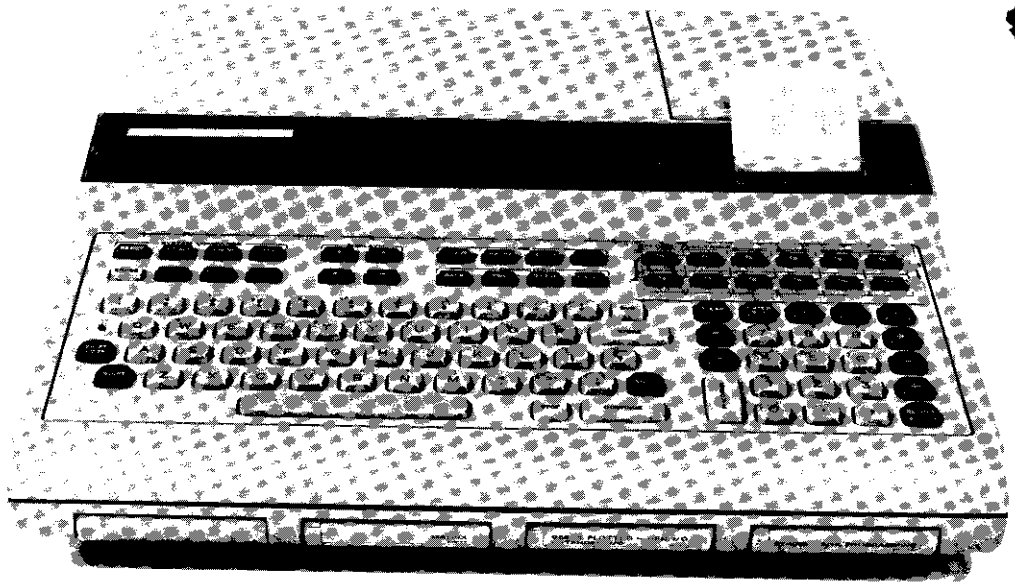
ar Calculator Application Summary Calculator Ar



museum

HP 9825A - THE LATEST STATISTICAL ANSWER

Whatever your vocation: chemist, biologist, psychologist, or statistician; whatever your concern: process control, manufacturing yield, or pure research, the HP 9825A Programmable Calculator is your statistical answer. The 9825 gives you power and flexibility at an economical price. The built-in, high-speed data cartridge provides fast storage and retrieval of data. The 16-character, alphanumeric, thermal printer gives you quiet, readable results at 3.2 lines per second.

The 9825's high level programming language, along with powerful editing features, permits you to dedicate it to do exactly the calculations you need in addition to providing all of the available statistical solutions.

YEARS OF EXPERIENCE

Consider the background and experience that has led to the 9825's statistics library. The 9825 statistics software library is the result of a cooperative effort between a major university and Hewlett-Packard. Several years ago, a professor with this university's statistical laboratory wrote several of his own statistical analysis programs with HP's first desktop programmable calculator. Hewlett-Packard published these programs with his permission, and there was an overwhelming demand for more of these flexible statistical programs. It was his applied experience that came from solving all types of problems in many different disciplines, as well as in the field of statistics, that gave the first HP statistical library its uniquely useful character. This relationship flourished, and now Hewlett-Packard, through a grant with this university, has almost all of its statistical programs on each programmable calculator developed by this professor and the people he directs. He has since become director and turned his group of people into one of the largest and most highly regarded statistical laboratory staffs connected with any university in the United States. HP has combined years of research and development of programmable calculators with this storehouse of applied knowledge of data analysis in order to develop these first three volumes of statistical programs on the 9825.

FIRST THREE VOLUMES AVAILABLE

Statistics, Volume 1 -
General Statistics
Statistics, Volume 2 -
Analysis of Variance and Regression Analysis
Statistics, Volume 3 -
Nonparametric Statistics
Each volume is ready to use and includes:

- -Prerecorded cartridge containing all of the programs in that volume
- -Overlay template that labels the 12 Special Function keys
- -Operating manual describing each program along with meaningful examples

Statistics on the HP 9825

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STATISTICS, VOLUME 1
GENERAL STATISTICS

The first volume of programs provides many of the simple statistical routines that you use over and over again. All of the programs will operate in a standard 4k-byte machine. A HP 9862A Plotter is optional. Here is a listing of the programs included in Volume 1 (Part Number 09825-15000):

- Basic Statistics for One Variable - Includes arithmetic mean, variance, standard deviation, second, third, and fourth moments about the mean, geometric mean, and harmonic mean along with correction features for ungrouped data.
- Random Number Generator.
- Normal Distribution - Generates probabilities if given an ordinate value, or generates tabled values if given a probability.
- Chi-Square Distribution - Generates right-tail probabilities given a value and the degrees of freedom.
- t-Distribution - Generates right-tail probabilities given a value and the degrees of freedom.
- F-Distribution - Generates probabilities given an X value and the degrees of freedom.
- Linear Regression - This program fits a least squares line to a set of paired data points and, as an option, will plot the regression line, a confidence interval about the line, and print or plot a complete analysis of variance table. Values of X may be entered after the coefficients are generated, and predicted Y values are calculated automatically.
- Parabolic Regression - This program fits a least squares quadratic curve to a set of data, and at the user's option, will plot the line. A complete analysis of variance table is provided with the coefficients. Predicted Y values can be automatically calculated from input X values.
- Family Regression - Generates a family of curves and the associated coefficients for the following seven models:

$y = a + bx$	$y = a + b(\ln x)$
$y = a + bx + cx^2$	$y = a + b(1/x)$
$y = ax^b$	$1/y = a + bx$
$y = ae^{bx}$	

Included with each model is a complete analysis of variance table, correlation coefficient, and a data and curve plot.

- One Sample t-Test - Calculates the student's t for single sets of data with a specified mean.
- Paired t-Statistic - Calculates student's t for paired data sets.
- t-Statistic for Two Means - Tests the hypothesis that there is a difference between two population means by the t-statistics.
- Chi-Squared Evaluation - Calculates a χ^2 value for data which has either equal or unequal expected values.

The following plotting programs are included in this Pac:

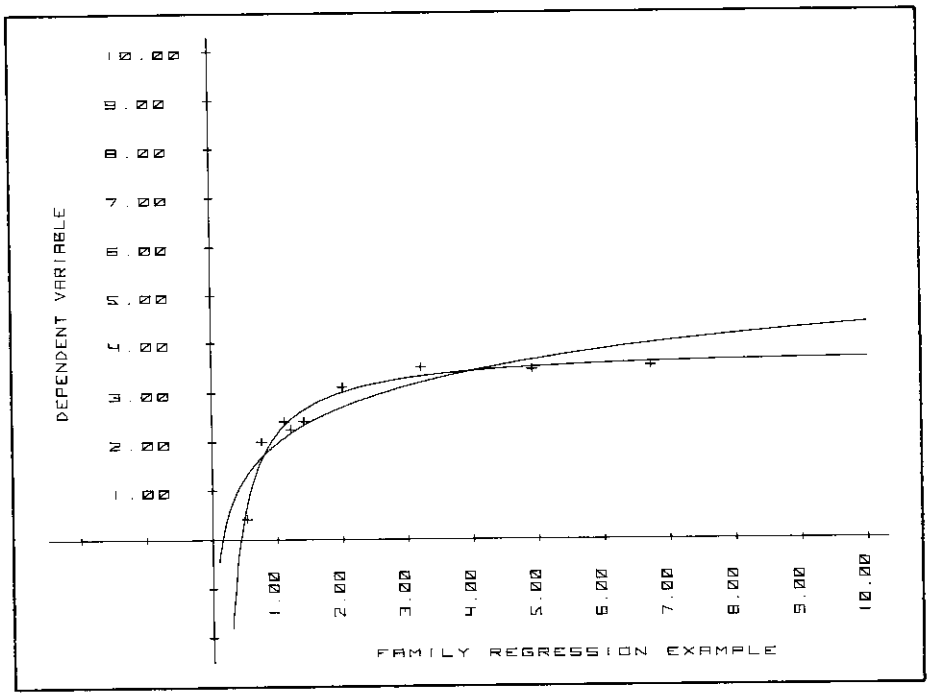
Histogram on printer or plotter
General X-Y plot with labels
$\bar{X}$-R control chart
Family regression

```
 **MODEL 9825**
 BASIC STAT PAC
     INDEX

PROGRAM
NUMBER

0 SPECIAL F.KEYS
1  INDEX
2  BASIC STATS
3  HISTOGRAM
    ON PRINTER
4  HISTOGRAM
    WITH PLOTTER
5  T-TEST
    (1 SAMPLE)
6  T-TEST
    (2 SAMPLES)
    (UNPAIRED)
7  T-TEST
    (2 SAMPLES)
    (PAIRED)
8  CHI-SQUARE
    (=EXP.FREQ.)
9  CHI-SQUARE
  (NOT=EXP.FREQ.)
10 LINEAR REG.
    WITH PLOTTER
11 PARABOLIC REG
    WITH PLOTTER
12 GENERAL X-Y
    WITH PLOTTER
13 X-R CONTROL
      CHART WITH
         PLOTTER
14 RANDOM NUMBER
    GENERATOR
15 FAMILY
    REGRESSION
    WITH PLOTTER
16 NORMAL
     PROBABILITY
17 F PROBABILITY
18 T PROBABILITY
19 CHI-SQUARE
     PROBABILITY

ENTER NUMBER OF
DESIRED PROGRAM
```

```
****************
*    BASIC     *
* STATISTICS   *
****************

   DATA LISTING:

          12.5600
          13.1400
          11.2400
           9.8000
          14.3200
          15.9600
          16.2300
          12.3800

****************

SAMPLE STATS:

MEAN      13.2038
VARIANCE   4.9343
STD. DEV.  2.2213
N          8.0000

 CENTRAL MOMENTS

2ND        4.3175
3RD        0.2765
4TH       36.6082

  COEFFICIENTS

SKEWNESS  0.0252
KURTOSIS  1.5036

GEOM.MEAN
          13.0376
HARM.MEAN
          12.8698

****************
```

```
****************
*    FAMILY    *
* REGRESSION   *
****************

X-MIN          0.00
X-MAX         10.00

Y-MIN          0.00
Y-MAX         10.00

****************

X
Y

                0.52
                0.41

****************
MODEL NO.--MODEL

1     Y=A+BX
2     Y=A+B/X
3   1/Y=A+B/X
4     Y=A+B√X
5     Y=Ae↑(BX)
6     Y=AX↑B
7     Y=A+BlnX
8     Y=A+BX+CX↑2

MODEL NO.       7
MODEL
Y = A + BlnX
A              1.97
B              1.05
RSQUARE        0.81
S(Y/X)         0.46
F             30.54

****************
```

Listing and Examples of Programs From Volume 1

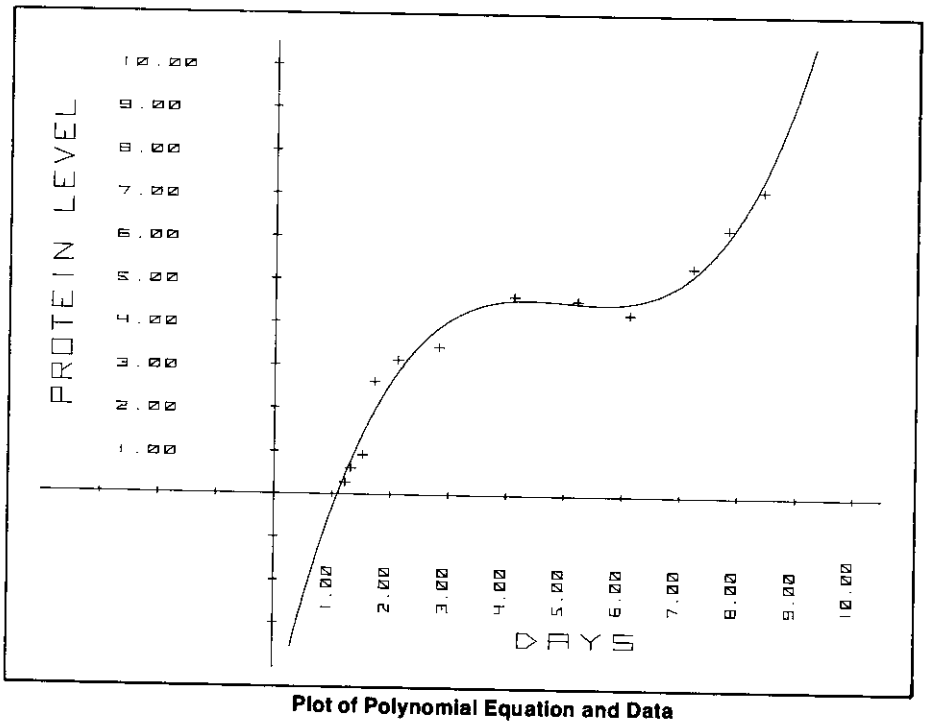


STATISTICS, VOLUME 2
ANALYSIS OF VARIANCE AND REGRESSION ANALYSIS

This collection of programs provides you with the most widely used classical statistical analysis techniques available today. The tremendous power and flexibility of the 9825 is amply demonstrated by these programs. Who would believe that something only as big as yesterday's adding machine could be calculating the coefficients for an 11-variable multiple regression or analyzing a three-way analysis of variance, providing complete tables of means, and permitting contrast calculations? Whether it is a tough regression, or model building problem of production yields, or an attempt to find that new and better process with analysis of variance, your data won't be confined to those black, three-ring binders any longer with the 9825 and Volume 2 of the 9825 Statistics Library.

Here are the programs in Volume 2 (Part Number 09825-15010):

- One-Way Analysis of Variance - Performs a one-way AOV for balanced or unbalanced design providing cell means, complete AOV table, comparisons between treatments, and Bartlett's test.
- Two-Way Analysis of Variance - Performs a complete two-way AOV for a balanced design, calculating and printing cell means and variances, row and column means, and overall means. A complete AOV table is printed as well as allowing row or column contrasts.
- Three-Way Analysis of Variance - Performs a complete three-way AOV. Also main effect, two-way, and overall means are printed; and comparisons can be made between the means of any factor.
- Latin Square Analysis - Calculates and prints a complete latin square AOV, as well as row, column treatment, and overall means.
- Analysis of Covariance - Calculates a complete analysis of covariance table for equal numbers of observations per treatment. The number of treatments must be less than 40.
- Multiple Linear Regression - Fits an equation of the form $y = b_0 + b_1x_1 + \ldots + b_kx_k$ to data sets of the form $y,x_1,\ldots,x_k$, $k \leq 11$. Any incorrect data may be edited and a data set may be added or deleted. The output includes means and variances for each variable, the correlation matrix, a complete analysis of variance table, and the regression coefficients.
- Polynomial Regression - Fits a p_{th} degree polynomial to data of the form (x_i,y_i) where $p \leq 9$. The model is $y = b_0+b_1x+b_2x^2+ \ldots + b_px^p$.
- Data entry is from keyboard. Any incorrect data may be edited and a data set may be added or deleted. The output includes means and variances of x and y, a simple correlation coefficient, a complete analysis of variance table, and the regression coefficients.
- F, t, and χ^2 Distributions - To improve the convenience of this volume, the F, t, and χ^2 distributions have been included and eliminate the need for distribution tables. This program calculates probabilities for F, t, and χ^2 distributions. For an F probability, given a numerator degrees of freedom, a denominator degrees of freedom, and an F value, this program calculates the probability that an F random variable has a value greater than or equal to the input value. For at and χ^2 probability, given a t and χ^2 value with n degrees of freedom, this program calculates the probability that a t and χ^2 random variable is greater than or equal to the input value.
- Family Regression - This program generates eight different models similar to the program in Volume 1 of the 9825 Statistics Library.



Plot of Polynomial Equation and Data

```
****************
*  POLYNOMIAL  *
*  REGRESSION  *
****************


X-MIN          0.00
X-MAX         10.00
Y-MIN          0.00
Y-MAX         10.00
MAX DEG        6.00

    DATA LISTING:

                1.20
                0.25

                1.30
                0.59

                1.50
                0.91


X
 MEAN           3.92
 VAR            7.31
 STDEV          2.70

Y
 MEAN           3.36
 VAR            4.96
 STDEV          2.23

RXY
                0.93

COEFF
 A0
 .
 .
 AK
               -5.38
                6.09
               -1.23
                0.08


RSQUARE        0.98


        AOV
SS
 TOT
 MEAN
 TOT ADJ
 REG
 RES
             206.61
             147.03
              59.58
              58.17
               1.41
DF
 TOT
 REG
 RES
              12.00
               3.00
               9.00
MS
 REG           19.39
 RES            0.16

FRATIO        124.14
```

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STATISTICS, VOLUME 3
NONPARAMETRICS

- One Sample - Data that is gathered under one set of experimental conditions is considered as one sample or a single vector of observations. It usually represents a sample or set of measurements on a larger population in an attempt to determine properties of that larger population, rather than having to measure every value. Some of the reasons for one sample analysis are to obtain the basic statistics that represent the data, i.e., mean, standard deviation, largest value, or smallest value. These are all basic techniques that permit a characterization or a description of the population, instead of presenting every point in the population (a complete but rather dry description). All of these descriptive statistics are presented in the one sample ranking program in Volume 3.
- Independent Sample - When data is gathered in a manner such that the observations in the first sample are not related to the observations in the second sample, we say that we have two independent samples.

```
*****************
*  ONE SAMPLE   *
*     BASIC     *
*  STATISTICS   *
*****************

DATA
              12.30
               2.60
              14.50
               3.65
              11.50
               8.90
               2.58
               9.75
               4.50
 ***************

ORDERED DATA
               2.58
               2.60
               3.65
               4.50
               8.90
               9.75
              11.50
              12.30
              14.50

N                 9

MEAN           7.81

MEDIAN         8.90

MIDRANGE       8.54

VARIANCE      20.78

STD. DEV.      4.56

RANGE         11.92

 ***************
```

The nonparametric tests available in Volume 3 can be used to determine whether the population responses for the first sample are significantly different from the second sample based on these samples. The two tests available for two independent samples and the general hypothesis which can be tested are:

1. Median Test - Both populations have the same median. The test procedure assumes that the distributions do not differ except in terms of their median.
2. Mann-Whitney Test - The probability functions are the same, i.e., the population distributions have the same shape. The probability that a control observation is greater than an experimental value is 1/2. Quite frequently this test is used to determine whether the "average" values are the same between two populations.

- Two Paired Samples - For the situation in which the observations in the first sample are paired or related to the observations in the second sample, we will, of course, have exactly the same number of observations in each sample. Four keys have been defined for this situation, in addition to the data entry key.
  The relationship between two treatments (or groups) of paired observations may be studied by looking at the correlation between the pair. In order to calculate the correlation between the X's and Y's, two measures of correlation on the ranks of the original data are available. Spearman's Rho determines the ranks for the X's and the ranks for the Y's and then calculates the ordinary correlation coefficient on the ranks. The Kendall's Tau rank correlation is slightly more complicated.

```
*****************
*   KENDALL'S   *
*      TAU      *
*****************

NUMBER OF
CONCORDANT
PAIRS=            5

NUMBER OF
DISCORDANT
PAIRS=            0

TAU=           0.83

Z=            -0.87

*****************
```

Two other tests are available to determine whether the X group (treatment one) is significantly different from the Y group (treatment two). Both tests eliminate the effects of the pairing of the observations in order to measure true group difference. These tests and their hypotheses are:

1. The Sign Test - Prob. X>Y = P [X<Y] = 1/2
   This test really is a binomial test equivalent to determining whether a coin is balanced (one half, heads; one half, tails).
2. Wilcoxon Signed Rank Test - The values of X tend to be about the same as the values of Y. The average values are about the same. This test is equivalent to the paired t-test.

```
*****************
*   WILCOXON    *
*  SIGNED RANK  *
*     TEST      *
*****************


SUM. OF RANKS OF
POSITIVE
DIFFERENCES= 7.5

NUMBER OF DIFF.
EQUAL TO ZERO= 0

STANDARD
NORMAL
DEVIATE=
              0.91
 ***************
```

SYSTEM REQUIREMENTS

All programs can be run on a basic 4k byte 9825A. The 9862A Plotter and general I/O ROM are optional.

ORDERING INFORMATION

Any or all of the 9825 statistics software volumes can be ordered through your local HP sales office. Ask for the following:

Description	Part Number
9825 Statistics, Volume 1	- 09825-15000
9825 Statistics, Volume 2	- 09825-15010
9825 Statistics, Volume 3	- 09825-15020
9825 Statistics Library (Vol. 1,2, and 3)	- 09825-15030

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