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SPECIAL INTERIM TECHNICAL REPORT
THE BAYESIAN APPROACH TO IDENTIFICATION OF A REMOTELY SENSED ENVIRONMENT

by

Robert Haralick

CRES Technical Report No. 133-9

July 1969

Sponsored by

ADVANCED RESEARCH PROJECTS AGENCY, DEPARTMENT OF DEFENSE

Work Order No. 1079

Monitored by

U.S. ARMY ENGINEER TOPOGRAPHIC LABORATORIES
GEOGRAPHIC INFORMATION SYSTEMS BRANCH
GEOGRAPHIC SYSTEM DIVISION
FT. BELVOIR, VIRGINIA

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ABSTRACT

The first part of this paper provides a brief tutorial introduction of the Bayesian Approach to identification of a remotely sensed environment. The second part describes the input data deck setup for the Fortran IV program which has been written to implement this approach. The third part describes file usage and subroutine organization. The fourth part provides a listing of the program with a simple sample data set.

ACKNOWLEDGEMENT

I wish to acknowledge the assistance of Carl Smith who did most of the programming, and the University of Kansas Computation Center for providing some of the necessary computer time.

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PART I

THE BAYESIAN APPROACH TO IDENTIFICATION OF A REMOTELY SENSED ENVIRONMENT

I. THE BAYESIAN APPROACH TO IDENTIFICATION OF A REMOTELY SENSED ENVIRONMENT

Using remote sensors we can make measurements of an environment. The set of measurements made will be called the data set. Our job is to examine the data set in order to identify what the environment is made up of: our problem is how should we do it? In what follows we describe the Bayesian decision approach with a deterministic decision rule.

We assume that distinct boundaries enclose a limited environment, which is made up of small-area patches, one next to the other. The identification of the environment consists of identifying each small-area patch within one category of a given set of categories. We assume that such an identification is sensible and possible.

In order to make any identification we must have knowledge concerning which kind of measurements are typical measurements of the categories we wish to identify. This knowledge is succinctly contained in a classification, which is a mapping, associating with each measurement the category to which it is most typical - given a specific decision criterion. Therefore, if we are to identify measurements in a data set we must have a classification.

How do we obtain a classification? We perform an information gathering experiment. From the population of all environments, we sample one or a few in which it is possible to identify many small-area patches within each category of interest. The proportion of occurrence of each category in the sampled environment(s) does not have to be representative of the average probability of occurrence of each category in the entire environmental population. However, if we have no information regarding the average probability of occurrence of each category in the environmental population, then we would want to choose the sampled environment(s) so that the proportion of occurrence of each category in the sampled environment(s) is an unbiased estimate of the average probability of occurrence of each category in the environmental population. In either case, the small-area patches within each of the sampled environment(s) do have to be representative of the categories with which they are identified.

With each of our sensors, we measure each small-area patch in the chosen environments. From photo-interpretation or field studies, the environments are examined first hand, and an identification of each small-area patch is made. The sequence of such identifications is called the "ground truth identification" or simply "ground truth". It is from the data set (the sequence of measurements) and the ground truth (the sequence of identifications) that we can find a Bayes classification.

At this point we must introduce some mathematical notation. Let $C = \{c_i\}_{i=1}^{K}$ be the set of K given categories; c_i is the symbol used for the i^{th} category. We suppose, for convenience, that each sensor produces only one number for each measurement it makes of a small-area patch We suppose further, that the j^{th} sensor must produce a number belonging to its range set $L_j = \{l_{j1}, l_{j2}, \ldots, l_{jN_j}\}$. This supposition is fully in accord with reality, since the output of any sensor is always equivalent to a pointer-reading on a dial. Pointer-readings can never be discerned precisely, and are thus discerned approximately to third, or fourth, or, . . . , N^{th} place accuracy.

Measurement space M is the set of all measurements which are possible to make with the set of S sensors. M is conveniently described as the cartesian product of the range sets; $M = L_1 \times L_2 \times \ldots \times L_S$. This is the set of measurements which contain for elements, all the possible numbers produced by sensor one, combined with all the possible numbers produced by sensor two, . . . , combined with all the possible numbers produced by sensor S. For convenience we number the measurements in M: $M = \{m_n\}_{n=1}^{N}$, where N is the total number of elements in measurement space. Finally we must provide a goodness criterion; thus, we introduce a gain function g. $g(c_i, c_j)$ is our economic gain if we identify a measurement as belonging within the i^{th} category when that measurement was made of a small-area patch actually belonging within the j^{th} category.

We have already mentioned that a classification is a mapping or rule which associates with each measurement m_n in M, the category c_i to which it is most typical - according to some decision criterion. Our decision criterion is economic; "most typical to" translates to, "that association by which we, on the average, gain the most economically". Therefore, according to our decision crit rion, we can judge each possible classification. That classification which enables us to gain the most, on the average, is the classification which is best; it is that classification which we wish to find.

Let us now examine how the average gain may be calculated. Let f be a classification mapping. f is a function whose domain is the set M, and whose range is the set C; $f: M \to C$. For each element $m_n \in M$ the function associates one and only one category $c_i \in C$. We define the characteristic function h_f for f as follows: for every $m_n \in M$, $c_i \in C$.

$$h_f(c_i, m_n) = \left. \begin{array}{l} 1 \text{ if and only if } f(m_n) = c_i \\ 0 \text{ otherwise} \end{array} \right\} .$$

In other words $h_f(c_i, m_n)$ is 1 if and only if the classification f identifies the measurement m_n as belonging within the category c_i. The average gain A for the classification f is easily seen to be:

$$A(f) = \sum_{i=1}^{K} \sum_{k=1}^{K} \sum_{n=1}^{N} g(c_k, c_i) h_f(c_k, m_n) P(m_n | c_i) P(c_i)$$

where $P(m_n | c_i)$ is the conditional probability that the measurement m_n will be made of a small-area patch given that the patch belongs within category c_i. $P(c_i)$ is the probability that any small-area patch of the environments in the population belongs within category c_i, and $g(c_k, c_i)$ is the amount gained if a patch which actually belongs within category c_i is identified within category c_k.

Of the four terms in the summation, $g(c_k, c_i)$ is specified as part of the identification goodness criteria, $h_f(c_k, m_n)$ is defined from the classification f, $P(m_n|c_i)$ will be determined from the data gathered in the experiment, and $P(c_i)$ is an additional a priori probability which we will have to specify. Let us now examine in detail how the conditional probabilities are determined from the experimental data.

The data set is a sequence D of R measurements;

$$D = \langle m_{r_1}, m_{r_2}, \ldots, m_{r_R} \rangle .$$

The ground truth corresponding to sequence D is a sequence T of R not necessarily different category identifications; $T = \langle c_{r_1}, c_{r_2}, \ldots, c_{r_R} \rangle$. Let # be the counting measure. #(D) is the number of elements in the sequence D; thus, #(D) = R. A sequence is really a function whose domain is the set of integers I. The data set D is then a function which associates with each integer, a measurement; $D: I \to M$. The ground truth T is also a function and it associates with each integer a category; $T: I \to C$. D(7), for example, is then just the seventh element in the sequence D; $D(7) = m_{r_7}$. $D^{-1}(m)$ is the set of all integers i for which $D(i) = m$. The statistic $\hat{P}(m_n|c_i)$ estimating $P(m_n|c_i)$ is defined as

$$\left. \begin{aligned} \hat{P}(m_n|c_i) &= \frac{\#(D^{-1}(m_n) \cap T^{-1}(c_i))}{\#(T^{-1}(c_i))} \quad \text{when } \#(T^{-1}(c_i)) \neq 0 \\ &= 0 \text{ otherwise} \end{aligned} \right\} .$$

$\hat{P}(m_n|c_i)$ is the number of integers which are associated with the measurement m_n in the sequence D and with the category c_i in the sequence T, divided by the number of integers associated with the category c_i in sequence T. Stated simply, $\hat{P}(m_n|c_i)$ is just the number of times the measurement m_n was made of a small-area patch belonging within category c_i, divided by the number of times a small-a... patch belonged within the category c_i.

The a priori probabilities $P(c_i)$ can either be estimated from the sampled data set (if this data set is representative of the population) or from our foreknowledge of the population of environments. If we can assume that the few environments we have chosen to sample for our experiment are representative of the population, then

$$\hat{P}(c_i) = \frac{\#(T^{-1}(c_i))}{R}$$

is a reasonable estimate. If we cannot make such an assumption and we believe that a small-area patch is just as likely to belong within one category as within another, then $\hat{P}(c_i) = 1/K$ is a reasonable estimate.

From the estimates $\hat{P}(m_n|c_i)$ and $\hat{P}(c_i)$ we may estimate the average gain $\hat{A}$ for any classification f. As before let h_f be the characteristic function for f.

$$h_f(c_k, m_n) = 1 \text{ if and only if } f(m_n) = c_i \\ = 0 \text{ otherwise}$$

$$\hat{A}(f) = \sum_{i=1}^{K} \sum_{k=1}^{K} \sum_{n=1}^{N} g(c_k, c_i) h_f(c_k, m_n) \hat{P}(m_n|c_i) \hat{P}(c_i).$$

We seek the Bayes classification f* which maximizes $\hat{A}$. f* is easily defined. For each measurement m_n and for any classification f, there will be one and only one category c_j such that $h_f(c_j, m_n) = 1$. Consider the amount $\hat{a}(c_j, m_n)$ gained due to the identification of measurement m_n as belonging within category c_j.

$$\hat{a}(c_j, m_n) = \sum_{i=1}^{K} g(c_j, c_i)\hat{P}(m_n | c_i)\hat{P}(c_i)$$

The maximum $\hat{A}(f)$ is certainly achieved if for each measurement m_n, $f(m_n) = c_j$ where c_j maximizes $\hat{a}(c_j, m_n)$. Therefore we just have to compute $\hat{a}(c_j, m_n)$ for $j = 1, 2, \ldots, K$ to determine which category, c_j, maximizes it. Then we define $f^*(m_n) = c_j$.

In this manner we can define how to best identify each measurement which actually occurred in the data sequence D. However, there may be many measurements in measurement space M which did not occur in the data sequence. How should these measurements be identified in the classification? Since we have no data or statistics for these measurements it seems that we have no way to deal with them! Here we must draw upon our knowledge of the structure of reality. We know that in any environment if a measurement m is made of a small-area patch belonging within category c_i, then it is likely to make measurements $m + \delta$ for other small-area patches which also belong within category c_i. If a measurement m is typical of category c_i, then for small δ, $m + \delta$ is also typical of category c_i. Similar or close measurements are usually associated with similar or the same categories. Thus in the classification we can identify a measurement m, which did not occur in the data sequence, with the category associated with m', its nearest neighbor.

The part of the classification f* which was defined by means of the statistics generated by the experiment is called a Bayes Classification and hence the name "Bayesian approach." The part of the classification which is not Bayesian is said to be defined by a nearest neighbor search.

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PART II

INPUT DATA DECK

II. INPUT DATA DECK

The data for this program are received as a sequence of measurements of small-area patches or objects with each measurement made by a sensor or set of sensors. A measurement may be, for example, the average backscatter power return from a small-area patch at incidence angles 5°, 10°, 15°, 20°, 30°, 40°, 50°, and 60°. In this case, each measurement has 8 components. The patches themselves are examined and identified as belonging within one of several given categories. The sequence of such identifications is called the "ground truth identification" or simply the "ground truth." The Bayes program can determine a Bayes classification of measurement space, based on the data and the ground truth for the data. Once a classification is determined, the Bayes program can identify each measurement within a sequence of measurements. This identification is done by a nearest-neighbor search.

The input deck is organized into four sections: title, program options, parameter cards, and format and data.

I. Title

A) The title section consists of a single card specifying the name of the data. The title may begin in column one and continue through column eighty.

II. Program Options

A) The program option section consists of two cards, the first card specifying all the input options and the second card specifying all the output options.

B) Each option is a six-character abbreviation or code.

C) The options start in column 16, are separated only by commas (no embedding blanks) and may appear in any order.

D) Only input options may appear on the input card and only output options may appear on the output card.

1) The input options are: PHOPTS, CORPTS, FLTING, PATERN, DIAGON, HLFNHF, ABSQNT.

2) The output options are: ALTICH, STDPNT, DPUNCH, PHOUT1, PHOUT2, TERMNL.

III. Parameters

A) The parameter section consists of cards, the number of which varies with the options chosen.

B) There are seven basic types of information which can possibly appear in the parameter section: gain matrix, dimensionality of measurements, number of measurements in the data set, number of categories in the classification, display size, number of levels to which the measurements will be quantized, and means of estimating the <u>a priori</u> probability distribution.

IV. Format and Data

A) There are two ways to organize the format and data: photographic form and corresponding-point form. Depending on the options chosen, the ground truth identification and its format may or may not be present. One and only one of the two forms must be specified: otherwise, an error message and termination of the job will result.

1) In the photographic form the data are organized as follows:

a) format for identification (if any)

b) identification (if any) for measurement one, measurement two,...,measurement N.

c) format for measurements

d) component one, measurement one; component one, measurement two;...;component one, measurement N; component two, measurement one; component two, measurement two;...;component two, measurement N;...component M, measurement one; component M, measurement two;...;component M, measurement N.

2) In the corresponding-point form the data are organized as follows:

a) format for identification (if any) and measurements

b) identification (if any) for measurement one; component one, measurement one; component two, measurement one;...; component M, measurement one: identification (if any) for measurement two; component one, measurement two; component two, measurement two;... component M, measurement two:... identification (if any) for measurement N; component one, measurement N; component two, measurement N;... component M, measurement N.

We now describe the options.

I. Input Options

A) PHOPTS -- is the abbreviation for photographic form, and is used when the data are in that form.

B) CORPTS -- is the abbreviation for corresponding point form, and is used when the data are in that form.

C) FLTING -- is the abbreviation for floating point, and is used when the data are punched on cards in floating-point form. It is not used when the data are punched on cards in integer form.

D) PATERN -- is the abbreviation for pattern classification by Bayes' strategy. Use of this option will output a probability matrix where element (i, j) is the conditional probability that a measurement which was identified as within the i^{th} ground truth category is identified in the classification as within the j^{th} category. A punched deck of the compacted quantized measurements with their identifications in the Bayes' classification will also be produced.

E) DIAGON -- is the abbreviation for diagonal gain matrix with ones on the diagonal. Specification of DIAGON will internally generate an identity matrix for the gain matrix. This relieves the user of the need to supply the appropriate cards in the parameter section.

F) HLFNHF -- is the abbreviation for half and half. Specification of HLFNHF will divide the data into halves: even and odd points. The first, third,. . ., data points are used to construct a Bayes' classification, and the second, fourth, . . . ,data points are identified on the basis of the classification.

G) ABSQNT -- is the abbreviation for absolute maximum quantization. Specification of ABSQNT will quantize the measurements by determining the minimum and maximum values occurring among all the components, normalizing each component by subtracting this minimum, dividing by this maximum minus this minimum, and multiplying by the number of quantized levels desired. If ABSQNT is not specified, the program finds the maximum and minimum for each component, and normalizes component by component.

II. Output Options

A) ALTPCH -- is the abbreviation for alternate punch. Specification of ALTPCH produces a punched quantized data deck in the alternate form. If the data are in photographic form, the punched deck will be in corresponding-point form. If the data are in corresponding-point, the punched deck will be in photographic-point form.

B) STDPNT -- is the abbreviation for standard identification print out. Specification of STDPNT will print out the ground truth identification.

C) DPUNCH -- is the abbreviation for punched deck. Specification of DPUNCH will produce a punched quantized data deck in the same form as the input data.

D) PHOUT1 -- is the abbreviation for photograph output. Specification of PHOUT1 will identify data according to a given classification. The classification can be internally generated by the Bayes routine or it can be externally supplied in the data deck. Identification is done by a table look-up procedure. If the quantized measurement cannot be found in the classification, a nearest-neighbor search is initiated, and the measurement is identified with the same identification as the closest measurement to it in the classification.

If the input includes ground truth identification for a data set and the data are further identified relative to a classification (by specification of PHOUT1), then a contingency table of the ground truth identification versus the classification identification will be printed out. The $(i,j)^{th}$ element of the table is the number of measurements which were identified in the i^{th} ground truth category and classified in the j^{th} ground truth category.

E) PHOUTD -- is the abbreviation for photograph output deck. Specification of PHOUTD will produce a punched deck of the identification which the photograph output routine determined. PHOUTD can only be specified if PHOUT1 is specified.

F) TERMNL is the abbreviation for remote terminal format. Specification of TERMNL will format all printed output from the Bayes program so that each line has no more than seventy columns. If TERMNL is not specified, each line is printed with one hundred thirty columns.

The generality of the program requires that the input parameters be quite variable, depending on the type of data to be processed and the options desired. For example, the PATERN option may or may not require the gain matrix as input depending on whether or not DIAGON was also specified. To facilitate setting up the input data deck, a flow chart is illustrated in Figure 1a and 1b.

The flow chart contains two symbols. The first symbol is the elongated circle (rectangle with rounded edges), which asks the question printed in the circle and requires a "true" or "false" answer. Depending upon the user's answer, one branch is chosen from the bottom of the circle.

The second symbol is the rectangle, which usually signals the addition of a single data card. Data cards are added when rectangles are encountered in the flow chart. Two exceptions to the "one-rectangle, one-data-card" rule are the gain matrix and the data itself. If the gain matrix is required (PATERN is specified and DIAGON is not specified), the user must supply all the elements for the matrix. This will take up more than one card if there are more than two ground truth identification groups. Similarly, if there are more than eight measurements in the data set, the data deck will have more than one card.

The final control card is the STOP card and is the last card in the input deck. The four-character word STOP is punched in columns one through four. The program is designed to handle more than one data set per run, and the user may place behind the first (or second, or third, etc.) data set the NAME of the next data set, the proper /INPUT and /OUTPUT cards, and the other necessary parameter cards as specified by the flow chart. The STOP card is placed after the final set of data, and informs the system to terminate the job. Excluding the STOP card or misplacing any control cards will cause a read error and termination of the job.

FLOW CHART FOR SETTING UP INPUT DATA DECK

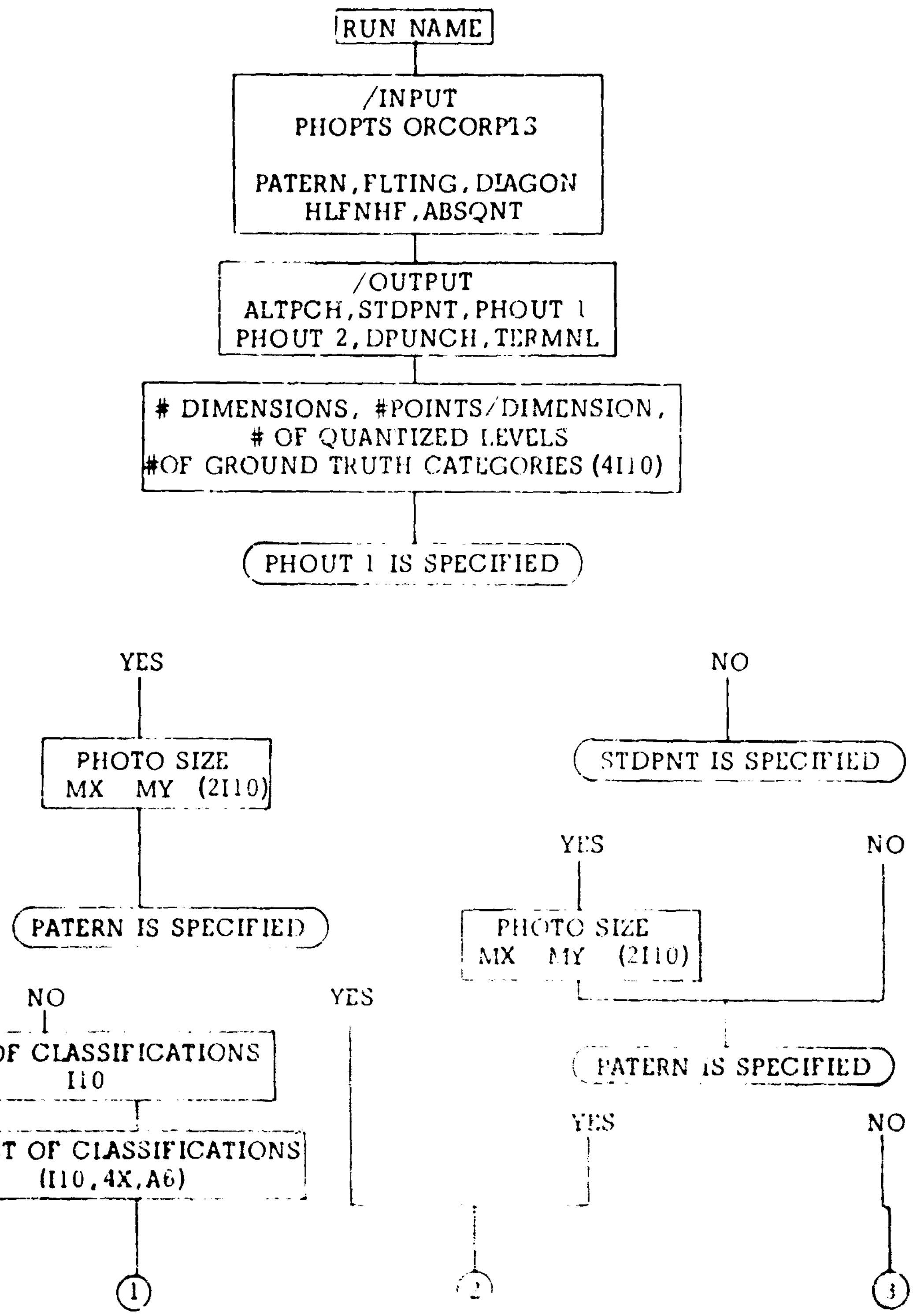
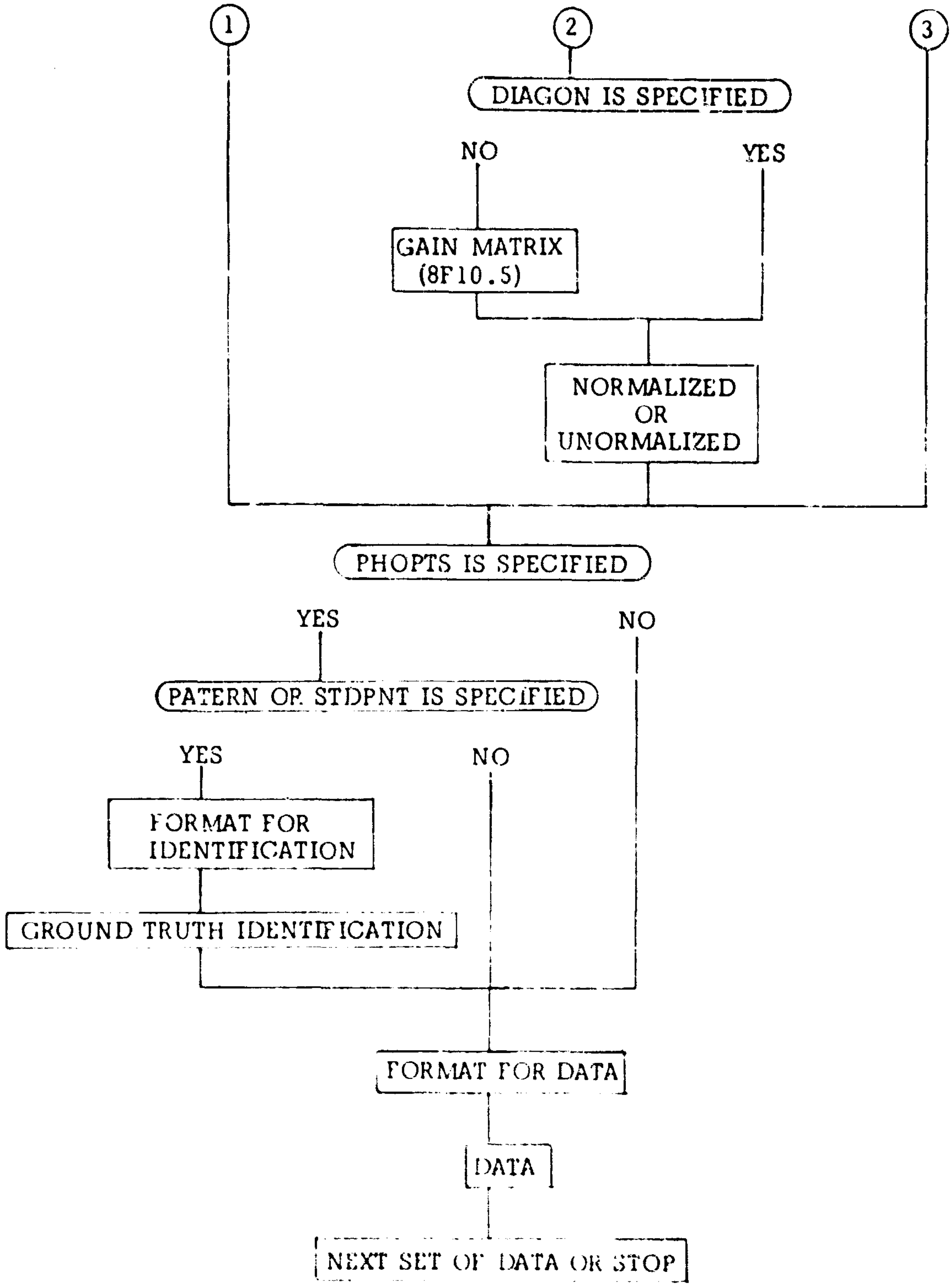


Figure 1a.



1
2
3
DIAGON IS SPECIFIED
NO
YES
GAIN MATRIX
(8F10.5)
NORMALIZED
OR
UNORMALIZED
PHOPTS IS SPECIFIED
YES
NO
PATERN OR STDPNT IS SPECIFIED
YES
NO
FORMAT FOR
IDENTIFICATION
GROUND TRUTH IDENTIFICATION
FORMAT FOR DATA
DATA
NEXT SET OF DATA OR STOP

Figure 1b.

PART III

FILE USAGE AND SUBROUTINE ORGANIZATION

III. FILE USAGE AND SUBROUTINE ORGANIZATION

Blank common storage carries all problem parameters and user options (CORPTS, PHOPTS, etc.), as well as providing a 24,000-word scratch area. Many routines in different links require such parameters as the number of dimensions of the current problem, the number of points being processed, and the number of ground truth categories.

All other communications between links are handled by tape, disc, or drum files. The program requires nine files -- 01, 02, 03, 04, 09, 10, 11, 20, 21 — as well as the input (05), output (06), and punch (43) files normally used in FORTRAN. Figure 2 describes file usage, and Figure 3 illustrates how much storage is needed on each of the files.

The Bayes program, as mentioned before, requires 36,000 words of storage in the computer core, of which 25,000 may be shared during loading. The program has been observed to process 350 sixteen-dimensional data points in less than ten minutes' processor time.

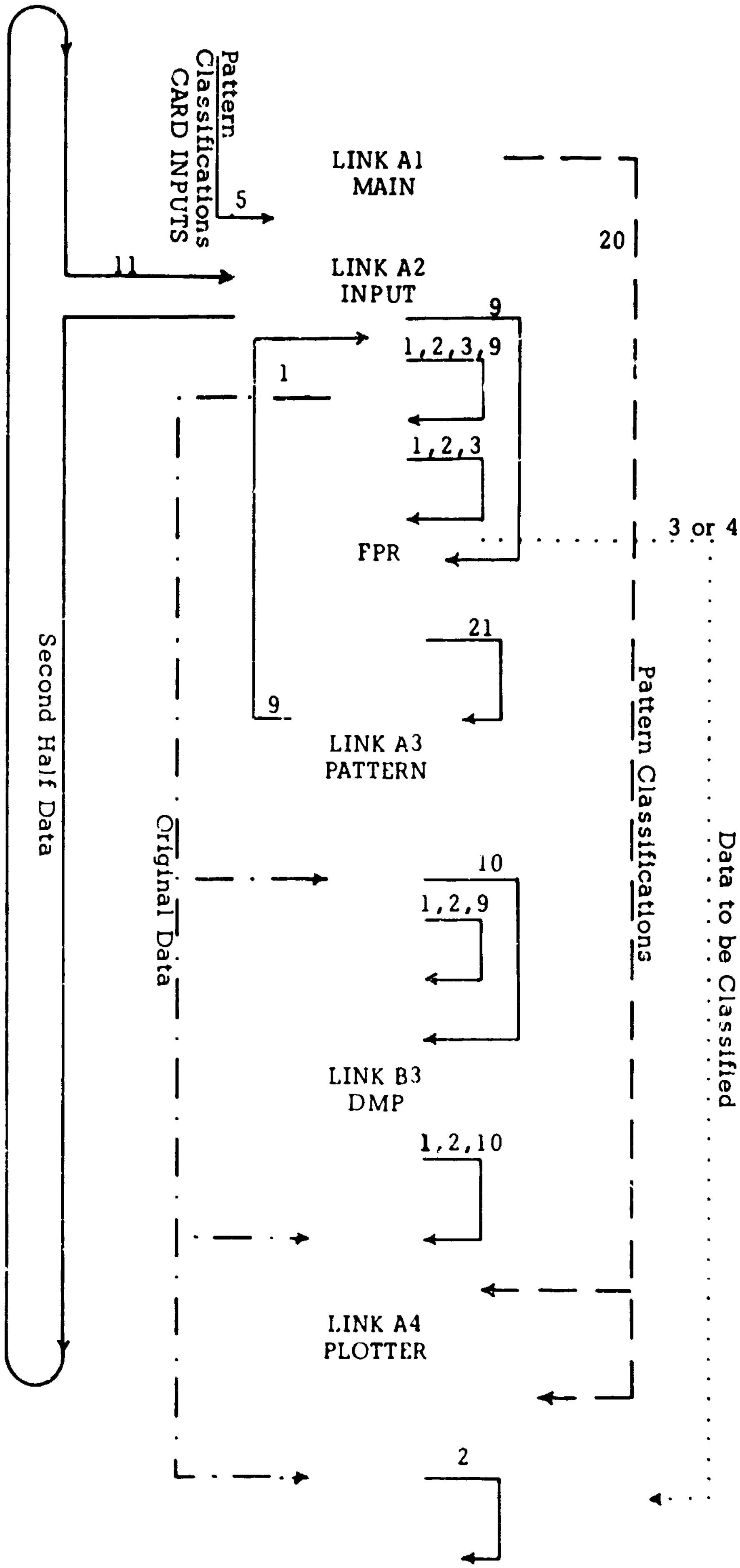


Figure 2. Tape Usage

FILE	NUMBER OF WORDS NEEDED
01	Total points
02	Total points
03	(Total Points) * # dimensions
04	
09	(Total Points) * # dimensions
10	2*(total points)
11	1/2*(total point)
20	2*(# unique n-tuples in data)
21	(Total Points) * # dimensions

Figure 3. Storage Requirements for the Tape or Disc Files

The program organization is briefly described below. Listed first are the mainline and CHNXT, the system supervisor, followed by the six-character link names used during overlay processing. Under each link name are listed the routines contained in the link. Link names containing the alphabetic character "A" refer to links essential for proper data processing: link names containing the alphabetic character "B" refer to links which output intermediate calculations, but which do not contribute to the overall program results.

LINKB2

.....(mainline) -- reserves all common storage, provides entry point to program, and contains comment cards stating program parameters and input deck setup.

CHNXT -- a small resident program used to control the entry and exits of the different links. This routine must comply with the overlay rules of the operating system in use.

LINKA1

MAIN -- parameter input and selection is accomplished in this routine. Also, if the photo classifications and the gain matrix must be read in, it is done in MAIN.

FORM -- selects and places in common all formats affected by terminal or non-terminal use.

LINKA2

INPUT -- performs data input, saves every even point for later processing if desired, and changes data to alternate form if called for.

FPR-FPR1 -- searches data for the maximum and minimum points so that proper quantization and shifting may be done in INPUT.

DEF -- defines the single-character symbols to be used in the classification.

TRANE -- prints a cross-reference between the single-character symbols used in the program and the original symbols.

CHANGE -- an assembly language routine which creates a suitable output format for the data.

LINKA3

PATERN -- Bayes program

OUTP -- prints out results of PATERN in eye-appealing format.

DECSON -- selects and assigns to each n-tuple the proper classification according to Bayes theory.

LINKB3

DMP -- used for debugging; prints out n-tuples vs. categories and n-tuples vs. classification.

LINKA4

PLOTER -- classifies and plots input data according to n-tuple classifications.

SEARCH -- searches a list of n-tuples to find the list element which is closest in distance to another n-tuple.

IDIST -- calculates n-dimensional space distances.

PART IV

EXAMPLE PROBLEM AND PROGRAM LISTING

IV. EXAMPLE PROBLEM

Suppose the problem is to input a set of data in photographic form, punch out the data in the alternate form, print the data identification, and then classify a new set of data. Let there be nine points in the horizontal direction and ten points in the vertical direction for the first data set. The data appear in Figure 4a. For the first part of the problem, the program must produce an alternate data deck, a print-out of the identification, and a Bayes' classification based on the first set of input data.

The first card is the title card. The next two cards specify the input and output options needed. The options start in column 16 and are separated by commas. The data are in photographic form, so the input card is:

/INPUT PHOPTS,PATERN

The output card is:

/OUTPUT ALTPCH,STDPNT

The parameter card follows. From the flow chart we see that the fourth card must specify the number of dimensions per measurement (number of photographs), total number of measurements, number of quantized levels, and number of ground truth categories. In our example the number of photographs is two and the number of measurements is ninety. We wish to quantize the data to ten levels and there are two ground truth categories. The fourth card thus appears as:

2 90 10 2

Since PHOUT1 is not specified and STDPNT is, the fourth card must specify the photograph size, which is nine points horizontal by ten vertical. The fifth card appears as:

9 10

111151111
111151111
111151111
111151111
555555555
555555555
111151111
111151111
111151111
111151111
111151111

Photo 1 for Test 1

51115
15151
11511
15151
51115

Photo 1 for Test 2

222262222
222262222
222262222
222262222
333333333
333333333
222262222
222262222
222262222
222262222

Photo 2 for Test 1

32223
26262
22322
23232
62226

Photo 2 for Test 2

Figure 4a. Data for Test 1

Figure 4b. Data for Test 2

Since PATERN is specified and DIAGON is not, the user must supply the gain matrix. Suppose we choose a gain matrix where we gain ten for a correct decision and lose five for an incorrect decision, as illustrated in Figure 5.

```
10  -5
-5  10
```

Figure 5. Gain Matrix

The sixth card, specifying the above matrix, is

```
10.     -5.     -5.     10.
```

We must now indicate how the _a priori_ probability distribution is estimated. We choose to suppose that each identification group has equal probability. Therefore NORMALIZED is specified on the next card,

NORMALIZED

The data are in photographic form, so the format for the ground truth identification must come next. In our example this would be:

(9A1).

After the identification format, the identification itself comes:

AAAABAAAA
AAAABAAAA
AAAABAAAA
AAAABAAAA
BBBBBBBBB
BBBBBBBBB
AAAABAAAA
AAAABAAAA
AAAABAAAA
AAAABAAAA

Finally we reach the format for the data, the data itself, and the STOP card. In our example these appear as:

```
(9I1)
111151111
111151111
111151111
111151111
555555555
555555555
111151111
111151111
111151111
111151111
111151111
222262222
222262222
222262222
222262222
333333333
333333333
222262222
222262222
222262222
222262222
STOP
```

The input data deck is illustrated in Figure 5.

At this point we must run a job with the input deck as shown in Figure 6. The job produces a punched deck of the Bayes classification. We must now identify a new set of data which is illustrated in Figure 4b. This is done by a separate job. The first card is, as usual, the title card. The second and third cards are the input and output option cards. The new set of data is in photographic form, and we wish to have a print-out of the identification for it, based on the classification of the previous job. The next cards thus appear:

```
/INPUT          PHOPTS
/OUTPUT         PHOUT1
```

There are two dimensions, twenty-five measurements, ten quantized levels, and two identification groups. The fourth card is:

2 25 10 2

Since PHOUT1 is specified, the next card must indicate the photographic size which is, in our example, five points horizontal by five vertical. The next card is thus:

5 5

The number of quantized measurements in the classification and the Bayes classification itself come next. These cards were obtained from the output of the previous job.

For our example, they are:

```
3
            65.02     35.02     21.01
```

All that now remains is the format for the data, the data itself, and the STOP card.

```
(5I1)
51115
15151
11511
15151
51115
32223
26262
22322
23232
62226
STOP
```

The input data deck is illustrated in Figure 7.

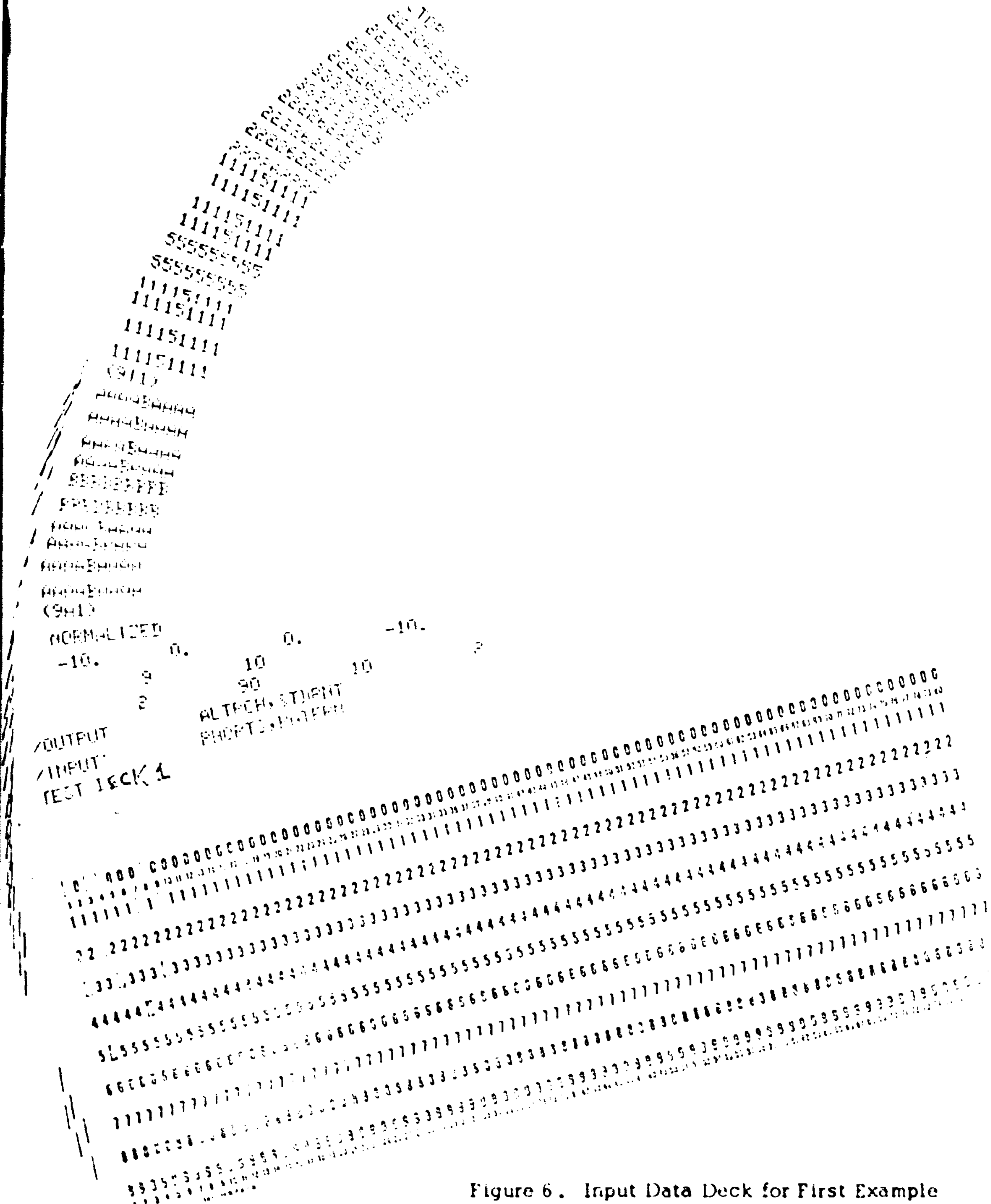


Figure 6. Input Data Deck for First Example Problem

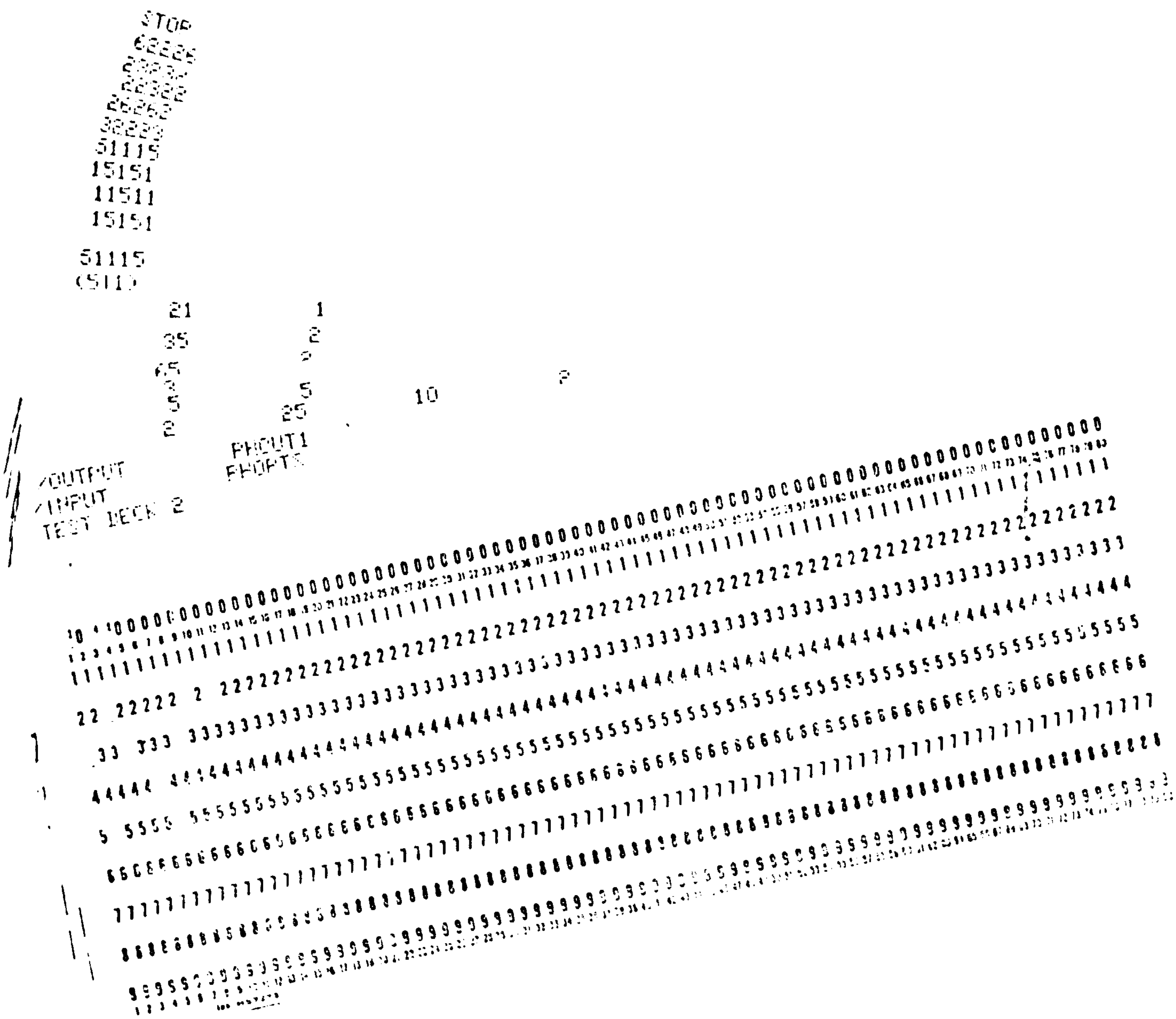


Figure 7. Input Data Deck for Second Example Problem

TEM DATA SPECIFICATIONS

```
C                      ***
C       SYSTEM DATA SPECIFICATIONS
C
C     ...................................................................
C
C      EACH DATA SET SHOULD BE PREFIXED WITH A SINGLE  CARD
C        CONTAINING THE RUN NAME
C
C        1 ST CARD  (INSTRUCTION PARAMETERS) FORMAT(5(A6,1X))
C          THIS CARD CONTAINS UP TO FIVE SPECIFICATIONS SEPERATED BY A
C          COMMA ENABLING THE USER TO ENTER AND EXIT THE PROGRAM AT
C          ANY POINT DESIRED.
C
C          THE PROGRAM EXPECTS THE INPUT DATA IN ONE OF TWO FORMS, THE
C          USER IS RESPONSIBLE FOR SPECIFING THE FORM.  IF NEITHER OR
C          BOTH ARE SPECIFIED AN ERROR MESSAGE RESULTS.
C
C          LITERAL           DATA FORM
C
C          PHOPTS            TRAINING REGIONS,PHOTO 1 ' PHOTO 2 ' ' ETC.
C
C          COMPTS            POINT1-PHOTO 1 , POINT1-PHOTO 2, ----------
C                            POINT2-PHOTO 1, POINT 2-PHOTO 2, ----------
C                              .
C                              .
C                            POINT N-PHOTO 1, POINT N-PHOTO 2, ---------
C
C          THE OTHER PARAMETERS THAT MAY BE SPECIFIED ARE
C
C          LITERAL
C
C          ALTPCH            A DATA DECK WILL BE MADE IN THE ALTERNATE D
C                            'DATA FORM'
C
C          STOPUT            A PRINT OUT OF THE TRAINING REGIONS WILL BE
C                            MADE
C
C          PATERN            SUBROUTINE PATERN WILL BE CALLED
C                            (SCATTEROMETRY PROGRAM) A TAPE SUCH AS IS
C                            MADE IN PATTAP MUST BE AVAILABLE ON FORTRAN
C                            UNIT 1
C
C          PHOUT1            PREPARES A PHOTO PRINT USING PATERN
C                            CLASSIFICATION ( IF PATERN IS NOT SPECIFIED
C                            PATERN CLASSIFICATIONS MUST BE READ IN-
C                            SEE 3RD CARD )
C
C          PHOUT2            PREPARES A PHOTO PUNCHED OUTPUT USING
C                            PATERN CLASSIFICATIONS
C
C          GPUNCH            PUNCH OUTPUT OF QUANTIZED DATA
C
C          FLTING            SPECIFIED IF DATA IS IN FLOATING POINT
C                            FORMAT
C
C         TERMNL              SPECIFIED IF REMOTE TERMINAL IS BEING USED
C
C          DIAGON            SPECIFIED IF THE GAIN MATRIX USED IN PATERN
C                            IS TO HAVE ONES ON ALL DIAGONAL ELEMENTS
C                            AND ZEROS ELSEWHERE
C
C     .........................................................  ................
C
C        2 ND  CARD
C
C          NO. PHOTOS,NO. POINTS PER PHOTO,
C                            DESIRED LEVEL OF QUANTIZATION, NO. OF
C          TRAINING REGIONS (NR), FORMAT(5I10)
C          NR MUST BE LESS THAN 20
C     ...................................................................
C
C
C        3 RD   CARD / CARDS
C
C          IF PHOUT1 IS SPECIFIED, READ IN PHOTO SIZE
C                 (NA,NB) FORMAT(2I10) )
C          AND PATERN CLASSIFICATIONS IF SUBROUTINE PATERN IS NOT USED.
C          NCLAS = NO. OF POINTS CLASSIFIED FORMAT(I10), NTUPLES WITH
C          CLASSIFICATIONS FORMAT(8F10.0)
C
C        IF STOPUT IS SPECIFIED, READ IN PHOTO SIZE (NA,NB) FORMAT(2I10)
C          IF PATERN IS SPECIFIED,
C            READ IN THE GAIN MATRIX TO BE USED (NNxNN) FORMAT(8F10.5)
C            READ IN 'NORMALIZED' OR 'UNNORMALIZED' FORMAT(A6,A6) LEFT-
C            JUSTIFIED
C
C     ..................................     ...........................
C
C        OTHERS
C
C          READ FORMAT FOR DATA
C        READ DATA
C
C          PUNCH STOP IN COL 1-4 OF THE LAST CARD - THIS ENABLES MORE
C          THAN ONE SET OF DATA TO BE PROCESSED ON A SINGLE RUN
C
C     ...................................................................
C
C                       ***
      COMMON NPOL,FORM(12)
      COMMON F
      COMMON FMT1(20),FMT2(2),FMT3(5),FMT4(10),FMT5(7),FMT6(3),FMT7(
     1),FMT8(2),FMT9(2),FMT10(4),FMT11(4),FMT12(6)
      COMMON L8,L9,L10,L11,L12,L13,L14
      COMMON N,M,LEVEL,NP1,NRTANT(20),ITAPE,ANAT(20),L7,L1,L2,L3,L4,L5,
     1L6,NA,NB,NN,N,L3,NA,NB,NE,II(6000)
      LOGICAL L7,L1,L2,L3,L4,L5,L6,L7
      LOGICAL L8,L9,L10,L11,L12,L13
      INTEGER F
C      SET 16TH WORD IN COMMON TO 9 AND 7TH WORD IN COMMON TO 6
      F=3
      N=0
      CALL CONNEY
      STOP
      END
```

****
*   00000 WORDS OF MEMORY USED BY THIS COMPILATION
****

```
17564 01  05-02-69   10.141

      SUBROUTINE CHNXT
      DIMENSION NAME(3)
      COMMON MPO1,FORMT1(12)
      COMMON F
      COMMON FMT1(15),FMT2(3),FMT9(5),FMT11(6),FMT12(7),FMT13(3),FMT14(2
     1),FMT16(2),FMT22(3),FMT56(6),FMT57(4),FMT58(8)
      COMMON L8,L9,L10,L11,L12,L13,L14
      COMMON N,M,LEVEL,KZ1,KCOUNT(36),ITAPE,AMAT(625),LT,L1,L2,L3,L4,L5,
     1L6,KK,MX,MY,K,L7,MA,MB,MC,ZZ(24000)
      LOGICAL LT,L1,L2,L3,L4,L5,L6,L7
      LOGICAL L8,L9,L10,L11,L12,L13
      INTEGER F
      DATA NN/6HSTOP  /
C                              ***
C       K POINTS TO LINK IN USE
C                              ***
    1 K=K+1
      GO TO (2,3,4,5,6,7), K
    2 READ (F,9) NAME
      IF (NAME(1).EQ.NN) STOP
C      CALL MAIN
      CALL LINK (6HLINKA1)
C      CALL INPUT
    3 CALL LINK (6HLINKA2)
    4 IF (L6) GO TO 6
      CALL LINK (6HLINKA3)
    5 IF (L6) GO TO 6
      CALL LINK (6HLINKB3)
    6 K=5
      IF (L7) GO TO 7
      CALL LINK (6HLINKA4)
    7 IF (L12) GO TO 8
      K=0
      GO TO 1
C                              ***
C         IF DATA IS RUN IN HALFS SET UP PARAMETERS
C                              ***
    8 L12=.FALSE.
      L13=.TRUE.
      L5=.FALSE.
      L6=.TRUE.
      L7=.FALSE.
      M=MPO1/2
      K=1
      WRITE(6,100) M
  100 FORMAT(//34H SECOND HALF, NUMBER OF POINTS IS ,I10)
      GO TO 1
      ENTRY WNAME
C                              ***
C     PRINT ID NAME
C                              ***
      WRITE (6,FMT22) NAME
      RETURN
C                              ***
C
C                              ***
    9 FORMAT (3A6)
      END

<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>
*    22906 WORDS OF MEMORY USED BY THIS COMPILATION
<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>
```

```
$      FORTRAN STACK,COMOH
       SUBROUTINE MAIN
C       LINKAS
       DIMENSION LL(14), PAR(12), CH(14)
       COMMON MPOT,FORMT1(12)
       COMMON F
       COMMON FMT1(19),FMT2(3),FMT9(9),FMT11(6),FMT12(7),FMT13(3),FMT14(2
      1),FMT16(7),FMT22(3),FMT56(8),FMT97(4),FMT99(8)
       COMMON L8,LV,L10,L11,L12,L13,L14
       COMMON NP,M,LEVEL,K71,KCOUNT(34),ITAPE,AMAT(429),LT,L1,L2,L3,L4,L5
      1,L6,NN,MY,MV,STUMY,L7,N8,NR,MC,ZZ(24020)
       LOGICAL LL,L1,L3,L4,L5,L2,L6,L7,L7
       LOGICAL L8,L9,L10,L11,L12,L13,L14
       LOGICAL SS
       INTEGER F
       REAL A(8),H(8)
       DATA CH/4HCOMPTS,4HPHOPTS,4HALTPCH,4HSTOPNT,4HPATTAP,4HPATERN,4HPH
      1OUT1,4HFLTING,4HPHOUT2,4HPUNCH,4HTERMNL,4HDIAGON,4HLFMT,4HARBON
      2T/
       DATA BLK/4H    /
       DATA STP/4HSTOP /
       DATA NOR/4HNORMAL/
C                       ***
C       READ IN PARAMETERS ON /INPUT AND /OUTPUT CARDS
C                       ***
       READ (F,21) PAR
       WRITE(6,21) PAR
       IF (PAR(1).EQ.STP) GO TO 3
C                       ***
C      INITIALIZE LL
C                       ***
       DO 1 I=1,14
     1 LL(I)=.TRUE.
C                       ***
C      SEEK PARAMETERS IN LIST
C                       ***
       DO 2 I=1,12
       IP=I
       SS=.TRUE.
       IF(PAR(I).EQ.BLK) GO TO 2
       DO 200 J=1,14
       IF(PAR(I).NE.CH(J)) GO TO 200
       LL(J)=.FALSE.
       SS=.FALSE.
   200 CONTINUE
       IF(SS) GO TO 300
     2 CONTINUE
       IF (.NOT.(LL(1).AND.LL(2))) GO TO 4
C                       ***
C      IF NEITHER PHOPTS OR COMPTS IS SPECIFIED PRINT ERROR AND ABORT
C                       ***
       WRITE (6,22)
     3 STOP
C                       ***
C      INITIALIZE L
C                       ***
     4 L1=.FALSE.
       L2=.TRUE.
       L3=.TRUE.
       L4=.TRUE.
       L5=.TRUE.
       L6=.TRUE.
       L8=.FALSE.
       L9=.TRUE.
       L10=.TRUE.
       L11=LL(11)
       L12=.FALSE.
       L13=.FALSE.
C                       ***
C      TRANSFER LL TO L
C                       ***
       L14=.FALSE.
       IF (.NOT.LL(14)) L14=.TRUE.
       IF (.NOT.LL(13)) L12=.TRUE.
C    LOAD FORMATS FOR EITHER TERMINAL OR COMPUTER USE DEPENDING ON LL(11)
       CALL FFAM(LL(11))
       IF (LL(10)) L10=.FALSE.
       IF (LL(6)) L4=.TRUE.
       IF (LL(9)) L9=.FALSE.
C       IF PATERN IS SPECIFIED CONTINUE
       IF (LL(6)) GO TO 5
       L3=.FALSE.
       L2=.FALSE.
       L6=.FALSE.
     5 IF (LL(4)) GO TO 6
       L5=.FALSE.
     6 IF (LL(3)) GO TO 7
       L4=.FALSE.
       L3=.FALSE.
C       LL(1) FALSE MEANS COMPTS WAS SPECIFIED
C       L1 TRUE MEANS COMPTS WAS SPECIFIED
     7 IF (LL(1)) GO TO 8
       L1=.TRUE.
C                       ***
C       READ NO. OF PHOTOS, NO. POINTS PER PHOTO,
C                                       DESIRED LEVEL OF QUANTIZATION,
C         AND NUMBER OF TRAINING REGIONS
C                       ***
     8 READ (F,23) NP,M,LEVEL,NN
       WRITE(6,23) NP,M,LEVEL,NN
       NP81=M
C       L7 FALSE MEANS PHOUT1 WAS SPECIFIED
       L7=.FALSE.
       IF (LL(7)) L7=.TRUE.
```

```
      IF (L(2)) GO TO 12
C                      ***
C     READ IN PHOTO SIZE HX-HORIZONTAL  HV-VERTICAL
C                      ***
      READ (5,24) HX,HV
      WRITE(6,24) HX,HV
      [illegible]
      [illegible]
      [illegible]
      IF([illegible]) GO TO 30
   31 CONTINUE
C      IF PATERN IS SPECIFIED GO TO 12
      IF (.NOT.LL(A)) GO TO 12
      NC=0
C                      ***
C     IF PATERN NOT USED READ IN MULTIPLES AND CLASSIFICATIONS
C     STORING BY EIGHTS ON FILE 20
C                      ***
      READ (5,25) NCLAS
      REWIND 20
      J=NCLAS/8
      IF (J.EQ.0) GO TO 10
      DO 9 I=1,J
      K=8
      WRITE (20) K
      NC=NC+1
      READ (5,26) (A(K),B(K),K=1,8)
      WRITE (20) (A(K),K=1,8)
    9 WRITE (20) (B(K),K=1,8)
   10 J=NCLAS-8*J
      IF (J.EQ.0) GO TO 11
      WRITE (20) J
      NC=NC+1
      READ (5,26) (A(K),B(K),K=1,J)
      WRITE (20) (A(K),K=1,J)
      WRITE (20) (B(K),K=1,J)
   11 J=0
      WRITE (20) J
C                      ***
C        *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
C                      ***
      REWIND 20
C                      ***
C      IF STORMY IS SPECIFIED , READ IN THE PHOTO SIZE (HX,HY)
C                      ***
   12 IF (L(5)) GO TO 14
      IF (L(7)) GO TO 13
      HX=HA
      HY=HB
      GO TO 14
   13 READ (5,27) HX,HY
      WRITE(6,27) HX,HY
      [illegible]
      IF([illegible]) GO TO 30
   32 CONTINUE
C                      ***
C      IF PATERN IS SPECIFIED, READ IN THE LOSS MATRIX TO BE USED
C        (KK X KK )
C                      ***
   14 IF (L(6)) GO TO 20
      KK=KK**2
C      KKK IS THE NUMBER OF TRAINING REGIONS SQUARED
C      IF DIAGON IS SPECIFIED SET UP DIAGONAL GAIN MATRIX
      IF (LL(1P)) GO TO 17
      DO 15 I=1,625
   15 AMAT(I)=0.0
      DO 16 I=1,KK
      II=(I-1)*KK+I
   16 AMAT(II)=1.00
      GO TO 18
   17 READ (5,28) (AMAT(I),I=1,KKK)
   18 DO 19 I=1,KKK
   19 AMAT(I)=-AMAT(I)
      LT=.FALSE.
C                      ***
C     READ IN NORMALIZED OR UNNORMALIZED
C     LT TRUE SIGNALS NORMALIZED
C                      ***
      READ (5,29) NORM
      IF (NORM.EQ.NOR) LT=.TRUE.
   20 CALL CHART
      STOP
C                      ***
C
C                      ***
   21     [illegible] (1H0,8I10,A6/1H0,8I10,A6))
   22 FORMAT (1X,20HINCORRECT PARAMETER CARD)
   23 FORMAT (4I10)
   24 FORMAT (2I10)
   25 FORMAT (I10)
   26 FORMAT (7(I10,I10))
   27 FORMAT (2I10)
   28 FORMAT (8F10.5)
   29 FORMAT (12A6)
   30  CONTINUE
      [illegible]
      WRITE(6,100) [illegible]
  100 FORMAT([illegible]TOTAL NUMBER OF POINTS WAS PURPORTED TO BE ,I10/
     1[illegible] BUT [illegible] ,I5,1HX,I5,3H = ,I10/[illegible] SET TOTAL NUMBER OF POINTS
     2 AT ,I10)
      [illegible]
      GO TO (31,32),[illegible]
  300 WRITE(6,301) [illegible]
  301 FORMAT(1X,A6,[illegible] IS A BAD PARAMETER ON /INPUT OR /OUTPUT CARD)
      STOP
      END
```

17964 01 05-02-69 10.163

```
      SUBROUTINE FFRM(L)
      COMMON MPO1,FORMT1(12)
      COMMON F
      COMMON FMT1(19),FMT2(3),FMT9(5),FMT11(6),FMT12(7),FMT13(3),FMT14(2
     1),FMT16(2),FMT22(3),FM196(6),FMT97(4),FMT98(8)
      DIMENSION O(64), T(64)
      LOGICAL L
      INTEGER F
      DATA T/6H(//30X,6H,11HLA,6HBLE TA,6HBLE //,6H 16X,2,6HOHPLOT,6H SY
     1MBO,6HLS VS ,6HINPUT ,6HSYMBOL,6HS  //2,6H6X,A1,,6H12X,A6,6H)
     2,6H       ,6H(/26X,,6HA1,12X,6H,A6)  ,6H(27X,1,6HONTRAI,6HNING R,6H
     3EGIONS,6H //)  ,6H(24X,2,6HOHPHOT,6HO CLAS,6HSIFICA,6HTION /,6H/)
     4   ,6H(//15X,6H,29HTR,6HAINING,6H REGIO,6HN CLAS,6HSIFIED,6H AS /)
     5,6H(5X,8(,6H5X,I2),6H/)     ,6H(1H*,2,6HX,A1) ,6H(3X,A1,6H)     ,6H
     6(1H1,2,6H5X,3A6,6H//)   ,6H(24X,2,6H2HTHE ,6HPROBAB,6HILITY ,6HMAT
     7RIX,6H)      ,6H(6X,I2,6H,8(2X,,6HF4,2)),6H       ,6H(/////,6H//21X,
     8,6H17HTOT,6HAL PRO,6HBABILI,6HTY //2,6H3X,1E1,6H2,4)  /
      DATA O/6H(//60X,6H,11HLA,6HBLE TA,6HBLE //,6H51X,31,6HHPLOT ,6HSYM
     1BOL,6HS  VS ,6HINPUT ,6HSYMBOL,6HS //56,6HX,A1,1,6H2X,A6),6H
     2,6H       ,6H(/56X,,6HA1,12X,6H,A6)  ,6H(57X,1,6HONTRAI,6HNING R,6H
     3EGIONS,6H //)  ,6H(54X,2,6HOHPHOT,6HO CLAS,6HSIFICA,6HTION /,6H/)
     4   ,6H(//50X,6H,29HTR,6HAINING,6H REGIO,6HN CLAS,6HSIFIED,6H AS /)
     5,6H(4X,8(,6H13X,I2,6H)/)    ,6H(1H*,1,6HX,A1) ,6H (2X,A,6H1)     ,6H
     6(1H1,5,6H5X,3A6,6H//)    ,6H(54X,2,6H2HTHE ,6HPROBAB,6HILITY ,6HMAT
     7RIX,6H )     ,6H(5X,I2,6H,8(3X,,6HE12.4),6H)      ,6H(/////,6H//51X,
     8,6H17HTOT,6HAL PRO,6HBABILI,6HTY  ./,6H/53X,1,6HE12.4)/
C                                 ...
C      SETUP FORMATS FOR USE IN THE PROGRAM
C                                 ...
      IF (L) GO TO 2
      DO 1 I=1,64                                                   4
    1 FMT1(I)=T(I)                                                  5
      RETURN                                                        7
    2 DO 3 I=1,64                                                   8
    3 FMT1(I)=O(I)                                                  9
      RETURN                                                       11
      END                                                          12
```

<>

* 22987 WORDS OF MEMORY USED BY THIS COMPILATION

<>

```
$       FORTRAN KUECH,COMDK
CINT          INPUT LINEA2                                           INPUT
        SUBROUTINE INPUT
C        LINEA2
        DIMENSION LARGE(20), LSL(20), ACC(20)
        DIMENSION TRAIN(8000), STO(36), KCOUNT(36), DATA(8000), NCOUNT(37)
       1 , STA(8000),FORM(12)
        COMMON MPO1,FORM(12)
        COMMON F
        COMMON FMT1(15),FMT2(3),FMT9(5),FMT11(6),FMT12(7),FMT13(3),FMT14(2
       1),FMT16(2),FMT22(3),FMT54(5),FMT57(4),FMT58(6)
        COMMON L8,L9,L10,L11,L12,L13,L14
        COMMON N,M,LEVEL,N21,KCOUNT,ITAPE,KMAT(675),L7,L1,L2,L3,L4,L5,L6,K
       1P,MX,MY,KDUMY,L7,MM1,MM2,MM3,ZZ(24000)
        EQUIVALENCE (ZZ(1),STA(1)),(ZZ(8001),DATA(1)),(ZZ(16001),TRAIN(1))
        LOGICAL LOC,L7,L1,L2,L3,L4,L5,L6,L7
        LOGICAL L8,L9,L10,L11,L12,L13
        LOGICAL L14
        DIMENSION IPRIME(20)
        INTEGER F
        INTEGER DATA,STA
        DATA BLANK/1H /
        DATA IPRIME/1,2,4,5,8,10,12,16,20,24,28,30,32,36,40,44,48,60,62,96/
C                             ***
C
C        TAPE 11 STORES THE SECOND HALF OF THE TRAINING REGION AND THE
C        SECOND HALF OF THE DATA FOR H,FORM
C        TAPE 9 STORES THE ORIGINAL DATA SET BEING PRESENTLY WORKED ON
C        THIS IS THE ENTIRE DATA SET IF AN ENTIRE CLASSIFICATION IS DONE
C        OR IT IS THE FIRST HALF OF THE DATA IF HLFHNF
C
C        LEVEL= LEVEL OF QUANTIZATION
C        NZ1=NO. OF SIGNIFICENT FIG. IN INPUT DATA NZ1 .LE. 9
C        M=NO. OF DATA POINTS PER PHOTO
C        N=NO. OF PHOTOS
C
C                             ***
       IF (.NOT.L4) WRITE (61,94)
C                             ***
C      INITILIZE KCOUNT ,MPO,K,KK,ITAPE
C                             ***
       DO 1 I=1,36
     1 KCOUNT(I)=0
       IF (L13.OR.L12) REWIND 11
       MPO=M
       K=1
       KK=1
       ITAPE=1
       MM1=MX
       MM2=MY
C                             ***
C      JUMP TO INPUT SECTIONS ON TYPE OF DATA L1=TRUE SIGNALS CONPTS
C                             ***
       IF (L1) GO TO 70
C                             ***
C      IF NEITHER PATERN OR ALTERNATE PUNCH  GO TO 41
C                             ***
       IF (L5.AND.L2) GO TO 9
C                             ***
C      L13 =TRUE SIGNALS SECOND HALF DATA
C                             ***
C       L12 IS TRUE WHEN HLFHNF IS SPECIFIED AND THE FIRST HALF OF DATA IS BEING
C      RUN.    FOR THE SECOND HALF, L12 IS FALSE
       IF (.NOT.L13) GO TO 2
       READ (11) (TRAIN(I),I=1,M)
       GO TO 600
C                             ***
C      READ IN FORMAT AND DATA
C                             ***
     2 READ (F,85) FORM
       WRITE(6,101) FORM
   101 FORMAT(20H FORMAT FOR TRAINING DATA IS ,12A6)
       READ (F,FORM) (TRAIN(I),I=1,M)
       IF (L12) WRITE (11) (TRAIN(I),I=2,M,2)
       IF (.NOT.L13) GO TO 3
   600 CONTINUE
C       SECOND HALF
       MM1=MX-MX/2
       MM2=MY
       IF(MM1*MM2.EQ.MPO) GO TO 3
       DO 200 JACK=1,20
       IF(MPO/IPRIME(JACK)*IPRIME(JACK).NE.MPO) GO TO 200
       INDEX=IPRIME(JACK)
       INDEXY=MPO/IPRIME(JACK)
   200 CONTINUE
       MM1=INDEX
       MM2=INDEXY
     3 IF (.NOT.L12) GO TO 9
C       FIRST HALF
       J=1
       DO 4 I=3,M,2
       J=J+1
     4 TRAIN(J)=TRAIN(I)
       MPO=M/2
       IF (2*MPO.NE.M) MPO=MPO+1
       MM1=MX/2
       MM2=MY
       IF(MM1*MM2.EQ.MPO) GO TO 9
       DO 300 JACK=1,20
       IF(MPO/IPRIME(JACK)*IPRIME(JACK).NE.MPO) GO TO 300
       INDEX=IPRIME(JACK)
       INDEXY=MPO/IPRIME(JACK)
   300 CONTINUE
       MM1=INDEX
```

```
      MM2=INCEXX
    5 NCOUNT(1)=1                                                      E  81
      STO(1)=TRAIN(1)                                                  E  82
C      STO IS THE ARRAY OF UNIQUE SYMBOLS USED IN TRAINING REGION
C      NCOUNT(I) IS THE NUMBER OF TIMES THE ITH UNIQUE SYMBOL OCCURRED
C      IN TRAINING REGION
      DO 8 I=2,M                                                       E  83
    6 IF (TRAIN(I).EQ.STO(K)) GO TO 7                                  E  84
      K=K+1                                                            E  85
      IF (K.LE.KK) GO TO 6                                             E  86
      STO(K)=TRAIN(I)                                                  E  87
      NCOUNT(K)=1                                                      E  88
      KK=KK+1                                                          E  89
      GO TO 8                                                          E  90
    7 NCOUNT(K)=NCOUNT(K)+1                                            E  91
    8 K=1                                                              E  92
C                             ***                                      E  93
C     NCOUNT CONTAINS THE NUMBER OF POINTS IN EACH TRAINING REGION     E  94
C       NR IS THE NO. OF TRAINING REGIONS                              E  95
C     L3=FALSE SIGNALS PATERN OR LINEAR                                E  96
C                             ***                                      E  97
    9 IF (L3) GO TO 76                                                 E  98
      NCOUNT(1)=0                                                      E  99
      NRP1=NR+1                                                        E 100
C                             ***                                      E 101
C     NCOUNT CONTAINS CUMULATIVE TRAINING REGIONS                      E 102
C                             ***                                      E 103
      DO 10 I=2,NRP1                                                   E 104
   10 NCOUNT(I)=NCOUNT(I-1)+NCOUNT(I-1)                                E 105
      REWIND 3                                                         E 106
      IF(L13) GO TO 11
C                             ***                                      E 108
C     READ FORMAT FOR DATA                                             E 109
C                             ***                                      E 110
      READ (F,85) FORM                                                 E 111
C                             ***                                      E 112
C     SET UP OUTPUT FORMAT                                             E 113
C                             ***                                      E 114
      CALL CHANGE (FORM,FORM1)                                         E 115
C      WRITE OUT NAME OF RUN
   11 CALL HNAME                                                       E 116
C      WRITE OUT ORIGINAL DATA
      WRITE (6,86)                                                     E 117
C                             ***                                      E 118
C        .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .    E 119
      IF(.NOT.L13) WRITE(6,100) FORM,FORM1
  100 FORMAT(/27H INPUT FORMAT FOR DATA WAS ,12A8/
     1 27H OUTPUT FORMAT FOR DATA IS ,12A8)
C     READ IN DATA AND DETERMINE LARGEST AND SMALLEST DATA VALUES      E 120
C                             ***                                      E 121
      DO 12 I=1,N                                                      E 122
      LARGE(I)=0                                                       E 123
   12 LSL(I)=100000000000                                              E 124
      REWIND 9                                                         E 125
      DO 18 J=1,N                                                      E 126
      WRITE(6,777) J
  777 FORMAT(1H1,10X,6HPHOTO ,I5)
C      L13 IS TRUE IF HLFNMF IS SPECIFIED AND PROGRAM IS WORKING ON
C      SECOND HALF OF DATA
      IF (.NOT.L13) GO TO 13                                           E 127
      READ (11) (DATA(I),I=1,M)                                        E 128
      GO TO 15                                                         E 129
   13 READ (F,FORM) (DATA(I),I=1,M)                                    E 130
      IF (.NOT.L12) GO TO 15                                           E 131
      WRITE (11) (DATA(I),I=2,M,2)                                     E 132
      JWRONG=1
      DO 14 I=3,M,2                                                    E 134
      JWRONG=JWRONG+1
      DATA(JWRONG)=DATA(I)
   14 CONTINUE                                                         E 137
   15 DO 606 I=1,MY
      K1S=(I-1)*MM1+1
      K1F=I*MM1
  606 WRITE(6,FORM1) (DATA(K),K=K1S,K1F)
C      L8 FALSE MEANS THAT FLTING WAS SPECIFIED
      IF (.NOT.L8) GO TO 17                                            E 140
      DO 16 I=1,MPO
      IF (DATA(I).GT.LARGE(J)) LARGE(J)=DATA(I)                        E 142
   16 IF (DATA(I).LT.LSL(J)) LSL(J)=DATA(I)                            E 143
   17 WRITE (9) (DATA(I),I=1,M)                                        E 144
   18 CONTINUE                                                         E 145
      M=MPO                                                            E 146
      L8 IS TRUE IF FLTING WAS NOT SPECIFIED
      IF(L8) GO TO 190
C                             ***                                      E 147
C     IF DATA IS FLOATING USE FPR TO DETERMINE LARGEST AND SMALLEST VALU  E 148
C                             ***                                      E 149
      CALL FPR (LSL,LARGE,M,N)                                         E 150
      GO TO 19
C                             ***                                      E 151
C        .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .    E 152
C     QUANTITIZE DATA AND STORE ON TAPE 3                              E 153
C                             ***                                      E 154
  190 IF(.NOT.L14) GO TO 19
C      DATA IS TO BE ABSOLUTELY QUANTIZED
      LLARGE=LARGE(1)
      LLSL=LSL(1)
      DO 607 J=2,N
      IF(LLARGE.LT.LARGE(J)) LLARGE=LARGE(J)
      IF(LLSL.GT.LSL(J)) LLSL=LSL(J)
  607 CONTINUE
      DO 608 J=1,N
      LARGE(J)=LLARGE
  608 LSL(J)=LLSL
```

```
   19 REWIND 9
      DO 20 J=1,M
   20 ACC(J)= FLOAT(LEVEL-1)/FLOAT(LARGE(J)-    (J))
      DO 22 J=1,M
      READ (9) (DATA(I),I=1,M)
      DO 21 I=1,M
      DATA(I)=FLOAT(DATA(I)-LSL(J))*ACC(J)+.5
   21 CONTINUE
C      TAPE 3 HAS QUANTIZED DATA
      WRITE (3) (DATA(I),I=1,M)
   22 CONTINUE
C                              ***
C        .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
C                              **
      IC=1
      C=1.0
      REWIND 1
      REWIND 2
C                              ***
C     L2 FALSE SIGNALS TAPE MUST BE CREATED FOR USE IN PATERN
C                              ***
      IF (L2) GO TO 92
C                              ***
C        .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
C                              ***
   23 DO 24 I=1,NR
   24 RCOUNT(I)=0
      READ (3) (DATA(I),I=1,M)
      DO 27 I=1,M
      DO 25 K=1,NR
      IF (TRAIN(I).EQ.STD(K)) GO TO 26
   25 CONTINUE
   26 RCOUNT(K)=RCOUNT(K)+1
      J=RCOUNT(K)+RCOUNT(K)
   27 STA(J)=DATA(I)
      J=RCOUNT(NR+1)
      WRITE (1) C,(STA(I),I=1,J),C
      IC=IC+1
      IF (IC.LE.N) GO TO 23
      REWIND 2
      REWIND 1
      REWIND 3
      DO 29 II=1,NR
      DO 29 LL=1,N
      J=RCOUNT(II)+1
      L=RCOUNT(II)
      K=RCOUNT(NR+1)+2-J-L
      READ (1) (SS,I=1,J),(DATA(I),I=1,L),(SS,I=1,K)
   28 WRITE (2) (DATA(I),I=1,L)
   29 REWIND 1
      GO TO 48
C                              ***
C        .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
C     CORRTS INPUT
C                              ***
   30 REWIND 3
      REWIND 9
      DO 31 I=1,M
      LARGE(I)=0
   31 LSL(I)=1000000000
      IF (.NOT.L13) GO TO 32
C      SECOND HALF
      MM1=MX-MX/2
      MM2=MY
      IF(MM1*MM2.EQ.MPQ) GO TO 32
      DO 400 JACK=1,20
      IF(MPQ/IPRIME(JACK)*IPRIME(JACK).NE.MPQ) GO TO 400
      INDEXX=IPRIME(JACK)
      INDEXY=MPQ/IPRIME(JACK)
  400 CONTINUE
      MM1=INDEXX
      MM2=INDEXY
   32 IF (.NOT.L12) GO TO 33
      MPQ=M/2
      IF (MPQ*2.NE.M) MPQ=MPQ+1
      MM1=MX/2
      MM2=MY
      IF(MM1*MM2.EQ.MPQ) GO TO 33
      DO 900 JACK=1,20
      IF(MPQ/IPRIME(JACK)*IPRIME(JACK).NE.MPQ) GO TO 900
      INDEXX=IPRIME(JACK)
      INDEXY=MPQ/IPRIME(JACK)
  900 CONTINUE
      MM1=INDEXX
      MM2=INDEXY
   33 IF (L13) GO TO 34
C                              ***
C     READ IN FORMAT FOR DATA
C                              ***
      READ (5,85) FORM
      CALL CHANGE (FORM,FORM1)
   34 CALL NNAME
      WRITE (6,86)
C                              ***
C        .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
C     OBTAIN DATA AND FIND MAX AND MIN
C                              ***
      IF(.NOT.L13) WRITE(6,100) FORM,FORM1
      DO 38 J=1,N
      IF (.NOT.L13) GO TO 39
      READ (11) TRAIN(J),(DATA(I),I=1,M)
      GO TO 36
   39 READ (5,FORM1) TRAIN(J),(DATA(I),I=1,M)
      IF (.NOT.L12.OR.J/2*2.NE.J) GO TO 36
```

```
C       USE ALL ODD ONES FOR FIRST HALF
        WRITE (11) TRAIN(J),(DATA(I),I=1,N)
        GO TO 38
   36   WRITE (8,END=41) TRAIN(J),(DATA(I),I=1,N)
        IF (.NOT.LF) GO TO 35
C       DATA IS IN INTEGER FORMAT
        DO 37 I=1,N
        IF (DATA(I).LT.LSL(I)) LSL(I)=DATA(I)
   37   IF (DATA(I).GT.LARGE(I)) LARGE(I)=DATA(I)
   38   WRITE (9) (DATA(I),I=1,N)
        IF(.NOT.LIT) GO TO 800
        JWRONG=1
        DO 801 I=2,M,2
        JWRONG=JWRONG+1
  801   TRAIN(JWRONG)=TRAIN(I)
  800   CONTINUE
        M=M
C       CALL FORT IF DATA IS IN INTEGER FORM
        IF(LF)  GO TO 700
        CALL FORT (LSL,LARGE,N,M)
        GO TO 39
  700   IF(.NOT.LIS) GO TO 39
C       DATA IS TO ABSOLUTELY QUANTIZED
        LLARGE=LARGE(1)
        LLSL=LSL(1)
        DO 700 J=2,N
        IF(LLARGE.LT.LARGE(J)) LLARGE=LARGE(J)
        IF(LLSL.GT.LSL(J)) LLSL=LSL(J)
  700   CONTINUE
        DO 701 J=1,N
        LARGE(J)=LLARGE
  701   LSL(J)=LLSL
C                              ***
C          .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
C       QUANTIZE DATA AND BUILD TRAINING REGION ARRAY WITH KCOUNT [illegible] NTS
C                              ***
   39   REWIND 9
        DO 40 J=1,N
   40   ACC(J)=(FLOAT(LEVEL-1))/(FLOAT(LARGE(J)-LSL(J)))
        DO 42 J=1,M
        READ (9) (DATA(I),I=1,N)
        DO 41 I=1,N
        DATA(I)=IFIX(FLOAT(DATA(I)-LSL(I))*ACC(I)+.5
   41   CONTINUE
        WRITE (3) (DATA(I),I=1,N)
   42   CONTINUE
        REWIND 2
        STO(1)=TRAIN(1)
        KCOUNT(1)=1
        DO 45 I=2,M
   43   IF (TRAIN(I).EQ.STO(K)) GO TO 44
        K=K+1
        IF (K.LE.KK) GO TO 43
        STO(K)=TRAIN(I)
        KCOUNT(K)=1
        KK=KK+1
        GO TO 45
   44   KCOUNT(K)=KCOUNT(K)+1
   45   K=1
        REWIND 3
        IF (L.2) GO TO 52
        DO 47 K=1,KK
        DO 47 L=1,M
        REWIND 3
        II=1
C                              ***
C       STORE [illegible] ING REGIONS ON TAPE 3
C                              ***
        DO 46 J=1,M
        READ (3) (STA(I),I=1,N)
        IF (TRAIN(J).NE.STO(K)) GO TO 46
        DATA (II)=STA(L)
        II=II+1
   46   CONTINUE
C                              ***
C       STORE DATA ON TAPE 2
C                              ***
   47   WRITE (2) (DATA(I),I=1,II)
C                              ***
C          .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
C       QUANTIZE DATA IN INTEGER LEVELS FROM 1 THROUGH LEVEL.
C       PLACE RESULTS ON TAPE ONE DIMENSION BY DIMENSION
C                              ***
   48   REWIND 3
        REWIND 1
        REWIND 2
        IF (FLOAT(LEVEL).GT.1.E11) STOP
        DO 51 I=1,N
        KK=KCOUNT(I)
        DO 49 J=1,M
   49   STA(J)=0
        DO 50 II=1,N
        READ (2) (DATA(J),J=1,K)
C                              ***
C          .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
C                              ***
        DO 50 J=1,M
   50   STA(J)=ACC(I)*FLOAT(DATA(J))
   51   WRITE (1) (STA(J),J=1,M)
C                              ***
C       PLACE DATA IN ALTERNATE FORM OF INPUT IF ALT IS SPECIFIED ON
C       THE PARAMETER CARD
C                              ***
   52   IF (L.A.AND.ALT.EQ.LIT) GO TO 55
```

```
      REWIND 2
      REWIND 4
      REWIND 3
      IF (L1) GO TO 72
C                            ***
C     PHONES TO CHORDS SECTION
C                            ***
      NPHO=N
      LOG=.FALSE.
      IC=0
      NT=N
   53 IM=NPHO*M
      IF (.NOT.(IM.GT.16000)) GO TO 54
      NPHO=(NT-((IM-16000)/M+1))
      IM=NPHO*M
      LOG=.TRUE.
   54 DO 55 I=1,NPHO
      J=(I-1)*M+1
      K=J+M
   55 READ (3) (STA(I),L=J,K)
      IF (LOG) GO TO 57
      DO 56 I=1,N
      IF (.NOT.L4) WRITE (43,87) TRAIN(I),(STA(K),K=I,IM,N)
   56 IF (.NOT.L7) WRITE (4) (STA(K),K=I,IM,N)
      GO TO 76
   57 DO 58 I=1,N
   58 WRITE (2) (STA(K),K=I,IM,N)
      IC=IC+1
      NT=NT-NPHO
      KCOUNT(IC)=NPHO
      NPHO=NT
      IF (NT.EQ.0) GO TO 59
      GO TO 53
   59 REWIND 2
      K=16000/N
      L=M-K
      JJJ=0
      DO 63 LL=1,IC
      DO 60 I=1,K
      JJ=JJJ+1
      JJJ=JJ+KCOUNT(LL)-1
   60 READ (2) (STA(II),II=JJ,JJJ)
      DO 61 J=1,L
   61 READ (2) (A,I=JJ,JJJ)
      DO 62 I=1,K
      CALL DFF (NCOUNT,STA,KCOUNT,I,IC,K)
      IF (.NOT.L4) WRITE (43,87) TRAIN(I),(NCOUNT(K1),K1=1,N)
   62 IF (.NOT.L7) WRITE (4) (NCOUNT(K1),K1=1,N)
      REWIND 2
      MULT=1
   63 IF (K.LT.L) GO TO 67
      K1=MULT*K
      JJJ=0
      DO 65 LL=1,IC
      J=KCOUNT(LL)
      DO 64 I=1,K1
   64 READ (2) (A,II=1,J)
      DO 65 J=1,L
      JJ=JJJ+1
      JJJ=JJ+KCOUNT(LL)-1
   65 READ (2) (STA(I),I=JJ,JJJ)
      DO 66 I=1,L
      CALL DFF (NCOUNT,STA,KCOUNT,I,IC,L)
      K1=I+K*MULT
      IF (.NOT.L4) WRITE (43,87) TRAIN(K1),(NCOUNT(K1),K1=1,N)
   66 IF (.NOT.L7) WRITE (4) (NCOUNT(K1),K1=1,N)
      GO TO 76
   67 L=L-K
      K1=MULT*K
      JJJ=0
      DO 70 LL=1,IC
      JJ1=KCOUNT(LL)
      DO 68 I=1,K1
   68 READ (2) (A,II=1,JJ1)
      DO 69 J=1,K
      JJ=JJJ+1
      JJJ=JJ+KCOUNT(LL)-1
   69 READ (2) (STA(I),II=JJ,JJJ)
      DO 70 J=1,L
   70 READ (2) (A,I=1,JJ1)
      DO 71 I=1,K
      CALL DFF (NCOUNT,STA,KCOUNT,I,IC,K)
      K1=I+MULT*K
      IF (.NOT.L4) WRITE (43,87) TRAIN(K1),(NCOUNT(K1),K1=1,N)
   71 IF (.NOT.L7) WRITE (4) (NCOUNT(K1),K1=1,N)
      MULT=MULT+1
      REWIND 2
      GO TO 63
C                            ***
C        * * * * * * * * * * * * * * * * * * * * *
C     CCMPTS TO PHONES SECTION
C                            ***
   72 NT=N
      CALL TRANS(TRAIN,M,DATA)
      WRITE (43,88) (TRAIN(I),I=1,M)
      JJJ=0
   73 K=16000/M
      IF (K.GT.NT) K=NT
      DO 74 L=1,K
      READ (3) (NCOUNT(I),I=1,M)
      DO 74 I=1,M
      J=(I-1)*K+L
   74 STA(J)=NCOUNT(I)
      K1=1
```

```
      K2=M
      JJ=JJJ+1
      JJJ=JJJ+K
      DO 75 I=JJ,JJJ
      WRITE (43,89) I
      WRITE(43,90) (STA(J),J=K1,K2)
   90 FORMAT(13I6)
      K1=K2+1
   75 K2=K2+M
      NT=NT-K
      IF (NT.GT.0) GO TO 73
C                         ***
C        *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
C     WRITE OUT TRAINING REGIONS CENTERED ON PAGE
C                         ***
   76 IF (L5) GO TO 78
      CALL TRANE (TRAIN,M,DATA)
      WRITE (1) (DATA(I),I=1,M)
      J=1
      JJ=MM1
      L=(130-MM1)/2
      IF(.NOT.L11) L=(70-MM1)/2
      CALL MNAME
      WRITE (6,FMT9)
      DO 77 I=1,MM2
      WRITE (6,91) (BLANK,II=1,L),(TRAIN(II),II=J,JJ)
      J=JJ+1
   77 JJ=JJ+MM1
      REWIND 3
   78 IF (L10) WRITE (43,94)
      CALL MNAME
C                         ***
C     PRINT AND PUNCH QUANTITIZED DATA IF DESIRED
C                         ***
      WRITE (6,93)
C      IF L1 IS TRUE THEN COMPTS WAS SPECIFIED
      IF (L1) GO TO 80
      DO 79 I=1,N
      WRITE(6,777) I
      READ (3) (DATA(J),J=1,M)
      IF (L10) WRITE (43,95) (DATA(J),J=1,M)
   79 WRITE (6,92) (DATA(J),J=1,M)
      GO TO 82
   80 DO 81 I=1,N
      READ (3) (DATA(J),J=1, )
      IF (L10) WRITE (43,95) (DATA( ),J=1,M)
   81 WRITE (6,92) (DAT   ),  =1, )
   82 IF (.NOT.L4.AND.F    ) GO TO 83
      KR=MAX0(KR,KK)
      REWIND 1
      CALL CHNXT
   83 WRITE (6,96)
      WRITE (6,96)
      WRITE (6,98)
      WRITE (6,97) KK,KR
      WRITE (6,98)
      WRITE (6,96)
      WRITE (6,96)
      STOP
C                         ***
C
                          ***
   84 FORMAT (15HALTERNATE PUNCH)
   85 FORMAT (17A5)
   86 FORMAT (1X,13HORIGINAL DATA/)
   87 FORMAT (A6,3X,10(1X,I10))
   88 FORMAT (80A1)
   89 FORMAT (5HPHOTO,2X,I3)
   90 FORMAT (15I6)
   91 FORMAT (1X,131A1)
   92 FORMAT (10(1X,I10))
   93 FORMAT (1X,14HQUANTIZED DATA/)
   94 FORMAT (27HQUANTIZED DATA FORMAT(8I10))
   95 FORMAT (8I10)
   96 FORMAT (103H ***************************************************************
     1****************************************                )
   97 FORMAT (44H ONE OF US CAN NOT COUNT  I FIND THAT THERE ARE ,I3,27H
     1TRAINING REGIONS  YOU FOUND,I3)
   98 FORMAT (//)
      END
```

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```
      SUBROUTINE FPR (LSL,LARGE,M,N)
      DIMENSION SS(20), BB(20), LSL(20), LARGE(20), IDATA(13)
      COMMON PP01,FORMT1(12)
      COMMON F
      COMMON FMT1(15),FMT2(3),FMT9(5),FMT11(6),FMT12(7),FMT13(3),FMT14(2
     1),FMT16(2),FMT22(3),FMT96(6),FMT97(4),FMT98(8)
      COMMON L8,L6,L10,L11,L12,L13,L14
      COMMON K,L,B(8679),DATA(8000)
      EQUIVALENCE (IDATA(1),DATA(1))
      INTEGER F
      LOGICAL L8,L9,L10,L11,L12,L13,L14
      REWIND 9
      REWIND 21
C                          ***
C      L14 IS TRUE IF ABSOLUTE QUANTIZAION
C      PHOTO FORM
C      N IS THE NUMBER OF PHOTOGRAPHS
C      M IS THE NUMBER OF DATA POINTS
C     READ IN DATA
C                          ***
      S=1.E20
      B=-1.E20
C      GO THRU EACH PHOTOGRAPH
      DO 3 I=1,N
      READ (9) (DATA(J),J=1,M)
C                          ***
C     SEARCH FOR MAX AND MIN VALUES IN DATA
C                          ***
      DO 1 J=1,M
      IF (S.GT.DATA(J)) S=DATA(J)
    1 IF (B.LT.DATA(J)) B=DATA(J)
      IF (L14) GO TO 3
      B=1./(B-S)*1.E10
C                          ***
C     QUANTITIZE AND STORE DATA ON 21
C      QUANTIZE RELATIVELY
C                          ***
      DO 2 J=1,M
    2 IDATA(J)=(DATA(J)-S)*B
      S=1.E20
      B=-1.E20
    3 WRITE (21) (IDATA(J),J=1,M)
      REWIND 9
      REWIND 21
C                          ***
C     STORE DATA BACK ON 9
C      FOR EACH PHOTOGRAPH
C                          ***
      DO 5 I=1,N
      READ (21) (IDATA(J),J=1,M)
      IF (.NOT.L14) GO TO 5
C      QUANTIZE ABSOLUTELY
      B=1./(B-S)*1.E10
      DO 4 J=1,M
    4 IDATA(J)=(DATA(J)-S)*B
    5 WRITE (9) (IDATA(J),J=1,M)
    6 DO 7 I=1,10
      LSL(I)=0
    7 LARGE(I)=10000000000
      RETURN
      ENTRY FPR1(LSL,LARGE,M,N)
      REWIND 9
      REWIND 21
C                          ***
C      CORPTS FORM
C      M IS THE NUMBER OF PHOTOGRAPHS
C      N IS THE NUMBER OF DATA POINTS
C      L14 IS TRUE FOR ABSOLUTE QUANTIZATION
C     INITIALIZE
C                          ***
      DO 8 I=1,M
      SS(I)=1.E20
    8 BB(I)=-1.E20
C                          ***
C     SEARCH FOR EXTREME VALUES
C                          ***
C      GO THRU EACH POINT
      DO 9 I=1,N
C      READ IN ALL THE COMPONENTS FOR THAT POINT
      READ (9) (DATA(J),J=1,M)
      WRITE (21) (DATA(J),J=1,M)
      DO 9 J=1,M
      IF (SS(J).GT.DATA(J)) SS(J)=DATA(J)
    9 IF (BB(J).LT.DATA(J)) BB(J)=DATA(J)
      IF (.NOT.L14) GO TO 12
      S=1.E20
      B=-1.E20
      DO 10 I=1,M
      IF (S.GT.SS(I)) S=SS(I)
   10 IF (B.LT.BB(I)) B=BB(I)
      DO 11 I=1,M
      SS(I)=S
   11 BB(I)=B
   12 REWIND 9
      REWIND 21
C                          ***
C      QUANTIZE
C                          ***
      DO 13 I=1,M
   13 BB(I)=1./(BB(I)-SS(I))*1.E10
      DO 15 I=1,N
      READ (21) (DATA(J),J=1,M)
C                          ***
C     STORE DATA ON 9
C                          ***
      DO 14 J=1,M
   14 IDATA(J)=(DATA(J)-SS(J))*BB(J)
   15 WRITE (9) (IDATA(J),J=1,M)
      GO TO 6
      END
```

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* 23065 WORDS OF MEMORY USED BY THIS COMPILATION
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```
17964 01  05-02-69   10.269

      SUBROUTINE DEF (L,M,N,I,IC,K)
      DIMENSION L(2), M(2), N(2)
      JT=(I-1)*M(1)
C                            ***
C     SET SINGLE CHARACTER TRAINING REGION
C     DEFINE IN ALPHABETICAL ORDER
C                            ***
      JS=0
      KC=0
      DO 2 J=1,IC
      JJ=N(J)
      DO 1 II=1,JJ
      JT=JT+1
      JS=JS+1
    1 L(JS)=K(JT)
      KC=KC+JJ
    2 JT=JT+(I-1)*N(J+1)
      RETURN
      END

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*    23015 WORDS OF MEMORY USED BY THIS COMPILATION
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```

```
17964 01  05-02-69   10.269

      SUBROUTINE TRANS (A,M,DATA)
      COMMON NPSL,FORMT1(12)
      COMMON F
      COMMON FMT1(15),FMT2(3),FMT9(5),FMT11(6),FMT12(7),FMT13(3),FMT141(2
     1),FMT16(2),FMT22(3),FMT50(6),FMT57(6),FMT58(8)
      DIMENSION A(2), B(36), D(36)
      INTEGER DATA
      DIMENSION DATA(8)
      INTEGER F
      DATA D/1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HL,1HM,1HN,1HO
     1,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ,1H1,1H2,1H3,1H4,1H5,1
     2H6,1H7,1H8,1H9,1H0/
C                            ***
C     CREATE CROSS REFERENCE TABLE FOR TRAINING REGIONS
C                            ***
      CALL NNAME
      WRITE (6,FMT1) B(1),A(1)
      B(1)=A(1)
      A(1)=D(1)
      DATA (1)=1
      NN=1
      K=1
      DO 3 I=2,M
    1 IF (A(I).EQ.B(K)) GO TO 2
      K=K+1
      IF (K.LE.NN) GO TO 1
      WRITE (6,FMT2) B(K),A(I)
      B(K)=A(I)
      A(I)=D(K)
      DATA (I)=K
      NN=NN+1
      GO TO 3
    2 A(I)=D(K)
      DATA (I)=K
    3 K=1
      RETURN
      END

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*    22917 WORDS OF MEMORY USED BY THIS COMPILATION
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```
17964 02  05-02-69   10.276

                                      1          SYMBOL  CHANGE
   000000  000016 2350 00  010        2 CHANGE  LDA     T1
   000001  000020 7550 00  010        3         STA     T2
   000002  000002 6200 31  000        4         EASE    2,1*
   000003  000022 7400 00  010        5         STXE    T2
   000004  000017 2350 00  010        6         LDA     T3
   000005  000021 7550 00  010        7         STA     LOC
   000006  000003 6200 31  000        8         EASE    3,1*
   000007  000021 7400 00  010        9         STXE    LOC
   000010  000022 2350 00  010       10         LDA     OCT
   000011  000003 7553 31  000       11         STA     3,1*
   000012  000020 2350 02  010       12 J.      LDA     T2,DC
   000013  000021 7550 02  010       13         STA     LOC,DC
   000014  000012 6070 00  010       14         TTF     J.
   000015  0000 0 7100 11  000       15         TRA     0,1
   000016  000004 0104 01  000       16 T1      TALLY   **,00,1
   000017  000004 2104 04  000       17 T2      TALLY   **,00,4
                    000020           18 T3      BSS     1
                    000021           19 LOC     BSS     1
   000022  350100732220      000     20 OCT     OCT     1,110.

       ERROR LINKAGE

      000023  000000000000      000
   END OF BINARY CARD 00000002
      000024  333021403725      000
   END OF BINARY CARD 00000003
                                      21          END
     24 IS THE NEXT AVAILABLE LOCATION, SNAP AT 000000
 THERE WERE     NO  WARNING FLAGS IN THE ABOVE ASSEMBLY
```

17564 03 05-02-69 10.284

```
      SUBROUTINE PATERN
      COMMON MPO1,FORMT1(12)
      COMMON F
      COMMON FMT1(15),FMT2(3),FMT9(5),FMT11(6),FMT12(7),FMT13(3),FMT14(2
     1),FMT16(2),FMT22(3),FMT56(6),FMT57(4),FMT58(8)
      COMMON L8,L9,L10,L11,L12,L13,L14
      COMMON NP,MM,LEVEL,KZ1,NPOINT,ITAPE,AAA,LT,L1,L2,L3,L4,L5,L6,N,M1,
     1M2,NDUMY,L7,M3,ME,KC,ZZZ
C                          ***
C     N=NUMBER OF TRAINING REGIONS
C     LEVEL=NUMBER OF LEVELS OF QUANTITIZATION
C     NP=NUMBER OF PHOTOS
C     KZ1=NUMBER OF SIGNIVICENT FIGURES PER DATA POINT
C     NPOINT=ORDERED LIST OF POINTS PER TRAINING REGION
C      INPUT IS EXPECTED ON TAPE UNIT 'ONE'
C     LT=LOGICAL TRUE FOR NORMALIZED AND FALSE FOR UNORMALIZED
C                          ***
      DIMENSION AAA(625)
      DIMENSION ZZZ(24000), IPT(2), IREM(2), NREG(2), NPOINT(30), KPT(30
     1), RESULT(625), SIGMA(30), FORM(12), BLANK(4)
      EQUIVALENCE (ZZZ(1),IPT(1)), (ZZZ(1),IREM(1)), (ZZZ(1),NREG(1))
      LOGICAL LT,L1,L2,L3,L4,L5,L6,L7
      LOGICAL L8,L9,L10,L11,L12,L13
      INTEGER F
      DATA BLANK/6HUNORMA,5HLIZED,6HNORMAL,6HIZED/
      REWIND 1
      REWIND 2                                                           2
      REWIND 8                                                           3
      REWIND 10                                                          4
      REWIND 20                                                          5
C                          ***
C     PRINT HEADING FOR PUNCH
C     NHIGH IS ABSOLUTE MAX NUMBER OF POINTS IN A SINGLE TRAINING REGION
C                          ***
      WRITE (10) N                                                       6
      WRITE (43,32)                                                      9
      NHIGH=0                                                           11
      NTOTAL=0                                                          12
C                          ***
C     NPOINT CONTAINS NO. OF POINTS PER TRAINING REGION
C     COUNT TOTAL PTS.     FIND MAX IN NPOINT
C                          ***
      DO 1 I=1,N                                                        13
      NTOTAL=NTOTAL+NPOINT(I)                                           14
      IF (NPOINT(I).LT.NHIGH) GO TO 1                                   15
      NHIGH=NPOINT(I)                                                   18
    1 CONTINUE                                                          19
      J=1                                                               21
      IF (LT) J=3                                                       22
      K=J+1                                                             25
      CALL NNAME                                                        26
      WRITE (6,33) (BLANK(I),I=J,K)                                     27
      WRITE (6,34)                                                      32
C                          ***
C     PRINT PARAMETERS
C                          ***
      WRITE (6,35) N,LEVEL,NP                                           34
C                          ***
C     INITIALIZE
C                          ***
      DO 2 I=1,102                                                      37
    2 RESULT(I)=0.                                                      38
C                          ***
C     RESULT IS PROBABILITY MATRIX
C     CALCULATE NO. OF LOCATIONS FOR USE IN IREM AND IPT
C     NEVER MORE THAN 1 TR IN BOTTOM OF ZZZ
C                          ***
      NG=20000-NHIGH                                                    40
      IF (NG.LT.10000) NG=10000                                         41
      NBC=0                                                             44
      NC=0                                                              45
      IT=0                                                              46
      SP=0.                                                             47
C                          ***
C     CALCULATE NORMALIZING FACTORS
C                          ***
      DO 3 I=1,N                                                        48
      SIGMA(I)=1./FLOAT(NPOINT(I))                                      49
    3 SP=SP+FLOAT(NPOINT(I))                                            50
C                          ***
C     KCOUNT IS A FUNCTION OF THE POSITION IN THE TOP PART OF ZZZ
C     INDICATION WHERE THE PRESENT UNIQUE N-TUPLE(UNIQUE TO TR)
C     WILL BE STORED
C     LICH IS THE BEGINNING OF THE BLOCK KI IN THE TOP HALF OF ZZZ
C     IPOI IS NUMBER OF POINTS IN KI TRAINING REGION
C     AND LOAD IT UP IN THE BOTTOM PART OF ZZZ
C     STARTING AT THE TOP AND COMMING DOWN
C                          ***
      KCOUNT=1                                                          52
      LICH=1                                                            53
C                          ***
C     KI RANGES OVER NO. OF TRAINING REGIONS
C                          ***
      DO 8 KI=1,N                                                       54
      IPOI=NPOINT(KI)                                                   55
C                          ***
C     READ IN SINGLE TRAINING REGION
C                          ***
      READ (1) (NREG(I),I=1,IPOI)                                       56
C                          ***
C     SET N-TUPLE IN EVEN LOCATIONS
C     PUT NO. TIMES OCCURED IN ODD LOCATIONS
C     TRAINING REGION IS STORED IN LOWER HALF OF ODD LOCATIONS
```

```
C                           ***
      DO 7 LJ=1,IPOI
      NNNN=NREG(LJ)
      IF (LICN.EQ.NCOUNT) GO TO 5
      II=NCOUNT-1
      DO 4 I=LICN,II
      I1=20002-I*2
      IF (NNNN.EQ.IREM(I1)) GO TO 6
    4 CONTINUE
C                           ***
C     IF OVERLAP OCCURES IN SCRATCH AREA GO TO 777 AND STORE RESULTS
C     NREG(LJ) HAS NOT OCCURED BEFOR  IN THE TRAINING REGION, MAKE
C     POSITION TO STORE IT
C                           ***
    5 IF (NCOUNT*2.GT.N8) GO TO 27
      NCOUNT2=20002-NCOUNT*2
      IREM(NCOUNT2)=NNNN
      IPT(NCOUNT-1)=10000+K*100
      NCOUNT=NCOUNT+1
      GO TO 7
C                           ***
C     NREG(LJ) HAS OCCURED BEFOR IN TO R1
C                           ***
    6 I1=20001-I*2
      IPT(I1)=IPT(I1)+10000
    7 CONTINUE
      LICN=NCOUNT
    8 NN=NCOUNT-1
C                           ***
C     N2 IS THE LOWEST LOCATION ON THE TOP PART WHICH IS USED
C                           ***
      I=2*NN
      N2=20001-I
C                           ***
C     STORE RESULTS ON TAPE 10
C                           ***
      WRITE (10) I
      WRITE (10) (IREM(I),I=N2,20000)
    9 IF (NRC.EQ.0) GO TO 11
      JTAPE=2
      LTAPE=3
      REWIND 2
      REWIND 3
      LL=1
   10 READ (JTAPE) NCOUNT
      N=20001-NCOUNT
      NM1=N2-1
      N4=N2-N
      READ (JTAPE) (IREM(I),I=N4,NM1)
      NN=N4
   11 L=NN-1
C                           ***
C     SEQUENCE N-TUPLES IN DECENDING ORDER
C                           ***
      DO 12 I=1,L
      IP1=I+1
      DO 12 J=IP1,NN
      I1=20002-I*2
      J1=20002-J*2
      IF (IREM(I1).GE.IREM(J1)) GO TO 12
      IPOI=IREM(I1)
      IREM(I1)=IREM(J1)
      IREM(J1)=IPOI
      IPOI=IPT(I1-1)
      IPT(I1-1)=IPT(J1-1)
      IPT(J1-1)=IPOI
   12 CONTINUE
      IF (NRC.EQ.0) GO TO 15
      WRITE (LTAPE) (IREM(I),I=NN,NM1)
      LL=LL+1
      IF (LL.LE.NRC) GO TO 10
      NP1=NN+1
      NNN=IREM(NN+1)
      DO 13 I=NP1,20000,2
      IF (IREM(I).NE.NNN) GO TO 14
   13 CONTINUE
   14 NN=I/2
   15 CONTINUE
      NCOUNT=0
      I=1
C                           ***
C     LOOK FOR STARTING AND END POINTS OF EACH N-TUPLE
C     LOOK FROM PRESENT N-TUPLE DOWN
C                           ***
   16 DO 17 IJ=I,NN
      J=IJ
      I1=20002-I*2
      J1=20002-J*2
      IF (IREM(I1).NE.IREM(J1)) GO TO 18
   17 CONTINUE
      J=NN+1
   18 J=J-1
C                           ***
C     J IS A FUNCTION OF THE LAST N-TUPLE LIKE THE I TH N-TUPLE TOP OFF
C                           ***
      K =1
      IF (I.EQ.J) GO TO 19
C                           ***
C     N-TUPLE OCCURS IN MORE THAN ONE TO
C                           ***
      GO TO 20
C                           ***
C     IF ONLY ONE T.R. IN N-TUPLE CLASSIFY N-TUPLE
C                           ***
```

17504 03 05-02-69 10.284

```
   19 I1=20001-I+2
C                      ***
C     I1 IS THE LOCATION OF THE CONT FOR THE I TH N-TUPLE
C                      ***
      N=IPT(I1)/10000
      N=(IPT(I1)-N*10000)/100
C                      ***
C     N IS NUMBER OF TIMES THAT THE N-TUPLE IN I1+1 OCCURED
C                      ***
      GO TO 21
C                      ***
C     IF TWO OR MORE T.O. IN N-TUPLE LOOK FOR PREDOMINANT T.O.
C     AND CLASSIFY
C                      ***
   20 CALL DECISN (I1,J,IPT,SIGMA,R,N,AAA,LT,NTOTAL,SPROB)
   21 DO 22 L=1,J
      ...
   22 IPT(L)=IPT(L)+...
      NCOUNT=NCOUNT+1
C                      ***
C     STORE IN NREG N-TUPLE AND CLASSIFICATION
C     IF NREG FULL GO TO 701 AND STORE NREG
C                      ***
   23 IF (NCOUNT.GT.NHIGH) GO TO 30
      ...
      NREG(NCOUNT)=IPT(I1)
      WRITE (9) N,SPROB
      ...
      IF (I.LE.NN) GO TO 19
      NCOUNT=NCOUNT+1
      IF (...NE.0) GO TO 30
C                      ***
C     CLASSIFY ALL N-TUPLES
C     NN IS TO FOR THE N-TUPLE
C     NNN IS THE CLASSIFICATION BY BAYES' RULE
C     LJ IS POSITION IN RESULT ARRAY FOR (NN,NNN)
C                      ***
      DO 24 I=1,NN
      I1=20001-I+2
      N=IPT(I1)/10000
      ...
      ...
      LJ=(NN-1)*N+NNN
C                      ***
C     IF DATA WAS STORED GO FETCH IT
C                      ***
   24 RESULT(LJ)=RESULT(LJ)+FLOAT(N)
      IF (NOC.GT.0) GO TO 30
      SUM=0.
C                      ***
C     CALCULATE PROBABILITIES AND PRINT OUT RESULTS
C                      ***
      ...
      ...
      DO 25 I=1,NNS,NP1
   25 SUM=SUM+RESULT(I)
C                      ***
C     SUM IS TOTAL PROB OF CORRECT CLASSIFICATIONS TO CONDITIONAL PROB
C                      ***
      SUM=SUM/SP
      DO 26 I=1,N
      ...
      ...
      DO 26 J=1,N
   26 RESULT(J)=RESULT(J)/SIGMA(I)
      CALL OUTP (RESULT,N)
      WRITE (6,FMT50) SUM
C                      ***
C     WRITE END OF FILE MARKS ON TAPES
C                      ***
      I=0
      WRITE (10) I
      WRITE (20) I
      REWIND 10
      CALL CHAST
C                      ***
C     STORE RESULTS AND INITIALIZE NCOUNT
C     NCOUNT IS NOW THE NUMBER OF LOCATIONS ACTUALLY FILLED
C     NCOUNT IS THE BOTTOM MOST POSITION FILLED IN THE TOP PART OF III
C     DUMP TOP PATH OF III ONTO 2
C     NOC GIVES NUMBER OF DUMPS ON 2
C                      ***
   27 NCOUNT=(NCOUNT-1)+2
      NCOUNT=20001-NCOUNT
      WRITE (2) NCOUNT
      WRITE (2) ((IPT(I1),IPT(I1+1)),I1=NCOUNT,20000,2)
      NCOUNT=1
      ...
      NOC=NOC+1
      GO TO 9
   28 ...
      ...
      ...
      ...
      DO 29 J=...
      ...
   29 ...
      ...
      ...
      ...
      ...
      ...
      GO TO 9
C                      ***
C     STORE, PUNCH AND INITIALIZE N-TUPLES
C                      ***
   30 NCOUNT=NCOUNT-1
      WRITE (20) NCOUNT
      REWIND 9
      WRITE (20) (NREG(I),I=1,NCOUNT)
      DO 31 I=1,NCOUNT
      READ (9) N1,SPROB
      WRITE (...) NREG(I),N1,SPROB
   31 NREG(I)=0
      WRITE (20) (NREG(I),I=1,NCOUNT)
      REWIND 9
      ...
      ...
      ...
      GO TO 23
C
C                      ***
   ... FORMAT (...CLASSIFICATIONS...)
   ... FORMAT (...)
   ... FORMAT (...TRAINING PATTERNS...)
      ...
   ... FORMAT (...)
   ... FORMAT (...)
      END
```

[illegible] WORDS OF MEMORY USED BY THIS COMPILATION

17964 03 05-02-69   19.395

```
      SUBROUTINE OUTP (RESULT,N)
      DIMENSION RESULT(N,N), IDL(23)
      COMMON MP31,FORMT1(12)
      COMMON K
      COMMON FMT1(19),FMT2(3),FMT9(5),FMT11(6),FMT12(7),FMT13(3),FMT14(2
     1),FMT16(2),FMT22(3),FMT56(6),FMT57(4),FMT58(6)
      COMMON L8,L9,L10,L11,L12,L13,L14
      INTEGER K
      DATA IDL/1HT,1HR,1HU,1HE,1H ,1HT,1HR,1HA,1HI,1HN,1HI,1HN,1HG,1H ,1
     1HR,1HE,1HG,1HI,1HO,1HN/
C                        ***
C     PRINT OUT PROBABILITY MATRIX IN PUBLISHABLE FASHION
C                        ***
      II=1
      III=8
      NN=N
    1 CALL MNAME
      K=NN
      IF (K.LT.8) GO TO 9
      LINE=0
      K=8
      NS=25-N
      IF (NS.EQ.0) GO TO 3
      DO 2 I=1,NS
      LINE=LINE+1
    2 WRITE (6,15)
    3 LINE=LINE+7
      WRITE (6,FMT56)
      WRITE (6,FMT12)
      WRITE (6,FMT13) (I,I=II,III)
      IF (LINE.NE.24) GO TO 4
      WRITE (6,FMT14) IDL(1)
    4 DO 6 J=1,N
      LINE=LINE+1
      WRITE (6,FMT57) J,(RESULT(I,J),I=II,I
      IF (44-LINE.LE.0) GO TO 5
      L=LINE-23
      IF (L.LE.0) GO TO 5
      WRITE (6,FMT14) IDL(L)
    5 LINE=LINE+1
      WRITE (6,15)
      IF (44-LINE.LT.0) GO TO 6
      L=LINE-23
      IF (L.LE.0) GO TO 6
      WRITE (6,FMT14) IDL(L)
    6 CONTINUE
    7 LINE=LINE+1
      L=LINE-23
      IF (L.GT.23) GO TO 8
      WRITE (6,FMT16) IDL(L)
      GO TO 7
    8 NN=NN-K
      II=II+8
      III=III+8
      IF (NN.GT.0) GO TO 1
      RETURN
    9 DO 10 I=1,23
   10 WRITE (6,15)
      WRITE (6,FMT56)
      WRITE (6,FMT12)
      III=II+K-1
      WRITE (6,FMT13) (I,I=II,III)
      WRITE (6,FMT16) IDL(1)
      LINE=24
      DO 12 J=1,N
      LINE=LINE+1
      WRITE (6,FMT57) J,(RESULT(I,J),I=II,III)
      IF (44-LINE.LE.0) GO TO 11
      L=LINE-23
      IF (L.LE.0) GO TO 11
      WRITE (6,FMT14) IDL(L)
   11 LINE=LINE+1
      WRITE (6,15)
      IF (44-LINE.LE.0) GO TO 12
      L=LINE-23
      IF (L.LE.0) GO TO 12
      WRITE (6,FMT14) IDL(L)
   12 CONTINUE
   13 LINE=LINE+1
      L=LINE-23
      IF (L.GT.23) GO TO 14
      WRITE (6,FMT16) IDL(L)
      GO TO 13
   14 RETURN
C                        ***
C
C                        ***
   15 FORMAT (/)
      END
```

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*     22930 WORDS OF MEMORY USED BY THIS COMPILATION
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17564 03 05-02-69 18.316

```
      SUBROUTINE DECSON (I,J,M1,SIGMA,K,N,A,LT,NTOTAL,XPROB)
      DIMENSION M1(2), SIGMA(2)
      DIMENSION A(2), C(30)
      LOGICAL LT
      M=0
      DO 1 K=1,N
    1 C(K)=0.
      XPROB=0.
      ZLARGE=.1E+21
      DO 2 K1=1,J
      K=20001-2*K1
      LL=M1(K)/10000
      L=(M1(K)-LL*10000)/100
    2 C(L)=C(L)+FLOAT(LL)
      XPROB=FLOAT(M)/FLOAT(NTOTAL)
      M=1
C                                    ***
C     IF NORMALIZED IS SPECIFIED MULT BY NORMALIZING FACTORS
C                                    ***
      IF (.NOT.LT) GO TO 4
      DO 3 L=1,N
      IF (C(L).LT.1.E-10) C(L)=0.
    3 C(L)=C(L)*SIGMA(L)
    4 DO 6 L=1,N
      SMALL=0.
C                                    ***
C     A IS THE LOSS MATRIX
C                                    ***
      DO 5 K=1,N
      SMALL=SMALL+A(M)*C(K)
    5 M=M+1
      SMALL=SMALL-10000.
C                                    ***
C     LOOK FOR PREDONOMINT [illegible] REGION
C                                    ***
      IF (SMALL.GT.ZLA[illegible]
      ZLARGE=SMALL
      K=L
    6 CONTINUE
C                                    ***
C     K IS THE RESULTING TRAINING REGION
C                                    ***
      RETURN
      END
```

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*   22985 WORDS OF MEMORY USED BY THIS COMPILATION

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```
      SUBROUTINE DMP
      DIMENSION IA(20), IB(20), IC(20)
      COMMON NPO1,FORMT1(12)
      COMMON F
      COMMON IDUMY(752),IZZ(24000)
      EQUIVALENCE (IA(1),IZZ(1)), (IB(1),IZZ(12001))
      INTEGER F
      REWIND 9
      REWIND 2
      REWIND 10
      ITAPE=10
      KTAPE=9
      READ (10) N
      IF (N.GT.20) GO TO 15
    1 READ (ITAPE) I
      IF (I.GT.12000) GO TO 15
      IF (I.LE.0) GO TO 6
      ITEST=I
      READ (ITAPE) (IZZ(J),J=1,I)
    2 READ (ITAPE) M
      IMP1=I+1
      L=I+M
      IF (M.LE.0) GO TO 3
      READ (ITAPE) (IZZ(J),J=IMP1,L)
    3 LM1=L-1
      DO 4 II=2,LM1,2
      IP1=II+2
      DO 4 JJ=IP1,L,2
      IF (IZZ(II).GT.IZZ(JJ)) GO TO 4
      IS=IZZ(II-1)
      IZZ(II-1)=IZZ(JJ-1)
      IZZ(JJ-1)=IS
      IS=IZZ(II)
      IZZ(II)=IZZ(JJ)
      IZZ(JJ)=IS
    4 CONTINUE
      WRITE (KTAPE) M
      IF (M.LE.0) GO TO 5
      WRITE (KTAPE) (IZZ(J),J=IMP1,L)
      GO TO 2
    5 WRITE (2) I
      WRITE (2) (IZZ(J),J=1,I)
      KK=KTAPE
      KTAPE=ITAPE
      ITAPE=KK
      REWIND 9
      REWIND 10
      GO TO 1
    6 M1=0
      WRITE (2) M1
      REWIND 2
      WRITE (6,16)
      WRITE (6,17) (I,I=1,N)
    7 DO 8 I=1,20
    8 IC(I)=0
      READ (2) M
      IF (M.LE.0) GO TO 12
      READ (2) (IZZ(I),I=1,M)
      IREM=IZZ(2)
      K1=IZZ(1)/10000
      K2=(IZZ(1)-10000*K1)/100
      IC(K2)=K1
      DO 11 I=3,M,2
      IF (IREM.NE.IZZ(I+1)) GO TO 9
      K1=IZZ(I)/10000
      K2=(IZZ(I)-10000*K1)/100
      IC(K2)=K1+IC(K2)
      GO TO 11
    9 WRITE (6,18) IREM,(IC(J),J=1,N)
      IREM=IZZ(I+1)
      DO 10 J=1,20
   10 IC(J)=0
      K1=IZZ(I)/10000
      K2=(IZZ(I)-10000*K1)/100
      IC(K2)=K1
   11 CONTINUE
      WRITE (6,18) IREM,(IC(J),J=1,N)
      GO TO 7
   12 NN=IDUMY(742)
      REWIND 20
   13 READ (20) N
      IF (N.LE.0) GO TO 14
      READ (20) (IA(J),J=1,N)
      READ (20) (IB(J),J=1,N)
      WRITE (6,19) (IA(J),IB(J),J=1,N)
      GO TO 13
   14 CALL CHNST
   15 WRITE (6,20)
      CALL CHNST
      RETURN
C                             ***
C
C                             ***
   16 FORMAT (1H1,10,8HN-TUPLES,4OX,19HTRAINING REGIONS//)
   17 FORMAT (/,9X,20I5)
   18 FORMAT (9X,I10,9X,20I10,I4)/)
   19 FORMAT(9(I6,I10,I00,I2))
   20 FORMAT (70H TOO MANY TRAINING REGIONS FOR CONVIENT OUTPUT EXECUTIO
   16 CONTINUED
      END
```

<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>
*   22900 WORDS OF MEMORY USED BY THIS COMPILATION

17904 03 09-02-69 10.536

```
      SUBROUTINE PLOTER
      DIMENSION CPS(20,130), PLOT(130), DATA(30), NPT(1000), KLAS(1000),
     1 ENT(1000)
      DIMENSION PLT(130)
      DIMENSION AAA(25), NPOINT(30)
      COMMON /IST/ IST
      COMMON NPDI,FORMT(12)
      COMMON F
      COMMON FMT1(15),FMT2(3),FMT4(5),FMT11(6),FMT12(7),FMT13(3),FMT14(2
     1),FMT15(2),FMT22(3),FMT56(6),FMT57(6),FMT58(8)
      COMMON L8,L9,L10,L11,L12,L13,L14
      COMMON NP,NN,LEVEL,NZ1,NPRINT,ITAPE,AAA,LT,L1,L2,L3,L4,L5,L6,NA,NB
     1,NC,ND,L7,MS,MY,ITEN,ZPZ(24000)
      EQUIVALENCE (KLAS(1),ENT(1)),(ZPZ(1),NPT(1)),(ZPZ(1000)),KLAS(1))
     1 , (ZPZ(2000)),CPS(1,1))
      LOGICAL LT,L1,L2,L3,L4,L5,L6,L7
      LOGICAL L8,L9,L10,L11,L12,L13
      INTEGER F
      INTEGER CPS
      INTEGER PLT
      DATA BLANK/1H /
C      NP IS NUMBER OF PHOTOS
C      NN IS NUMBER OD DATA POINTS PER PHOTO
C      PLOT ARRAY OUTPUTS PHOTO CLASSIFICATION LINE BY LINE
C      NO MORE THAN 20 PHOTOS CAN BE HANDLED HERE
      REWIND 3
      IST=35435900753
      REWIND 4
      REWIND 20
      IF (L9) WRITE (43,12)
      CALL NNAME
      J1=1
      J2=0
    1 READ (20) KCOUNT
      IF (KCOUNT.LE.0) GO TO 2
      J2=J2+KCOUNT
C      NPT IS THE COMPACTED POINT ARRAY
C      KLAS IS THE CATEGORY WHICH NPT IS PUT IN
      READ (20) (NPT(J),J=J1,J2)
      READ (20) (KLAS(J),J=J1,J2)
      J1=J2+1
      GO TO 1
    2 WRITE (6,FMT11)
      J3=(130-NN)/2+1
      J4=J3+70
      REWIND 2
      DO 7 I=1,MY
C      READ A LINE OF UNCOMPACTED N-TUPLES
      DO 3 J=1,NN
      IF (L1) READ (3) (CPS(K,J),K=1,NP)
    3 IF (.NOT.L1) READ (4) (CPS(K,J),K=1,NP)
      DO 4 J=1,130
    4 PLOT(J)=BLANK
      JJ=(130-NN)/2
      DO 6 J=1,NN
C      FOR EACH N-TUPLE IN LINE COMPACT IT AND FIND OUT HOW TO CLASSIFY
      JJ=JJ+1
      KK=0
      DO 5 K=1,NP
    5 KK=KK*LEVEL+CPS(K,J)
      CALL SEARCH (NPT,KLAS,KK,SYMBOL,J2,NP,N,LEVEL)
C      PLT CONTAINS NUMERIC CODE FOR SYMBOL
      PLT(J)=N
    6 PLOT(JJ)=SYMBOL
      WRITE (2) (PLT(J),J=1,NN)
C      NOW WRITE OUT THE LINE
      IF (L9) WRITE (43,13) (PLOT(J),J=J3,J4)
      IF (.NOT.L11) WRITE (6,14) (PLOT(J),J=31,100)
    7 IF (L11) WRITE (6,14) (PLOT(J),J=1,130)
      ITEN=0
      IF (L2.AND.L5) GO TO 11
C      COMPUT. CONTINGENCY TABLE HERE
      REWIND 1
      REWIND 2
      DO 8 I=1,NA
      KK=NPOINT(I)
    8 READ (1) (ZPZ(J),J=1,KK)
C      READ IN TRAINING REGION
      NS=NA+NA
      TN=1
      NPNS=NN+NS
      READ(1) (NPT(J),J=NT,NNPNS)
      DO 9 I=1,NS
    9 ZPZ(I)=0.
      JJ=NS
C      FOR EACH LINE OF OUTPUT
      DO 10 I=1,MY
C      READ ALL THE POINTS ON THE LINE
      READ (2) (PLT(J),J=1,NN)
C      FOR EACH POINT ON THE LINE
      DO 10 J=1,NN
      JJ=JJ+1
      NN=(NPT(JJ)-1)*NA+PLT(J)
   10 ZPZ(NN)=ZPZ(NN)+1.
      CALL OUTP (ZPZ,NA)
   11 CALL CHNST
      STOP
C                             ***
C
C                             ***
   12 FORMAT (20HPHOTO CLASSIFICATION)
   13 FORMAT (80A1)
   14 FORMAT (1X,130A1)
      END
```

- 23070 WORDS OF MEMORY USED BY THIS COMPILATION

40

17564 03 05-02-69   18.349

```
      SURROUTINE OUTP (RESULT,N)
      DIMENSION RESULT(N,N), IDL(20)
      COMMON MP01,FORMT1(12)
      COMMON F
      COMMON FMT1(15),FMT2(3),FMT9(5),FMT11(6),FMT12(7),FMT13(3),FMT14(2
     1),FMT16(2),FMT22(3),FMT56(6),FMT57(4),FMT58(8)
      COMMON L8,L9,L10,L11,L12,L13,L14
      INTEGER F
      DATA IDL/1HT,1HR,1HU,1HE,1H ,1HT,1HR,1HA,1HI,1HN,1HI,1HN,1HG,1H ,1
     1HR,1HE,1HG,1HI,1HO,1HN/
C                         •••
C     PRINT OUT PROBABILITY MATRIX IN PURLISHABLE FASHION
C                         •••
      II=1
      III=8
      NN=N
    1 CALL HNAME
      K=NN
      IF (K.LT.8) GO TO 9
      LINE=0
      K=8
      NS=25-N
      IF (NS.EQ.0) GO TO 3
      DO 2 I=1,NS
      LINE=LINE+1
    2 WRITE (6,15)
    3 LINE=LINE+7
      WRITE (6,16)
      WRITE (6,FMT12)
      WRITE (6,FMT13) (I,I=II,III)
      IF (LINE.NE.24) GO TO 4
      WRITE (6,FMT14) IDL(1)
    4 DO 6 J=1,N
      LINE=LINE+1
      WRITE (6,FMT57) J,(RESULT(I,J),I=II,III)
      IF (44-LINE.LE.0) GO TO 5
      L=LINE-23
      IF (L.LE.0) GO TO 5
      WRITE (6,FMT14) IDL(L)
    5 LINE=LINE+1
      WRITE (6,15)
      IF (44-LINE.LT.0) GO TO 6
      L=LINE-23
      IF (L.LE.0) GO TO 6
      WRITE (6,FMT14) IDL(L)
    6 CONTINUE
    7 LINE=LINE+1
      L=LINE-23
      IF (L.GT.20) GO TO 8
      WRITE (6,FMT16) IDL(L)
      GO TO 7
    8 NN=NN-K
      II=II+8
      III=III+8
      IF (NN.GT.0) GO TO 1
      RETURN
    9 DO 10 I=1,23
   10 WRITE (6,15)
      WRITE (6,16)
      WRITE (6,FMT12)
      III=II+K-1
      WRITE (6,FMT13) (I,I=II,III)
      WRITE (6,FMT16) ID'(1)
      LINE=24
      'O 12 J=1,N
      _INE=LINE+1
      WRITE (6,FMT57) J,(RESULT(I,J),I=II,III)
      IF (44-LINE.LE.0) GO TO 11
      L=LINE-23
      IF (L.LE.0) GO TO 11
      WRITE (6,FMT14) IDL(L)
   11 LINE=LINE+1
      WRITE (6,15)
      IF (44-LINE.LE.0) GO TO 12
      L=LINE-23
      IF (L.LE.0) GO TO 12
      WRITE (6,FMT14) IDL(L)
   12 CONTINUE
   13 LINE=LINE+1
      L=LINE-23
      IF (L.GT.20) GO TO 14
      WRITE (6,FMT16) IDL(L)
      GO TO 13
   14 RETURN
C                         •••
C
C                         •••
   15 FORMAT (/)
   16 FORMAT (57X,17HCONTINGENCY TABLE)
      END

<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><<
•    22939 WORDS OF MEMORY USED BY THIS COMPILATION
<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><<
```

```
R9379 01  05-25-69   21.006                    CHDEX EXECUTION REPORT

$       FORTRAN NDECK,COMDK                                          SEARCH
        SUBROUTINE SEARCH (KPT,KLAS,KK,SYMBOL,J2,NP,K,LEVEL)
        DIMENSION KPT(2), KLAS(2), SY(36)
        DIMENSION KP(100)
        DIMENSION LIST(2)
        COMMON /ISTT/ IST
        DATA SY/1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HL,1HM,1HN,1H
       1O,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ,1H1,1H2,1H3,1H4,1H5,
       21H6,1H7,1H8,1H9,1H0/
C        K IS THE CATEGORY NUMBER
C        SYMBOL IS THE CATEGORY CODE
C        KK IS THE COMPACTED NTUPLE
C        J2 IS UPPER LIMIT FOR KPT AND KLAS ARRAYS
C        LOOK FOR COMPACTED N-TUPLE KK IN LIST
        KS=0
        KL=J2+1
        KTRY=(KS+KL)/2
      1 CONTINUE
        IF(KK-KPT(KTRY)) 3,4,2
      2 IF ((KL-KS).LE.1) GO TO 5
        KL=KTRY
        KTRY=(KL+KS+1)/2
        GO TO 1
      3 IF (KL-KS.LE.1) GO TO 5
        KS=KTRY
        KTRY=(KL+KS)/2
        GO TO 1
      4 K=KLAS(KTRY)
        SYMBOL=SY(K)
        RETURN
      5 CONTINUE
C        KK CANNOT BE FOUND DO NEAREST NEIGHBOR SEARCH
        I1=IDIST(KK,KPT(1),NP,LEVEL)
        L=1
        KP(1)=1
        DO 7 J=2,J2
        I2=IDIST(KK,KPT(J),NP,LEVEL)
        IF (I1.LT.I2) GO TO 7
        IF (I1.NE.I2) GO TO 6
        IF(L.GT.99) GO TO 7
        L=L+1
        KP(L)=J
        GO TO 7
      6 CONTINUE
        I1=I2
        L=1
        KP(1)=J
      7 CONTINUE
        X=RCM(IST)
        K=X*FLOAT(L-1)+1.5
C        KP IS THE ARRAY CONTAINING THE INDEXES FOR ALL THOSE POINTS IN
C        THE KPT ARRAY WHICH ARE CLOSEST TO KK
C        L IS THE UPPER LIMIT OF KP
C        WE WILL CHOOSE ONE POINT FROM THE KP ARRAY AT RANDOM AND
C        IDENTIFY KK WITH THE CATEGORY OF THE POINT IN KPT ASSOCIATED WITH
C        THE RANDOMLY CHOSEN ONE
        K=KP(K)
      8 K=KLAS(K)
        SYMBOL=SY(K)
        RETURN
        END
```

```
R9379 01  05-25-69   21.006                    CHDEX EXECUTION REPORT

$       FORTRAN NDECK,COMDK                                          IDIST
        FUNCTION IDIST(KG,KP,NP,LEVEL)
        IDIST=0
        KK=KG
        LL=KP
        NP1=NP-1
        DO 1 J=1,NP1
        K=KK/LEVEL
        L1=KK-K*LEVEL
        I=LL/LEVEL
        L2=LL-I*LEVEL
        KK=K
        LL=I
      1 IDIST=IDIST+(L1-L2)*(L1-L2)
        IDIST=IDIST+(K-I)*(K-I)
        RETURN
        END
```

```
SNUMB = 17564. ACTIVITY # = 04. REPORT CODE = 06. RECORD COUNT = 05082

          PHOPTS PATERN DIAGON HLFNHF
          STOPNT PHOUTS
     2     8808       6       2
    28      400
FORMAT FOR TRAINING DATA IS (20A1)
```

TEST DATA

ORIGINAL DATA

INPUT FORMAT FOR DATA WAS (20I1)
OUTPUT FORMAT FOR DATA IS (1X,20I1)

PHOTO 1		PHOTO 2	
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
[illegible]	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431420	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
0352431410	0352431410	0352431410	0352431410
	0352431410	0352431410	0352431410
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
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0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
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0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
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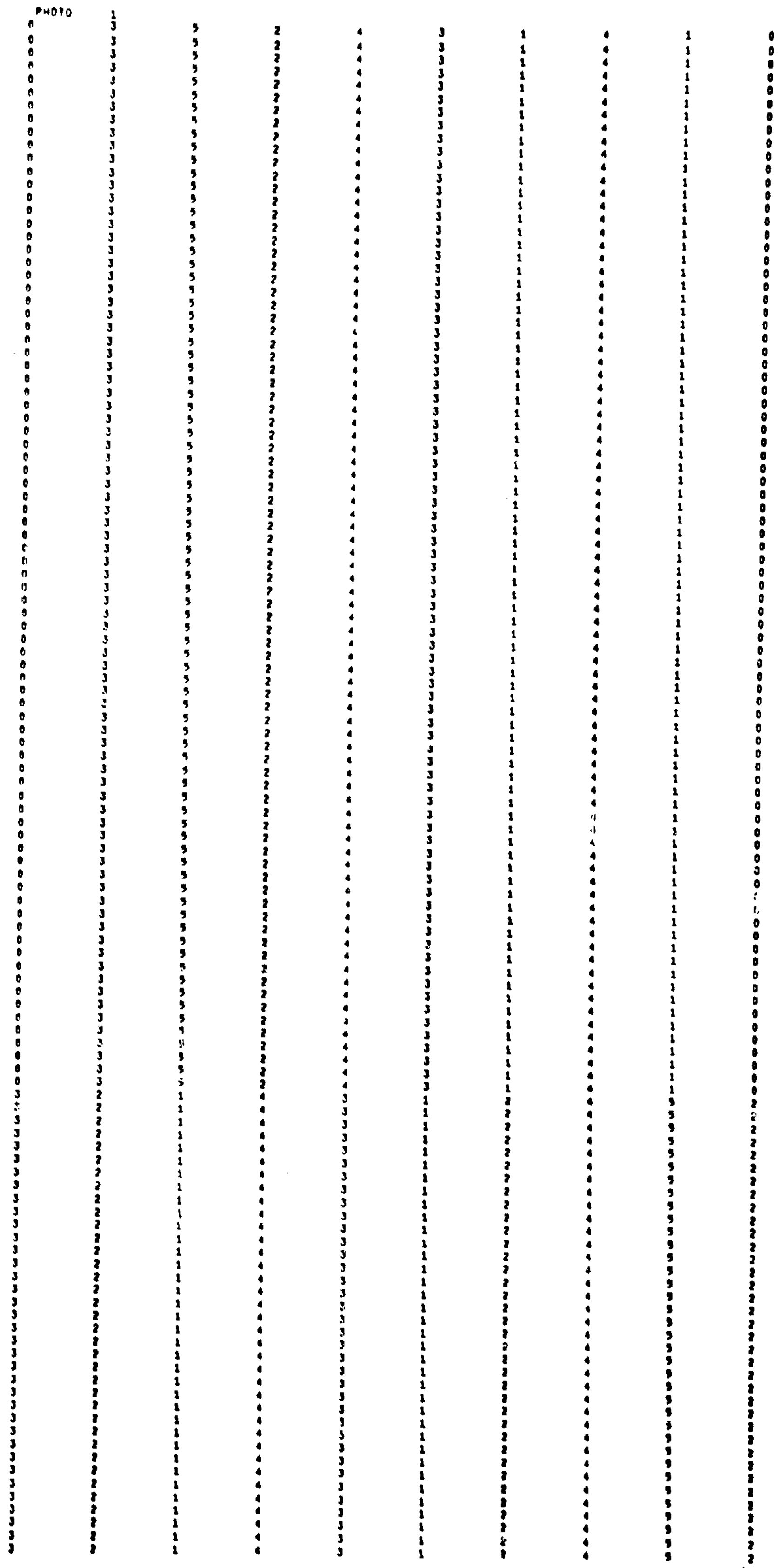
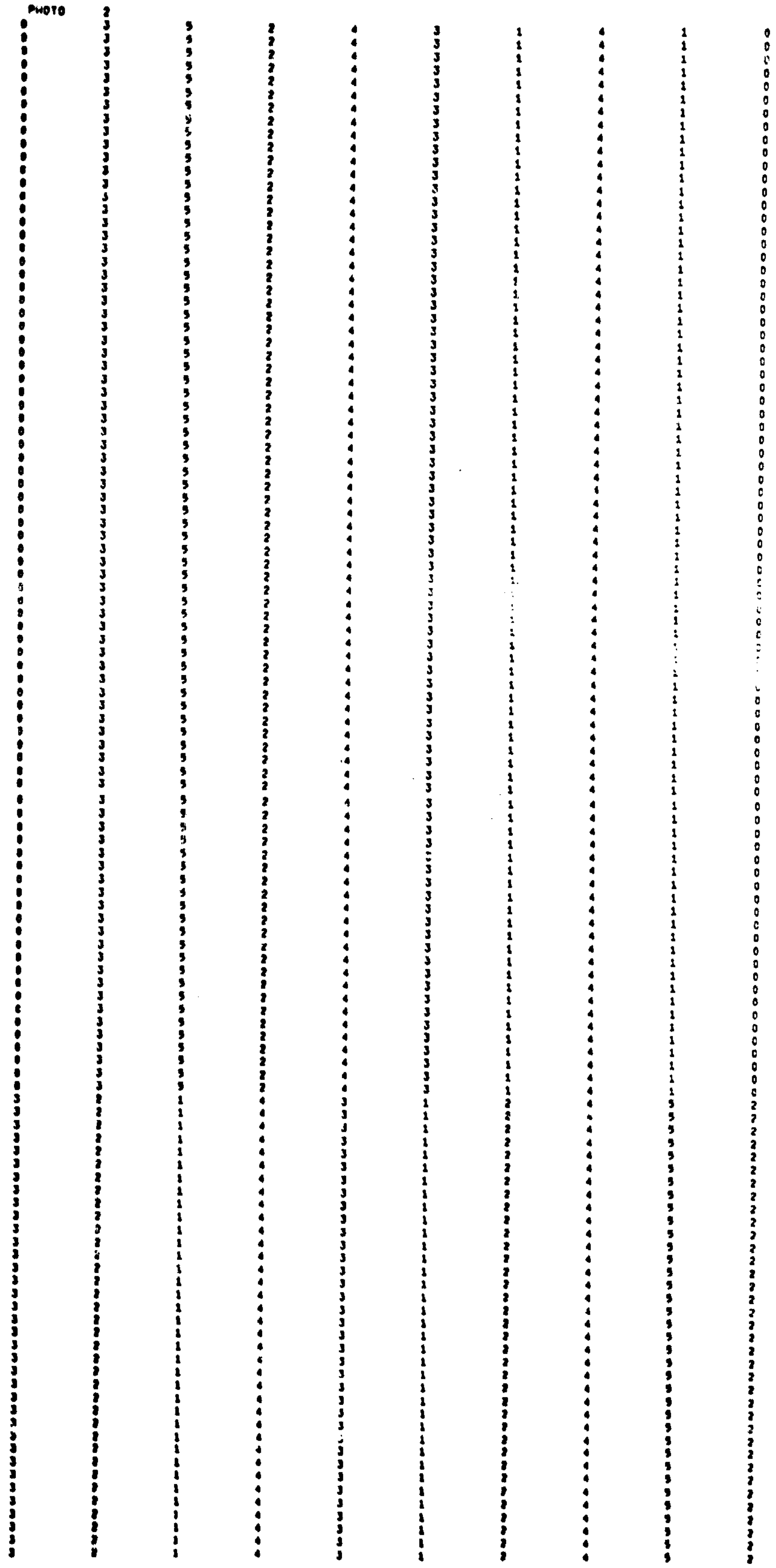
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452
0352431410	3214312452	0352431410	3214312452



PHOTO



PHOTO

TEST DATA

LABLE TABLE

PLOT SYMBOLS VS INPUT SYMBOLS

PLOT SYMBOLS	INPUT SYMBOLS
A	A
B	B

TEST DATA

TRAINING REGIONS

```
ABBABBBABA
ABBABBBABA
ABBABBBABA
ABBABBBABA
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ABBABBBABA
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AAAAAAABBB
```

TEST DATA

NO. TRAINING REGIONS	NORMALIZED NO.LEVELS	NO. PHOTOS
2	4	2

TEST DATA

THE PROBABILITY MATRIX

TRAINING REGION CLASSIFIED AS

TRUE TRAINING REGION	1	2
1	0.4545E 00	0.5455E 00
2	0.1111E 00	0.8889E 00

TOTAL PROBABILITY

0.6500E 00

N-TUPLES

TRAINING REGION

	1	2
35	0	400
28	400	400
21	400	400
14	600	200
7	400	400
0	400	0

35	2	28	2	21	2	14	1	7	2
0	1								

TEST DATA

PHOTO CLASSIFICATION

```
.BRABHBBBA
ABBABPAPBA
ABBABPBRBA
ABBABHAHBA
ABBABPAPBA
ABBABSBHBA
ABBABPAPBA
ABBABPARBA
ARBAEPBPBA
ARBABPAHBA
ARBABPARBA
AOBABHBHBA
AURABPBPBA
ARRABPBHRA
ARRABPBPBA
ARRABPBRBA
ABRABPAHBA
ARBABPBRBA
ABRABPBPBA
ABRABPBHBA
ARRABPBPBA
ABRABRBRRA
AURABRAPUA
ARBABPRHUA
ABBABOAHBA
ARBABRRRBA
ABJABHBHBA
ABBABPRRBA
ABBABHAHBA
ABBABPAHBA
ABBABHBHBA
ABBABPBHBA
ARBAEHBPBA
ARBABPBHBA
ABBABPRRBA
ABBABRBRBA
ABRABPRRBA
ABBABPBRBA
ABBABPBPBA
ABBABRBHBA
ASBABPBBBA
ABBABPBEBA
ABBABHBPBA
ABBABHSBBA
ARBABRBRBA
ABBABPBHBA
ABBABHBRBA
ABJABHBHBA
ABBABPBBBA
ABBABPBHBA
ABBABPAHBA
ARBABHBRBA
ABBABHBHBA
ABUABPBRBA
ABBABPBHBA
ABBABHBHBA
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ARBABPAPBA
ARRABHAPBA
ABRABPAHBA
ABBABHBPBA
ABRABPAPBA
ABRABPAPBA
ABBABFAPBA
ABBABHAHBA
ABRABAAPBA
ABBABHBPBA
ABBABPBHBA
ARBABPAHBA
ARBABPAPBA
ARBABRRRBA
ABBABRRHEA
ABBABPRRBA
AdBABPBHBA
ARBABHAHBA
APRABPBPBA
ABRABPAHBA
ABBABHARBA
ARRABPAHBA
ABBABRAPBA
ABBABPBHBA
ARRABPAPBA
ARBABHAHBA
BABRBPAHBA
BABPBPAPBA
BABRBPAPBA
BABRBHAHBA
BABRBPARGA
BABRBRABBA
BABPBPAHBA
BABPBHARBA
BABRBHAPBA
BABPBPARBA
BABRBRARBA
BABRBPARBA
BABPBRAPBA
BABPBRABBA
BABRBRABRA
BABPBPAPBA
BABRBPARBA
BABPBPAHBA
BABPBHARBA
BABPBRARBA
BABPBRARBA
BABRBRARRA
BABRBRAHBA
BABRBPABBA
RABRBFABBA
BABPBPABBA
BABPBHABBA
RABPBPARBA
BASRBRABBA
BABPBRARBA
BABPBRABBA
BABPBPABBA
BABRBPAPBA
```

TEST DATA

CONTINGENCY TABLE

TRAINING REGION CLASSIFIED AS

TRUE TRAINING REGION		1	2
	1	0.1000E 04	0.1200E 04
	2	0.2000E 03	0.1600E 04

SECOND HALF, NUMBER OF POINTS IS 4000

PHOTO 1

1403552510	1403552510
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PHOTO 2

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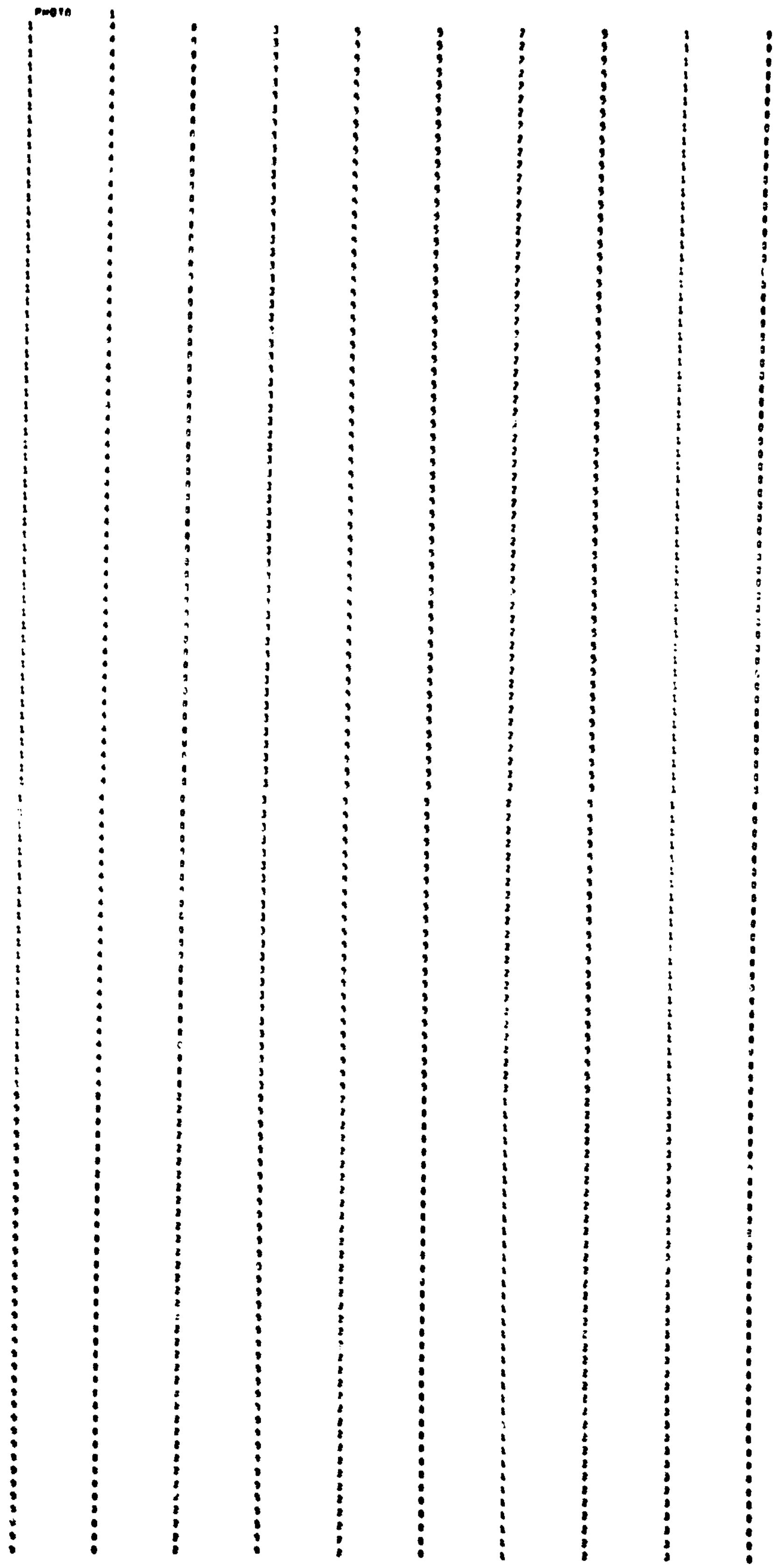

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TEST DATA

LABLE TABLE

PLOT SYMBOLS	VS INPUT SYMBOLS
A	A
B	B

TEST DATA

TRAINING REGIONS

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TEST DATA

PHOTO CLASSIFICATION

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                RRARBHARBA
                RRAHRHARBA
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PBAHBPARBA      RRAHBFARBA
BBARBRARBA      RBARBRAHBA
BBARBHARRA      RRARBRARBA
BHARBRARBA      RRARBRARBA
BRARBRARBA      RRARBRAHBA
BRARBRARBA      RBARBFAHBA
RBAHBRARBA      RBARBRARBA
RBARBRAHBA      RRAHBRARBA
HRARBHARBA      BBARBRARBA
RRARBRARBA      RBARBRARBA
RRARBRARBA      BRAHBRAHBA
BRARBRARBA      BRARBRARBA
RBARBRARBA      RRARBRARBA
ORARBPARRA      RRARBRAYBA
RBARBRARBA      RBARBRAHBA
RBARBRABBA      BRARBHARBA
PHARBRARBA      RBARBRARBA
PRARBRARBA      RBARBRARBA
R3ARBPARBA      BBARBPARBA
RBARBRARBA      RBARBRARBA
BBARBRARBA      RRARBRARBA
RBARBRAHBA      BBARBRARBA
RRARBHARBA      RAARAARABA
PRARBRARBA      RAARAABABA
PRARBRARBA      RAARAABABA
RRARBHARRA      RAARAABABA
BBARBRARRA      BAARAABABA
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BBARBRAHBA      BAARAABABA
RRARBRARBA      BAARAARABA
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PBARBHARBA      BAARAABABA
RRARBHARBA      RAARAABABA
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BRARBRARRA      BAARAABABA
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BBARBRABBA      BAARAARABA
PRARBHAHBA      RAARAABABA
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RHARBRARBA      BAARAARABA
BBARBPARBA      RAARAABABA
RBARBRARRA      RAARAAB:DA
RHARBRABBA      BAARAABABA
RRABBPARBA      RAARAARABA
RBARBRARBA      RAARAARABA
RBARBRARBA      RAARAABABA
BHARBPARRA      RAARAABARA
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RBARBPARBA      RAABAABABA
BRARBRARBA      BAARAABABA
BRABBRABBA      RAARAABABA
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TEST DATA

CONTINGENCY TABLE

TRAINING REGION CLASSIFIED AS

TRUE TRAINING REGION	1	2
1	0.1400E 04	0.1000E 04
2	0.4000E 03	0.1200E 04

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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6. REPORT DATE July 1969	7a. TOTAL NO. OF PAGES 68 — 7b. NO. OF REFS
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13. ABSTRACT

The first part of this paper provides a brief tutorial introduction of the Bayesian Approach to identification of a remotely sensed environment. The second part describes the input data deck setup for the Fortran IV program which has been written to implement this approach. The third part describes file usage and subroutine organization. The fourth part provides a listing of the program with a simple sample data set.

CRES LABORATORIES

Chemical Engineering Low Temperature Laboratory

Remote Sensing Laboratory

Electronics Research Laboratory

Chemical Engineering Heat Transfer Laboratory

Nuclear Engineering Laboratory

Environmental Health Engineering Laboratory

Digital Computer Technology Laboratory

Water Resources Institute