EDUCATION/RESEARCH T2
062-5983-01

Data acquisition and statistical analyses are integral parts of research and education. Sixteen programs provide methods and algorithms to aid such endeavors. The individual abstracts describe each program.

Five of the programs must be transferred to their own dedicated tapes. The documentation contains complete instructions for accomplishing the transfers.

Title/
Previous Abstract #

3D Function Plot
51/00-5506/0

Digitize and Modify Data
51/00-8033/0

Kaplan-Meier Survival Table Compu-Plotter
51/00-5701/0

NMR Calculation for a Three Spin System
51/00-5202/0

Optical Ray-Trace
51/00-5404/0

CHROMPLOT
51/00-5204/0

Measurement of Absorption Spectra
51/00-5407/0

Cobalt-60 Calibration Chart
51/00-4001/0

Blood Pressure Evaluation and Patient Data With Statistical Analysis
51/00-4002/0

Timer Calculation For Cobalt-60 Treatment Plans
51/00-4003/0

One Factor Repeated Measures Analysis of Variance
51/00-5703/0

Two Factor Repeated Measures of Independent ANOVA
51/00-5702/0

Scheffe' Multiple Comparison Procedure
51/00-5721/0

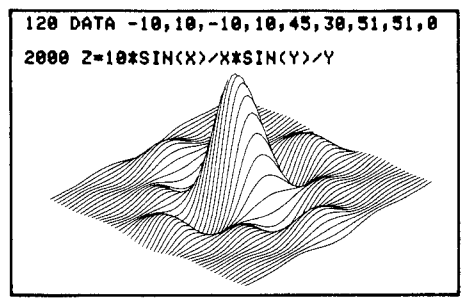
Cubic Spline Interpolation
51/00-5504/0

On-Line Spectral Analysis (OLSA)
51/00-5205/0

On-Line Calorimetry Data Acquisition and Analysis (DCAL)
51/00-5206/0

Program 1

Title: **3D Function Plot**
Author: Dony Robert
Brussels, Belgium
Memory Requirement: 8K
Peripherals: Optional 4662 Plotter
Statements: 206
Files: 1 ASCII Program



This program draws a 3D plot of a two-variable mathematical function (Z=F(X,Y)), with the hidden lines removed from the plot. The user defines the function and enters real or representative data to obtain the plot. However, the program does not prompt for these inputs; the user simply enters them into the specified lines in the program.

The program provides the option of obtaining uniform scaling so that the plot surface fills the entire screen, which doesn't provide an accurate representation of the function, or obtaining true (rather than uniform) scaling. This option is set by changing a single program line.

The user may also set the following:
- interval on the X and Y axis
- azimuth angle in degrees
- dip angle in degrees
- number of lines on the surface
- number of points on each line
- file number to record the data on tape for later use or faster drawing

Program 2

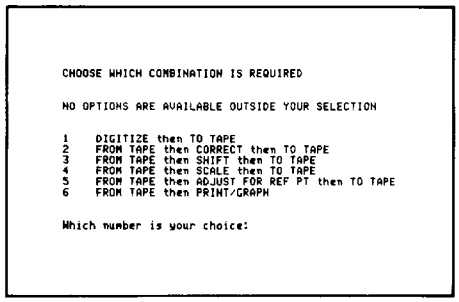
Title: **Digitize and Modify Data**
Author: Barry T. Bates
Dept. of Physical Education
University of Oregon
Eugene, OR
Memory Requirement: 16K
Peripherals: Digitizer using GPIB

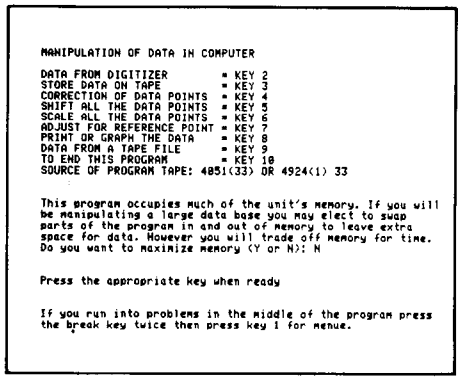
Statements: 505
Files: 1 ASCII Program
Data Files Required

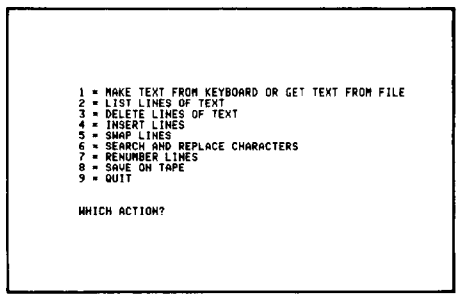
The program inputs data from a digitizer and writes it to tape. Data may be stored in two forms: A) Two files per data point digitized, first file: I$,N,T1,X1,T2,X2, . . .; second file: I$,N,T1,Y1,T2,Y2; or B) Single file: I$,N,P,X1,Y1,X2,Y2 . . Xn,Yn,T1,T2, . . . TN; where T values are absolute time of occurrence or image number input as integer values and X and Y are the coordinates of the data points. Choice A is convenient if data is to be smoothed.

The user indicates the number of data points to be digitized per frame/image and the total number of frames/images is determined by memory. The data for each frame/image may be digitized once or several times and averaged for storage. In addition the user can input a reference point as the last data point and all values can be shifted so they are identified relative to this point. This references all frames/images to a common coordinate system without reorientation of the coordinate system with each new frame/image. Program is terminated by a time or counter value greater than 99. The data may be corrected during or following digitizing. User-Definable Keys scale, shift, print and graph the data.

Parts of the program may be overlaid to increase memory for data.







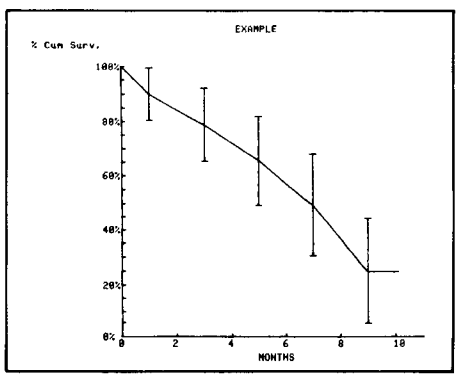
Program 3

Title: **Kaplan-Meier Survival Table Compu-Plotter**
Author: Paul W. Baim
Division of Biostatistics
University of Miami
School of Medicine
Miami, FL
Memory Requirement: 24K
Statements: 348
Files: 1 ASCII Program

The survival table is a means of measuring the response or nonresponse of subjects over time. This response may mean improvement of patients receiving a new drug, or failure of light bulbs using a new type of filament; both lend themselves equally well to this type of study.

The program accepts raw data from the keyboard in the form of dates and subject status (minimum of 2 cases, maximum of 85, with 24k). The dates correspond to the beginning and end of the interval during which a particular subject is under study. The subject status indicates whether the subject is still responding at the end of the interval, or has stopped responding; for instance, whether a battery is still producing current after six days time, or has gone dead. The program then converts the raw data into a table of three columns: the interval, the cumulative survival, and the standard error. The interval is the same as that mentioned earlier, the cumulative survival represents the percentage of subjects surviving (i.e. responding) for this particular interval or longer, and the standard error establishes the reliability of the cumulative survival figure. Next, the program will, on demand, graph the calculated values, with the time intervals on the X axis and the cumulative survival percentages on the Y axis. The standard errors are shown by vertical lines. The purpose of the graph is to show clearly, how subjects are responding. Finally, the program will, on demand, list the data as it was entered.

Limitations: No provision to correct or store data.



Program 4

Title: **NMR Calculation for a Three Spin System**
Authors: Tom Price, Dr. Jack Reid
Lorillard Div. of Loews
Greensboro, NC
Memory Requirement: 16K
Peripherals: Optional-4641 Printer
Statements: 267
Files: 1 ASCII Program

This program calculates the spin-spin transition frequencies and relative intensities for a three spin Nuclear Magnetic Resonance (NMR) system. The energies of the eight possible energy states are calculated using the chemical shifts, in Hz, and coupling constants in Hz, entered from the keyboard.

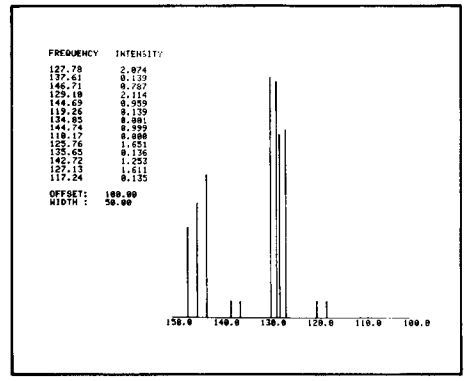
In the three spin system there are four possible energy levels. The first and fourth each contain one spin state; however, the second and third each contain three spin states. The energies of these states are used as the diagonals of two 3 x 3 matrices. The off diagonal elements are calculated from the respective coupling constants. The two matrices are diagonalized, by the method of Jacobi[1][2] and the intensities calculated by identical diagonalization operations on an identity matrix. The final transition frequencies are calculated by the difference in the energies between adjacent energy levels.

The output is displayed as either a listing and an NMR line spectrum on the graphic terminal or a listing on the printer.

```
NMR PATTERN FOR THREE SPIN SYSTEM

CHEMICAL SHIFT FREQ:    125 HZ, 130 HZ, 144.6 HZ
COUPLING CONSTANTS: J1,2= 8.5 J2,3= 1.75 J1,3= 2.25

      LINE( 1)=    127.78 HZ  INT = 20.74
      LINE( 2)=    137.61 HZ  INT = 1.39
      LINE( 3)=    146.71 HZ  INT = 7.87
      LINE( 4)=    129.10 HZ  INT = 21.14
      LINE( 5)=    144.69 HZ  INT = 9.59
      LINE( 6)=    154.58 HZ  INT = 0.01
      LINE( 7)=    119.26 HZ  INT = 1.39
      LINE( 8)=    134.85 HZ  INT = 0.01
      LINE( 9)=    144.74 HZ  INT = 9.99
      LINE(10)=    110.17 HZ  INT = 0.00
      LINE(11)=    125.76 HZ  INT = 16.51
      LINE(12)=    135.65 HZ  INT = 1.36
      LINE(13)=    142.72 HZ  INT = 12.53
      LINE(14)=    127.13 HZ  INT = 16.11
      LINE(15)=    117.24 HZ  INT = 1.35
```



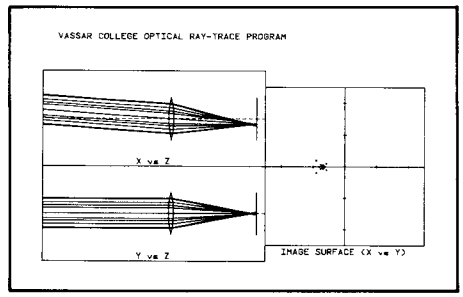
Program 5

Title: **Optical Ray-Trace**
Author: James L. Hutchinson
Dept. of Physics/Astronomy
Vassar College
Poughkeepsie, NY
Memory Requirement: 32K
Peripherals: 4662 Plotter
Statements: 555
Files: 1 ASCII Program

The program consists of two parts. The first part calculates the actual three-dimensional paths of light rays through a user-specified system of spherical or planar surfaces, lenses, mirrors or stops. A plot of the system is made in plane and elevation to show the paths of the rays along the Z-axis. Light rays proceed through the system normally from left to right and can be plotted in contrasting colors. The rays are followed until they intersect the image surface or a stop, or until they fail to intercept a subsequent optical surface. Distance units are arbitrary; the program plots the system to scale. A plot of the intersection of the rays with the chosen image surface is also given.

The rays traced through the system can be chosen manually or automatically. In the manual mode, you must separately specify the orientation of each incoming ray. In the automatic mode, rays are chosen from a standard set of 21 rays distributed over four zones of the first optical surface. The end results of the calculations can be saved internally in the program or on tape (manual mode only) to allow further investigation of the structure of the image.

In the second part of the program, you can select different locations of the image surface to see how the presence of aberrations affect the quality of focus of the image.



Program 6

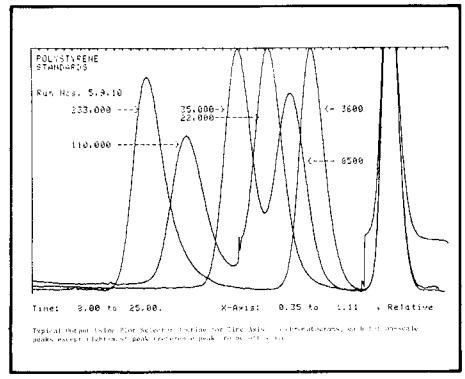
Title: **Chromatographic Data Acquisition and Plotting (CHROMPLOT)**
Author: Leonard H. Ponder
American ENKA Company
Enka, NC
Memory Requirement: 24K/16K
Peripherals: Opt. 1 Data Communications Interface
Statements: 528
Files: 1 ASCII Program

Chromatographic data from an electronic integrator (or digitizer) is recorded on magnetic tape and subsequently plotted on the basis of the original time axis, relative time axis, or molecular size axis. Relative retentions and molecular sizes are calculated automatically. The program is useful in liquid chromatography, gel permeation chromatography, and gas chromatography, or with similar data.

Each chromatogram or selection portion of the chromatogram is scaled to fit the allotted plotting area.

The program is easy to use. Pressing a User-Definable Key activates the desired routine; the routines are shown below. Documentation includes a variable table, flowcharts and detailed instructions.

UDK	Function
1	Minimum and maximum for entire chromatogram
2	Scale and plot entire chromatogram
3	Data to tape
4	Plot entire chromatogram
5	Return to BASIC
6	Change ordinate and abscissa
7	Plot selector
8	Label under chromatogram
9	Read tape
10	Display-only (terminal mode)
11	Minimum and maximum, specific interval
12	Not used
13	Data to tape (no instructions)
14	Molecular size label
15	Display molecular size
16	Print times and min-max
17	Continue over-plot
18	Label above chromatogram
19&20	Not used



Program 7

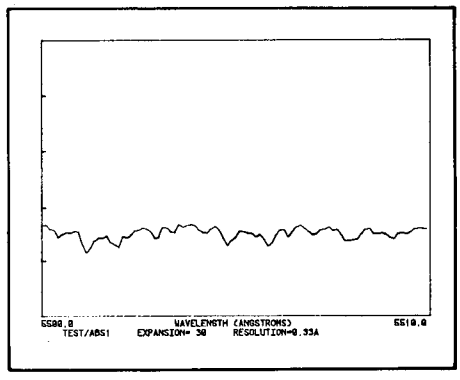
Title: **Measurement of Absorption Spectra**
Author: John Rolfe
National Research Council
Ottawa, Canada
Memory Requirement: 16K
Peripherals: 4907 File Manager
GPIB Digital Voltmeter
Hewlett Packard 6940B Multiprogrammer
300 Baud Printer
Optical Apparatus
Option 1 Data Communications Interface
Statements: 349
Files: 1 ASCII Program
Requires Data Files

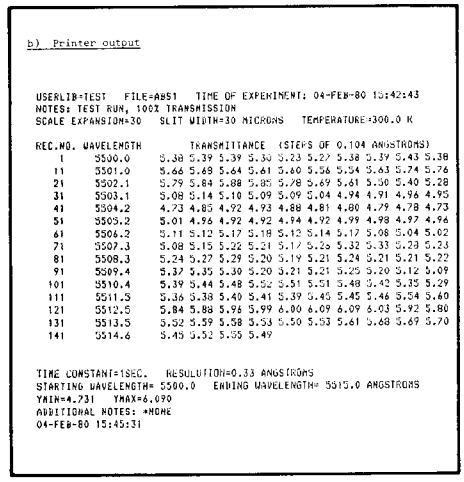
The apparatus controlled by this program measures optical transmittance of a sample as a function of wavelength. Wavelength is varied by a stepping motor on a monochromator. An analog circuit with a voltage output of 0 to +10 volts monitors the transmittance.

The program controls the stepping motor through an HP 6940B with a 59500A GPIB Interface unit. The digital voltmeter used to read transmittance is a Systron-Donner 7344A. Program slews stepping motor to starting wavelength, scans through to ending wavelength in steps separated by time intervals. Step size and time intervals are calculated by the program for optimum information collection based on the monochromator band width (calculated from the slit width) and the time constant of the analog circuit.

The data is printed in tabular form, plotted on the 4050 screen and recorded on the 4907 disc as the run progresses. The main data file is random access binary, each record containing the transmittance. The wavelength is easily calculated from the record number since readings are taken at equal wavelength intervals. At the end of the experiment all parameters are written on a separate header file, a short sequential file which is useful for subsequent data processing.

User-Definable Keys allow for interruption or stopping the run, manual stepping of the monochromator, and some housekeeping functions.





b) Printer output

USERLIB=TEST FILE=ABS1 TIME OF EXPERIMENT: 04-FEB-80 15:42:43
NOTES: TEST RUN, 100% TRANSMISSION
SCALE EXPANSION=30 SLIT WIDTH=30 MICRONS TEMPERATURE=300.0 K

REC.NO.	WAVELENGTH	TRANSMITTANCE (STEPS OF 0.104 ANGSTROMS)									
1	5500.0	5.38	5.39	5.39	5.30	5.23	5.22	5.38	5.39	5.43	5.38
11	5501.0	5.66	5.68	5.64	5.61	5.60	5.56	5.54	5.63	5.74	5.76
21	5502.1	5.79	5.84	5.88	5.85	5.78	5.69	5.61	5.60	5.60	5.58
31	5503.1	5.08	5.14	5.10	5.09	5.09	5.04	4.94	4.91	4.96	4.95
41	5504.2	4.93	4.85	4.92	4.93	4.88	4.81	4.80	4.79	4.78	4.73
51	5505.2	5.01	4.96	4.92	4.92	4.94	4.92	4.99	4.98	4.97	4.96
61	5506.2	5.11	5.12	5.17	5.18	5.12	5.14	5.17	5.08	5.04	5.02
71	5507.3	5.08	5.15	5.22	5.21	5.17	5.25	5.32	5.33	5.28	5.23
81	5508.3	5.24	5.27	5.29	5.20	5.19	5.21	5.24	5.21	5.21	5.22
91	5509.4	5.37	5.35	5.30	5.20	5.21	5.21	5.25	5.20	5.12	5.09
101	5510.4	5.39	5.44	5.48	5.52	5.51	5.51	5.48	5.42	5.35	5.29
111	5511.5	5.36	5.38	5.40	5.41	5.39	5.45	5.45	5.46	5.54	5.60
121	5512.5	5.84	5.88	5.94	5.99	6.00	6.09	6.09	6.03	5.92	5.80
131	5513.5	5.52	5.59	5.58	5.53	5.50	5.53	5.61	5.68	5.69	5.70
141	5514.6	5.49	5.52	5.55	5.49						

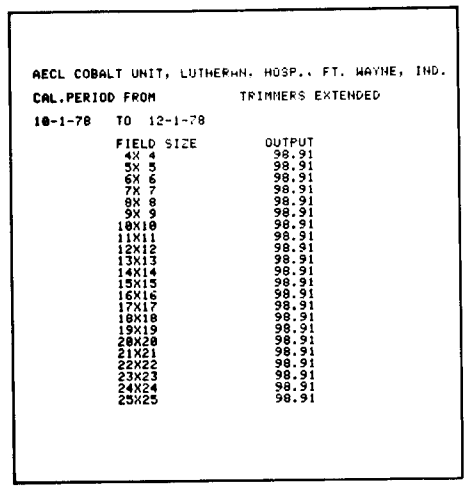
TIME CONSTANT=1SEC. RESOLUTION=0.33 ANGSTROMS
STARTING WAVELENGTH= 5500.0 ENDING WAVELENGTH= 5515.0 ANGSTROMS
YMIN=4.731 YMAX=6.090
ADDITIONAL NOTES: *NONE
04-FEB-80 15:45:31

Program 8

Title: **Cobalt-60 Calibration Chart**

Author: C.S. Narayanan
Lutheran Hospital
Ft. Wayne, IN
Memory Requirement: 8K
Statements: 48
Files: 1 ASCII Program

The program calibrates treatment time for CO-60 Teletherapy units, which are used to treat cancer patients. The CO-60 radioactive source decays (loses its strength) according to its half life. The output of the therapy unit must be calibrated and changed accordingly. This program will give you the output calibration. Enter the present output for various field sizes, and the calibrated output will be displayed. The display can be copied with the 4631 Hard Copy Unit.



```
AECL COBALT UNIT, LUTHERAN. HOSP., FT. WAYNE, IND.
CAL.PERIOD FROM          TRIMMERS EXTENDED
10-1-78   TO  12-1-78

          FIELD SIZE          OUTPUT
            4X 4               98.91
            5X 5               98.91
            6X 6               98.91
            7X 7               98.91
            8X 8               98.91
            9X 9               98.91
           10X10               98.91
           11X11               98.91
           12X12               98.91
           13X13               98.91
           14X14               98.91
           15X15               98.91
           16X16               98.91
           17X17               98.91
           18X18               98.91
           19X19               98.91
           20X20               98.91
           21X21               98.91
           22X22               98.91
           23X23               98.91
           24X24               98.91
           25X25               98.91
```

WARNING

The recipient of this program is solely responsible for checking the accuracy and appropriateness of this program and procedure.

Program 9

Title: **Blood Pressure Evaluation and Patient Data With Statistical Analysis**

Memory Requirement: 32K
Peripherals: Optional-4051R05 Binary Loader
Statements: 581
Files: 1 ASCII Program
Requires Data Tape & PLOT 50 Stat 4 Program

Although this program was custom designed for a particular hospital, it serves as a pattern for other medical users. The graphically-aided data entry for blood pressure readings and TcP02 readings is unique. It's user-oriented with all data entry initiated through User-Definable Keys.

The user keys in patient data:

Name
Record Number
Age
PVES #
Sex
Diabetic
Smoker
Standard Blood Pressure

Next a diagram of the lower torso guides blood pressure and TcP02 readings. These readings and the ratio of normal blood pressure to actual are displayed on the screen.

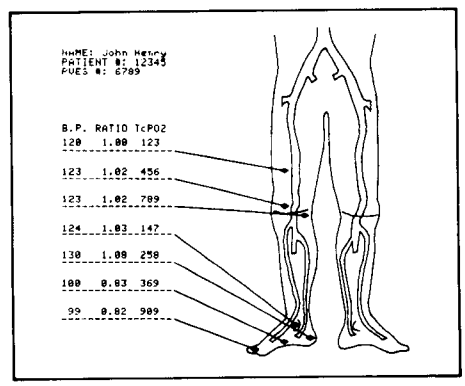
Then the patient's history is keyed in:

Influencing Drugs
Pertinent Laboratory Data
Operative Procedures
Outcome of Operative Procedures
Doppler Flow
Pre or Post

The program combines all of the data into one string and writes it to a patient data tape. Data for up to 240 patients may reside on one tape. A routine will select two data items from each patient file and write these items to another data tape in a format for use with Statistics Volume 4. In this case, the Linear Regression program analyzed sets of data.

The first file on the patient data tape contains the number of full data files on the tape, and an index into the files by patient record number.

Although no routines for data correction or special searching are provided, with the index already in place, it would be relatively simple to insert.



Program 10

Title: **Timer Calculation For Cobalt-60 Treatment Plans**

Author: David H. Robinson
St. Mary's Hospital
Waterbury, CT

Memory Requirements: 8K
Peripherals: 4662 Plotter
Statements: 154
Files: 1 ASCII Program

The program allows the user to specify the physical parameters necessary for implementing a completed treatment plan and performs the treatment time calculation for each beam. Data is entered via the keyboard and is then plotted on the treatment plan using the 4662 Plotter.

User Input:

Plan Description

- number of beams
- normalization number
- total tumor dose

Individual Beam Parameters

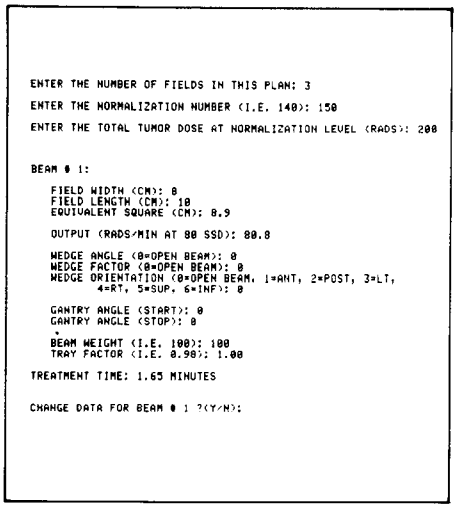
- field width
- field length
- output (RADS/MIN at 80 SSD)
- wedge angle
- wedge factor
- wedge orientation
- gantry angles
- beam weight
- tray factor

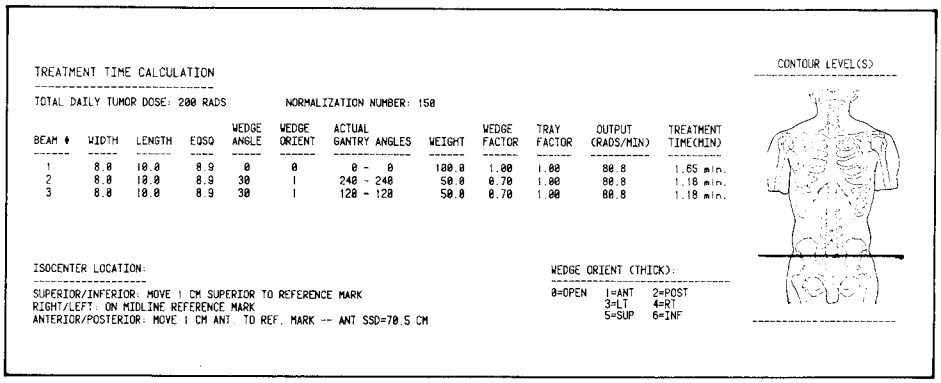
Isocenter Location

The program calculates the treatment time for each beam. All plan parameters are then plotted on the plan. Space is allocated for the user to place an anatomical drawing and indicate the level(s) at which the patient contour was taken.

WARNING

The recipient of this program is solely responsible for verifying the accuracy and appropriateness of this program for his treatment planning system.





Program 11

Title: **One Factor Repeated Measures Analysis of Variance**

Author: Richard M. Engeman
U.S. Fish and Wildlife Service
Denver, CO

Memory Requirements: 16K
Peripherals: Optional—4641 Printer
Statements: 193
Files: 1 ASCII Program

The program calculates the univariate analysis of variance for data from a one factor repeated measures experimental design (see Winer, *Statistical Principles in Experimental Design*, pps 261-308).

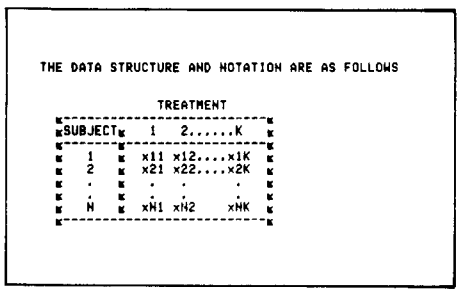
Data is input from the keyboard and allows the user to make any necessary corrections. The program then outputs the following:

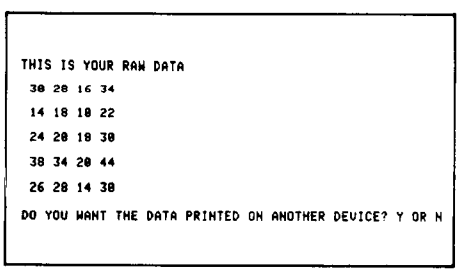
- Analysis of variance table
- Subject means
- Means for treatment levels

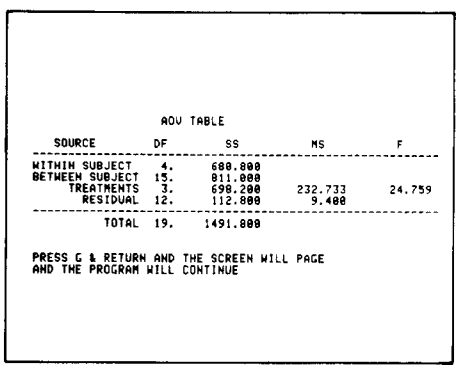
All output, including the raw data, may be printed to the screen or to the 4641 Printer.

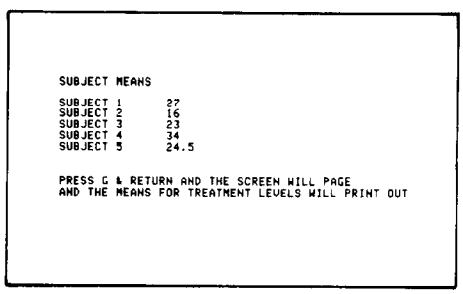
User Prompted Input:

- Number of treatments
- Number of subjects
- Each subject's data
- Output device (screen or printer)









Program 12

Title: **Two Factor Repeated Measures and Independent ANOVA**

Author: Barry T. Bates
Dept. of Physical Education
University of Oregon
Eugene, OR

Memory Requirement: 16K

Peripherals: 4051R05 Binary ROM Pack
TransEra Auxiliary Memory Manager

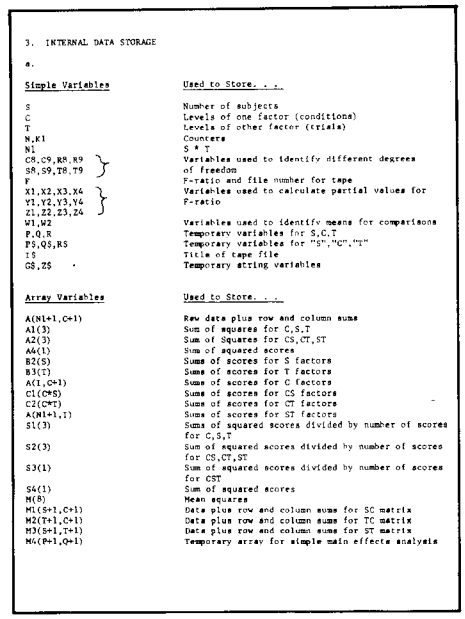
Statements: 744

Files: 1 ASCII Auto Load
8 Binary Program
Requires dedicated tape

This statistical package analyzes two factor repeated measure designs (AxBxS). Data may be input from the keyboard or from tape, and stored on tape. In addition to the summary table, the marginal means of each of the three matrices can be evaluated as well as any of the simple main effects. A final feature collapses the data into a two-factor independent measures design (AxB) or simply analyzes two-factor independent measures data. All main effects and simple main effects can be evaluated.

The program is separated into eight sections. Although the sections are stored in the Auxiliary Memory Module, they could be called from tape or disc. User-Definable Keys drive the program:

Data from keyboard
Data from tape
Data to tape
Compute
Matrix Computations
Summary Table (R)
Matrix Analysis (R)
Simple Main Effects (R)
Main Effects (I)
Summary Table (I)
Simple Main Effects (I)



Program 13

Title: **Scheffe' Multiple Comparison Procedure**

Author: Glenn Galfond
Patuxent Wildlife Research
Laurel MD

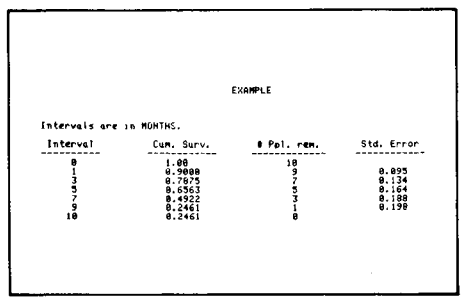
Memory Requirement: 16K

Statements: 329

Files: 2 ASCII Program
Requires dedicated tape

This performs the Scheffe' multiple comparison procedure to separate linear model parameters in an analysis of variance (see Scheffe', *The Analysis of Variance,* pages 68—72).

File one allows the user to enter from the keyboard and conveniently edit the covariance matrix. The matrix is then stored on tape.



File two contains the multiple comparison procedure. The user enters the coefficient vector, the desired confidence level, and the file number on which the covariance matrix is stored. The analysis returns the half-length of the confidence interval.

Program 14

Title: **Cubic Spline Interpolation**

Authors: Monty McGraw
Jim Yadon

Memory Requirement: 8K

Statements: 135

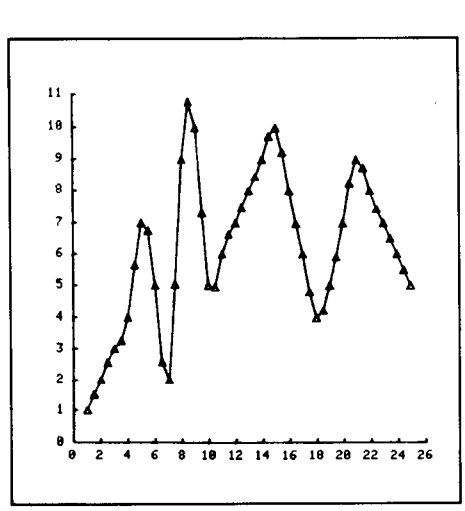
Files: 2 ASCII Program
1 Binary Data (example)
Requires dedicated tape

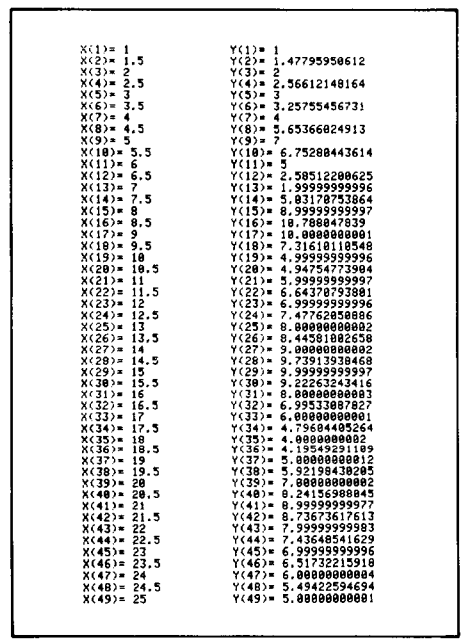
This program will fit a smooth curve to up to 25 ordered X-Y data pairs (more if more memory) by generating piecewise cubic equations of the form:

$$Y_0 = A_3X_0^3 + A_2X_0^2 + A_1X_0 + A_0$$

The cubic equations allow up to 290 interpolations of Y values and derivatives of the curve between data points. The program allows keyboard or tape entry of the data points and records the interpolated values on tape. The data file structure is compatible with the 4050 System Software X-Y Plot Program.

Limitations: No provision for data correction.

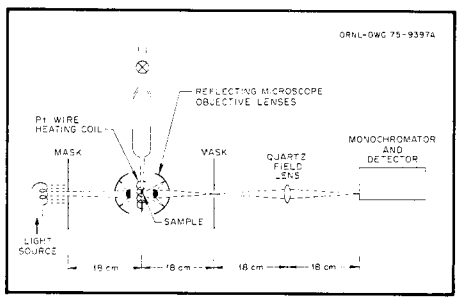




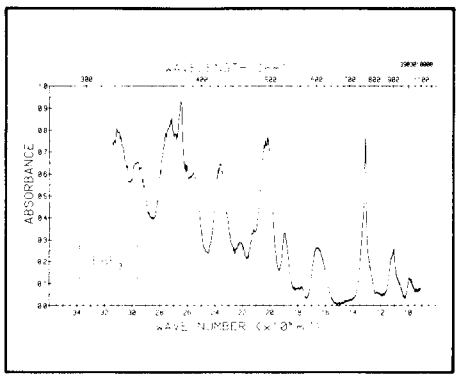
Program 15

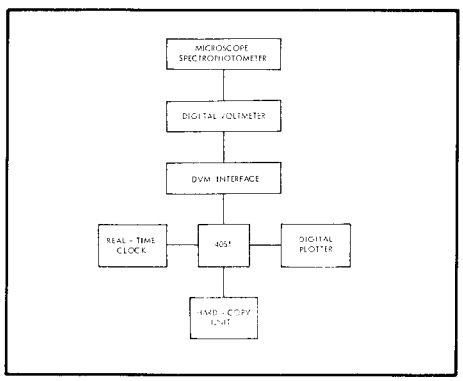
Title: **On-Line Spectral Analysis (OLSA)**
Authors: R.J. Peterson
D.L. Raschella
J.R. Uchida
Dept. of Chemistry
University of Tennessee
Knoxville, TN
Memory Requirement: 32K
Peripherals: DVM
TransEra 641
4662 Plotter
Statements: 1327
Files: 5 ASCII Program
Requires dedicated tape

The program acquires spectrophotometric data from a digital voltmeter on a real-time basis. The data are recorded on magnetic tape and are subsequently analyzed and plotted. The resulting spectra may be displayed in several formats on either the 4050 Screen or the 4662 Plotter. Absorbance is plotted versus wave number and wave length. Scale expansions and spectrum flattening routines are provided.



The program is divided into four segments: input, baseline fit, plotting and display edit routines. At the end of each segment, the operator can initiate the overlaying of the next segment or branching to another segment through the User-Definable Keys.





Program 16

Title: **On-Line Calorimetry Data Acquisition and Analysis (DCAL)**
Authors: J.R. Peterson
D.L. Raschella
J.R. Uchida
Dept of Chemistry
University of Tennessee
Knoxville, TN
Memory Requirement: 32K
Peripherals: Digital Voltmeter
Hewlett Packard 3495A Scanner
TransEra 641
4924 Tape Drive
4662 Plotter
Statements: 1485
Files: 6 ASCII Program
Requires dedicated tape

The program acquires calorimetric data from a digital voltmeter and an HP 3495A Scanner on a real-time basis. Using a thermistor in the microcalorimeter, the changes in temperature are detected as changes in resistance. A Wheatstone bridge is used to measure this resistance change. The change of resistance is monitored by the bridge detector. The output of the bridge detector and the voltages E_h and E_{std} are input to the 3495A Scanner. The 4050 System commands the scanner to connect the appropriate channel. It then directs the DVM to read the voltage and send it to the 4050 System, where it's stored on tape. The program operates on an interrupt mode, with the operator inputting bridge resistance values and initiating action by depressing appropriate User-Definable Keys. Reading rates may be altered. Experimental data that are collected consist of bridge calibrations, calibration heatings, and the dissolution reaction heat of the sample.

The data analysis/evaluation routine performs drift line extrapolations and all integrations; the results are stored on magnetic tape.