=ZPCW     SAVE CHANNELS THAT PRODUCED IT
00672   87*          GO TO 90     GO TEST FOR NEW MAX. MIN. DIJ
00673   88*   91     CONTINUE     GO TEST NEXT SMALLER SAVED DIJ
00673   89*   90     IF(ZMIN.LE.ZMMDIJ(NPRT,1)) GO TO 93  IS THIS MAX-MIN IN TOP "NPRT" RANK
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00677    90*          DO 94 J=1,NPRT     YES, RANK IT AND INSERT IT
00702    91*          IF(ZMIN.LE.ZMMDIJ(J,1)) GO TO 94     IS THIS MIN. DIJ .GT. J"TH SAVED MIN
00704    92*          JJ=J+1     YES, COPY ALL J RANKED ELEMENTS TO J+1"ST RANK
00705    93*          DO 95 I=NPRT,JJ,-1     INDEX THRU MAX-MIN DIJ"S THAT ARE SMALLER THAN ZMIN
00710    94*          ZMMDIJ(I,1)=ZMMDIJ(I-1,1)     REDUCE RANK OF I"TH MIN DIJ
00711    95*    95    ZMMDIJ(I,2)=ZMMDIJ(I-1,2)     ALONG WITH ITS ASSOCIATED CHANNELS
00713    96*          ZMMDIJ(J,1)=ZMIN     INSERT NEW MAX-MIN
00714    97*          ZMMDIJ(J,2)=ZFCW     ALONG WITH ITS ASSOCIATED CHANNELS
00715    98*          GO TO 93     GO SEE IF PERCENT SEPARATION IS TOPS
00716    99*    94    CONTINUE     GO TEST NEXT SMALLER SAVED MIN
00720   100*    93    IF(PCTPRT.LE.0) GO TO 96     DO I SAVE MAX. PERCENTAGE DIJ"S
00722   101*          DO 98 J=1,PAIRS     YES, INDEX THRU CLASS PAIRS FOR DIJ LIMITS
00725   102*          IF(ZDIJ(J).LE.0) RETURN 0     NEGATIVE DIJ NOT ALLOWED
00727   103*          IF(ZDIJ(J).GT.MDIJ) ZDIJ(J)=MDIJ     MAX. DIJ ALLOWED IN SEPARATION COMP.
00731   104*          IF(ZDIJ(J).LT.2.) ZDIJ(J)=2.     MIN. DIJ ALLOWED IN SEPARATION COMP.
00733   105*    98    CONTINUE     CHECK LIMITS ON NEXT CLASS PAIR
00735   106*          ZPCT=1.     INITIALIZE PERCENT SEPARATION RATIO
00736   107*          DO 97 J=1,PAIRS     INDEX THRU CLASS PAIRS
00741   108*          IF(ZPCT.GT.1.0E+35) GO TO 96     AVOID MULTIPLY OVERFLOW
00743   109*    97    ZPCT=ZPCT*(ZMPDIJ(J,PCTPRT)/ZDIJ(J))     CALC. RATIO OF NEW DIJ TO SAVED PCT
00745   110*          IF(ZPCT.GE.1) GO TO 96     IS PCT SEPARATION .GT. LOWEST RANK SAVED
00747   111*          DO 99 J=1,PCTPRT     YES, SEE WHERE THIS SET SHOULD BE INSERTED
00752   112*          ZPCT=1.     INITIALIZE PERCENTAGE RATIO
00753   113*          DO 100 JJ=1,PAIRS     INDEX THRU CLASS PAIRS
00756   114*   100    ZPCT=ZPCT*ZMPDIJ(JJ,J)/ZDIJ(JJ)     CALC. PERCENT SEPARATION RATIO
00760   115*          IF(ZPCT.GE.1.) GO TO 99     DOES THIS SET YIELD BIGGER PERCENT SEPARATION
00762   116*          JJJ=J+1     YES, COPY ALL J RANKED SETS INTO J+1 RANK
00763   117*          UP=FAIRS+1     CLASS PAIRS + CHANNEL WORD
00764   118*          DO 101 I=PCTPRT,JJJ,-1     INDEX THRU SETS THAT HAVE SMALLER SEPARATION
00767   119*          DO 101 II=1,UP     COPY ALL DIJ"S + CHANNEL WORD
00772   120*   101    ZMPDIJ(II,I)=ZMPDIJ(II,I-1)     REDUCE RANK OF I"TH PCT SEP.
00775   121*          DO 102 II=1,PAIRS     INDEX THRU CLASS PAIRS
01000   122*   102    ZMPDIJ(II,J)=ZDIJ(II)     INSERT NEW PERCENT SEPARATION SET
01002   123*          ZMPDIJ(PAIRS+1,J)=ZFCW     ALONG WITH ITS ASSOCIATED CHANNEL SET
01003   124*          GO TO 96     FINISHED CHECKS. GO GET ANOTHER UNIQUE CHANNEL COMBO.
01004   125*    99    CONTINUE     GO CALC. PCT SEP RATIO FOR NEXT LOWER SET
01006   126*          END

      END OF COMPILATION:        NO  DIAGNOSTICS.
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DISPLA

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 FOR,S DISPLA,DISPLA
FOR 9%L-06/12-08'43 (2,0)

    SUBROUTINE DISPLA     ENTRY POINT 001531

    STORAGE USED' CODE(1) 001545  DATA(0) 000460  BLANK COMMON(2) 000000

     COMMON BLOCKS'

     0003   UNITS  000002
     0004   MAX    000005
     0005   INF    025416
     0006   INV    005514
     0007   YDIJ   015735

    EXTERNAL REFERENCES (BLOCK, NAME)

     0010   DIV
     0011   NERR6$
     0012   NUOU$
     0013   NIO2$
     0014   NIO1$
     0015   NERR7$
     0016   NSTOP$
     0017   NERR3$

    STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

     0001   000041 1L      0001   000110 10L     0001   000167 11L     0001   000177 12L     0001   000124 13L
     0001   000244 14L     0001   000203 15L     0001   000023 152G    0000   000057 155F    0000   000033 157F
     0001   000251 16L     0001   000261 17L     0001   000054 170G    0001   000323 18L     0001   000330 19L
     0001   000012 2L      0001   000340 20L     0000   000065 202F    0000   000073 203F    0000   000101 204F
     0000   000107 205F    0000   000115 206F    0000   000123 207F    0001   001026 209L    0001   000265 21L
     0001   000133 215G    0001   001122 22L     0001   001061 23L     0001   001233 24L     0001   000215 242G
     0001   001155 25L     0001   001163 26L     0001   000274 267G    0001   001171 27L     0001   001177 28L
     0001   001205 29L     0001   001213 30L     0001   000535 300L    0001   000574 301L    0001   000633 302L
     0001   000672 303L    0001   000731 304L    0001   000770 305L    0000   000137 31F     0000   000154 32F
     0001   000366 321G    0000   000173 33F     0001   000431 336G    0000   000214 34F     0001   000444 345G
     0000   000235 35F     0001   000453 351G    0000   000257 36F     0001   000472 361G    0001   001117 37L
     0001   000515 374G    0001   001466 39L     0001   001135 4L      0000   000421 40F     0001   000551 404G
     0000   000276 41F     0001   000560 411G    0000   000303 42F     0001   000610 424G    0001   000617 431G
     0000   000313 44F     0001   000647 444G    0000   000317 45F     0001   000656 451G    0000   000327 46F
     0001   000706 464G    0001   000715 471G    0000   000337 48F     0001   000031 5L      0001   000745 504G
     0001   000754 511G    0000   000360 52F     0001   001004 524G    0000   000367 53F     0001   001013 531G
     0000   000402 54F     0001   001051 550G    0000   000410 56F     0001   001070 561G    0001   000045 6L
     0001   001261 646G    0001   001305 665G    0001   001322 676G    0001   000103 7L      0001   001055 70L
     0001   001335 705G    0001   000415 71L     0001   001344 711G    0001   001041 72L     0001   001363 721G
     0001   000357 73L     0001   001402 732G    0000   000130 74F     0001   001422 745G    0001   001503 771G
     0001   000120 8L      0001   000521 86L     0001   000162 9L      0000   000415 98F     0000   000417 99F
     0003   000000 CARD    0005 I 024203 CHAR    0005 I 024436 DIJ     0000 I 000031 I       0000 I 000022 II
     0000 I 000024 IJ      0000   000431 INJF$   0000 I 000023 J       0000 I 000025 K       0000 I 000027 LOW
     0004   000001 MAXCLS  0004   000002 MBEST   0005   024244 MDIJ     0000 I 000030 MM      0004   000004 MPRNT
     0004   000003 MSHO    0004   000000 MXHSMT  0005 I 024202 NBEST    0005 I 024201 NCL     0005 I 024200 NM
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0005 I 024243 NPRT      0005 I 024245 NSHOW     0000 I 000026 P         0000 I 000020 PAIRS     0000 I 000021 PRIN
0003 I 000001 FRINT     0005 I 024246 SHOW      0000 I 000032 UP        0006 I 005500 VEC       0007 R 015733 ZAVG
0007 R 015672 ZCAVG     0005   001400 ZCOV      0007 R 000000 ZDIJ      0006   000000 ZINV      0007 R 004000 ZMADIJ
0007 R 003700 ZMCDIJ    0007 R 000760 ZMDIJ     0005   000000 ZMEAN     0007 R 015734 ZMIN      0007 R 004050 ZMMDIJ
0007 R 004120 ZMPDIJ    0000 R 000000 ZNCLA     0007 R 015732 ZPCT      0006   004700 ZV
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00101    1*        SUBROUTINE DISPLA                                                    JONES
00101    2*  C
00101    3*  C  THIS SUBROUTINE RECOMPUTES DIVERGENCE FOR THOSE CHANNEL COMBINATIONS
00101    4*  C  DETERMINED TO BE IMPORTANT AND OUTPUTS THEM TO UNIT "PRINT"
00103    5*        INCLUDE SPEC,LIST    PARAMETERS,DIMENSIONS,COMMON
00103    5*  C                                                                          JONES
00104    5*        IMPLICIT INTEGER(A-Y)    ALL INTEGER EXCEPT Z
00105    5*        PARAMETER MAXCLA=32   MAX. NO. OF CLASSES. CAN
00105    5*  C  INCREASE IF NEEDED.
00106    5*        PARAMETER MXMSMA=24    MAX NO. OF MEASUREMENTS (CHANNELS). CAN INCREASE.
00107    5*        PARAMETER MBESTA=12    MAX. NO. OF MEASUREMENTS IN "BEST" SUBSET
00110    5*        PARAMETER RSUMA=(MBESTA+1)*MBESTA/2    SUM OF 1,2,...,NO. IN "BEST" SUBSET
00111    5*        PARAMETER SUMA=(MXMSMA+1)*MXMSMA/2    SUM OF 1,2,...,MAX NO. MEASUREMENTS
00112    5*        COMMON/UNITS/CARD,PRINT    I/O UNITS-CARD READER, PRINTER
00113    5*        COMMON /MAX/MXMSMT,MAXCLS,MBEST,MSHO,MPRNT    MAXIMUMS
00114    5*        COMMON /INP/ ZMEAN,ZCOV,NM,NCL,
00114    5*       *NBEST,CHAR,NPRT,MDIJ,NSHOW,SHOW,DIJ    INPUT
00115    5*        DIMENSION ZMEAN(MXMSMA,MAXCLA)    HOLDS MEANS FOR EACH MEASUREMENT, CLASS
00116    5*        DIMENSION ZCOV(SUMA,MAXCLA)    HOLDS COVARIANCES (LOWER TRIANGLE)
00116    5*  C                                      FOR EACH CLASS.
00117    5*        PARAMETER PCTPRT=10    NO. OF COMBO"S RANKED BY PERCENT TO BE PRINTED
00120    5*        DIMENSION VEC(MBESTA)    HOLDS UNIQUE COMBINATION OF FEATURES (CHANNELS)
00121    5*        COMMON /INV/ZINV,ZV,VEC    INVERSION ARRAYS
00122    5*        DIMENSION ZINV(RSUMA,MAXCLA)    HOLDS INVERSE COVARIANCE MATRICES
00122    5*  C                                          FOR EACH CLASS
00123    5*        DIMENSION ZV(MBESTA,MAXCLA)    WORKING ARRAY USED WHEN COMPUTING
00123    5*  C                                        INVERSE BY BORDERING METHOD.
00124    5*        PARAMETER DSUM=(MAXCLA-1)*MAXCLA/2    "MAXCLA" COMBO"S TAKEN TWO AT A TIME
00125    5*        DIMENSION ZDIJ(DSUM)    WORKING BUFFER FOR INTERCLASS DIVERGENCE
00126    5*        DIMENSION CHAR(MAXCLA)    HOLDS CHARACTER REPRESENTATION OF CLASSES
00127    5*        COMMON /YDIJ/ ZDIJ,ZMDIJ,ZMCDIJ,ZMADIJ,
00127    5*       *ZMMDIJ,ZMPDIJ,ZCAVG,ZPCT,ZAVG,ZMIN    FOR DIJ
00130    5*        PARAMETER MSHOW=10    MAXIMUM NO. OF SHOW REQUESTS HONORED
00131    5*        DIMENSION SHOW (MBESTA,MSHOW)    HOLDS CHANNEL COMBO"S REQUESTED
00132    5*        PARAMETER MPRINT=20    MAXIMUM NO. OF PRINT REQUESTS TO BE HONORED
00133    5*        DIMENSION ZMDIJ(DSUM,3)    HOLDS MAX. DIJ,AVG. DIJ,PACKED CHANNEL WORD(PCW)
00134    5*        DIMENSION ZMCDIJ(MAXCLA,2)    HOLDS MAX. DIJ FOR CLASS,PCW
00135    5*        DIMENSION ZMADIJ(MPRINT,2)    HOLDS MAX. AVG. DIJ,PCW FOR NO. PRINT REQUEST
00136    5*        DIMENSION ZMMDIJ(MPRINT,2)    HOLDS MAX. MIN. DIJ,PCW FOR NO. PRINT REQUEST
00137    5*        PARAMETER DSUM1=DSUM+1    CLASSES TAKEN 2 AT A TIME + 1 WORD
00140    5*        DIMENSION ZMPDIJ(DSUM1,PCTPRT)    DIJ"S RANKED BY PERCENT,PCW
00141    5*        DIMENSION ZCAVG(MAXCLA)    WORK ARRAY USED TO FIND LARGEST CLASS AVG. DIJ
00142    5*        DIMENSION DIJ(DSUM)    HOLDS CHARACTER COMBO"S FOR DIJ PAIRS
00142    5*    END
00143    6*        DIMENSION ZNCLA(16)    HOLDS MAXIMUM AVG. INTERCLASS DIVERGENCE
00144    7*        PAIRS=(NCL-1)*NCL/2    COMPUTE NO. OF CLASS PAIRS
00145    8*        IF(NSHOW.EQ.0) GO TO 1    ANY SHOW CARDS
00147    9*        PRIN=1    YES,FLAG TELLING TO PRINT "SHOW" COMBINATIONS
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00150   10*         II=1    POINTS AT "SHOW" CARD 1
00151   11*   2     DO 3 J=1,NBEST    INDEX THRU "SHOW" CHANNELS
00154   12*   3     VEC(J)=SHOW(J,II)    GET CHANNELS FOR DIV. COMPUTATION
00156   13*         CALL DIV    COMPUTE DIVERGENCE
00157   14*         GO TO 4    PRINT OUT RESULTS
00160   15*   5     II=II+1    BUMP SHOW CARD COUNTER
00161   16*         IF(II.GT.NSHOW)  GO TO 1    AM I THRU WITH "SHOW" CARDS
00163   17*         GO TO 2    NO, GET NEXT ONE
00164   18*   1     II=1    COUNTS MAXIMUM INTERCLASS DIV. AVG.
00165   19*         PRIN=2    FLAG TELLS TO PRINT MAX. INTERCLASS DIV. AVG.
00166   20*   6     IJ=1    COUNTS CHANNELS IN SUBSET FOUND
00167   21*         DO 7 J=1,NM    INDEX THRU TOTAL NO. CHANNELS
00172   22*         K=IABS(J-1)    AVOID NEGATIVE ZERO
00173   23*         IF(FLD(K,1,ZMADIJ(II,2)).EQ.0) GO TO 7    IS THIS MAX. DIV. AVG. CHANNEL
00175   24*         IF(IJ.GT.NBEST) RETURN 0    YES, ERROR IF MORE CHANNELS THAN IN SUBSET
00177   25*         VEC(IJ)=J    SAVE CHANNEL OF INTEREST FOR DIVERGENCE CALC.
00200   26*         IJ=IJ+1    BUMP CHANNEL COUNTER
00201   27*   7     CONTINUE    GO SEE IF NEXT CHANNEL IN SUBSET
00203   28*         CALL DIV    COMPUTE DIVERGENCE
00204   29*         GO TO 4    PRINT RESULTS
00205   30*   10    II=II+1    BUMP MAX. DIJ AVG. COUNTER
00206   31*         IF(II.GT.NPRT) GO TO 8    AM I THRU WITH DIJ AVG.
00210   32*         GO TO 6    NO,GET NEXT ONE
00211   33*   8     PRIN=3    FLAG TELLS TO PRINT MAX. MIN. DIJ
00212   34*         II=1    COUNTS MAX. MIN. DIJ'S PRINTED
00213   35*   13    IJ=1    COUNTS CHANNELS IN SUBSET FOUND
00214   36*         DO 9 J=1,NM    INDEX THRU TOTAL NO. OF CHANNELS
00217   37*         K=IABS(J-1)    AVOID -0
00220   38*         IF(FLD(K,1,ZMMDIJ(II,2)).EQ.0) GO TO 9    IS THIS MAX. MIN. CHANNEL
00222   39*         IF(IJ.GT.NBEST) RETURN 0    YES. ERROR IF MORE CHANNELS THAN IN SUBSET
00224   40*         VEC(IJ)=J    SAVE CHANNELS OF INTEREST FOR DIV. CALC.
00225   41*         IJ=IJ+1    BUMP CHANNEL COUNTER
00226   42*   9     CONTINUE    GO SEE IF NEXT CHANNEL IN SUBSET
00230   43*          CALL DIV    COMPUTE DIVERGENCE
00231   44*         GO TO 4    PRINT RESULTS
00232   45*   11    II=II+1    BUMP MAX. MIN. PRINT COUNTER
00233   46*         IF(II.GT.NPRT) GO TO 12    AM I THRU WITH MAX. MIN.
00235   47*         GO TO 13    NO,GO GET NEXT ONE
00236   48*   12    PRIN=4    FLAG TELLS ME I AM ON MAX. PERCENT
00237   49*         II=1    COUNTS WHICH MAX. PERCENT ON
00240   50*   15    IJ=1    COUNTS CHANNELS IN SUBSET FOUND
00241   51*         DO 14  J=1,NM    INDEX THRU TOTAL NO. OF CHANNELS
00244   52*         K=IABS(J-1)    AVOID -0
00245   53*         IF(FLD(K,1,ZMPDIJ(PAIRS+1,II)).EQ.0) GO TO 14    IS THIS MAX. PERCENT CH.
00247   54*         IF(IJ.GT.NBEST) RETURN 0    YES. ERROR IF MORE CHANNELS THAN IN SUBSET
00251   55*         VEC(IJ)=J    SAVE CHANNELS OF INTEREST FOR DIV. CALC.
00252   56*         IJ=IJ+1    BUMP CHANNEL COUNTER
00253   57*   14    CONTINUE    GO SEE IF NEXT CHANNEL IN SUBSET
00255   58*         CALL DIV    COMPUTE DIVERGENCE
00256   59*         GO TO 4    PRINT RESULTS
00257   60*   16    II=II+1    BUMP MAX. PERCENT PRINT COUNTER
00260   61*         IF(II.GT.NPRT) GO TO 17    AM I THRU WITH MAX. PERCENT PRINT
00262   62*         GO TO 15    NO, GO GET NEXT ONE
00263   63*   17    II=1    COUNTS WHICH CLASS AVERAGE PRINT IN ON
00264   64*         PRIN=5    FLAG TELLS ME TO PRINT DIJ AVERAGES BY CLASS
00265   65*   21    IJ=1    COUNTS CHANNELS IN SUBSET FOUND
00266   66*         DO 18   J=1,NM    INDEX THRU TOTAL NO. OF CHANNELS
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00271    67*          K=IABS(J-1)     AVOID -0
00272    68*          IF(FLD(K,1,ZMCDIJ(II,2)).EQ.0) GO TO 18    IS THIS MAX. CLASS CHANNEL
00274    69*          IF(IJ.GT.NBEST) RETURN 0    YES, ERROR IF MORE CHANNELS THAN IN SUBSET
00276    70*          VEC(IJ)=J    SAVE CHANNEL OF INTEREST FOR DIV. CALC.
00277    71*          IJ=IJ+1    BUMP CHANNEL COUNTER
00300    72*    18    CONTINUE    GO SEE IF NEXT CHANNEL IS IN SUBSET
00302    73*          CALL DIV    COMPUTE DIVERGENCE
00303    74*          GO TO 4    PRINT RESULTS
00304    75*    19    II=II+1    BUMP CLASS AVERAGE PRINT COUNTER
00305    76*          IF(II.GT.NCL) GO TO 20    AM I THRU WITH MAX. CLASS DIJ PRINT
00307    77*          GO TO 21    NO, GO GET NEXT ONE
00310    78*    20    IF(NCL.GT.16) GO TO 70    TEST MAXIMUM NO. OF CLASSES
00312    79*          IF(NBEST.GT.6) GO TO 70    TEST MAXIMUM NO. OF BEST CHANNELS
00314    80*          II=1    COUNTS LINE OF PRINT ON
00315    81*          PRIN=5    FLAGS TELLS ME TO PRINT MAX. AVG. INTERCLASS DIVERGENCE
00316    82*          P=1    INITIALIZE P
00317    83*    73    IJ=1    COUNTS CHANNELS IN SUBSET FOUND
00320    84*          DO 71 J=1,NM    INDEX THRU TOTAL NO. OF CHANNELS
00323    85*          K=IABS(J-1)    AVOID -0
00324    86*          IF(FLD(K,1,ZMCDIJ(II,2)).EQ.0) GO TO 71    IS THIS MAX. CLASS
00324    87*    C     CHANNEL
00326    88*          IF(IJ.GT.NBEST) RETURN 0    YES,ERROR IF MORE CHANNELS
00326    89*    C     THAN IN SUBSET
00330    90*          VEC(IJ)=J    SAVE CHANNELS OF INTEREST FOR DIV. CAL.
00331    91*          IJ=IJ+1    BUMP CHANNEL COUNTER
00332    92*    71    CONTINUE    GO SEE IF NEXT IS IN SUBSET
00334    93*          CALL DIV    COMPUTE DIVERGENCE
00335    94*          DO 79 J=1,NCL    INDEX THRU CLASSES
00340    95*    79    ZCAVG(J)=0    INITIALIZE CLASS AVG. MATRIX
00342    96*          LOW=NCL-1    NO. OF PAIRS TO SUM FOR EACH CLASS
00343    97*          MM=0    INDEX THRU DIJ'S FOR THIS CHANNEL COMBO
00344    98*          DO 80 I=2,NCL    INDEX THRU I'S OF DIJ
00347    99*          UP=I-1    UPPER LIMIT ON J
00350   100*          DO 80 J=1,UP    THE J OF THE DIJ
00353   101*          MM=MM+1    GO TO NEXT DIJ
00354   102*          ZCAVG(I)=ZCAVG(I)+ZDIJ(MM)    COMPUTE SUM FOR I'TH CLASS
00355   103*    80    ZCAVG(J)=ZCAVG(J)+ZDIJ(MM)    COMPUTE SUM FOR J'TH CLASS
00360   104*          DO 81 J=1,NCL    THRU CLASSES
00363   105*    81    ZCAVG(J)=ZCAVG(J)/LOW    COMPUTE AVG. DIJ FOR CLASS
00365   106*          IF(II.NE.1) GO TO 86    HAVE I PRINTED HEADING
00367   107*          WRITE(PRINT,157)
00371   108*    157   FORMAT(1H1,"MATRIX OF DIVERGENCES FOR CHANNEL SET YIELDING",
00371   109*         *" THE MAXIMUM SEPARATION OF A CLASS FROM ALL OTHER CLASSES")
00372   110*          WRITE(PRINT,155) (CHAR(J),J=1,NCL)
00400   111*    155   FORMAT("0          FEATURES",16(5X,A1))
00400   112*    C     PRINT OUT BEST CHANNELS,CLASS AND THE MAXIMUM AVERAGE DIVERGENCE
00401   113*    86    GO TO (300, 301, 302, 303, 304, 305),NBEST
00402   114*    300   WRITE(PRINT,202) (VEC(J),J=1,NBEST),CHAR(P),(ZCAVG(J),J=1,NCL)
00415   115*    202   FORMAT(15X,(1X,I2),1X,A1,16(1X,F5.0))
00416   116*          IF(P.EQ.NCL) GO TO 209
00420   117*          P=P+1    BUMPS P
00421   118*          GO TO 209
00422   119*    301   WRITE(PRINT,203) (VEC(J),J=1,NBEST),CHAR(P),(ZCAVG(J),J=1,NCL)
00435   120*    203   FORMAT(12X,2(1X,I2),1X,A1,16(1X,F5.0))
00436   121*          IF(P.EQ.NCL) GO TO 209
00440   122*          P=P+1    BUMPS P
00441   123*          GO TO 209
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00442   124*   302   WRITE(PRINT,204)  (VEC(J),J=1,NBEST),CHAR(P),(ZCAVG(J),J=1,NCL)
00455   125*   204   FORMAT(9X,3(1X,I2),1X,A1,16(1X,F5.0))
00456   126*         IF(P.EQ.NCL) GO TO 209
00460   127*         P=P+1    BUMPS P
00461   128*         GO TO 209
00462   129*   303   WRITE(PRINT,205)  (VEC(J),J=1,NBEST),CHAR(P),(ZCAVG(J),J=1,NCL)
00475   130*   205   FORMAT(6X,4(1X,I2),1X,A1,16(1X,F5.0))
00476   131*         IF(P.EQ.NCL) GO TO 209
00500   132*         P=P+1    BUMPS P
00501   133*         GO TO 209
00502   134*   304   WRITE(PRINT,206)  (VEC(J),J=1,NBEST),CHAR(P),(ZCAVG(J),J=1,NCL)
00515   135*   206   FORMAT(3X,5(1X,I2),1X,A1,16(1X,F5.0))
00516   136*         IF(P.EQ.NCL) GO TO 209
00520   137*         P=P+1    BUMPS P
00521   138*         GO TO 209
00522   139*   305   WRITE(PRINT,207)  (VEC(J),J=1,NBEST),CHAR(P),(ZCAVG(J),J=1,NCL)
00535   140*   207   FORMAT(6(1X,I2),1X,A1,16(1X,F5.0))
00536   141*         IF(P.EQ.NCL) GO TO 209
00540   142*         P=P+1    BUMPS P
00541   143*   209   ZNCLA(II)=ZCAVG(II)    SAVES MAX. AVG. DIJ
00542   144*         II=II+1    BUMPS LINE COUNTER
00543   145*         IF(II.GT.NCL) GO TO 72    AM I THRU WITH MAX. AVG. DIJ PRINT
00545   146*         GO TO 73
00546   147*   72    WRITE(PRINT,74)  (ZNCLA(J),J=1,NCL)
00554   148*   74    FORMAT(*        DIAGONAL ",4X,16(1X,F5.0))
00555   149*   70    II=1    COUNTS WHICH MAX. DIJ PRINT ON
00556   150*         PRIN=6     FLAG TELLS TO PRINT MAX. DIJ
00557   151*   23    IJ=1     COUNTS CHANNELS IN SUBSET FOUND
00560   152*         DO 37 J=1,NM     INDEX THRU TOTAL NUMBER OF CHANNELS
00563   153*         K=IABS(J-1)     AVOID -0
00564   154*         IF(FLD(K,1,ZMDIJ(II,3)).EQ.0) GO TO 37     IS THIS MAX. DIJ CHANNEL
00566   155*         IF(IJ.GT.NBEST) RETURN 0     YES, HAVE I FOUND MORE THAN POSSIBLE
00570   156*         VEC(IJ)=J     NO, SAVE CHANNEL INDICATOR
00571   157*         IJ=IJ+1     BUMP COUNTER  FOR CHANNEL FIND
00572   158*   37    CONTINUE     GO UNPACK NEXT CHANNEL
00574   159*         GO TO 4     PRINT RESULTS
00575   160*   22    II=II+1     BUMP MAX DIJ PRINT COUNTER
00576   161*         IF(II.GT.PAIRS)  STOP     AM I FINISHED
00600   162*         GO TO 23     NO, GO PRINT NEXT MAX. DIJ
00601   163*   4     IF(II.NE.1) GO TO 24     HAVE I ALREADY PRINTED HEADING
00603   164*         GO TO (25,26,27,28,29,30),PRIN     NO, GO PRINT PROPER HDG
00604   165*   25    WRITE(PRINT,31)     SHOW CARDS
00606   166*   31     FORMAT(1H1," DISPLAY OF CHANNEL COMBINATIONS REQUESTED BY *SHOW* ",
00606   167*        *" CARDS.",///)
00607   168*         GO TO 24     PRINT OUT CHANNEL DATA
00610   169*   26    WRITE(PRINT,32)     AVG. PAIRWISE DIV.
00612   170*   32    FORMAT(1H1," DISPLAY OF CHANNELS RANKED ACCORDING TO AVERAGE",
00612   171*        *" PAIR-WISE DIVERGENCE.",///)
00613   172*         GO TO 24     PRINT CHANNEL DATA
00614   173*   27    WRITE(PRINT,33)     MAX. MIN DIJ
00616   174*   33    FORMAT(1H1," DISPLAY OF CHANNEL COMBINATIONS RANKED ACCORDING",
00616   175*        *" TO MINIMUM PAIR-WISE DIVERGENCE",///)
00617   176*         GO TO 24     PRINT CHANNEL DATA
00620   177*   28    WRITE(PRINT,34)     MAX. PERCENT SEPARATION
00622   178*   34    FORMAT(1H1," DISPLAY OF CHANNEL COMBINATIONS RANKED ACCORDING",
00622   179*        *" TO MAXIMUM PERCENT SEPARATION.",///)
00623   180*         GO TO 24     PRINT CHANNEL DATA
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00624   181*   29     WRITE(PRINT,35)     MAX. AVG. DIJ BY CLASS
00626   182*   35     FORMAT(1H1," DISPLAY OF CHANNEL COMBINATIONS RANKED ACCORDING",
00626   183*         *" TO MAXIMUM AVERAGE DIVERGENCE BY CLASS",///)
00627   184*          GO TO 24     PRINT CHANNEL DATA
00630   185*   30     WRITE(PRINT,36)     MAX. DIJ
00632   186*   36     FORMAT(1H1," DISPLAY OF CHANNEL COMBINATIONS YIELDING MAXIMUM",
00632   187*         *" PAIR-WISE DIVERGENCE:",//)
00633   188*          WRITE(PRINT,41)     PRINT FIRST LINE OF SUBHEADING
00635   189*          WRITE(PRINT,42)     PRINT SECOND LINE OF SUBHEADING
00637   190*   41     FORMAT(" CLASS     MAX      AVG  ")
00640   191*   42     FORMAT("  PAIR     DIJ      DIJ           CHANNELS",/)
00641   192*          GO TO 24     PRINT CHANNEL DATA
00642   193*   24     IF(FRIN.GT.5) GO TO 39     IS THIS MAX DIJ PRINT
00644   194*   38     WRITE(PRINT,44) (VEC(J),J=1,NBEST)     NO, PRINT CHANNELS
00652   195*   44     FORMAT(" CHANNELS=",24I3,/)
00653   196*          WRITE(PRINT,45) ZAVG     PRINT AVG. DIJ
00656   197*   45     FORMAT(" AVERAGE PAIR-WISE DIVERGENCE=",F8.1,/)
00657   198*          WRITE(PRINT,46) ZMIN     PRINT MIN. DIJ
00662   199*   46     FORMAT(" MINIMUM PAIR-WISE DIVERGENCE=",F8.1,/)
00663   200*          ZPCT=1       INITIALIZE RATIO MULTIPLIER TO ONE
00664   201*          DO 47   J=1,PAIRS     INDEX THRU CLASS PAIRS
00667   202*   47     ZPCT=ZPCT*ZDIJ(J)/ZMPDIJ(J,1)     CALC. RATIO OF THIS DIJ TO MAX. SET
00671   203*          WRITE(PRINT,48) ZPCT     PRINT PERCENT OF MAX
00674   204*   48     FORMAT(" RATIO OF THIS CHANNEL SET WITH CHANNEL SET",
00674   205*         *" YIELDING MAXIMUM PERCENT SEPARATION=",F6.2,/)
00675   206*          DO 49 J=1,NCL     INDEX THRU CLASSES
00700   207*   49     ZCAVG(J)=0     INITIALIZE CLASS AVG. MATRIX
00702   208*          LOW=NCL-1     NO. OF PAIRS TO SUM FOR EACH CLASS
00703   209*          MM=0     INDEX THRU DIJ'S FOR THIS CHANNEL COMBO.
00704   210*          DO 50 I=2,NCL     INDEX THRU I'S OF DIJ
00707   211*          UP =I-1     UPPER LIMIT ON J
00710   212*          DO 50 J=1,UP     THE J OF THE DIJ
00713   213*          MM=MM+1     GO TO NEXT DIJ
00714   214*          ZCAVG(I)=ZCAVG(I)+ZDIJ(MM)     COMPUTE SUM FOR I'TH CLASS
00715   215*   50     ZCAVG(J)=ZCAVG(J)+ZDIJ(MM)     COMPUTE SUM FOR J'TH CLASS
00720   216*          DO 51 J=1,NCL     THRU CLASSES
00723   217*   51     ZCAVG(J)=ZCAVG(J)/LOW     COMPUTE AVG. DIJ FOR CLASS
00725   218*          WRITE(PRINT,52)     SUBHDG FOR CLASS AVG. PRINT
00727   219*   52     FORMAT(" AVERAGE DIVERGENCE BY CLASS...")
00730   220*          WRITE(PRINT,53) (CHAR(J),ZCAVG(J),J=1,NCL)     PRINT CLASS CHARACTERS,AVG.
00737   221*   53     FORMAT(" AVERAGE INTERCLASS DIVERGENCE FOR CLASS ",A1," = ",F10.3)
00740   222*          WRITE(PRINT,54)
00742   223*   54     FORMAT(1H0," PAIR-WISE DIVERGENCE")
00743   224*          WRITE(PRINT,56) (DIJ(J),ZDIJ(J),J=1,PAIRS)
00752   225*   56     FORMAT(1X,10(1X,A2,"=",F8.1))
00753   226*          IF(NCL.GT.9) WRITE(PRINT,98)     GO TO NEXT PAGE
00756   227*   98     FORMAT(1H1,//)
00757   228*          IF(NCL.LE.9) WRITE(PRINT,99)     SKIP A FEW LINES
00762   229*   99     FORMAT(1H0,///)
00763   230*          GO TO (5,10,11,16,19), FRIN     FINISHED PRINTING THIS SET, GO GET NEXT ONE
00763   231*   C  PRINT OUT CLASS PAIR, MAX DIJ, AVG DIJ, AND CHANNELS
00764   232*   39     WRITE(PRINT,40) DIJ(II),ZMDIJ(II,1),ZMDIJ(II,2),(VEC(J),J=1,NBEST)
00775   233*   40     FORMAT(3X,A2,F9.1,F8.1,24I3)
00776   234*          GO TO 22     GO GET NEXT MAX DIJ TO PRINT
00777   235*          END

      END OF COMPILATION:        NO  DIAGNOSTICS.
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DIV

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FOR,S DIV,DIV
FOR 9#L-06/12-08'44 (1,0)

 SUBROUTINE DIV        ENTRY POINT 001261

 STORAGE USED' CODE(1) 001306  DATA(0) 000500  BLANK COMMON(2) 000000

 COMMON BLOCKS'

 0003   UNITS  000002
 0004   MAX    000005
 0005   INP    025416
 0006   INV    005514
 0007   YDIJ   015735

 EXTERNAL REFERENCES (BLOCK, NAME)

 0010   N4CU$
 0011   NIO2$
 0012   NIO1$
 0013   NERR6$
 0014   NERR3$

 STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

 0001   000016 147G    0001   000030 153G    0001   000044 157G    0001   000072 171G    0001   000123 209G
 0001   000145 203G    0001   000246 203L    0001   000155 211G    0001   000170 214G    0001   000222 227G
 0001   000415 230L    0000   000176 231F    0000   000215 232F    0000   000233 233F    0000   000235 236F
 0000   000237 237F    0000   000246 238F    0000   000256 239F    0001   000260 240G    0001   000622 240L
 0000   000273 241F    0000   000312 243F    0000   000317 244F    0001   000321 253G    0001   000336 256G
 0001   000370 266G    0001   001055 300L    0000   000321 310F    0001   000443 310G    0000   000344 311F
 0000   000352 312F    0000   000370 313F    0001   000452 317G    0001   000466 323G    0001   000512 335G
 0001   000572 366G    0001   000614 376G    0001   000635 410G    0001   000655 414G    0001   000677 422G
 0001   000712 425G    0001   001032 453G    0001   001075 502G    0001   001133 516G    0001   001146 525G
 0001   001155 531G    0001   001174 541G    0001   001204 547G    0003   000000 CARD    0005 I 024203 CHAR
 0005   024436 DIJ     0000 I 000000 ELE     0000 I 000174 I       0000   000410 INJP$   0000 I 000171 J
 0000 I 000172 LOW     0004   000001 MAXCLS  0004   000002 MBEST   0005 I 024244 MDIJ    0000 I 000173 MM
 0004   000004 MFRNT   0004   000003 MSHO    0004   000000 MXMSMT  0005 I 024202 NBEST   0005 I 024201 NCL
 0005 I 024200 NM      0005   024243 NFRT    0005   024245 NSHOW   0000 I 000170 PAIRS   0003 I 000001 PRINT
 0005   024246 SHOW    0000 I 000175 UP      0006 I 005500 VEC     0000 I 000154 WA      0000 I 000156 WB
 0000 I 000153 WC      0000 I 000160 WI      0000 I 000165 WIJ     0000 I 000161 WJ      0000 I 000162 WK
 0000 I 000164 WKL     0000 I 000163 WL      0000 I 000167 WM      0000 I 000155 WUP     0000 I 000134 XC
 0000 I 000132 XCL     0000 I 000133 XCT     0000 I 000136 XD      0000 I 000141 XF      0000 I 000135 XI
 0000 I 000144 XIJ     0000 I 000140 XINC    0000 I 000137 XJ      0000 I 000147 XJI     0000 I 000142 XK
 0000 I 000151 XKI     0000 I 000145 XKJ     0000 I 000150 XKK     0000 I 000146 XL      0000 I 000143 XM
 0000 I 000152 XPTS    0000 R 000166 Z       0007 R 015733 ZAVG    0007 R 015672 ZCAVG   0005 R 001400 ZCOV
 0000 R 000157 ZD      0007 R 000000 ZDIJ    0006 R 000000 ZINV    0007   004000 ZMADIJ  0007   003700 ZMCDIJ
 0007   000760 ZMDIJ   0005 R 000000 ZMEAN   0007 R 015734 ZMIN    0007   004050 ZMMDIJ  0007 R 004120 ZMPDIJ
 0007 R 015732 ZPCT    0000 R 000116 ZPRNT   0006 R 004700 ZV
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00101    1*        SUBROUTINE DIV                                                    JONES
00101    2*  C
00101    3*  C  THIS SUBROUTINE COMPUTES DIVERGENCE AND PARAMETERS NEEDED BY DISPLAY
00101    4*  C  FOR A GIVEN SET OF CHANNELS
00103    5*        INCLUDE SPEC,LIST    PARAMETERS,DIMENSIONS,COMMON                 JONES
00103    5*  C
00104    5*        IMPLICIT INTEGER(A-Y)    ALL INTEGER EXCEPT Z
00105    5*        PARAMETER MAXCLA=32   MAX. NO. OF CLASSES. CAN
00105    5*  C  INCREASE IF NEEDED.
00106    5*        PARAMETER MXMSMA=24    MAX NO. OF MEASUREMENTS (CHANNELS). CAN INCREASE.
00107    5*        PARAMETER MBESTA=12    MAX. NO. OF MEASUREMENTS IN "BEST" SUBSET
00110    5*        PARAMETER RSUMA=(MBESTA+1)*MBESTA/2    SUM OF 1,2,...,NO. IN "BEST" SUBSET
00111    5*        PARAMETER SUMA=(MXMSMA+1)*MXMSMA/2    SUM OF 1,2,...,MAX NO. MEASUREMENTS
00112    5*        COMMON/UNITS/CARD,PRINT    I/O UNITS-CARD READER, PRINTER
00113    5*        COMMON /MAX/MXMSMT,MAXCLS,MBEST,MSHO,MPRNT    MAXIMUMS
00114    5*        COMMON /INP/ ZMEAN,ZCOV,NM,NCL,
00114    5*       *NBEST,CHAR,NPRT,MDIJ,NSHOW,SHOW,DIJ    INPUT
00115    5*        DIMENSION ZMEAN(MXMSMA,MAXCLA)    HOLDS MEANS FOR EACH MEASUREMENT, CLASS
00116    5*        DIMENSION ZCOV(SUMA,MAXCLA)    HOLDS COVARIANCES (LOWER TRIANGLE)
00116    5*  C                                     FOR EACH CLASS.
00117    5*        PARAMETER PCTPRT=10    NO. OF COMBO"S RANKED BY PERCENT TO BE PRINTED
00120    5*        DIMENSION VEC(MBESTA)    HOLDS UNIQUE COMBINATION OF FEATURES (CHANNELS)
00121    5*        COMMON /INV/ZINV,ZV,VEC    INVERSION ARRAYS
00122    5*        DIMENSION ZINV(RSUMA,MAXCLA)    HOLDS INVERSE COVARIANCE MATRICES
00122    5*  C                                        FOR EACH CLASS
00123    5*        DIMENSION ZV(MBESTA,MAXCLA)    WORKING ARRAY USED WHEN COMPUTING
00123    5*  C                                       INVERSE BY BORDERING METHOD.
00124    5*        PARAMETER DSUM=(MAXCLA-1)*MAXCLA/2    "MAXCLA" COMBO"S TAKEN TWO AT A TIME
00125    5*        DIMENSION ZDIJ(DSUM)    WORKING BUFFER FOR INTERCLASS DIVERGENCE
00126    5*        DIMENSION CHAR(MAXCLA)    HOLDS CHARACTER REPRESENTATION OF CLASSES
00127    5*        COMMON /YDIJ/ ZDIJ,ZMDIJ,ZMCDIJ,ZMADIJ,
00127    5*       *ZMMDIJ,ZMPDIJ,ZCAVG,ZPCT,ZAVG,ZMIN    FOR DIJ
00130    5*        PARAMETER MSHOW=10    MAXIMUM NO. OF SHOW REQUESTS HONORED
00131    5*        DIMENSION SHOW (MBESTA,MSHOW)    HOLDS CHANNEL COMBO"S REQUESTED
00132    5*        PARAMETER MPRINT=20    MAXIMUM NO. OF PRINT REQUESTS TO BE HONORED
00133    5*        DIMENSION ZMDIJ(DSUM,3)    HOLDS MAX. DIJ,AVG. DIJ,PACKED CHANNEL WORD(FCW)
00134    5*        DIMENSION ZMCDIJ(MAXCLA,2)    HOLDS MAX. DIJ FOR CLASS,FCW
00135    5*        DIMENSION ZMADIJ(MPRINT,2)    HOLDS MAX. AVG. DIJ,FCW FOR NO. PRINT REQUEST
00136    5*        DIMENSION ZMMDIJ(MPRINT,2)    HOLDS MAX. MIN. DIJ,FCW FOR NO. PRINT REQUEST
00137    5*        PARAMETER DSUM1=DSUM+1    CLASSES TAKEN 2 AT A TIME + 1 WORD
00140    5*        DIMENSION ZMPDIJ(DSUM1,PCTPRT)    DIJ"S RANKED BY PERCENT,FCW
00141    5*        DIMENSION ZCAVG(MAXCLA)    WORK ARRAY USED TO FIND LARGEST CLASS AVG. DIJ
00142    5*        DIMENSION DIJ(DSUM)    HOLDS CHARACTER COMBO"S FOR DIJ PAIRS
00142    5*     END
00143    6*        DIMENSION ELE(RSUMA)    PRINT BUFFER. HOLDS ELEMENTS
00143    7*  C  OF COVARIANCE MATRIX ON ERROR.
00144    8*        DIMENSION ZPRNT(MBESTA)    PRINT BUFFER. HOLDS ROW
00144    9*  C  OF COVARIANCE MATRIX ON ERROR.
00145   10*        INCLUDE INVR,LIST    PROCEDURE INVERTS COVARIANCE MATRIX FOR ALL CLASSES
00145   10*  C                                                                       JONES
00145   10*  C  COMPUTES INVERSE FOR "NCL" MATRICES BY BORDERING TECHNIQUE
00145   10*  C
00145   10*  C  THIS ALGORITHM PERFORMS MATRIX INVERSION ON A SYMMETRIC MATRIX.
00145   10*  C SEE "STATISTICAL COMPUTATIONS ON A DIGITAL COMPUTER" BY HEMMERLE. PG 73
00145   10*  C THE INPUT MATRIX IS "ZCOV" IN LOWER TRIANGLE FORM
00145   10*  C THE INVERSE OF "ZCOV" IS STORED IN"ZINV" IN LOWER TRIANGLE FORM.
00145   10*  C  THIS PROCEDURE RESTRICTS ITSELF TO THE 200 SERIES
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00145    10*   C AND TO INTERNAL FLAGS STARTING WITH "X"
00146    10*   211   DO 221 XCL=1,NCL     REDUCE COV. MATRIX FOR EACH CLASS
00151    10*         XCT=0     COUNTS WHERE I AM IN REDUCED COV. MATRIX
00152    10*         DO 221 XC=1,NBEST     REDUCED MATRIX OF RANK "NBEST"
00155    10*         XI=VEC(XC)     RETRIEVE LOGICAL ROW INDEX
00156    10*         DO 221 XD=1,XC     COLUMN INDEX FOR REDUCED LOWER TRIANGLE MATRIX
00161    10*         XJ=VEC(XD)     RETRIEVE LOGICAL COLUMN INDEX
00162    10*         XIND=XI*(XI-1)/2+XJ     CONVERT TO LOWER TRIANGLE INDEXING SCHEME
00163    10*         XCT=XCT+1     BUMP POINTER IN REDUCED COVARIANCE ARRAY
00164    10*   221   ZINV(XCT,XCL)=ZCOV(XIND,XCL)     REDUCE COVARIANCE MATRIX FOR EACH CLASS
00164    10*   C  NOW COMPUTE INVERSE
00170    10*         DO 222 XCL=1,NCL     COMPUTE INVERSE FOR EACH CLASS
00173    10*         XF=1     FLAGS FIRST ROW ERROR
00174    10*         IF(ABS(ZINV(1,XCL)).LT. .00001) GO TO 230     WILL I BE
00174    10*   C  DIVIDING BY ZERO
00176    10*         ZINV(1,XCL)=1.0/ZINV(1,XCL)     NO, TAKE RECIPROCAL
00177    10*         DO 201  XK=2,NBEST     INDEX THRU ROWS
00202    10*         DO 202  XI=1,XK     INITIALIZE WORK ARRAY TO ZERO
00205    10*   202    ZV(XI,XCL)=0
00207    10*         XM=XK-1     UPPER ROW LIMIT
00210    10*         DO 203 XI=1,XM     INDEX THRU ROWS
00213    10*         DO 204 XJ=1,XI     INDEX THRU COLUMNS
00216    10*         XIJ=(XI-1)*XI/2+XJ     COMPUTE LOWER TRIANGLE INDEX FOR (I,J)
00217    10*         XKJ=(XK-1)*XK/2+XJ     DITTO FOR (K,J)
00220    10*   204    ZV(XI,XCL)=ZV(XI,XCL)+ZINV(XIJ,XCL)*ZINV(XKJ,XCL)     COLUMN WORK VECTOR
00222    10*         IF(XI-XM) 205,203,205     AM I THRU COMPUTING WORK VECTOR
00225    10*   205   XL=XI+1     NO, COMPUTE LOWER LIMIT AND CONTINUE
00226    10*         DO 208 XJ=XL,XM     MULTIPLY THE XK"TH ROW BY THE XJ"TH COLUMN
00231    10*         XKJ=(XK-1)*XK/2+XJ     COMPUTE LOWER TRIANGLE INDEX FOR (K,J)
00232    10*         XJI=(XJ-1)*XJ/2+XI     DITTO FOR (J,I)
00233    10*   208    ZV(XI,XCL)=ZV(XI,XCL)+ZINV(XKJ,XCL)*ZINV(XJI,XCL)     COLUMN WORK VECTOR
00235    10*   203   CONTINUE     GO TO NEXT ROW
00237    10*         DO 206 XJ=1,XM     GO THRU XJ"TH COLUMN OF THE XK"TH ROW
00242    10*         XKJ=(XK-1)*XK/2+XJ     COMPUTE LOWER TRIANGLE INDEX (LTI) FOR (K,J)
00243    10*   206   ZV(XK,XCL)=ZV(XK,XCL)+ZINV(XKJ,XCL)*ZV(XJ,XCL)     XK"TH ROW OF COLUMN VECTR
00245    10*         XKK=(XK+1)*XK/2     LTI FOR (K,K)
00246    10*         XF=2     FLAGS ERROR OCCURRED ON OTHER THAN FIRST ROW
00247    10*         IF(ABS(ZINV(XKK,XCL)-ZV(XK,XCL)).LT. .00001) GO TO 230     WILL I
00247    10*   C  BE DIVIDING BY ZERO
00251    10*         ZINV(XKK,XCL)=1.0/(ZINV(XKK,XCL)-ZV(XK,XCL))     INVERSE OF ELEMENT (K,K)
00252    10*         DO 207 XJ=1,XM     INDEX THRU ROWS
00255    10*         DO 207 XI=1,XJ     INDEX THRU COLUMNS
00260    10*         XJI=(XJ-1)*XJ/2+XI     LTI FOR (J,I)
00261    10*         XKK=(XK+1)*XK/2     LTI FOR (K,K)
00262    10*   207   ZINV(XJI,XCL)=ZINV(XJI,XCL)+ZINV(XKK,XCL)*ZV(XI,XCL)*ZV(XJ,XCL)     (J,I) INV
00265    10*         DO 209 XI=1,XM     INVERSE OF THE XK"TH ROW AND XI"TH COLUMNS
00270    10*         XKI=(XK-1)*XK/2+XI     LTI FOR (K,I)
00271    10*   209   ZINV(XKI,XCL)=-ZINV(XKK,XCL)*ZV(XI,XCL)     (K,I) INVERSE
00273    10*   201   CONTINUE     GO TO NEXT ROW
00275    10*   222   CONTINUE     GO TO NEXT CLASS
00277    10*         GO TO 240     SKIP ERROR PRINT
00277    10*   C
00277    10*   C  PROBLEMS ON ATTEMPTING TO INVERT MATRIX
00277    10*   C
00300    10*   230   WRITE(PRINT,231)
00302    10*   231   FORMAT(1H1,"***ERROR*** ON ATTEMPT TO COMPUTE INVERSE",
00302    10*        *" OF THE FOLLOWING SUB-MATRIX",//)
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00303   10*         WRITE(PRINT,232)
00305   10*   232   FORMAT(" THE DIAGONAL ELEMENTS CANNOT BE ZERO.",/,
00305   10*        *" NO TWO ROWS CAN BE THE SAME.",//)
00306   10*         WRITE(PRINT,233)  (VEC(XC),XC=1,NBEST)   PRINT FEATURES
00314   10*   233   FORMAT(1X,I8,7I15)
00315   10*         XL=0   COUNTS ELEMENTS IN LOWER TRIANGLE MATRIX
00316   10*         DO 234 XC=1,NBEST   INDEX THRU NO. CHANNELS IN SUBSET
00321   10*         XI=VEC(XC)   GET ROW INDEX IN BIG COV. MATRIX
00322   10*         DO 235 XD=1,XC   INDEX THRU COLUMNS
00325   10*         XJ=VEC(XD)   GET COL. INDEX IN BIG COV. MATRIX
00326   10*         XIND=XI*(XI-1)/2+XJ    COMPUTE WHERE EL. ARE IN LOWER TRIANGLE
00327   10*         XL=XL+1   BUMP COUNTER FOR NO. ELEMENTS IN LOWER TRIANGLE
00330   10*         ELE(XL)=XIND   SAVE LOWER TRIANGLE INDEX
00331   10*   235   ZPRNT(XD)=ZCOV(XIND,XCL)   RETRIEVE NEXT
00331   10*   C  ELEMENT IN ROW FROM BIG MATRIX
00333   10*         WRITE(PRINT,236)  (ZPRNT(XM),XM=1,XC)   PRINT THE ROW
00341   10*   236   FORMAT(1X,8E15.8)
00342   10*   234   CONTINUE   GO PRINT NEXT ROW
00344   10*         IF(XF.EQ.1) WRITE(PRINT,237)   TEST ERROR FLAG
00347   10*   237   FORMAT("0 ERROR OCCURRED ON FIRST ROW",//)
00350   10*         IF(XF.EQ.2) WRITE(PRINT,238)   TEST ERROR FLAG
00353   10*   238   FORMAT("0 ERROR DID NOT OCCUR ON FIRST ROW",//)
00354   10*         WRITE(PRINT,239)XCL
00357   10*   239   FORMAT(" THIS SUB-MATRIX IS LOCATED IN THE",I3,3H"TH,
00357   10*        *" COVARIANCE MATRIX.")
00360   10*         WRITE(PRINT,241) CHAR(XCL)
00363   10*   241   FORMAT(" THIS COVARIANCE MATRIX IS FOR CLASS ",A2,
00363   10*        *" AND IS PRINTED AS IT WAS INPUT.",/)
00364   10*         WRITE(PRINT,243)  (ELE(XM),XM=1,XL)   PRINT LOWER
00364   10*   C  TRIANGLE INDEXES
00372   10*   243   FORMAT(" CHECK ELEMENTS-",25I4)
00373   10*         XPTS=(NM+1)*NM/2   NO. PTS IN BIG MATRIX
00374   10*         WRITE(PRINT,244)  (ZCOV(XM,XCL),XM=1,XPTS)   PRINT BIG MATRIX
00402   10*   244   FORMAT(6X,5E15.8)
00403   10*         RETURN 0   FATAL ERROR. GET DUMP.
00404   10*   240   CONTINUE   CONNECTOR TO SKIP ERROR PRINT
00404   10*    END
00405   11*         INCLUDE DIJ,LIST    PROCEDURE TO COMPUTE DIJ FOR ALL CLASSES
                                                                          JONES
00405   11*   C
00405   11*   C  THIS PROCEDURE COMPUTES INTERCLASS DIVERGENCE AS FOLLOWS...
00405   11*   C   IM-MEAN VECTOR OF I"TH CLASS
00405   11*   C   DIJ-INTERCLASS DIVERGENCE BETWEEN CLASSSES I AND J
00405   11*   C   TR-TRACE. IE. SUM OF DIAGONAL ELEMENTS
00405   11*   C   IK-COVARIANCE MATRIX OF I"TH CLASS
00405   11*   C   JKIN-INVERSE COVARIANCE MATRIX OF J"TH CLASS
00405   11*   C   N-RANK OF MATRIX
00405   11*   C DIJ=TR(IK*JKIN + JK*IKIN) -2*N +TR((IKIN+JKIN)*(IM-JM)*(IM-JM))
00405   11*   C  THIS PROCEDURE RESTRICTS ITSELF TO STATEMENTS IN THE 300 SERIES
00405   11*   C  AND TO INTERNAL VARIABLES STARTING WITH W.
00406   11*         WC=0    POINTS TO WHERE I AM IN INTERCLASS DIVERGENCE ARRAY
00407   11*         DO 300 WA=2,NCL    THE "I" OF THE DIJ CALC. IE. CLASS I.
00412   11*         WUP=WA-1    UPPER LIMIT ON LOOP
00413   11*         DO 300 WB=1,WUP    THE "J" OF THE DIJ CALC. IE. CLASS J.
00416   11*         WC=WC+1    READY FOR NEXT DIJ CALC.
00417   11*         ZDIJ(WC)=0    INITIALIZE SUM
00420   11*         ZD=0    WORK CELL TO SUM UP ONE INTERCLASS DIVERGENCE
00421   11*         DO 301 WI=1,NBEST    LOGICAL ROWS OF COV. AND INVERSE COV. MATRIX
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00424   11*         DO 301 WJ=1,WI     LOGICAL COLUMNS
00427   11*         WK=VEC(WI)      GET ROW INDEX IN BIG MATRIX
00430   11*         WL=VEC(WJ)       GET COLUMN INDEX
00431   11*         WKL=(WK-1)*WK/2+WL     INDEX IN COVARIANCE MATRIX (NOT REDUCED)
00432   11*         WIJ=(WI-1)*WI/2+WJ     INDEX IN INVERSE MATRIX (REDUCED)
00433   11*         Z=2     ALL OFF DIAGONAL TERMS ARE ADDED TWICE
00434   11*         IF(WI.EQ.WJ) Z=1.0     ON DIAGONAL TERMS ARE ADDED ONCE
00436   11*         ZD=ZD+Z*ZCOV(WKL,WA)*ZINV(WIJ,WB)      TR(IK*JKIN)
00437   11*         ZD=ZD+Z*ZCOV(WKL,WB)*ZINV(WIJ,WA)      TR(JK*IKIN)
00440   11*  301    ZD=ZD+Z*(ZINV(WIJ,WA)+ZINV(WIJ,WB))
00440   11*        1*(ZMEAN(WK,WA)-ZMEAN(WK,WB))
00440   11*        2*(ZMEAN(WL,WA)-ZMEAN(WL,WB))      TR((IKIN+JKIN)*(IM-JM)*(IM-JM))
00443   11*         ZDIJ(WC)=ZD-2*NBEST      -2N
00444   11*         IF(ZDIJ(WC).GT.0) GO TO 300    IS DIVERGENCE POSITIVE
00446   11*         WRITE(PRINT,310)    NO, WE HAVE ILLEGAL VALUE
00450   11*  310    FORMAT(1H1,"***ERROR*** HAVE COMPUTED AN ILLEGAL VALUE",
00450   11*        *" FOR INTERCLASS DIVERGENCE--EITHER NEGATIVE OR ZERO.",/)
00451   11*         WRITE(PRINT,311)   (VEC(WM),WM=1,NBEST)    PRINT CHANNELS
00457   11*  311    FORMAT(" USING FEATURE SUBSET=",12I3,/)
00460   11*         WRITE(PRINT,312) CHAR(WA),CHAR(WB),ZDIJ(WC)    PRINT CLASS
00460   11*  C  PAIR AND DIJ
00465   11*  312    FORMAT(" THE INTERCLASS DIVERGENCE COMPUTED FOR",
00465   11*        *" CLASS PAIR ",2A1," IS",E15.8,/)
00466   11*         WRITE(PRINT,313)
00470   11*  313    FORMAT(" PLEASE CHECK THE INPUT STATISTICS FOR THESE CLASSES.")
00471   11*         RETURN 0    FATAL ERROR. GET DUMP.
00472   11*  300    CONTINUE     GO COMPUTE DIJ FOR NEXT COMBINATION OF CLASSES
00472   11*   END
00475   12*         INCLUDE STAT,LIST     PROCEDURE TO COMP. AVG. DIJ, MIN. DIJ, AVG. CLASS DIV
                                                                                    JONES
00475   12*  C
00475   12*  C  THIS PROCEDURE COMPUTES AVERAGE PAIR-WISE DIVERGENCE, MINIMUM PAIR-WISE
00475   12*  C  DIV., AND AVERAGE DIV. BY CLASS.
00475   12*  C  THIS PROCEDURE RESTRICTS ITSELF TO STATEMENTS IN THE 400 SERIES
00476   12*         PAIRS=(NCL-1)*NCL/2     COMPUTE NO. OF CLASS PAIRS
00477   12*         ZAVG=0     INITIALIZE AVERAGE PAIR-WISE DIV.
00500   12*         ZMIN=100000.     INITIALIZE TO LARGE NO. IN SEARCH FOR MIN. PAIR-WISE DIV.
00501   12*         DO 400 J=1,PAIRS     INDEX THRU PAIRS
00504   12*         IF(ZDIJ(J).LE.0) RETURN 0     ERROR IF NONPOSITIVE DIJ
00506   12*         IF(ZDIJ(J).GT.MDIJ) ZDIJ(J)=MDIJ     MAX. DIJ ALLOWED IN AVG. COMPUTATION
00510   12*         IF(ZDIJ(J).LT.ZMIN) ZMIN=ZDIJ(J)     SAVE MINIMUM PAIR-WISE DIJ
00512   12*  400    ZAVG=ZAVG+ZDIJ(J)     SUM PAIR-WISE DIV.
00514   12*         ZAVG=ZAVG/PAIRS     AVG. PAIR-WISE DIV.
00515   12*         DO 401 J=1,NCL     THRU CLASSES
00520   12*  401     ZCAVG(J)=0     INITIALIZE FOR AVG. DIV. BY CLASS COMP.
00522   12*         LOW=NCL-1     NO. OF PAIRS TO SUM FOR EACH CLASS
00523   12*         MM=0     INDEX THRU PAIR-WISE DIV.
00524   12*         DO 402 I=2,NCL     INDEX THRU I'S OF DIJ
00527   12*         UP=I-1     UPPER LIMIT ON J
00530   12*         DO 402 J=1,UP     THE J OF THE DIJ
00533   12*         MM=MM+1     GO TO NEXT DIJ
00534   12*         ZCAVG(I)=ZCAVG(I)+ZDIJ(MM)     COMPUTE PAIR-WISE SUM FOR I'TH CLASS
00535   12*  402    ZCAVG(J)=ZCAVG(J)+ZDIJ(MM)     COMPUTE PAIR-WISE SUM FOR J'TH CLASS
00540   12*         DO 403 J=1,NCL     THRU CLASSES
00543   12*  403    ZCAVG(J)=ZCAVG(J)/LOW     COMPUTE AVG. PAIR-WISE DIV. FOR EACH CLASS
00543   12*   END
00545   13*         ZPCT=1.     INITIALIZE PERCENT SEPARATION
00546   14*         DO 1 J=1,PAIRS     INDEX THRU CLASS PAIRS
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00551    15*          IF(ZDIJ(J).GT.MDIJ) ZDIJ(J)=MDIJ    MAX. DIJ ALLOWED IN SEPARATION COMP.
00553    16*          IF(ZDIJ(J).LT.2.) ZDIJ(J)=2.        MIN DIJ ALLOWED IN FCT SEPARATION COMP.
00555    17*    1     ZPCT=ZPCT*ZMPDIJ(J,1)/ZDIJ(J)       CALC. RATIO OF NEW DIJ TO MAX. FCT
00557    18*          RETURN
00560    19*          END

      END OF COMPILATION'        NO  DIAGNOSTICS.
```

Input Data Deck
(from flight line C-1)

This deck was input to produce the Example of Output.

```
 DATA,L DATA.
DATA006-RLI867-10  06/12-08'41'12
000001      CHANNELS=12 CLASSES=09 BEST=04
000002      MEAN    .16997769+03   .17495210+03   .19327100+03   .19252034+03   .16906102+03
000003      MEAN    .16705183+03   .19051837+03   .17088713+03   .18449409+03   .17286023+03
000004      MEAN    .16242322+03   .18200590+03
000005      MEAN    .17085855+03   .17711908+03   .19527697+03   .19497829+03   .17264605+03
000006      MEAN    .16823223+03   .19251315+03   .17829999+03   .19304539+03   .18202960+03
000007      MEAN    .14818815+03   .17376513+03
000008      MEAN    .17872218+03   .18174953+03   .19723617+03   .19657800+03   .17516097+03
000009      MEAN    .17049099+03   .19132753+03   .16950404+03   .18331013+03   .16658421+03
000010      MEAN    .14759664+03   .17001491+03
000011      MEAN    .18260169+03   .18367144+03   .19701955+03   .19534094+03   .17455737+03
000012      MEAN    .17377575+03   .19161604+03   .16234224+03   .17112711+03   .15899739+03
000013      MEAN    .17283181+03   .18596349+03
000014      MEAN    .18234438+03   .18560948+03   .20049707+03   .20072515+03   .18267511+03
000015      MEAN    .17498570+03   .19682326+03   .18611500+03   .19962053+03   .17815334+03
000016      MEAN    .11384275+03   .14711826+03
000017      MEAN    .17783389+03   .18299663+03   .19925926+03   .19918069+03   .17933109+03
000018      MEAN    .16979460+03   .19422109+03   .18477328+03   .19993602+03   .17645118+03
000019      MEAN    .10342536+03   .14320426+03
000020      MEAN    .17489414+03   .17520609+03   .19134081+03   .18964955+03   .16111868+03
000021      MEAN    .15829190+03   .18242902+03   .15211467+03   .16892622+03   .15519086+03
000022      MEAN    .15898716+03   .17907938+03
000023      MEAN    .16494736+03   .16969132+03   .18957894+03   .18815505+03   .16247937+03
000024      MEAN    .16552632+03   .18784068+03   .15987767+03   .17153627+03   .16476387+03
000025      MEAN    .18318918+03   .19461735+03
000026      MEAN    .17433800+03   .17444000+03   .19021799+03   .18774299+03   .15613600+03
000027      MEAN    .15355899+03   .17782400+03   .13898700+03   .15473799+03   .13909599+03
000028      MEAN    .15609799+03   .17802300+03
000029      COVAR   .65274073+01   .53574336+01   .77711774+01   .39174090+01   .39079335+01
000030      COVAR   .39718175+01   .37877160+01   .42324261+01   .28162173+01   .38085157+01
000031      COVAR   .74806794+01   .82846057+01   .54437276+01   .60450481+01   .13914199+02
000032      COVAR   .64108749+01   .73504820+01   .48119443+01   .54267190+01   .11094011+02
000033      COVAR   .12005847+02   .44160372+01   .48613533+01   .35376967+01   .37425675+01
000034      COVAR   .72447743+01   .70952387+01   .56575742+01   .71964298+01   .86472496+01
000035      COVAR   .56510909+01   .63811547+01   .12734403+02   .11478605+02   .77670126+01
000036      COVAR   .16037155+02   .55520678+01   .70039848+01   .44864996+01   .52108884+01
000037      COVAR   .10100492+02   .87373384+01   .62906335+01   .12599464+02   .12289525+02
000038      COVAR   .57565647+01   .70405760+01   .48323850+01   .53846570+01   .10931712+02
000039      COVAR   .10475405+02   .72931145+01   .13130637+02   .11170218+02   .14280519+02
000040      COVAR   .32038015+01   .23827286+01   .25201619+01   .24244122+01   .61632565+01
000041      COVAR   .97626821+01   .56964213+01   .35008504+01   -.16000719-00   .60677266+01
000042      COVAR   .37219972+02   .89507602-00   .74552272-00   .40220684-00   .95687257-00
000043      COVAR   .27100793+01   .50692932+01   .25373175+01   .17656046+01   -.48881713-01
000044      COVAR   .31544700+01   .14667230+02   .13187752+02
000045      COVAR   .95184916+01   .69115220+01   .88646785+01   .44309080+01   .37431651+01
000046      COVAR   .54408007+01   .32507022+01   .32040280+01   .22252403+01   .31219773+01
000047      COVAR   .74805143+01   .70079423+01   .42429308+01   .39982355+01   .95862911+01
000048      COVAR   .48544640+01   .49499441+01   .27374774+01   .29444791+01   .57372899+01
000049      COVAR   .58729561+01   .29416253+01   .29717698+01   .19558660+01   .19986400+01
000050      COVAR   .34101902+01   .31941114+01   .32717162+01   .56928901+01   .61907175+01
000051      COVAR   .35284398+01   .38050691+01   .69838051+01   .57373931+01   .39782751+01
000052      COVAR   .95662936+01   .43204475+01   .50512070+01   .27207958+01   .33479249+01
000053      COVAR   .55295736+01   .46932031+01   .36034181+01   .75018433+01   .82316443+01
000054      COVAR   .33267710+01   .38898232+01   .24236578+01   .26517294+01   .51118681+01
000055      COVAR   .48265631+01   .37793995+01   .70766951+01   .65806170+01   .86976087+01
```

000056	COVAR	-.26494707+01	-.43871340+01	-.16018528+01	-.33224428+01	-.24777953+01
000057	COVAR	.14784744-00	-.78588752-00	-.70749177+01	-.86234251+01	-.30648236+01
000058	COVAR	.53809208+02	-.29094777+01	-.30246799+01	-.17406981+01	-.21301847+01
000059	COVAR	-.22589593+01	.14740523-00	-.87083781-00	-.40789334+01	-.45364016+01
000060	COVAR	-.20127919+01	.23381943+02	.20961916+02		
000061	COVAR	.91161802+01	.66045035+01	.82326256+01	.47323188+01	.41854335+01
000062	COVAR	.39852351+01	.40835606+01	.44924960+01	.27806968+01	.39517793+01
000063	COVAR	.98973590+01	.94961882+01	.63655668+01	.63851358+01	.16003301+02
000064	COVAR	.98305172+01	.91012862+01	.54772540+01	.58472519+01	.13257359+02
000065	COVAR	.15131915+02	.60014969+01	.56218878+01	.38423741+01	.39368126+01
000066	COVAR	.81580653+01	.82277669+01	.62664118+01	.71519314+01	.86548805+01
000067	COVAR	.59418313+01	.67607232+01	.12994063+02	.10407219+02	.77813252+01
000068	COVAR	.18960338+02	.37690475+01	.65223772+01	.42861632+01	.58287180+01
000069	COVAR	.93032812+01	.62325852+01	.59841798+01	.16819952+02	.19493933+02
000070	COVAR	.43850395+01	.63043769+01	.45273624+01	.54767917+01	.92168462+01
000071	COVAR	.65711884+01	.61959697+01	.16203484+02	.16684998+02	.18009228+02
000072	COVAR	.31018034+01	-.20718610+01	-.94758997-00	-.36734321+01	-.36875191+01
000073	COVAR	.25831164+01	-.76394983-00	-.15302163+02	-.21300202+02	-.15697665+02
000074	COVAR	.53635088+02	-.18416247+01	-.42929035+01	-.31558881+01	-.41417114+01
000075	COVAR	-.68693180+01	-.25502386+01	-.34632219+01	-.12824065+02	-.14913833+02
000076	COVAR	-.11681605+02	.26076915+02	.24453757+02		
000077	COVAR	.78732130+01	.65937731+01	.86930263+01	.46457593+01	.47161490+01
000078	COVAR	.45136420+01	.43315808+01	.49940202+01	.33801512+01	.42900776+01
000079	COVAR	.89083828+01	.99973337+01	.67359941+01	.69300961+01	.15971593+02
000080	COVAR	.83313652+01	.93587591+01	.62085633+01	.66909869+01	.13493629+02
000081	COVAR	.14117976+02	.58906708+01	.65134262+01	.45411082+01	.46625306+01
000082	COVAR	.93328693+01	.93437159+01	.75400166+01	.10912009+02	.12441285+02
000083	COVAR	.83905627+01	.90841533+01	.18665611+02	.18224221+02	.12909707+02
000084	COVAR	.27528585+02	.10326594+02	.11844141+02	.79355423+01	.88170364+01
000085	COVAR	.17647301+02	.17422523+02	.12573303+02	.25320456+02	.26206269+02
000086	COVAR	.15398830+02	.17003708+02	.11564956+02	.12488822+02	.25537658+02
000087	COVAR	.25300784+02	.18426264+02	.36561884+02	.35929881+02	.54530977+02
000088	COVAR	.14244121+02	.14743792+02	.98199905+01	.10013674+02	.21706284+02
000089	COVAR	.22493244+02	.16482672+02	.30686431+02	.28524981+02	.44914107+02
000090	COVAR	.85121075+02	.10988059+02	.11674234+02	.73607926+01	.78108687+01
000091	COVAR	.16864456+02	.17394939+02	.12055119+02	.23843551+02	.22248609+02
000092	COVAR	.34414124+02	.34789681+02	.30148698+02		
000093	COVAR	.43000513+01	.27386034+01	.42186616+01	.21128412+01	.18470369+01
000094	COVAR	.23645883+01	.19068092+01	.20096312+01	.13551776+01	.21591266+01
000095	COVAR	.40020739+01	.40453468+01	.27818842+01	.27845078+01	.76108952+01
000096	COVAR	.40016750+01	.43084581+01	.27385797+01	.29434026+01	.68653137+01
000097	COVAR	.10031005+02	.26428291+01	.26298962+01	.20345934+01	.20216123+01
000098	COVAR	.41551566+01	.52269907+01	.41364936+01	.39005493+01	.41281670+01
000099	COVAR	.28342117+01	.31259096+01	.65373893+01	.64847400+01	.41971929+01
000100	COVAR	.84698590+01	.26567734+01	.31176464+01	.19793839+01	.24352960+01
000101	COVAR	.44871692+01	.40680440+01	.29523959+01	.56737098+01	.57284728+01
000102	COVAR	.40576895+01	.42328746+01	.28606567+01	.28217591+01	.67202036+01
000103	COVAR	.91874991+01	.52553362+01	.60837826+01	.38612180+01	.11560847+02
000104	COVAR	.49560077+01	.31544185+01	.26165750+01	-.46498452-01	.65058956+01
000105	COVAR	.21281885+02	.82790828+01	-.42543552+01	-.91409824+01	.28502022+02
000106	COVAR	.21452662+03	.34650994+01	.24480321+01	.10881223+01	.31731039-00
000107	COVAR	.36359748+01	.12624578+02	.46594059+01	-.17684862+01	-.47743413+01
000108	COVAR	.16360267+02	.11183525+03	.77383924+02		
000109	COVAR	.33948498+01	.25994401+01	.50617863+01	.21565959+01	.25345817+01
000110	COVAR	.30394506+01	.20761157+01	.28601597+01	.20531002+01	.31010202+01
000111	COVAR	.34786529+01	.46314531+01	.35623803+01	.37389828+01	.80846391+01
000112	COVAR	.17849468+01	.25869481+01	.18847690+01	.21843453+01	.39456058+01

000113	COVAR	.42240608+01	.18502503+01	.25434419+01	.21325010+01	.21892167+01
000114	COVAR	.36267141+01	.27769227+01	.34712846+01	.45274682+01	.64026065+01
000115	COVAR	.44936745+01	.52252815+01	.89684043+01	.53846447+01	.48782720+01
000116	COVAR	.13406971+02	.39994741+01	.59548405+01	.41357053+01	.49273030+01
000117	COVAR	.77874967+01	.47508909+01	.45006771+01	.11354019+02	.11864442+02
000118	COVAR	.20885105+01	.31060152+01	.23975031+01	.25172587+01	.46931487+01
000119	COVAR	.34219839+01	.30405818+01	.62507169+01	.55648507+01	.56771081+01
000120	COVAR	-.13339377+02	-.18982835+02	-.12817145+02	-.16108408+02	-.25014025+02
000121	COVAR	-.13251863+02	-.13568311+02	-.36761883+02	-.35367139+02	-.14273030+02
000122	COVAR	.15790088+03	-.81828862+01	-.11334143+02	-.84552642+01	-.92627939+01
000123	COVAR	-.15442987+02	-.77197972+01	-.83564496+01	-.21086223+02	-.20130738+02
000124	COVAR	-.87529375+01	.80553464+02	.57769464+02		
000125	COVAR	.49165548+01	.35723952+01	.66244251+01	.27712584+01	.28550640+01
000126	COVAR	.33452266+01	.25022005+01	.32616881+01	.21989867+01	.32165788+01
000127	COVAR	.44058318+01	.53944606+01	.37548627+01	.39188325+01	.87499475+01
000128	COVAR	.30541981+01	.43250253+01	.25601462+01	.31882508+01	.51250390+01
000129	COVAR	.56659295+01	.25037174+01	.29187314+01	.23071127+01	.24442102+01
000130	COVAR	.36849948+01	.32887907+01	.36319976+01	.51782802+01	.67187227+01
000131	COVAR	.46591196+01	.52472817+01	.88234575+01	.73300628+01	.54515640+01
000132	COVAR	.14565491+02	.49408197+01	.68539010+01	.43839127+01	.54075115+01
000133	COVAR	.86026637+01	.74982783+01	.56424323+01	.13265289+02	.15126174+02
000134	COVAR	.49800909+01	.65810188+01	.45143542+01	.51375642+01	.84701067+01
000135	COVAR	.71898295+01	.55528820+01	.12795913+02	.13242022+02	.15011698+02
000136	COVAR	-.86492268-00	-.13986376+01	-.50846461-00	-.87849683-00	-.19069832+01
000137	COVAR	-.50989533-00	.96199417-01	-.29078372+01	-.34271111+01	-.16644834+01
000138	COVAR	.17327283+02	-.55900517-00	-.94253881-00	-.69481619-00	-.88467602-00
000139	COVAR	-.14524477+01	-.49831312-00	-.82782820-00	-.23742799+01	-.27734318+01
000140	COVAR	-.16796910+01	.39055138+01	.62561319+01		
000141	COVAR	.32550607+01	.12615095+01	.33219616+01	.11530214+01	.69605637-00
000142	COVAR	.18139151+01	.62498125-00	.79294274-00	.38161643-00	.13705122+01
000143	COVAR	.11976308+01	.12165587+01	.74486429-00	.76317410-00	.31644600+01
000144	COVAR	.10077973+01	.11926076+01	.57662318-00	.80004498-00	.13071675+01
000145	COVAR	.22610586+01	.78932373-00	.62739054-00	.70775228-00	.48912475-00
000146	COVAR	.61779188-00	.77627830-00	.15472314+01	.77417903-00	.86959226-00
000147	COVAR	.67491378-00	.58737077-00	.10544532+01	.12339931+01	.72692125-00
000148	COVAR	.33097997+01	.46986055-00	.73557160-00	.24606387-00	.65462425-00
000149	COVAR	.88500848-00	.11760384+01	.58983275-00	.12109964+01	.21664174+01
000150	COVAR	.91205578-00	.82444388-00	.79787074-00	.77740493-00	.12629289+01
000151	COVAR	.14620633+01	.10777113+01	.16277674+01	.15384919+01	.36108294+01
000152	COVAR	.11438746+01	.82058982-00	.90170940-00	.66720566-00	.73966274-00
000153	COVAR	.12279202+01	.13620929+01	.12468237+01	.11263186+01	.18567028+01
000154	COVAR	.77661507+01	.16501724-00	.37032174-00	.39511170-01	.39132249-00
000155	COVAR	.73212484-00	.66891588-00	.12413628+00	.72520293-00	.84082260-00
000156	COVAR	.10505424+01	.40155540-00	.31083594+01		
000157	COVAR	.68706266+01	.80503303+01	.17179579+02	.59722883+01	.10002082+02
000158	COVAR	.86030789+01	.63652312+01	.12261341+02	.87287547+01	.11986938+02
000159	COVAR	.15630663+02	.27509669+02	.20399752+02	.24139091+02	.59919423+02
000160	COVAR	.15201259+02	.29750790+02	.20878015+02	.27081744+02	.60787763+02
000161	COVAR	.72358877+02	.10344833+02	.20139579+02	.14737105+02	.19183952+02
000162	COVAR	.41799735+02	.40025309+02	.35709733+02	.18155549+02	.35931651+02
000163	COVAR	.26728562+02	.34390049+02	.77293060+02	.87182449+02	.62261973+02
000164	COVAR	.11890974+03	.13068625+02	.27502782+02	.20461577+02	.27469134+02
000165	COVAR	.58330962+02	.65934391+02	.48013902+02	.90495088+02	.77933288+02
000166	COVAR	.16157709+02	.33659419+02	.26132204+02	.34770442+02	.75321265+02
000167	COVAR	.86183519+02	.63325221+02	.12094319+03	.99297449+02	.13741620+03
000168	COVAR	.14353229+02	.29527407+02	.22783419+02	.29585771+02	.66133805+02
000169	COVAR	.81671889+02	.59687936+02	.10293521+03	.79427103+02	.10954714+03

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000170      COVAR    .11816456+03   .91153413+01   .19363242+02   .14838825+02   .18418329+02
000171      COVAR    .44470342+02   .50277419+02   .35527575+02   .65798096+02   .30066092+02
000172      COVAR    .89153946+02   .56374119+02   .48951422+02
000173      CLASSES=S,C,O,W,R,A,Y,X,E
000174      PRINT=10 MAX DIJ=30000 NO. SHOW=03
000175      CHANNELS=01,09,11,12
000176      CHANNELS=06,09,10,11
000177      CHANNELS=01,06,10,11
```

Input Deck Description

Please refer to pages 61-64 as an example of a typical input deck.

Card 1

Field 1. n - the number of input channels (measurements). In this case, n=12.

Field 2. m - The number of classes (populations). In this case, m=9.

Field 3. k - The size of the "best" subset. The task is to pick the "best" k of n channels. In this case, k=4.

Format: This card is read with the following format: (9X,I2,9X,I2,6X,I2)

Cards 2-4 These cards contain the mean readings for the n channels of class 1. Field 1 is the mean response for the first channel, ..., field 12 is the mean response for the twelfth channel. Three cards are required to hold the data for 12 channels.
Format: (5X,5E15.8)

Cards 5-28 These cards contain the mean readings for the n channels of classes 2 through m. In this case, three cards are required per class.
Format: (5X,5E15.8)

Cards 29-44 These cards contain the lower triangular covariance matrix for class 1. (Since the matrix is symmetric, it is only necessary to read the lower triangular portion).

Field 1 - The variance of channel 1 for class 1
Field 2 - The covariance of channels 2 and 1 for class 1
Field 3 - The variance of channel 2 for class 1
Field 4 - The covariance of channels 3 and 1 for class 1
Field 5 - The covariance of channels 3 and 2 for class 1

.
.
.

Field $\frac{n(n+1)}{2}$ - The variance of channel n for class 1

From this, it can be seen that there are 78 fields per class in the 12 channel case and that there are 16 cards/class.
Format: (5X,5E15.8)

Cards 45-172 These cards contain the lower triangular covariance matrices for classes 2 through m. The fields are encoded in a similar to those for cards 29-44. There are 16 cards/class in this case.
Format: (5X,5E15.8).

Card 173 A symbol associated with each class. These symbold should be in the same order as the class statistics they represent, i.e., symbol 1 represents class 1, ..., symbol m represents class m.
Format: (7X,36(1X,A1)).

Card 174 Field 1. The number of top ranked channel sets to be printed for criteria, 1, 2, and 3.

Field 2. The maximum pairwise divergence to be allowed by the program in its criteria tests. If a divergence is greater than this maximum, then it is set to it.

Field 3. The number of specific channel combinations asked to be displayed, i.e., the number of "show" requests. If there are no show requests, this field should be set to zero.

Format: (6X,I2,9X,I5,10X,I2)

Cards 175-177 The specific channel combinations the investigator would like to have displayed. For example, the investigator has requested to see set (1, 9, 11, 12). There should be the same number of these cards as was specified in field 3 of card 174.
Format: (8X,24(1X,I2)).