HEWLETT hp PACKARD

HP-65

STAT PAC 1

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INTRODUCTION

Programs for your HP-65 Stat Pac 1 have been selected from the areas of general statistics, distribution functions, curve fitting and test statistics.

Each program includes a general description, formulas used in the program solution, numerical examples, and user instructions. Program listings and register allocations are given in the back of the Pac.

Some related individual programs were combined on one card when it seemed they might be useful together. In this way more programs could be included in the Pac.

We hope you find the HP-65 Stat Pac 1 a useful tool for your computational work, and welcome your comments, requests and suggestions—these are our most important source of future user-oriented programs.

FORMAT OF USER INSTRUCTIONS

The following is an example of a set of User Instructions.

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Clear registers		A		
3	Perform 3–4 for i=1, ..., n	a_i	↑		
4		b_i	B		
5			C		Answer
	(To run a new case, go to 2)				

To follow the instructions, start with line 1 and read from left to right, performing indicated operations as you proceed. Lines having no numbers contain special notes to the user and are inside parentheses in the INSTRUCTIONS column. The message "To run a new case, go to 2" following line 5 in the above example is a special note.

Lines are read in sequential order except where the INSTRUCTIONS column directs otherwise. For example, "go to 2" means to jump to line 2. Repeated processes–used in most cases for a long string of input/output data–are outlined with a bold border together with a "Perform" instruction. In the above example, "Perform 3–4 for i = 1, ..., n" means to execute the loop (line 3 and line 4) n times. The first time, the dummy variable i takes the value 1; the second time i takes the value 2; etc.

Normally, as in the above example, the first instruction is "Enter program" which means load the preprogrammed magnetic card (for instructions of loading a card, see "Entering A Program" on P. 7). Some instructions are self-contained and can be carried out by just reading the INSTRUCTIONS column alone, e.g., "Enter program". But some instructions depend on the information supplied by the DATA and/or KEYS columns. In line 2 of the example above, "Clear registers" appears in the INSTRUCTIONS column and **A** appears in the KEYS column, which means you have to clear the working registers by pressing the **A** key.

The DATA column specifies the input data to be supplied. Invalid arguments which result in division by zero, finding square root of a negative number, etc. will result in flashing zeros. Arguments out of the designated program range will result in incorrect answers or flashing zeros. When a computed value exceeds the calculator range, an overflow or underflow occurs and halts the program.

The KEYS column specifies the keys to be pressed. [↑] is the symbol used to denote the [ENTER↑] key. All other key designations are identical to those appearing on the HP-65. Ignore any blank positions in the KEYS column.

The DISPLAY column may show counters, intermediate or final results. In line 5 of the example, the answer will be displayed after pressing the [C] key.

ENTERING A PROGRAM

From the card case supplied with this application pac, select a program card.

Set W/PRGM-RUN switch to RUN.

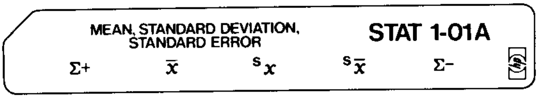
Turn the calculator ON. You should see 0.00

Gently insert the card (printed side up) in the right, lower slot as shown. When the card is part way in, the motor engages it and passes it out the left side of the calculator. Sometimes the motor engages but does not pull the card in. If this happens, push the card a little farther into the machine. Do not impede or force the card; let it move freely. (The display will flash if the card reads improperly. In this case, press [CLX] and reinsert the card.)

When the motor stops, remove the card from the left side of the calculator and insert it in the upper "window slot" on the right side of the calculator.

The program is now stored in the calculator. It remains stored until another program is entered or the calculator is turned off.

MEAN, STANDARD DEVIATION, STANDARD ERROR



Given a set of data points

$$\{x_1, x_2, \ldots, x_n\}$$

the program computes the following statistics:

mean $\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$

standard deviation $s_x = \sqrt{\frac{\Sigma x_i^2 - n\bar{x}^2}{n-1}}$

$\left(\text{or } s_x' = \sqrt{\frac{\Sigma x_i^2 - n\bar{x}^2}{n}}\right)$

standard error of the mean $s_{\bar{x}} = \frac{s_x}{\sqrt{n}}$

$\left(\text{or } s_{\bar{x}}' = \frac{s_x'}{\sqrt{n}}\right)$

Notes:

1. $n, \Sigma x_i, \Sigma x_i^2$ are in registers R_1, R_2, R_3.
2. To remove erroneous data, key in that data value and press **E**. "Σ–" is the operational inverse of "Σ+".
3. n is a positive integer and $n > 1$.
4. Due to roundoff errors, flashing zeros may be returned for the standard deviation when it is very small relative to the mean.

Example:

The set of numbers $\{2, 3.4, 7, 11, 23, 3.41\}$ has

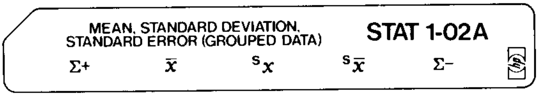
$\bar{x} = 8.30$

$s_x = 7.91$ $s_x' = 7.22$

$s_{\bar{x}} = 3.23$ $s_{\bar{x}}' = 2.95$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		RTN	R/S	
3	Perform 3 for $i = 1, 2, \ldots, n$	x_i	A		i
	(Correct erroneous data x_k)	x_k	E		
4	Compute $\bar{x}$		B		$\bar{x}$
5	Compute s_x		C		s_x
	(optional)		R/S		s_x'
6	Compute $s_{\bar{x}}$		D		$s_{\bar{x}}$
	(optional)		R/S		$s_{\bar{x}}'$
	(For a new case, go to 2)				

MEAN, STANDARD DEVIATION, STANDARD ERROR (GROUPED DATA)



Given a set of data points

$$x_1, x_2, \ldots, x_n$$

with respective frequencies

$$f_1, f_2, \ldots, f_n$$

the program computes the following statistics:

$$\text{mean } \bar{x} = \frac{\Sigma f_i x_i}{\Sigma f_i}$$

$$\text{standard deviation } s_x = \sqrt{\frac{\Sigma f_i x_i^2 - (\Sigma f_i)\bar{x}^2}{\Sigma f_i - 1}}$$

$$\left(\text{or } s_x{}' = \sqrt{\frac{\Sigma f_i x_i^2 - (\Sigma f_i)\bar{x}^2}{\Sigma f_i}}\right)$$

$$\text{standard error } s_{\bar{x}} = \frac{s_x}{\sqrt{\Sigma f_i}}$$

$$\left(\text{or } s_{\bar{x}}{}' = \frac{s_x{}'}{\sqrt{\Sigma f_i}}\right)$$

Notes: 1. Σf_i, $\Sigma f_i x_i$, $\Sigma f_i x_i^2$, n are in registers R_1, R_2, R_3, R_4.

2. To remove erroneous data x_k, f_k:

   x_k [↑] f_k [E]

   "Σ−" is the operational inverse of "Σ+".

3. n is a positive integer and $n > 1$.

Example:

x_i	2	3.4	7	11	23	3.41
f_i	5	3	4	2	3	1

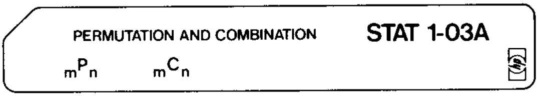
$\bar{x} = 7.92$

$s_x = 7.52$ $\qquad s_x' = 7.31$

$s_{\bar{x}} = 1.77$ $\qquad s_{\bar{x}}' = 1.72$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		RTN	R/S	
3	Perform 3–4 for i = 1, 2, ..., n	x_i	↑		
4		f_i	A		i
	(Correct erroneous data x_k, f_k)	x_k	↑		
		f_k	E		
5	Compute $\bar{x}$		B		$\bar{x}$
6	Compute s_x		C		s_x
	(optional)		R/S		s_x'
7	Compute $s_{\bar{x}}$		D		$s_{\bar{x}}$
	(optional)		R/S		$s_{\bar{x}}'$
	(For a new case, go to 2)				

PERMUTATION AND COMBINATION



$$_mP_n = \frac{m!}{(m-n)!} = m(m-1)\ldots(m-n+1)$$

$$_mC_n = \frac{m!}{(m-n)!\,n!} = \frac{m(m-1)\ldots(m-n+1)}{1\cdot 2\cdot\ldots\cdot n}$$

where m, n are integers and $0 \leqslant n \leqslant m$.

Notes: 1. $_mP_0 = 1$, $_mP_1 = m$, $_mP_m = m!$

2. $_mC_0 = {_mC_m} = 1$

3. $_mC_1 = {_mC_{m-1}} = m$

4. $_mC_n = {_mC_{m-n}}$

Examples:

1. $_{27}P_5$ = 9687600.00

2. $_{73}C_4$ = 1088430.00

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute $_mP_n$	m	↑		
3		n	A		$_mP_n$
4	Compute $_mC_n$	m	↑		
5		n	B		$_mC_n$

ARITHMETIC, GEOMETRIC, HARMONIC AND GENERALIZED MEANS

ARITHMETIC, GEOMETRIC, HARMONIC AND GENERALIZED MEANS			STAT 1-04A	
a_k	A	G	H	M(t)

Arithmetic mean

$$A = \frac{a_1 + \ldots + a_n}{n}$$

Geometric mean

$$G = (a_1 a_2 \ldots a_n)^{\frac{1}{n}}$$

Harmonic mean

$$H = \frac{n}{\frac{1}{a_1} + \frac{1}{a_2} + \ldots + \frac{1}{a_n}}$$

Generalized mean

$$M(t) = \left(\frac{1}{n} \sum_{k=1}^{n} a_k{}^t \right)^{\frac{1}{t}}$$

Notes: 1. $a_k > 0, k = 1, 2, \ldots, n$

2. $M(1) = A$
$M(-1) = H$

Examples:

The set of numbers $\{2, 3.4, 3.41, 7, 11, 23\}$ has

A = 8.30

G = 5.87

H = 4.40

M(1) = 8.30

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		RTN	R/S	
3	If M(t) is desired	t	R/S		
4	Perform 4 for k=1, 2, ..., n	a_k	A		k
5	Compute A		B		A
6	Compute G		C		G
7	Compute H		D		H
8	Compute M(t)		E		M(t)

SUMS FOR TWO VARIABLES

SUMS FOR TWO VARIABLES			STAT 1-05A
$\Sigma+$	$\Sigma-$	Sums	

This program computes sums for a set of given data

$$\left\{ (x_i, y_i), i = 1, 2, ..., n \right\}.$$

n, Σx_i, Σx_i^2, Σy_i, Σy_i^2, $\Sigma x_i y_i$ are in registers R_1 through R_6.

This program can be used in conjunction with *Stat 1–22A, Linear Regression,* to fit a linear regression line or *Stat 1–06A, Basic Statistic (Two Variables),* to obtain means, standard deviations, covariance and correlation coefficient.

Example:

x_i	26	30	44	50	62	68	74
y_i	92	85	78	81	54	51	40

$n = 7.00$

$\Sigma x_i = 354.00$

$\Sigma x_i^2 = 19956.00$

$\Sigma y_i = 481.00$

$\Sigma y_i^2 = 35451.00$

$\Sigma x_i y_i = 22200.00$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		f	REG	
3	Perform 3–4 for i=1, 2,...,n	x_i	↑		
4		y_i	A		i
	(Correct erroneous data x_k, y_k)	x_k	↑		
		y_k	B		
5			C		n
6			R/S		Σx_i
7			R/S		Σx_i^2
8			R/S		Σy_i
9			R/S		Σy_i^2
10			R/S		$\Sigma x_i y_i$
	(To run a new case, go to 2)				

BASIC STATISTICS (TWO VARIABLES)

BASIC STATISTICS (TWO VARIABLES)			STAT 1-06A
$\bar{x},\bar{y}$	s_x, s_y	s_{xy}	r_{xy}

This program must be used in conjunction with *Stat 1–05A, Sums for Two Variables,* to compute means, standard deviations, covariance and correlation coefficient derived from a set of data points

$$\{(x_i, y_i), i = 1, 2, ..., n\}.$$

means $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad \bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$

standard deviations $s_x = \sqrt{\frac{\Sigma x_i^2 - n\bar{x}^2}{n-1}}$

$$\left(\text{or } s_x' = \sqrt{\frac{\Sigma x_i^2 - n\bar{x}^2}{n}}\right)$$

$$s_y = \sqrt{\frac{\Sigma y_i^2 - n\bar{y}^2}{n-1}}$$

$$\left(\text{or } s_y' = \sqrt{\frac{\Sigma y_i^2 - n\bar{y}^2}{n}}\right)$$

covariance $s_{xy} = \frac{1}{n-1}\left(\Sigma x_i y_i - \frac{1}{n}\Sigma x_i \Sigma y_i\right)$

$$\left(\text{or } s_{xy}' = \frac{1}{n}\left[\Sigma x_i y_i - \frac{1}{n}\Sigma x_i \Sigma y_i\right]\right)$$

correlation coefficient $r_{xy} = \frac{s_{xy}}{s_x s_y} = \frac{s_{xy}'}{s_x' s_y'}$

Note: n is a positive integer and $n > 1$.

Example:

x_i	26	30	44	50	62	68	74
y_i	92	85	78	81	54	51	40

$\bar{x} = 50.57$, $\bar{y} = 68.71$

$s_x = 18.50$, $s_y = 20.00$

$s_x' = 17.13$, $s_y' = 18.51$

$s_{xy} = -354.14$

$s_{xy}' = -303.55$

$r_{xy} = -0.96$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program *Stat 1–05A*				
2	Initialize		f	REG	
3	Perform 3–4 for i = 1, 2, ..., n	x_i	↑		
4		y_i	A		i
	(Correct erroneous data x_k, y_k)	x_k	↑		
		y_k	B		
5	Enter program *Stat 1–06A*				
6			A		$\bar{x}$
7			R/S		$\bar{y}$
8			B		s_x
9			R/S		s_y
	(optional)		R/S		s_x'
	(optional)		R/S		s_y'
10			C		s_{xy}
	(optional)		R/S		s_{xy}'
11			D		r_{xy}

MOMENTS, SKEWNESS AND KURTOSIS (FOR GROUPED OR UNGROUPED DATA)

MOMENTS, SKEWNESS AND KURTOSIS			STAT 1-07A 1
$\Sigma+$	$\Sigma-$	$\Sigma+(f_i)$	$\Sigma-(f_i)$

MOMENTS, SKEWNESS AND KURTOSIS				STAT 1-07A 2
$\bar{x}$	m_2	m_3	m_4	γ_1, γ_2

This program computes the following statistics for a set of given data $\{x_1, x_2, ..., x_n\}$:

1st moment $$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$$

2nd moment $$m_2 = \frac{1}{n} \Sigma x_i^2 - \bar{x}^2$$

3rd moment $$m_3 = \frac{1}{n} \Sigma x_i^3 - \frac{3}{n} \bar{x} \Sigma x_i^2 + 2\bar{x}^3$$

4th moment $$m_4 = \frac{1}{n} \Sigma x_i^4 - \frac{4}{n} \bar{x} \Sigma x_i^3 + \frac{6}{n} \bar{x}^2 \Sigma x_i^2 - 3\bar{x}^4$$

Moment coefficient of skewness

$$\gamma_1 = \frac{m_3}{m_2^{3/2}}$$

Moment coefficient of kurtosis

$$\gamma_2 = \frac{m_4}{m_2^{2}}$$

This program also provides the option for computing those statistics for grouped data (using similar formulas as for ungrouped data):

data	y_1	y_2	...	y_m
frequency	f_1	f_2	...	f_m

Reference: Theory and Problems of Statistics, M. R. Spiegel, Schaum's Outline, McGraw-Hill, 1961

Examples:

1. Ungrouped data

i	1	2	3	4	5	6	7	8	9
x_i	2.1	3.5	4.2	6.5	4.1	3.6	5.3	3.7	4.9

$\bar{x} = 4.21$, $m_2 = 1.39$, $m_3 = 0.39$, $m_4 = 5.49$

$\gamma_1 = 0.24$, $\gamma_2 = 2.84$

2. Grouped data

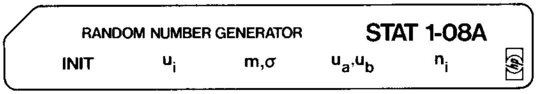
j	1	2	3	4	5
y_j	3	2	4	6	1
f_j	4	5	3	2	1

$\bar{x} = 3.13$, $m_2 = 1.98$, $m_3 = 2.14$, $m_4 = 11.05$

$\gamma_1 = 0.77$, $\gamma_2 = 2.81$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program on card 1				
2	Initialize		f	REG	
3	For grouped data, go to 12				
4	Perform 4 for i=1,2,...,n	x_i	A		i
	(Correct erroneous data x_k)	x_k	B		
5	Enter program on card 2				
6			A		$\bar{x}$
7			B		m_2
8			C		m_3
9			D		m_4
10			E		γ_1
11			R/S		γ_2
	(For a new case, go to 1)				
12	Perform 12–13 for j=1,2,...,m	y_j	↑		
13		f_j	C		
	(Correct erroneous data y_h, t_h)	y_h	↑		
		f_h	D		
14	Go to 5				

RANDOM NUMBER GENERATOR



This program calculates:

(1) Uniformly distributed random numbers u_i in the range

$$0 \leqslant u_i \leqslant 1$$

using the following formula:

$$u_i = \text{Fractional part of } [(\pi + u_{i-1})^8]$$

Initial value $u_0 = 0$ is used.

(2) Normally distributed random numbers n_i with mean m and standard deviation σ. The technique involves transforming uniform random variables to normal variables by the formulas:

$$N_i = (-2 \ln u_i)^{1/2} \cos (2\pi\, u_{i+1})$$

$$N_{i+1} = (-2 \ln u_i)^{1/2} \sin (2\pi\, u_{i+1})$$

where u_i, u_{i+1} are independent uniform random variables,

$$0 < u_i < 1.$$

The N_i thus generated are normally distributed with mean zero and unity variance.

Numbers N_i are used to generate a more general set of normally distributed numbers with mean m and standard deviation σ by

$$n_i = \sigma N_i + m$$

$$n_{i+1} = \sigma N_{i+1} + m$$

Note: Two initializing uniform random numbers u_a, u_b must be specified by the user, such that

$$u_a \neq u_b$$

$$0 < u_a < 1$$

$$0 < u_b < 1$$

Reference: Handbook of Mathematical Functions, U.S. Dept. of Commerce, Applied Mathematics Series, 1964

Examples:

1. The following uniformly distributed pseudo random numbers are generated:

   0.53, 0.52, 0.39, 0.49, 0.97, 0.29, 0.65, 0.30, 0.40, 0.06, 0.14, 0.16, 0.68, 0.22, ...

2. If $m = 2$, $\sigma = 1$, $u_a = 0.23$, $u_b = 0.82$ then the following pseudo normal numbers are obtained:

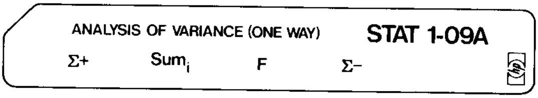
   2.73, 0.45, 2.52, 1.19, 3.51, 2.75, 1.79, 1.83, 1.00, 0.87, 1.90, 1.62, 1.74, 1.92, 1.24, 2.68, ...

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	For normal numbers, go to 5				
3	Initialize		A		
4	Perform 4 for i=1,2,3,...		B		u_i*
5	Store m, σ	m	↑		
6		σ	C		
7	Store u_a, u_b	u_a	↑		
8		u_b	D		
9	Perform 9 for i=1,2,3,...		E		n_i
	(Machine is set to RAD mode				
	in subroutine E)				

*If a different sequence of numbers is desired, choose a starting value u_0 such that $0 \leqslant u_0 \leqslant 1$ and do:

1. u_0 STO 1
2. Skip step 3 and perform step 4.

ANALYSIS OF VARIANCE (ONE WAY)



The one-way analysis of variance tests the differences between the population means of k treatment groups. Group i (i = 1, 2, ..., k) has n_i observations (treatment group may have equal or unequal number of observations).

$$\text{Sum}_i = \text{sum of observations in treatment group } i$$

$$= \sum_{j=1}^{n_i} x_{ij}$$

$$\text{Total SS} = \sum_{i=1}^{k} \sum_{j=1}^{n_i} x_{ij}^2 - \frac{\left(\sum_{i=1}^{k} \sum_{j=1}^{n_i} x_{ij} \right)^2}{\sum_{i=1}^{k} n_i}$$

$$\text{Treat SS} = \sum_{i=1}^{k} \frac{\left(\sum_{j=1}^{n_i} x_{ij} \right)^2}{n_i} - \frac{\left(\sum_{i=1}^{k} \sum_{j=1}^{n_i} x_{ij} \right)^2}{\sum_{i=1}^{k} n_i}$$

$$\text{Error SS} = \text{Total SS} - \text{Treat SS}$$

$$df_1 = \text{Treat df} = k - 1$$

$$df_2 = \text{Error df} = \sum_{i=1}^{k} n_i - k$$

$$\text{Treat MS} = \frac{\text{Treat SS}}{\text{Treat df}}$$

$$\text{Error MS} = \frac{\text{Error SS}}{\text{Error df}}$$

$$F = \frac{\text{Treat MS}}{\text{Error MS}} \qquad \left(\text{with } k - 1 \text{ and } \sum_{i=1}^{k} n_i - k \text{ degrees of freedom}\right)$$

Total SS, Treat SS, Error SS are in registers R_1, R_2, R_3.

Note: Erroneous data of the current treatment group can be corrected by entering the value then pressing **D** key.

Reference: Mathematical Statistics, J.E. Freund, Prentice Hall, 1962

Example:

	i \ j	1	2	3	4	5	6
	1	10	8	5	12	14	11
Treatment	2	6	9	8	13		
	3	14	13	10	17	16	

Sum_1 = 60.00

Sum_2 = 36.00

Sum_3 = 70.00

F = 3.79

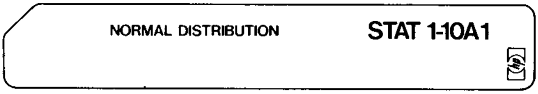
df_1 = 2.00

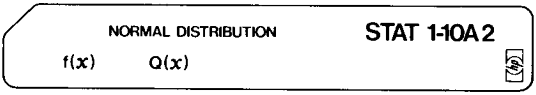
df_2 = 12.00

LINE	INSTRUCTIONS	DATA	KEYS	DISPLAY
1	Enter program			
2	Initialize		f REG	
3	Perform 3–5 for i=1,2,...,k			
4	Perform 4 for j=1,2,...,n_i	x_{ij}	A	j
	(Correct erroneous data x_{im})	x_{im}	D	
5			B	Sum_i
6			C	F
7			R/S	df_1
8			R/S	df_2

(For a new case, go to 2)

NORMAL DISTRIBUTION

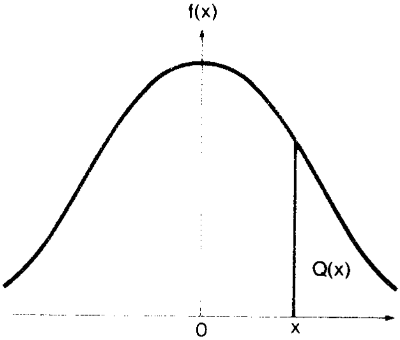




For a standard normal distribution

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^\infty e^{-\frac{t^2}{2}} dt$$



For $x \geqslant 0$, polynomial approximation is used to compute Q(x):

$$Q(x) = f(x)\,(b_1 t + b_2 t^2 + b_3 t^3 + b_4 t^4 + b_5 t^5) + \epsilon(x)$$

where $|\epsilon(x)| < 7.5 \times 10^{-8}$

$$t = \frac{1}{1 + rx}, \quad r = 0.2316419$$

$b_1 = .31938153, \quad b_2 = -.356563782$

$b_3 = 1.781477937, \quad b_4 = -1.821255978$

$b_5 = 1.330274429$

Note: $f(-x) = f(x)$, $Q(-x) = 1 - Q(x)$

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

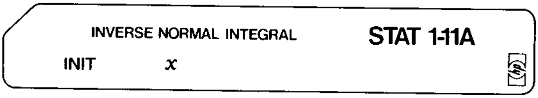
Examples:

1. $f(1.18) = 0.20$
   $Q(1.18) = 0.12$

2. $f(2.28) = 0.03$
   $Q(2.28) = 0.01$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program on card 1				
2			A		
3	Enter program on card 2				
4		x	A		f(x)
5			B		Q(x)
	(For a new x, go to 4)				

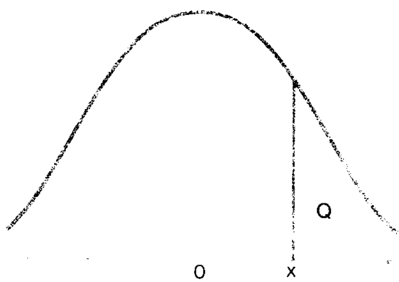
INVERSE NORMAL INTEGRAL



This program determines the value of x such that

$$Q = \int_x^{\infty} \frac{e^{-\frac{t^2}{2}}}{\sqrt{2\pi}}\, dt$$

where Q is given and $0 < Q \leqslant 0.5$.



The following rational approximation is used:

$$x = t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3} + \epsilon(Q)$$

where $|\epsilon(Q)| < 4.5 \times 10^{-4}$

$$t = \sqrt{\ln \frac{1}{Q^2}}$$

$c_0 = 2.515517$ $\quad d_1 = 1.432788$

$c_1 = 0.802853$ $\quad d_2 = 0.189269$

$c_2 = 0.010328$ $\quad d_3 = 0.001308$

Note: If $Q > 0.5$, or $Q \leqslant 0$, flashing zeros will indicate the error.

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

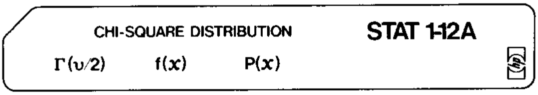
Examples:

1. $Q = 0.12$
   $x = 1.18$

2. $Q = 0.05$
   $x = 1.65$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2			A		
3		Q	B		x
	(For a new Q, go to 3)				

CHI-SQUARE DISTRIBUTION

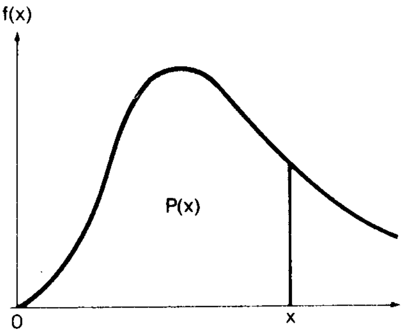


This program evaluates the chi-square density

$$f(x) = \frac{1}{2^{\frac{\nu}{2}}\,\Gamma\left(\frac{\nu}{2}\right)}\; x^{\frac{\nu}{2}-1}\, e^{-\frac{x}{2}}$$

where $x \geqslant 0$

ν is the degrees of freedom.



Series approximation is used to evaluate the cumulative distribution

$$P(x) = \int_0^x f(t)\,dt$$

$$= \left(\frac{x}{2}\right)^{\frac{\nu}{2}} \frac{e^{-\frac{x}{2}}}{\Gamma\left(\frac{\nu+2}{2}\right)} \left[1 + \sum_{k=1}^{\infty} \frac{x^k}{(\nu+2)(\nu+4)\ldots(\nu+2k)}\right]$$

The program computes successive partial sums of the above series. When two consecutive partial sums are equal, the value is used as the sum of the series.

Notes:

1. Program requires $\nu \leqslant 141$. If $\nu > 141$ and ν is even, then display shows all 9's for $\Gamma(\nu/2)$; if $\nu > 141$ and ν is odd, no warnings will be given, but answers are incorrect.
2. If both x and ν are large, f(x) may overflow the machine.
3. If ν is even,

$$\Gamma\left(\frac{\nu}{2}\right) = \left(\frac{\nu}{2} - 1\right)!$$

If ν is odd,

$$\Gamma\left(\frac{\nu}{2}\right) = \left(\frac{\nu}{2} - 1\right)\left(\frac{\nu}{2} - 2\right) \cdots \left(\frac{1}{2}\right)\Gamma\left(\frac{1}{2}\right)$$

4. $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

Examples:

1. $\nu = 20$, $\Gamma\left(\frac{\nu}{2}\right) = 362880.00$

   $f(9.591) = 0.02$, $P(9.591) = 0.03$

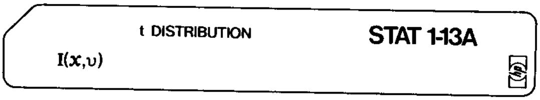
   $f(15) = 0.06$, $P(15) = 0.22$

2. $\nu = 3$, $\Gamma\left(\frac{\nu}{2}\right) = 0.89$

   $f(7.82) = 0.02$, $P(7.82) = 0.95$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		ν	A		$\Gamma(\nu/2)$
3	Compute f(x) and P(x)	x	B		f(x)
4			C		P(x)
	(For a different x, go to 3.				
	For a new case, go to 2)				

t DISTRIBUTION

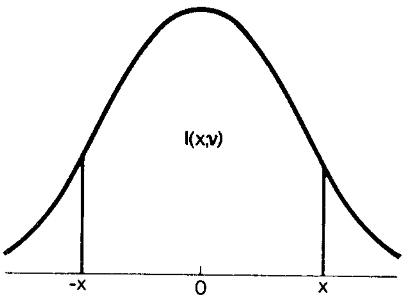


This program evaluates the integral for t distribution

$$I(x, \nu) = \int_{-x}^{x} \frac{\Gamma\left(\frac{\nu+1}{2}\right)\left(1 + \frac{y^2}{\nu}\right)^{-\frac{\nu+1}{2}}}{\sqrt{\pi\nu}\ \Gamma\left(\frac{\nu}{2}\right)} dy$$

where $x > 0$,

ν is the degrees of freedom.



Formulas used are:

(1) ν even

$$I(x, \nu) = \sin\theta \left\{1 + \frac{1}{2}\cos^2\theta + \frac{1 \cdot 3}{2 \cdot 4}\cos^4\theta + \dots + \frac{1 \cdot 3 \cdot 5 \dots (\nu-3)}{2 \cdot 4 \cdot 6 \dots (\nu-2)}\cos^{\nu-2}\theta\right\}$$

(2) ν odd

$$I(x,\nu) = \begin{cases} \dfrac{2\theta}{\pi} & \text{if } \nu = 1 \\ \dfrac{2\theta}{\pi} + \dfrac{2}{\pi}\cos\theta \left\{ \sin\theta \left[1 + \dfrac{2}{3}\cos^2\theta + \ldots \right.\right. & \\ \left.\left. + \dfrac{2\cdot 4 \ldots (\nu-3)}{1\cdot 3 \ldots (\nu-2)} \cos^{\nu-3}\theta \right]\right\} & \text{if } \nu > 1 \end{cases}$$

where $\theta = \tan^{-1}\left(\dfrac{x}{\sqrt{\nu}}\right)$

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

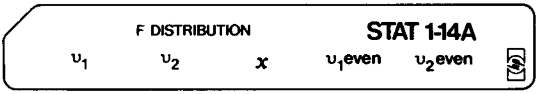
Example:

$I(2.201, 11) = 0.95$

$I(2.75, 30) = 0.99$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2		x	[↑]	[ ]	
3		ν	[A]	[ ]	$I(x, \nu)$
	(Machine now is in RAD mode)		[ ]	[ ]	

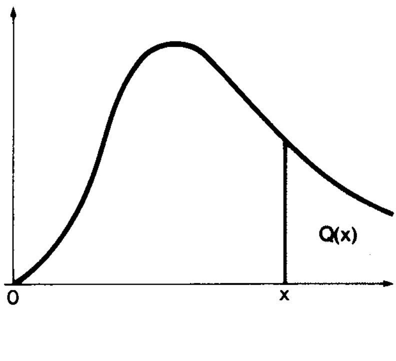
F DISTRIBUTION



This program evaluates the integral of the F distribution

$$Q(x) = \int_x^{\infty} \frac{\Gamma\left(\frac{\nu_1 + \nu_2}{2}\right) y^{\frac{\nu_1}{2} - 1} \left(\frac{\nu_1}{\nu_2}\right)^{\frac{\nu_1}{2}}}{\Gamma\left(\frac{\nu_1}{2}\right) \Gamma\left(\frac{\nu_2}{2}\right) \left(1 + \frac{\nu_1}{\nu_2} y\right)^{\frac{\nu_1 + \nu_2}{2}}} \, dy$$

for given values of x (>0), degrees of freedoms ν_1, ν_2, provided either ν_1 or ν_2 is even.



The integral is evaluated by means of the following series:

(1) ν_1 even

$$Q(x) = t^{\frac{\nu_2}{2}} \left[1 + \frac{\nu_2}{2}(1 - t) + \ldots + \frac{\nu_2(\nu_2 + 2) \ldots (\nu_2 + \nu_1 - 4)}{2 \cdot 4 \ldots (\nu_1 - 2)} (1 - t)^{\frac{\nu_1 - 2}{2}} \right]$$

(2) ν_2 even

$$Q(x) = 1 - (1-t)^{\frac{\nu_1}{2}} \left[1 + \frac{\nu_1}{2} t + \ldots + \frac{\nu_1(\nu_1+2)\ldots(\nu_2+\nu_1-4)}{2 \cdot 4 \ldots (\nu_2-2)} t^{\frac{\nu_2-2}{2}} \right]$$

where $t = \dfrac{\nu_2}{\nu_2 + \nu_1 x}$

Note: If both ν_1, ν_2 are even, the two formulas would generate identical answers. Using the smaller of ν_1, ν_2 could save computation time. For example, if $\nu_1 = 10$, $\nu_2 = 20$, then classify the problem as ν_1 is even and use the **D** key to obtain the answer.

Examples:

1. $\nu_1 = 7$, $\nu_2 = 6$

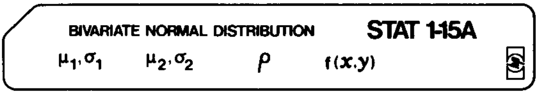
   $Q(4.21) = 0.05$

2. $\nu_1 = 4$, $\nu_2 = 20$

   $Q(2.25) = 0.10$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		ν_1	A		
3		ν_2	B		
4		x	C		
5	If ν_1 is even		D		Q(x)
6	If ν_2 is even		E		Q(x)
	(For a new case, go to 2)				

BIVARIATE NORMAL DISTRIBUTION



$$f(x,y) = \frac{1}{2\pi\,\sigma_1\sigma_2\,\sqrt{1-\rho^2}}\; e^{-P(x,y)}$$

where

$$P(x,y) = \frac{1}{2(1-\rho^2)}\left[\frac{(x-\mu_1)^2}{{\sigma_1}^2} - 2\rho\,\frac{(x-\mu_1)(y-\mu_2)}{\sigma_1\sigma_2} + \frac{(y-\mu_2)^2}{{\sigma_2}^2}\right]$$

Notes: 1. $\sigma_1 \neq 0, \sigma_2 \neq 0$

2. Program requires $\rho^2 < 1$.

Reference: Mathematical Statistics, J.E. Freund, Prentice Hall, 1962

Example:

$\mu_1 = -1,\ \sigma_1 = 1.5$

$\mu_2 = 1,\ \ \sigma_2 = 0.5$

$\rho = 0.7$

$f(1, 2) = 0.04$

$f(-1, 1) = 0.30$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		μ_1	↑		
3		σ_1	A		
4		μ_2	↑		
5		σ_2	B		
6		ρ	C		
7		x	↑		
8		y	D		f(x, y)
	(For new values of x, y go to 7)				

LOGARITHMIC NORMAL DISTRIBUTION

LOGARITHMIC NORMAL DISTRIBUTION			STAT 1-16A	
median	mode	mean	var	f(x)

If X is a random variable whose logarithm is normally distributed with mean m and variance σ^2, then X has a logarithmic normal distribution with density function

$$f(x) = \frac{1}{x\sqrt{2\pi\sigma^2}} e^{-\frac{1}{2\sigma^2}(\ln x - m)^2}$$

where $x > 0$

This program computes f(x) and the following statistics for given m, σ^2:

$$\text{median} = e^m$$

$$\text{mode} = e^{m-\sigma^2}$$

$$\text{mean} = e^{m+\sigma^2/2}$$

$$\text{variance} = e^{\sigma^2+2m}(e^{\sigma^2} - 1)$$

Note: Program requires $\sigma^2 \neq 0$.

Reference: Statistical Theory and Methodology in Science and Engineering, K.A. Brownlee, John Wiley & Sons, 1965

Example:

$m = 1, \ \sigma^2 = 1$

median = 2.72

mode = 1.00

mean = 4.48

variance = 34.51

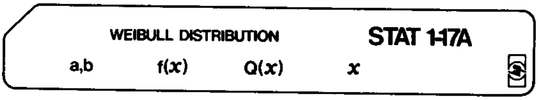
f(.1) = 0.02

f(.6) = 0.21

f(1) = 0.24

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		m	↑		
3		σ^2	A		median
4			B		mode
5			C		mean
6			D		variance
7	Compute f(x)	x	E		f(x)
	(For a different x, go to 7)				

WEIBULL DISTRIBUTION



This program can be used to find:

(1) $f(x) = ab\, x^{b-1} \exp(-ax^b)$

where $a > 0,\ b > 0,\ x > 0$

(2) $$Q(x) = \int_x^\infty ab\, t^{b-1} \exp(-at^b)\, dt$$

$$= \exp(-ax^b)$$

(3) x (for a given Q, $0 < Q < 1$), such that

$$Q = \int_x^\infty f(t)\, dt$$

The following formula is used:

$$x = \left(\frac{\ln Q}{-a}\right)^{\frac{1}{b}}$$

Reference: Statistics in Research, Bernard Ostle, Iowa State University Press, 1963

Example:

$a = 0.1, \; b = 0.8$

1. $f(3.2) = 0.05$
2. $Q(3.2) = 0.78$
3. If $Q = 0.5$, then $x = 11.25$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2		a	[↑]	[ ]	
3		b	[A]	[ ]	
4	Compute f(x), Q(x)	x	[B]	[ ]	f(x)
5			[C]	[ ]	Q(x)
6	Find x for a given Q	Q	[D]	[ ]	x

BINOMIAL DISTRIBUTION

	BINOMIAL DISTRIBUTION		STAT 1-18A
p,n	f(x)	P(x)	

This program evaluates the binomial density function for given p and n:

$$f(x) = \binom{n}{x} p^x (1 - p)^{n-x}$$

where n is a positive integer

$0 < p < 1$ and

$x = 0, 1, 2, ..., n$

The recursive relation

$$f(x+1) = \frac{p(n-x)}{(x+1)(1-p)} f(x)$$

$$(x = 0, 1, 2, ..., n - 1)$$

is used to find the cumulative distribution

$$P(x) = \sum_{k=0}^{x} f(k)$$

The mean m and the variance σ^2 are given by

$$m = np$$

$$\sigma^2 = np(1 - p)$$

Reference: Modern Probability Theory and its Applications, E. Parzen, John Wiley & Sons, 1960

Example:

$p = 0.49, \quad n = 6$

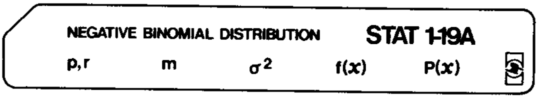
$m = 2.94, \quad \sigma^2 = 1.50$

$f(4) = 0.22$

$P(4) = 0.90$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2		p	[↑]	[ ]	
3		n	[A]	[ ]	m
4			[R/S]	[ ]	σ^2
5	Compute f(x) and P(x)	x	[B]	[ ]	f(x)
6			[C]	[ ]	P(x)
	(For a new value of x, go to 5)		[ ]	[ ]	

NEGATIVE BINOMIAL DISTRIBUTION



This program evaluates the negative binomial density function for given p and r:

$$f(x) = \binom{x+r-1}{r-1} p^r (1-p)^x$$

where r is a positive integer

$0 < p < 1$ and

$x = 0, 1, 2, \ldots$

The recursive relation

$$f(x+1) = \frac{(1-p)(x+r)}{x+1} f(x)$$

is used to find the cumulative distribution

$$P(x) = \sum_{k=0}^{x} f(k)$$

The mean m and the variance σ^2 are given by

$$m = \frac{r(1-p)}{p}$$

$$\sigma^2 = \frac{r(1-p)}{p^2}$$

Note: If we interpret p as the probability of success of a given event, then f(x) is the probability that exactly x + r trials will be required to get r successes.

Reference: Modern Probability Theory and its Applications, E. Parzen, John Wiley & Sons, 1960

Example:

$p = 0.9, \quad r = 4$

$m = 0.44$

$\sigma^2 = 0.49$

$f(1) = 0.26$

$P(1) = 0.92$

$f(2) = 0.07$

$P(2) = 0.98$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Enter p, r	p	↑		
3		r	A		
4	Compute mean m		B		m
5	Compute variance σ^2		C		σ^2
6	Compute f(x), P(x)	x	D		f(x)
7			E		P(x)
	(For a different x, go to 6)				

HYPERGEOMETRIC DISTRIBUTION

HYPERGEOMETRIC DISTRIBUTION			STAT 1-20A	
a,b	n	f(x)	P(x)	m,σ^2

This program evaluates the hypergeometric density function for given a, b and n:

$$f(x) = \frac{\binom{a}{x}\binom{b}{n-x}}{\binom{a+b}{n}}$$

where a, b, n are positive integers

$x \leqslant a,\ n - x \leqslant b$ and

$x = 0, 1, 2, \ldots, n$

The recursive relation

$$f(x+1) = \frac{(x-a)(x-n)}{(x+1)(b-n+x+1)} f(x)$$

$$(x = 0, 1, 2, \ldots, n-1)$$

is used to find the cumulative distribution

$$P(x) = \sum_{k=0}^{x} f(k)$$

The mean m and the variance σ^2 are given by

$$m = \frac{an}{a+b}$$

$$\sigma^2 = \frac{abn\,(a+b-n)}{(a+b)^2\,(a+b-1)}$$

Notes:
1. $f(0) = P(0)$
2. When x is large, due to round-off error, the computed value for P(x) might be slightly greater than one. In that case, let $P(x) = 1$.
3. This program requires $a + b \leqslant 69$.

Reference: Mathematical Statistics, J.E. Freund, Prentice Hall, 1962

Example:

Given a = 8, b = 12, n = 6, then

f(0) = P(0) = 0.02

f(3) = 0.32, P(3) = 0.86

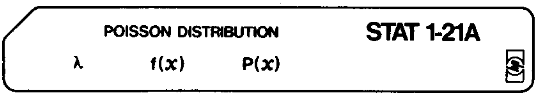
f(5) = 0.02, P(5) = 1.00

m = 2.40

σ^2 = 1.06

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		a	↑		
3		b	A		
4		n	B		f(0)
5	For x ⩾ 1	x	C		f(x)
6			D		P(x)
	(For a new value of x, go to 5.				
	For a new n, go to 4.				
	For different a, b, go to 2)				
7	Compute m, σ^2		E		m
8			R/S		σ^2

POISSON DISTRIBUTION



Density function

$$f(x) = \frac{\lambda^x e^{-\lambda}}{x!}$$

where $\lambda > 0$

$x = 0, 1, 2, \ldots$

Cumulative distribution

$$P(x) = \sum_{k=0}^{x} f(k)$$

This program evaluates f(x) and P(x) for a given λ using the recursive relation

$$f(x+1) = \frac{\lambda}{x+1} f(x)$$

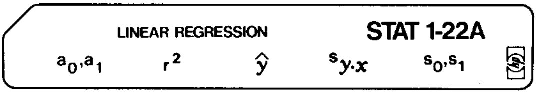
Note: Mean = variance = λ

Example:

$\lambda = 3.2$
$f(0) = 0.04$
$f(7) = 0.03$
$P(7) = 0.98$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		λ	A		f(0)
3	Compute f(x) and P(x)	x	B		f(x)
4			C		P(x)
	(For new value of x, go to 3.				
	For new value of λ, go to 2)				

LINEAR REGRESSION



This program must be used in conjunction with *Stat 1–05A, Sums for Two Variables,* to fit a straight line

$$y = a_0 + a_1 x$$

to a set of data points $\{(x_i, y_i), i = 1, 2, ..., n\}$ by the least squares method.

The program computes:

1. regression coefficients a_0, a_1

$$a_1 = \frac{\Sigma x_i y_i - \dfrac{\Sigma x_i \Sigma y_i}{n}}{\Sigma x_i^2 - \dfrac{(\Sigma x_i)^2}{n}}$$

$$a_0 = \bar{y} - a_1 \bar{x}$$

where

$$\bar{x} = \frac{\Sigma x_i}{n}$$

$$\bar{y} = \frac{\Sigma y_i}{n}$$

2. coefficient of determination

$$r^2 = \frac{\left[\Sigma x_i y_i - \dfrac{\Sigma x_i \Sigma y_i}{n}\right]^2}{\left[\Sigma x_i^2 - \dfrac{(\Sigma x_i)^2}{n}\right]\left[\Sigma y_i^2 - \dfrac{(\Sigma y_i)^2}{n}\right]}$$

r^2 can be interpreted as the proportion of total variation about the mean $\bar{y}$ explained by the regression. In other words, r^2 measures the "goodness of fit" of the regression line. Note that $0 \leqslant r^2 \leqslant 1$, and if $r^2 = 1$, we have a perfect fit.

3. estimated value $\hat{y}$ on the regression line for any given x

$$\hat{y} = a_0 + a_1 x$$

4. standard error of estimate of y on x

$$s_{y \cdot x} = \sqrt{\frac{\Sigma(y_i - \hat{y}_i)^2}{n-2}}$$

$$= \sqrt{\frac{\Sigma y_i^2 - a_0 \Sigma y_i - a_1 \Sigma x_i y_i}{n-2}}$$

5. standard error of the regression coefficient a_0

$$s_0 = s_{y \cdot x} \sqrt{\frac{\Sigma x_i^2}{n\left[\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}\right]}}$$

6. standard error of the regression coefficient a_1

$$s_1 = \frac{s_{y \cdot x}}{\sqrt{\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}}}$$

Note: n is a positive integer and $n \neq 1$ or 2.

References:

Applied Regression Analysis, Draper and Smith, John Wiley & Sons, 1966

Statistics in Research, B. Ostle, Iowa State University Press, 1963

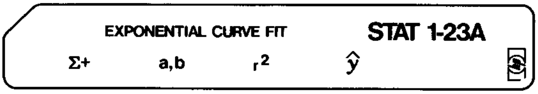
Example:

x_i	26	30	44	50	62	68	74
y_i	92	85	78	81	54	51	40

1. $a_0 = 121.04$
   $a_1 = -1.03$
   Regression line is $y = 121.04 - 1.03x$
2. $r^2 = 0.92$
3. For $x = 80$, $\hat{y} = 38.27$
4. $s_{y \cdot x} = 6.34$
5. $s_0 = 7.47$
   $s_1 = 0.14$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program *Stat 1–05A*				
2	Initialize		f	REG	
3	Perform 3–4 for i = 1, 2, ..., n	x_i	↑		
4		y_i	A		i
	(Correct erroneous data x_k, y_k)	x_k	↑		
		y_k	B		
5	Enter program *Stat 1–22A*				
6			A		a_0
7			R/S		a_1
8			B		r^2
9		x	C		$\hat{y}$
	(For a new x, go to 9)				
10			D		$s_{y \cdot x}$
11			E		s_0
12			R/S		s_1

EXPONENTIAL CURVE FIT



This program computes the least squares fit of n pairs of data points $\{(x_i, y_i), i = 1, 2, ..., n\}$, where $y_i > 0$, for an exponential function of the form

$$y = a\,e^{bx} \qquad (a > 0)$$

The equation is linearized into

$$\ln y = \ln a + bx$$

The following statistics are computed:

1. Coefficients a, b

$$b = \frac{\Sigma x_i \ln y_i - \frac{1}{n}(\Sigma x_i)(\Sigma \ln y_i)}{\Sigma x_i^2 - \frac{1}{n}(\Sigma x_i)^2}$$

$$a = \exp\left[\frac{\Sigma \ln y_i}{n} - b\,\frac{\Sigma x_i}{n}\right]$$

2. Coefficient of determination

$$r^2 = \frac{\left[\Sigma x_i \ln y_i - \frac{1}{n}\Sigma x_i\, \Sigma \ln y_i\right]^2}{\left[\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}\right]\left[\Sigma(\ln y_i)^2 - \frac{(\Sigma \ln y_i)^2}{n}\right]}$$

3. Estimated value $\hat{y}$ for a given x

$$\hat{y} = a\,e^{bx}$$

Note: n is a positive integer and $n \neq 1$.

Reference: Statistical Theory and Methodology in Science and Engineering, K.A. Brownlee, John Wiley & Sons, 1965

Example:

x_i	.72	1.31	1.95	2.58	3.14
y_i	2.16	1.61	1.16	.85	0.5

1. $a = 3.45, \quad b = -0.58$

   $y = 3.45\, e^{-0.58x}$

2. $r^2 = 0.98$

3. For $x = 1.5$, $\hat{y} = 1.44$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		f	REG	
3	Perform 3–4 for i=1, 2, ..., n	x_i	↑		
4		y_i	A		i
5			B		a
6			R/S		b
7			C		r^2
8	Compute estimated value $\hat{y}$	x	D		$\hat{y}$
	(For a new x, go to 8)				

POWER CURVE FIT

This program fits a power curve

$$y = ax^b \qquad (a > 0)$$

to a set of data points

$$\{(x_i, y_i), i = 1, 2, \ldots, n\}$$

where $x_i > 0, y_i > 0$.

By writing this equation as

$$\ln y = b \ln x + \ln a$$

the problem can be solved as a linear regression problem.

Output statistics are:

1. Regression coefficients

$$b = \frac{\Sigma (\ln x_i)(\ln y_i) - \dfrac{(\Sigma \ln x_i)(\Sigma \ln y_i)}{n}}{\Sigma (\ln x_i)^2 - \dfrac{(\Sigma \ln x_i)^2}{n}}$$

$$a = \exp\left[\frac{\Sigma \ln y_i}{n} - b\,\frac{\Sigma \ln x_i}{n}\right]$$

2. Coefficient of determination

$$r^2 = \frac{\left[\Sigma (\ln x_i)(\ln y_i) - \dfrac{(\Sigma \ln x_i)(\Sigma \ln y_i)}{n}\right]^2}{\left[\Sigma (\ln x_i)^2 - \dfrac{(\Sigma \ln x_i)^2}{n}\right]\left[\Sigma (\ln y_i)^2 - \dfrac{(\Sigma \ln y_i)^2}{n}\right]}$$

3. Estimated value $\hat{y}$ for given x

$$\hat{y} = ax^b$$

Note: n is a positive integer and $n \neq 1$.

Reference: Statistical Theory and Methodology in Science and Engineering, K.A. Brownlee, John Wiley & Sons, 1965

Example:

x_i	10	12	15	17	20	22	25	27	30	32	35
y_i	.95	1.05	1.25	1.41	1.73	2.00	2.53	2.98	3.85	4.59	6.02

1. $a = 0.03$, $b = 1.46$

   $y = 0.03x^{1.46}$

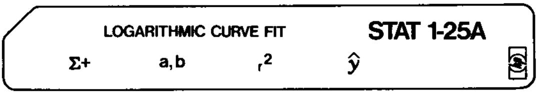
2. $r^2 = 0.94$

3. For $x = 18$, $\hat{y} = 1.76$

   $x = 23$, $\hat{y} = 2.52$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		f	REG	
3	Perform 3–4 for i=1, 2, ..., n	x_i	↑		
4		y_i	A		i
5			B		a
6			R/S		b
7			C		r^2
8	Compute estimated value $\hat{y}$	x	D		$\hat{y}$
	(For a new x, go to 8)				

LOGARITHMIC CURVE FIT



This program fits a logarithmic curve

$$y = a + b \ln x$$

to a set of data points

$$\left\{(x_i, y_i), i = 1, 2, ..., n\right\}$$

where

$$x_i > 0.$$

Program computes:

1. Regression coefficients

$$b = \frac{\Sigma\, y_i \ln x_i - \frac{1}{n} \Sigma \ln x_i\, \Sigma\, y_i}{\Sigma\, (\ln x_i)^2 - \frac{1}{n} (\Sigma \ln x_i)^2}$$

$$a = \frac{1}{n} (\Sigma\, y_i - b\, \Sigma \ln x_i)$$

2. Coefficient of determination

$$r^2 = \frac{\left[\Sigma\, y_i \ln x_i - \frac{1}{n} \Sigma \ln x_i\, \Sigma\, y_i\right]^2}{\left[\Sigma\, (\ln x_i)^2 - \frac{1}{n} (\Sigma \ln x_i)^2\right] \left[\Sigma\, y_i^2 - \frac{1}{n} (\Sigma\, y_i)^2\right]}$$

3. Estimated value $\hat{y}$ for given x

$$\hat{y} = a + b \ln x$$

Note: n is a positive integer and $n \neq 1$.

Example:

x_i	3	4	6	10	12
y_i	1.5	9.3	23.4	45.8	60.1

1. $a = -47.02$, $b = 41.39$

   $y = -47.02 + 41.39 \ln x$

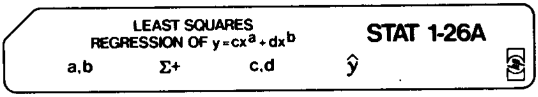
2. $r^2 = 0.98$

3. For $x = 8$, $\hat{y} = 39.06$

   For $x = 14.5$, $\hat{y} = 63.67$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		f	REG	
3	Perform 3–4 for i=1, 2, ..., n	x_i	↑		
4		y_i	A		i
5			B		a
6			R/S		b
7			C		r^2
8	Compute estimated value $\hat{y}$	x	D		$\hat{y}$
	(For a new x, go to 8)				

LEAST SQUARES REGRESSION OF $y = cx^a + dx^b$



This program determines the coefficients c, d of the equation

$$y = cx^a + dx^b$$

for a set of data points

$$\{(x_i, y_i), i = 1, 2, ..., n\}$$

where a, b are any given real numbers.

$$d = \frac{(\Sigma x_i^{2a})(\Sigma x_i^b y_i) - (\Sigma x_i^a y_i)(\Sigma x_i^{a+b})}{(\Sigma x_i^{2b})(\Sigma x_i^{2a}) - (\Sigma x_i^{a+b})^2}$$

$$c = \frac{\Sigma x_i^a y_i - d\Sigma x_i^{a+b}}{\Sigma x_i^{2a}}$$

where $x_i > 0$ for i = 1, 2, ..., n.

Note: n is a positive integer and $n \neq 1$.

Example:

$a = 0.5, \quad b = 3$

x_i	1	4	9	16
y_i	9	–44	–699	–4056

$c = 10.00, \quad d = -1.00$

Regression line is $y = 10x^{1/2} - x^3$

For $x = 6$, $\hat{y} = -191.51$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		f	REG	
3		a	↑		
4		b	A		
5	Perform 5–6 for i=1, 2, ..., n	x_i	↑		
6		y_i	B		
7			C		c
8			R/S		d
9	Compute estimated value $\hat{y}$ on	x	D		$\hat{y}$
	the line				
	(For a new x, go to 9)				

MULTIPLE LINEAR REGRESSION

MULTIPLE LINEAR REGRESSION **STAT 1-27A1**

$\Sigma+$ $\Sigma-$

MULTIPLE LINEAR REGRESSION **STAT 1-27A2**

a_0 a_1 a_2 $\hat{z}$

For a set of data points $\{(x_i, y_i, z_i), i = 1, 2, ..., n\}$ this program fits a linear equation of the form

$$z = a_0 + a_1 x + a_2 y$$

by the least squares method.

Regression coefficients a_0, a_1, a_2 can be found by solving the normal equations:

$$\begin{cases} \Sigma z_i = a_0 n + a_1 \Sigma x_i + a_2 \Sigma y_i \\ \Sigma x_i z_i = a_0 \Sigma x_i + a_1 \Sigma x_i^2 + a_2 \Sigma x_i y_i \\ \Sigma y_i z_i = a_0 \Sigma y_i + a_1 \Sigma x_i y_i + a_2 \Sigma y_i^2 \end{cases} \qquad i = 1, 2, ..., n$$

$$a_2 = \frac{A - B}{[n\Sigma x_i^2 - (\Sigma x_i)^2]\,[n\Sigma y_i^2 - (\Sigma y_i)^2] - [n\Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)]^2}$$

where $A = [n\Sigma x_i^2 - (\Sigma x_i)^2]\,[n\Sigma y_i z_i - (\Sigma y_i)(\Sigma z_i)]$

$B = [n\Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)]\,[n\Sigma x_i z_i - (\Sigma x_i)(\Sigma z_i)]$

$$a_1 = \frac{[n\Sigma x_i z_i - (\Sigma x_i)(\Sigma z_i)] - a_2\,[n\Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)]}{n\Sigma x_i^2 - (\Sigma x_i)^2}$$

$$a_0 = \frac{1}{n}(\Sigma z_i - a_2 \Sigma y_i - a_1 \Sigma x_i)$$

Notes:

1. $\Sigma x_i y_i$, $\Sigma x_i z_i$, $\Sigma y_i z_i$, Σy_i^2, n, Σx_i^2, Σx_i, Σy_i, Σz_i are in storage registers R_1 through R_9 before program on card 2 is executed. Recall and record these sums if desired when instructions indicate to do so.

2. Erroneous data x_k, y_k, z_k can be removed by the following keystrokes: x_k [↑] y_k [↑] z_k [B]

3. n is a positive integer and $n \neq 1$.

Reference: Introduction to the Theory of Statistics, Mood and Graybill, McGraw-Hill, 1963

Example:

i	1	2	3	4
x_i	1.5	0.45	1.8	2.8
y_i	0.7	2.3	1.6	4.5
z_i	2.1	4.0	4.1	9.4

Regression line is
$z = -0.10 + 0.79x + 1.63y$
For $x = 2$, $y = 3$, $\hat{z} = 6.37$

$\Sigma x_i y_i = 17.57$	$\Sigma x_i = 6.55$
$\Sigma x_i z_i = 38.65$	$\Sigma y_i = 9.10$
$\Sigma y_i z_i = 59.53$	$\Sigma z_i = 19.60$
$\Sigma y_i^2 = 28.59$	$a_0 = -0.10$
$n = 4.00$	$a_1 = 0.79$
$\Sigma x_i^2 = 13.53$	$a_2 = 1.63$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program on card 1				
2	Initialize		f	REG	
3	Perform 3–5 for i=1, 2, ..., n	x_i	↑		
4		y_i	↑		
5		z_i	A		i
	(Correct erroneous data	x_k	↑		
	x_k, y_k, z_k)	y_k	↑		
		z_k	B		
6	Recall and record sums		RCL	1	$\Sigma x_i y_i$
7			RCL	2	$\Sigma x_i z_i$
8			RCL	3	$\Sigma y_i z_i$
9			RCL	4	Σy_i^2
10			RCL	5	n
11			RCL	6	Σx_i^2
12			RCL	7	Σx_i
13			RCL	8	Σy_i
14			RCL	9	Σz_i
15	Enter program on card 2				
16			A		a_0
17			B		a_1
18			C		a_2
19	Obtain estimated value $\hat{z}$ on the	x	↑		
20	line (for new values, go to 19)	y	D		$\hat{z}$

PARABOLIC CURVE FIT

For a set of data points $\{(x_i, y_i), i = 1, 2, ..., n\}$ this program fits a parabola

$$y = a_0 + a_1 x + a_2 x^2$$

This program must be used in conjunction with *Stat 1–27A, Multiple Linear Regression,* to compute:

1. Regression coefficients

$$a_2 = \frac{A - B}{[n \Sigma x_i^2 - (\Sigma x_i)^2]\ [n \Sigma x_i^4 - (\Sigma x_i^2)^2] - [n \Sigma x_i^3 - (\Sigma x_i)(\Sigma x_i^2)]^2}$$

where

$$A = [n \Sigma x_i^2 - (\Sigma x_i)^2]\ [n \Sigma x_i^2 y_i - (\Sigma x_i^2)(\Sigma y_i)]$$

$$B = [n \Sigma x_i^3 - (\Sigma x_i)(\Sigma x_i^2)]\ [n \Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)]$$

$$a_1 = \frac{[n \Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)] - a_2\ [n \Sigma x_i^3 - (\Sigma x_i)(\Sigma x_i^2)]}{n \Sigma x_i^2 - (\Sigma x_i)^2}$$

$$a_0 = \frac{1}{n}(\Sigma y_i - a_2 \Sigma x_i^2 - a_1 \Sigma x_i)$$

2. Estimated value $\hat{y}$ for given x

$$\hat{y} = a_0 + a_1 x + a_2 x^2$$

Note: n is a positive integer and $n \neq 1$.

Reference: Introduction to the Theory of Statistics, Mood and Graybill, McGraw Hill, 1963

Example:

x_i	0	1	1.5	3	5
y_i	2.1	2	–5	–24.5	–80

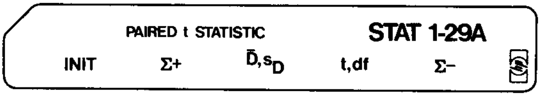
1. $\Sigma x_i^3 = 156.38$, $\Sigma x_i y_i = -479.00$, $\Sigma x_i^2 y_i = -2229.75$
   $\Sigma x_i^4 = 712.06$, $n = 5.00$, $\Sigma x_i^2 = 37.25$
   $\Sigma x_i = 10.50$, $\Sigma y_i = -105.40$

2. $a_0 = 2.28$, $a_1 = 1.85$, $a_2 = -3.66$
   $y = 2.28 + 1.85\,x - 3.66x^2$

3. For $x = 4$, $\hat{y} = -48.83$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program *Stat 1–28A*				
2	Initialize		f	REG	
3	Perform 3–4 for i=1, 2, ..., n	x_i	↑		
4		y_i	A		i
	(Correct erroneous data x_k, y_k)	x_k	↑		
		y_k	B		
5	Recall and record sums		RCL	1	Σx_i^3
6			RCL	2	$\Sigma x_i y_i$
7			RCL	3	$\Sigma x_i^2 y_i$
8			RCL	4	Σx_i^4
9			RCL	5	n
10			RCL	6	Σx_i^2
11			RCL	7	Σx_i
12			RCL	9	Σy_i
13	Enter program *Stat 1–27A2*				
14			A		a_0
15			B		a_1
16			C		a_2
17	Enter program *Stat 1–28A*				
18	Compute estimated value $\hat{y}$	x	C		$\hat{y}$
	(For a new x, go to 18)				

PAIRED t STATISTIC



Given a set of paired observations from two normal populations with means μ_1, μ_2 (unknown)

x_i	x_1	x_2	...	x_n
y_i	y_1	y_2	...	y_n

let

$$D_i = x_i - y_i$$

$$\overline{D} = \frac{1}{n} \sum_{i=1}^{n} D_i$$

$$s_D = \sqrt{\frac{\Sigma D_i^2 - \frac{1}{n}(\Sigma D_i)^2}{n-1}}$$

$$s_{\overline{D}} = \frac{s_D}{\sqrt{n}}$$

The test statistic

$$t = \frac{\overline{D}}{s_{\overline{D}}}$$

which has $n-1$ degrees of freedom (df) can be used to test the null hypothesis

$$H_0: \mu_1 = \mu_2$$

Reference: Statistics in Research, B. Ostle, Iowa State University Press, 1963

Example:

x_i	14	17.5	17	17.5	15.4
y_i	17	20.7	21.6	20.9	17.2

$\overline{D} = -3.20$
$s_D = 1.00$
$t = -7.16$
$df = 4.00$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		A		
3	Perform 3–4 for i=1, 2, ..., n	x_i	↑		
4		y_i	B		i
	(Correct erroneous data x_k, y_k)	x_k	↑		
		y_k	E		
5			C		$\overline{D}$
6			R/S		s_D
7			D		t
8			R/S		df

t STATISTIC FOR TWO MEANS

t STATISTIC FOR TWO MEANS				STAT 1-30A
INIT	Σ+	D	t,df	Σ-

Suppose $\{x_1, x_2, ..., x_{n_1}\}$ and $\{y_1, y_2, ..., y_{n_2}\}$ are independent random samples from two normal populations having means μ_1, μ_2 (unknown) and the same unknown variance σ^2.

We want to test the null hypothesis

$$H_0: \mu_1 - \mu_2 = D$$

Define

$$\overline{x} = \frac{1}{n_1} \sum_{i=1}^{n_1} x_i$$

$$\overline{y} = \frac{1}{n_2} \sum_{i=1}^{n_2} y_i$$

$$t = \frac{\overline{x} - \overline{y} - D}{\sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \sqrt{\frac{\Sigma x_i^2 - n_1 \overline{x}^2 + \Sigma y_i^2 - n_2 \overline{y}^2}{n_1 + n_2 - 2}}}$$

We can use this t statistic which has the t distribution with $n_1 + n_2 - 2$ degrees of freedom (df) to test the null hypothesis H_0.

Note: $n_2, \Sigma y_i, \Sigma y_i^2, n_1, \Sigma x_i, \Sigma x_i^2$ are in registers R_1 through R_6.

Reference: Statistical Theory and Methodology in Science and Engineering, K. A. Brownlee, John Wiley & Sons, 1965

Example:

x: 79, 84, 108, 114, 120, 103, 122, 120

y: 91, 103, 90, 113, 108, 87, 100, 80, 99, 54

$n_1 = 8$

$n_2 = 10$

If D = 0 (i.e., $H_0: \mu_1 = \mu_2$)

then t = 1.73, df = 16.00

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		A		
3	Perform 3 for i=1, 2, ..., n_1	x_i	B		i
	(Correct erroneous data x_k)	x_k	E		
4		D	C	R/S	
5	Perform 5 for j=1, 2, ..., n_2	y_j	B		j
	(Correct erroneous data y_h)	y_h	E		
6			D		t
7			R/S		df
	(For a different value of D)	D	C		
			D		t
			R/S		df

CHI-SQUARE EVALUATION

CHI-SQUARE EVALUATION			STAT 1-31A	
O_i, E_i	$\Sigma-$	O_i	$\Sigma-(O_i)$	χ^2

This program calculates the value of the χ^2 statistic for the goodness of fit test by the equation

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

where O_i = observed frequency

E_i = expected frequency

If the expected values are equal

$$\left(E = E_i = \frac{\Sigma O_i}{n} \text{ for all } i\right)$$

then

$$\chi^2 = \frac{n\Sigma O_i^{\,2}}{\Sigma O_i} - \Sigma O_i$$

Note: In order to apply the goodness of fit test to a set of given data, combining some classes may be necessary to make sure that each expected frequency is not too small (say, not less than 5).

Reference: Mathematical Statistics, J. E. Freund, Prentice Hall, 1962

Examples:

1.

O_i	8	50	47	56	5	14
E_i	9.6	46.75	51.85	54.4	8.25	9.15

$\chi^2 = 4.84$

2. The following table shows the observed frequencies in tossing a die 120 times. χ^2 can be used to test if the die is fair.

Note: Assume that the expected frequencies are equal.

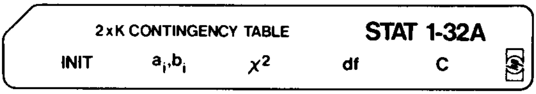
number	1	2	3	4	5	6
frequency O_i	25	17	15	23	24	16

$\chi^2 =$ 5.00

E = 20.00

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		RTN	R/S	
3	For equal expected values,				
	go to 7.				
4	Perform 4–5 for i = 1, 2, ..., n	O_i	↑		
5		E_i	A		i
	(Correct erroneous data O_k, E_k)	O_k	↑		
		E_k	B		
6			E		χ^2
	(For a new case, go to 2)				
7	Perform 7 for i = 1, 2, ..., n	O_i	C		i
	(Correct erroneous data O_h)	O_h	D		
8			f	SF 1	
9			E		χ^2
10			R/S		E
	(For a new case, go to 2)				

2 x k CONTINGENCY TABLE



Contingency tables can be used to test the null hypothesis that two variables are independent.

	1	2	3	...	k	Totals
A	a_1	a_2	a_3	...	a_k	N_A
B	b_1	b_2	b_3	...	b_k	N_B
Totals	N_1	N_2	N_3	...	N_k	N

Test statistic

$$\chi^2 = \frac{N}{N_A} \sum_{i=1}^{k} \frac{a_i^2}{N_i} + \frac{N}{N_B} \sum_{i=1}^{k} \frac{b_i^2}{N_i} - N$$

Degrees of freedom df = k – 1

Pearson's coefficient of contingency C measures the degree of association between the two variables

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

Reference: Statistics in Research, B. Ostle, Iowa State University Press, 1963

Example:

	1	2	3
A	2	5	4
B	3	8	7

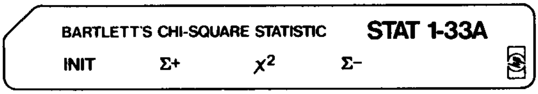
$\chi^2 = 0.02$

df = 2.00

C = 0.03

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2	Initialize		[A]	[ ]	
3	Perform 3–4 for i=1, 2, ..., k	a_i	[↑]	[ ]	
4		b_i	[B]	[ ]	i
5			[C]	[ ]	χ^2
6			[D]	[ ]	df
7			[E]	[ ]	C

BARTLETT'S CHI-SQUARE STATISTIC



$$\chi^2 = \frac{f \ln s^2 - \sum_{i=1}^{k} f_i \ln s_i^2}{1 + \frac{1}{3(k-1)}\left[\left(\sum_{i=1}^{k} \frac{1}{f_i}\right) - \frac{1}{f}\right]}$$

where s_i^2 = sample variance of the i^{th} sample

f_i = degrees of freedom associated with s_i^2

$i = 1, 2, \ldots, k$

k = number of samples

$$s^2 = \frac{\sum_{i=1}^{k} f_i s_i^2}{f}$$

$$f = \sum_{i=1}^{k} f_i$$

This χ^2 has a chi-square distribution (approximately) with $k - 1$ degrees of freedom which can be used to test the null hypothesis that $s_1{}^2, s_2{}^2, \ldots, s_k{}^2$ are all estimates of the same population variance σ^2; i.e.

H_0: Each of $s_1{}^2, s_2{}^2, \ldots, s_k{}^2$ is an estimate of σ^2.

Note: Erroneous data can be corrected by using the **D** key.

Reference: Statistical Theory with Engineering Applications, A. Hald, John Wiley and Sons, 1960

Example:

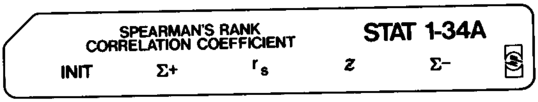
i	1	2	3	4	5	6
s_i^2	5.5	5.1	5.2	4.7	4.8	4.3
f_i	10	20	17	18	8	15

$\chi^2 = 0.25$

df = 5.00

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		A		
3	Perform 3–4 for i=1, 2, ..., k	s_i^2	↑		
4		f_i	B		i
	(Correct erroneous data s_m^2, f_m)	s_m^2	↑		
		f_m	D		
5			C		χ^2
6			R/S		df

SPEARMAN'S RANK CORRELATION COEFFICIENT



Spearman's rank correlation coefficient is defined by

$$r_s = 1 - \frac{6 \sum_{i=1}^{n} D_i^2}{n(n^2 - 1)}$$

where n = number of paired observations (x_i, y_i)

D_i = rank (x_i) – rank (y_i) = $R_i - S_i$

If the X and Y random variables from which these n pairs of observations are derived are independent, then r_s has zero mean and a variance

$$\frac{1}{n-1}$$

A test for the null hypothesis

$$H_0: \text{X, Y are independent}$$

is using

$$z = r_s \sqrt{n-1}$$

which is approximately a standardized normal variable (for large n, say $n \geqslant 10$).

If the null hypothesis of independence is not rejected, we can infer that the population correlation coefficient $\rho(x, y) = 0$, but dependence between the variables does not necessarily imply that $\rho(x, y) \neq 0$.

Note: $-1 \leqslant r_s \leqslant 1$

$r_s = 1$ indicates complete agreement in order of the ranks and $r_s = -1$ indicates complete agreement in the opposite order of the ranks.

Reference: Nonparametric Statistical Inference, J. D. Gibbons, McGraw Hill, 1971

Example:

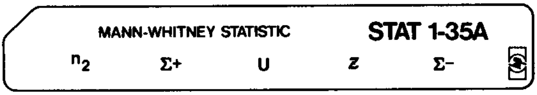
Student	x_i Math Grade	y_i Stat Grade	R_i Rank of x_i	S_i Rank of y_i
1	82	81	6	7
2	67	75	14	11
3	91	85	3	4
4	98	90	1	2
5	74	80	11	8
6	52	60	15	15
7	86	94	4	1
8	95	78	2	9
9	79	83	9	6
10	78	76	10	10
11	84	84	5	5
12	80	69	8	13
13	69	72	13	12
14	81	88	7	3
15	73	61	12	14

$r_s = 0.76$

$z = 2.85$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		A		
3	Perform 3–4 for i = 1, 2, ..., n	R_i	↑		
4		S_i	B		i
	(Correct erroneous data R_k, S_k)	R_k	↑		
		S_k	E		
5			C		r_s
6			D		z

MANN-WHITNEY STATISTIC



This program computes the Mann-Whitney test statistic on two independent samples of equal or unequal sizes. This test is designed for testing the null hypothesis of no difference between two populations.

Mann-Whitney test statistic is defined as

$$U = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - \sum_{i=1}^{n_1} R_i$$

where n_1 and n_2 are the sizes of the two samples. Arrange all values from both samples jointly (as if they were one sample) in an increasing order of magnitude, let R_i $(i = 1, 2, ..., n_1)$ be the ranks assigned to the values of the first sample (it is immaterial which sample is referred to as the "first").

When n_1 and n_2 are small, the Mann-Whitney test bases on the exact distribution of U and specially constructed tables. When n_1 and n_2 are both large (say, greater than 8) then

$$z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{n_1 n_2 (n_1 + n_2 + 1)/12}}$$

is approximately a random variable having the standard normal distribution.

Reference: Mathematical Statistics, J.E. Freund, Prentice Hall, 1962

Table for small samples:

Handbook of Statistical Tables, D.B. Owen, Addison-Wesley, 1962

Example:

Sample 1	14.9	11.3	13.2	16.6	17	14.1	15.4	13	16.9	
Rank R_i	7	1	4	12	14	5	10	3	13	

Sample 2	15.2	19.8	14.7	18.3	16.2	21.2	18.9	12.2	15.3	19.4
Rank	8	18	6	15	11	19	16	2	9	17

$n_1 = 9, \quad n_2 = 10$

$U = 66.00$

$z = 1.71$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		n_2	A		
3	Perform 3 for i=1, 2, ..., n_1	R_i	B		i
	(Correct erroneous data R_k)	R_k	E		
4	Compute U		C		U
5	Compute z		D		z

KENDALL'S COEFFICIENT OF CONCORDANCE

Suppose n individuals are ranked from 1 to n according to some specified characteristic by k observers, the coefficient of concordance W measures the agreement between observers (or concordance between rankings).

$$W = \frac{12 \sum_{i=1}^{n} \left(\sum_{j=1}^{k} R_{ij} \right)^2}{k^2 n(n^2 - 1)} - \frac{3(n+1)}{n-1}$$

Where R_{ij} is the rank assigned to the i^{th} individual by the j^{th} observer.

W varies from 0 (no community of preference) to 1 (perfect agreement). The null hypothesis that the observers have no community of preference may be tested using special tables, or if $n > 7$, by computing

$$\chi^2 = k\,(n - 1)\,W$$

which has approximately the chi-square distribution with $n - 1$ degrees of freedom (df).

Reference: Nonparametric Statistical Inference, J. D. Gibbons, McGraw-Hill, 1971

Table for small samples:

Rank Correlation Methods, M.G. Kendall, Hafner Publishing Co., 1962

Example:

Table for R_{ij} (n = 10, k = 3)

i \ j	1	2	3
1	6	7	3
2	1	4	2
3	9	3	5
4	2	6	1
5	10	8	9
6	3	2	6
7	5	9	8
8	4	1	4
9	8	10	10
10	7	5	7

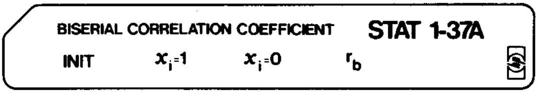
W = 0.69

χ^2 = 18.64

df = 9.00

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Initialize		RTN	R/S	
3	Perform 3–5 for i=1, 2, ..., n				
4	Perform 4 for j=1, 2, ..., k	R_{ij}	A		j
	(Correct erroneous data R_{im})	R_{im}	E		
5			B		i
6	Compute W		C		W
7	Compute χ^2 and df		D		χ^2
8			R/S		df
	(For a new case, go to 2)				

BISERIAL CORRELATION COEFFICIENT



The biserial correlation coefficient r_b is used where one variable Y is quantitatively measured while the other continuous variable X is artificially dichotomized (that is, artificially defined by two groups). It measures the degree of linear association between X and Y.

$$r_b = \frac{n\,(\Sigma' y_i) - n_1\,\Sigma y_i}{na\,\sqrt{n\,\Sigma y_i^2 - (\Sigma y_i)^2}}$$

Suppose X takes the value 0 or 1.

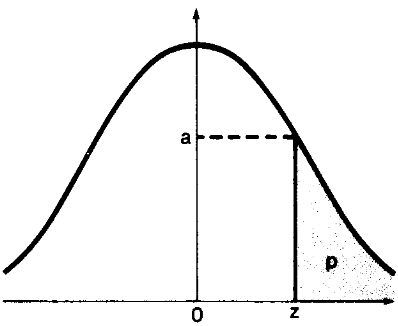
Define n_1 = number of x's such that x = 1

n = total number of data points

$\Sigma' y_i$ = sum of the y's for which x = 1

Σy_i = sum of all y's

a = ordinate of the standard normal curve at point z cutting off a tail of that distribution with area equal to $p = \dfrac{n_1}{n}$.



Notes: 1. $p = \dfrac{n_1}{n}$ must be less than or equal to 0.5, if not, interchange the roles of 0 and 1 for the X variable.

2. z and a can be found by using *Stat 1–10A, Normal Distribution,* and *Stat 1–11A, Inverse Normal Integral.*

3. Among the necessary assumptions for a meaningful interpretation of r_b are:
   (a) Y is normally distributed
   (b) the true distribution of X should be of normal form.

Reference: Statistics in Research, B. Ostle, Iowa State University Press, 1963

Example:

x_i	0	1	1	0	1	0	0	0	1
y_i	3.1	2.8	5.6	0.3	2.5	2.4	4.8	2.9	7.7

$n_1 = 4$

$n = 9$

$z = 0.14$

$a = 0.40$

$r_b = 0.60$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program *Stat 1–11A*				
2			A		
3		n_1	↑		
4		n	÷	B	z
5			STO	1	
6	Enter program *Stat 1–10A1*				
7			A		
8	Enter program *Stat 1–10A2*				
9			RCL	1	
10			A		a
11	Enter program *Stat 1–37A*				
12			A		
13	Perform 14 or 15 for i=1, ..., n				
14	If $x_i = 1$	y_i	B		
15	If $x_i = 0$	y_i	C		
16			D		r_b

PROGRAM LISTINGS

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MEAN, STANDARD DEVIATION, STANDARD ERROR

CODE	KEYS
00	0
33 01	STO 1
33 02	STO 2
33 03	STO 3
84	R/S
23	LBL
11	A
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
12	B
34 02	RCL 2
34 01	RCL 1
81	÷
24	RTN
23	LBL
13	C
34 03	RCL 3
34 02	RCL 2
34 01	RCL 1
81	÷
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1

CODE	KEYS
71	x
51	–
34 01	RCL 1
81	÷
31	f
09	$\sqrt{x}$
34 01	RCL 1
34 01	RCL 1
01	1
51	–
81	÷
31	f
09	$\sqrt{x}$
71	x
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
14	D
13	C
34 01	RCL 1
31	f
09	$\sqrt{x}$
81	÷
35 07	g x⇄y
35 00	g LST X
81	÷
35 07	g x⇄y
84	R/S
35 07	g x⇄y
24	RTN
23	LBL
15	E
33	STO
51	–

CODE	KEYS
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
03	3
34 01	RCL 1
01	1
51	–
33 01	STO 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4		R_7	
R_2	Σx_i	R_5		R_8	
R_3	Σx_i^2	R_6		R_9	

MEAN, STANDARD DEVIATION, STANDARD ERROR (GROUPED DATA)

CODE	KEYS
00	0
33 01	STO 1
33 02	STO 2
33 03	STO 3
33 04	STO 4
84	R/S
23	LBL
11	A
33	STO
61	+
01	1
35 07	g x⇄y
71	x
33	STO
61	+
02	2
35 00	g LST X
71	x
33	STO
61	+
03	3
01	1
34 04	RCL 4
61	+
33 04	STO 4
24	RTN
23	LBL
12	B
34 02	RCL 2
34 01	RCL 1
81	÷
24	RTN
23	LBL
13	C
34 03	RCL 3

CODE	KEYS
34 02	RCL 2
34 01	RCL 1
81	÷
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
71	x
51	−
34 01	RCL 1
81	÷
31	f
09	$\sqrt{x}$
34 01	RCL 1
34 01	RCL 1
01	1
51	−
81	÷
31	f
09	$\sqrt{x}$
71	x
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
14	D
13	C
34 01	RCL 1
31	f
09	$\sqrt{x}$
81	÷
35 07	g x⇄y
35 00	g LST X
81	÷
35 07	g x⇄y
84	R/S

CODE	KEYS
35 07	g x⇄y
24	RTN
23	LBL
15	E
42	CHS
11	A
34 04	RCL 4
02	2
51	−
33 04	STO 4
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Σf_i	R_4	n	R_7	
R_2	$\Sigma f_i x_i$	R_5		R_8	
R_3	$\Sigma f_i x_i^2$	R_6		R_9	

PERMUTATION AND COMBINATION

CODE	KEYS
23	LBL
11	A
35 24	g x>y
22	GTO
02	2
41	↑
00	0
35 23	g x=y
22	GTO
03	3
44	CLX
01	1
35 23	g x=y
22	GTO
04	4
51	–
33 08	STO 8
35 08	g R↓
33 07	STO 7
23	LBL
01	1
34 07	RCL 7
01	1
51	–
33 07	STO 7
71	x
35	g
83	DSZ
22	GTO
01	1
24	RTN
23	LBL
02	2
00	0
81	÷

CODE	KEYS
23	LBL
03	3
41	↑
01	1
24	RTN
23	LBL
12	B
35 24	g x>y
22	GTO
02	2
51	–
35 00	g LST X
35 22	g x≤y
33 06	STO 6
35 07	g x⇄y
33 07	STO 7
01	1
33 08	STO 8
61	+
33 06	STO 6
44	CLX
35 23	g x=y
01	1
24	RTN
23	LBL
00	0
35 08	g R↓
01	1
34 08	RCL 8
61	+
33 08	STO 8
35 24	g x>y
34 06	RCL 6
24	RTN
34 07	RCL 7

CODE	KEYS
35 07	g x⇄y
61	+
35 00	g LST X
81	÷
34 06	RCL 6
71	x
33 06	STO 6
22	GTO
00	0
23	LBL
04	4
35 08	g R↓
35 08	g R↓
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	R_4	R_7 Used
R_2	R_5	R_8 Used
R_3	R_6 Used	R_9 Used

ARITHMETIC, GEOMETRIC, HARMONIC AND GENERALIZED MEANS

CODE	KEYS
01	1
33 02	STO 2
44	CLX
33 01	STO 1
33 03	STO 3
33 04	STO 4
33 05	STO 5
84	R/S
33	STO
09	9
84	R/S
23	LBL
11	A
33	STO
61	+
01	1
33	STO
71	x
02	2
35	g
04	$^1/x$
33	STO
61	+
03	3
35 00	g LST X
34	RCL
09	9
35	g
05	y^x
33	STO
61	+
04	4
01	1
34 05	RCL 5
61	+

CODE	KEYS
33 05	STO 5
24	RTN
23	LBL
12	B
34 01	RCL 1
34 05	RCL 5
81	÷
24	RTN
23	LBL
13	C
34 02	RCL 2
34 05	RCL 5
35	g
04	$^1/x$
35	g
05	y^x
24	RTN
23	LBL
14	D
34 05	RCL 5
34 03	RCL 3
81	÷
24	RTN
23	LBL
15	E
34 04	RCL 4
34 05	RCL 5
81	÷
34	RCL
09	9
35	g
04	$^1/x$
35	g
05	y^x
24	RTN

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Σa	R_4	Σa^t	R_7	
R_2	Πa	R_5	n	R_8	
R_3	$\Sigma ^1/a$	R_6		R_9	t

SUMS FOR TWO VARIABLES

CODE	KEYS
23	LBL
11	A
33 07	STO 7
33	STO
61	+
04	4
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
05	5
35 07	g x⇄y
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
35 00	g LST X
34 07	RCL 7
71	x
33	STO
61	+
06	6
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
12	B
33 07	STO 7
33	STO
51	–
04	4
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
05	5
35 07	g x⇄y
33	STO
51	–
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
03	3
35 00	g LST X
34 07	RCL 7
71	x
33	STO
51	–
06	6
34 01	RCL 1
01	1
51	–
33 01	STO 1
24	RTN
23	LBL
13	C
34 01	RCL 1
84	R/S
34 02	RCL 2
84	R/S
34 03	RCL 3
84	R/S
34 04	RCL 4
84	R/S
34 05	RCL 5
84	R/S
34 06	RCL 6
84	R/S
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	Σy_i	R_7	Used
R_2	Σx_i	R_5	Σy_i^2	R_8	
R_3	Σx_i^2	R_6	$\Sigma x_i y_i$	R_9	

BASIC STATISTICS (TWO VARIABLES)

CODE	KEYS
23	LBL
11	A
34 02	RCL 2
34 01	RCL 1
81	÷
84	R/S
34 04	RCL 4
34 01	RCL 1
81	÷
24	RTN
23	LBL
12	B
34 03	RCL 3
34 02	RCL 2
15	E
33 07	STO 7
84	R/S
34 05	RCL 5
34 04	RCL 4
15	E
33 08	STO 8
84	R/S
34 01	RCL 1
01	1
51	–
34 01	RCL 1
81	÷
31	f
09	$\sqrt{x}$
33	STO
09	9
71	x
34 07	RCL 7
35 00	g LST X
71	x

CODE	KEYS
84	R/S
35 07	g x⇄y
24	RTN
23	LBL
13	C
34 06	RCL 6
34 02	RCL 2
34 04	RCL 4
71	x
34 01	RCL 1
81	÷
51	–
34 01	RCL 1
01	1
51	–
81	÷
24	RTN
34	RCL
09	9
32	f^{-1}
09	$\sqrt{x}$
71	x
84	R/S
23	LBL
14	D
13	C
34 07	RCL 7
34 08	RCL 8
71	x
81	÷
24	RTN
23	LBL
15	E
34 01	RCL 1
81	÷

CODE	KEYS
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
71	x
51	–
34 01	RCL 1
01	1
51	–
81	÷
31	f
09	$\sqrt{x}$
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	Σy_i	R_7	s_x
R_2	Σx_i	R_5	Σy_i^2	R_8	s_y
R_3	Σx_i^2	R_6	$\Sigma x_i y_i$	R_9	$[(n-1)/n]^{1/2}$

MOMENTS, SKEWNESS AND KURTOSIS (FOR GROUPED OR UNGROUPED DATA) (CARD 1)

CODE	KEYS
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
35 00	g LST X
71	x
33	STO
61	+
04	4
35 00	g LST X
71	x
33	STO
61	+
05	5
01	1
34 01	RCL 1
61	+
33 01	STO 1
84	R/S
23	LBL
12	B
33	STO
51	–
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
03	3
35 00	g LST X
71	x

CODE	KEYS
33	STO
51	–
04	4
35 00	g LST X
71	x
33	STO
51	–
05	5
34 01	RCL 1
01	1
51	–
33 01	STO 1
24	RTN
23	LBL
13	C
33	STO
61	+
01	1
35 07	g x⇄y
71	x
33	STO
61	+
02	2
35 00	g LST X
71	x
33	STO
61	+
03	3
35 00	g LST X
71	x
33	STO
61	+
04	4
35 00	g LST X
71	x

CODE	KEYS
33	STO
61	+
05	5
24	RTN
23	LBL
14	D
33	STO
51	–
01	1
35 07	g x⇄y
71	x
33	STO
51	–
02	2
35 00	g LST X
71	x
33	STO
51	–
03	3
35 00	g LST X
71	x
33	STO
51	–
04	4
35 00	g LST X
71	x
33	STO
51	–
05	5
24	RTN

R_1	n or Σf_j	R_4	Σx_i^3 or $\Sigma f_j y_j^3$	R_7	
R_2	Σx_i or $\Sigma f_j y_j$	R_5	Σx_i^4 or $\Sigma f_j y_j^4$	R_8	
R_3	Σx_i^2 or $\Sigma f_j y_j^2$	R_6		R_9	

MOMENTS, SKEWNESS AND KURTOSIS (FOR GROUPED OR UNGROUPED DATA) (CARD 2)

CODE	KEYS
23	LBL
11	A
34 02	RCL 2
34 01	RCL 1
81	÷
33 06	STO 6
24	RTN
23	LBL
12	B
34 03	RCL 3
34 01	RCL 1
81	÷
34 06	RCL 6
32	f^{-1}
09	$\sqrt{x}$
33 08	STO 8
51	–
33 07	STO 7
24	RTN
23	LBL
13	C
34 04	RCL 4
34 03	RCL 3
34 06	RCL 6
71	x
03	3
71	x
51	–
34 01	RCL 1
81	÷
34 06	RCL 6
34 08	RCL 8
71	x
02	2
71	x

CODE	KEYS
61	+
33	STO
09	9
24	RTN
23	LBL
14	D
34 05	RCL 5
34 06	RCL 6
34 04	RCL 4
71	x
04	4
71	x
51	–
34 08	RCL 8
34 03	RCL 3
71	x
06	6
71	x
61	+
34 01	RCL 1
81	÷
34 08	RCL 8
32	f^{-1}
09	$\sqrt{x}$
03	3
71	x
51	–
33 06	STO 6
24	RTN
23	LBL
15	E
34	RCL
09	9
34 07	RCL 7
01	1

CODE	KEYS
83	•
05	5
35	g
05	y^x
81	÷
84	R/S
34 06	RCL 6
34 07	RCL 7
32	f^{-1}
09	$\sqrt{x}$
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n or Σf_j	R_4	Σx_i^3 or $\Sigma f_j y_j^3$	R_7	m_2
R_2	Σx_i or $\Sigma f_j y_j$	R_5	Σx_i^4 or $\Sigma f_j y_j^4$	R_8	$\bar{x}^2$
R_3	Σx_i^2 or $\Sigma f_j y_j^2$	R_6	$\bar{x}$, m_4	R_9	m_3

RANDOM NUMBER GENERATOR

CODE	KEYS
23	LBL
11	A
00	0
33 01	STO 1
24	RTN
23	LBL
12	B
35	g
02	π
34 01	RCL 1
61	+
08	8
35	g
05	y^x
32	f^{-1}
83	INT
33 01	STO 1
24	RTN
23	LBL
13	C
33 04	STO 4
35 07	g x⇄y
33 03	STO 3
24	RTN
23	LBL
14	D
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
24	RTN
23	LBL
15	E
35	g
42	RAD
34 02	RCL 2

CODE	KEYS
31	f
07	LN
02	2
71	x
42	CHS
31	f
09	$\sqrt{x}$
33 05	STO 5
34 01	RCL 1
35	g
02	π
71	x
02	2
71	x
33 06	STO 6
31	f
05	COS
71	x
34 04	RCL 4
71	x
34 03	RCL 3
61	+
84	R/S
23	LBL
15	E
34 06	RCL 6
31	f
04	SIN
34 05	RCL 5
71	x
34 04	RCL 4
71	x
34 03	RCL 3
61	+
33 05	STO 5

CODE	KEYS
34 01	RCL 1
33 06	STO 6
34 02	RCL 2
33 01	STO 1
12	B
33 02	STO 2
34 06	RCL 6
33 01	STO 1
12	B
34 05	RCL 5
84	R/S
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	σ	R_7	
R_2	Used	R_5	Used	R_8	
R_3	m	R_6	Used	R_9	Used

ANALYSIS OF VARIANCE (ONE WAY)

CODE	KEYS
23	LBL
11	A
33	STO
61	+
01	1
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
06	6
01	1
34 02	RCL 2
61	+
33 02	STO 2
84	R/S
23	LBL
12	B
01	1
33	STO
61	+
04	4
34 01	RCL 1
32	f^{-1}
09	$\sqrt{x}$
34 02	RCL 2
81	÷
33	STO
61	+
03	3
34 01	RCL 1
33 08	STO 8
33	STO
61	+
07	7
34 02	RCL 2

CODE	KEYS
33	STO
61	+
05	5
00	0
33 01	STO 1
33 02	STO 2
34 08	RCL 8
84	R/S
23	LBL
13	C
34 06	RCL 6
34 07	RCL 7
32	f^{-1}
09	$\sqrt{x}$
34 05	RCL 5
81	÷
51	–
33 01	STO 1
34 03	RCL 3
34 07	RCL 7
32	f^{-1}
09	$\sqrt{x}$
34 05	RCL 5
81	÷
51	–
33 02	STO 2
51	–
33 03	STO 3
35 00	g LST X
34 04	RCL 4
01	1
51	–
33 08	STO 8
81	÷
35 07	g x⇄y

CODE	KEYS
34 05	RCL 5
34 04	RCL 4
51	–
33	STO
09	9
81	÷
81	÷
84	R/S
34 08	RCL 8
84	R/S
34	RCL
09	9
84	R/S
23	LBL
14	D
33	STO
51	–
01	1
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
06	6
34 02	RCL 2
01	1
51	–
33 02	STO 2
84	R/S
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	$\Sigma\Sigma x_{ij}$
R_2	Used	R_5	Σn_i	R_8	df_1
R_3	Used	R_6	$\Sigma\Sigma x_{ij}^2$	R_9	df_2

NORMAL DISTRIBUTION (CARD 1)

CODE	KEYS
23	LBL
11	A
83	•
02	2
03	3
01	1
06	6
04	4
01	1
09	9
33 03	STO 3
01	1
83	•
03	3
03	3
00	0
02	2
07	7
04	4
04	4
02	2
09	9
33 04	STO 4
01	1
83	•
08	8
02	2
01	1
02	2
05	5
05	5
09	9
07	7
08	8
42	CHS

CODE	KEYS
33 05	STO 5
01	1
83	•
07	7
08	8
01	1
04	4
07	7
07	7
09	9
03	3
07	7
33 06	STO 6
83	•
03	3
05	5
06	6
05	5
06	6
03	3
07	7
08	8
02	2
42	CHS
33 07	STO 7
83	•
03	3
01	1
09	9
03	3
08	8
01	1
05	5
03	3
33 08	STO 8

CODE	KEYS
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1		R_4	b_5	R_7	b_2
R_2		R_5	b_4	R_8	b_1
R_3	r	R_6	b_3	R_9	

NORMAL DISTRIBUTION (CARD 2)

CODE	KEYS
23	LBL
11	A
33 01	STO 1
41	↑
71	x
02	2
81	÷
42	CHS
32	f^{-1}
07	LN
35	g
02	π
02	2
71	x
31	f
09	$\sqrt{x}$
81	÷
33 02	STO 2
24	RTN
23	LBL
12	B
34 01	RCL 1
00	0
35 24	g $x>y$
22	GTO
01	1
23	LBL
13	C
01	1
34 01	RCL 1
34 03	RCL 3
71	x
61	+
35	g
04	$^1/x$

CODE	KEYS
41	↑
41	↑
41	↑
34 04	RCL 4
71	x
34 05	RCL 5
61	+
71	x
34 06	RCL 6
61	+
71	x
34 07	RCL 7
61	+
71	x
34 08	RCL 8
61	+
71	x
34 02	RCL 2
71	x
24	RTN
23	LBL
01	1
34 01	RCL 1
42	CHS
33 01	STO 1
13	C
01	1
35 07	g x⇄y
51	–
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	x or −x	R_4	b_5	R_7	b_2
R_2	f(x)	R_5	b_4	R_8	b_1
R_3	r	R_6	b_3	R_9	Used

INVERSE NORMAL INTEGRAL

CODE	KEYS
02	2
83	•
05	5
01	1
05	5
05	5
01	1
07	7
33 01	STO 1
83	•
08	8
00	0
02	2
08	8
05	5
03	3
33 02	STO 2
83	•
00	0
01	1
00	0
03	3
02	2
08	8
33 03	STO 3
01	1
83	•
04	4
03	3
02	2
07	7
08	8
08	8
33 04	STO 4
83	•

CODE	KEYS
01	1
08	8
09	9
02	2
06	6
09	9
33 05	STO 5
83	•
00	0
00	0
01	1
03	3
00	0
08	8
33 06	STO 6
24	RTN
23	LBL
12	B
41	↑
00	0
35 24	g x>y
00	0
81	÷
35 08	g R↓
83	•
05	5
35 07	g x⇄y
35 24	g x>y
00	0
81	÷
41	↑
71	x
35	g
04	$^1/x$
31	f

CODE	KEYS
07	LN
31	f
09	$\sqrt{x}$
33 07	STO 7
34 03	RCL 3
71	x
34 02	RCL 2
61	+
34 07	RCL 7
71	x
34 01	RCL 1
61	+
34 07	RCL 7
34 06	RCL 6
71	x
34 05	RCL 5
61	+
34 07	RCL 7
71	x
34 04	RCL 4
61	+
34 07	RCL 7
71	x
01	1
61	+
81	÷
34 07	RCL 7
35 07	g x⇄y
51	–
24	RTN

R_1	c_0	R_4	d_1	R_7	t
R_2	c_1	R_5	d_2	R_8	
R_3	c_2	R_6	d_3	R_9	Used

CHI-SQUARE DISTRIBUTION

CODE	KEYS
01	1
33 03	STO 3
35 07	g x⇄y
02	2
81	÷
33 01	STO 1
31	f
83	INT
35 00	g LST X
35 21	g x≠y
22	GTO
01	1
01	1
51	–
35	g
03	n!
33 03	STO 3
84	R/S
23	LBL
01	1
83	•
05	5
35 23	g x=y
22	GTO
02	2
35 07	g x⇄y
01	1
51	–
33	STO
71	x
03	3
22	GTO
01	1
23	LBL
02	2

CODE	KEYS
35	g
02	π
31	f
09	$\sqrt{x}$
34 03	RCL 3
71	x
33 03	STO 3
84	R/S
23	LBL
12	B
33 02	STO 2
34 01	RCL 1
01	1
51	–
35	g
05	y^x
34 02	RCL 2
02	2
81	÷
42	CHS
32	f^{-1}
07	LN
71	x
02	2
34 01	RCL 1
35	g
05	y^x
81	÷
34 03	RCL 3
81	÷
33 05	STO 5
84	R/S
23	LBL
13	C
34 02	RCL 2

CODE	KEYS
34 01	RCL 1
81	÷
33	STO
71	x
05	5
02	2
34 01	RCL 1
71	x
33 06	STO 6
01	1
33 04	STO 4
23	LBL
03	3
34 02	RCL 2
34 06	RCL 6
02	2
61	+
33 06	STO 6
81	÷
34 04	RCL 4
71	x
33 04	STO 4
61	+
35 21	g x≠y
22	GTO
03	3
34 05	RCL 5
71	x
84	R/S
35 01	g NOP

R_1	$\nu/2$	R_4	Used	R_7	
R_2	x	R_5	Used	R_8	
R_3	1, $\Gamma(\nu/2)$	R_6	Used	R_9	Used

t DISTRIBUTION

CODE	KEYS
23	LBL
11	A
33 01	STO 1
35	g
42	RAD
31	f
09	$\sqrt{x}$
81	÷
32	f^{-1}
06	TAN
33 02	STO 2
34 01	RCL 1
02	2
81	÷
31	f
83	INT
35 00	g LST X
35 21	g x≠y
22	GTO
02	2
00	0
33 05	STO 5
23	LBL
12	B
34 02	RCL 2
31	f
05	COS
32	f^{-1}
09	$\sqrt{x}$
33 03	STO 3
34 02	RCL 2
31	f
04	SIN
33 04	STO 4
34 01	RCL 1

CODE	KEYS
02	2
35 23	g x=y
34 04	RCL 4
24	RTN
81	÷
01	1
51	–
33 08	STO 8
01	1
33 06	STO 6
23	LBL
01	1
34 03	RCL 3
71	x
34 05	RCL 5
01	1
61	+
71	x
35 00	g LST X
01	1
61	+
33 05	STO 5
81	÷
33	STO
61	+
06	6
35	g
83	DSZ
22	GTO
01	1
34 06	RCL 6
34 04	RCL 4
71	x
24	RTN
23	LBL

CODE	KEYS
02	2
34 02	RCL 2
02	2
71	x
35	g
02	π
81	÷
33 07	STO 7
34 01	RCL 1
01	1
33 05	STO 5
33	STO
51	–
01	1
35 23	g x=y
34 07	RCL 7
24	RTN
12	B
34 02	RCL 2
31	f
05	COS
71	x
02	2
71	x
35	g
02	π
81	÷
34 07	RCL 7
61	+
24	RTN

R_1	ν or $\nu - 1$	R_4	$\sin\theta$	R_7	$2\theta/\pi$
R_2	θ	R_5	Used	R_8	Used
R_3	$\cos^2\theta$	R_6	Used	R_9	Used

F DISTRIBUTION

CODE	KEYS
33 01	STO 1
24	RTN
23	LBL
12	B
33 02	STO 2
24	RTN
23	LBL
13	C
41	↑
34 01	RCL 1
71	x
34 02	RCL 2
61	+
34 02	RCL 2
35 07	g x⇄y
81	÷
33 03	STO 3
24	RTN
23	LBL
14	D
34 03	RCL 3
34 02	RCL 2
02	2
33 07	STO 7
81	÷
35	g
05	y^x
33 04	STO 4
34 01	RCL 1
02	2
51	–
02	2
81	÷
33 08	STO 8
00	0

CODE	KEYS
35 23	g x=y
34 04	RCL 4
24	RTN
01	1
33 05	STO 5
34 03	RCL 3
51	–
33 03	STO 3
34 02	RCL 2
02	2
81	÷
71	x
33	STO
61	+
05	5
35	g
83	DSZ
22	GTO
03	3
22	GTO
02	2
23	LBL
03	3
34 02	RCL 2
02	2
61	+
33 02	STO 2
34 07	RCL 7
02	2
61	+
33 07	STO 7
81	÷
34 03	RCL 3
71	x
71	x

CODE	KEYS
33	STO
61	+
05	5
35	g
83	DSZ
22	GTO
03	3
23	LBL
02	2
34 05	RCL 5
34 04	RCL 4
71	x
24	RTN
23	LBL
15	E
34 01	RCL 1
34 02	RCL 2
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
01	1
34 03	RCL 3
51	–
33 03	STO 3
14	D
01	1
35 07	g x⇄y
51	–
84	R/S
35 01	g NOP

R_1	ν_1 or ν_2	R_4	$t^{\nu_2/2}$ or $t^{\nu_1/2}$	R_7	Used
R_2	ν_2 or ν_1	R_5	Used	R_8	Used
R_3	t, 1 – t	R_6		R_9	Used

BIVARIATE NORMAL DISTRIBUTION

CODE	KEYS
23	LBL
11	A
33 01	STO 1
35 07	g x⇄y
33 06	STO 6
24	RTN
23	LBL
12	B
33 03	STO 3
35 07	g x⇄y
33 07	STO 7
24	RTN
23	LBL
13	C
33 05	STO 5
24	RTN
23	LBL
14	D
35 07	g x⇄y
34 06	RCL 6
51	–
34 01	RCL 1
81	÷
33 02	STO 2
32	f^{-1}
09	$\sqrt{x}$
35 07	g x⇄y
34 07	RCL 7
51	–
34 03	RCL 3
81	÷
33 04	STO 4
32	f^{-1}
09	$\sqrt{x}$
61	+

CODE	KEYS
34 02	RCL 2
34 04	RCL 4
71	x
02	2
71	x
34 05	RCL 5
71	x
51	–
01	1
34 05	RCL 5
32	f^{-1}
09	$\sqrt{x}$
51	–
33 08	STO 8
02	2
71	x
81	÷
42	CHS
32	f^{-1}
07	LN
34 08	RCL 8
31	f
09	$\sqrt{x}$
34 01	RCL 1
71	x
34 03	RCL 3
71	x
02	2
71	x
35	g
02	π
71	x
81	÷
24	RTN
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	σ_1	R_4	$(y-\mu_2)/\sigma_2$	R_7	μ_2
R_2	$(x-\mu_1)/\sigma_1$	R_5	ρ	R_8	$1-\rho^2$
R_3	σ_2	R_6	μ_1	R_9	

LOGARITHMIC NORMAL DISTRIBUTION

CODE	KEYS
23	LBL
11	A
33 02	STO 2
35 07	g x⇄y
33 01	STO 1
32	f^{-1}
07	LN
24	RTN
23	LBL
12	B
34 01	RCL 1
34 02	RCL 2
51	–
32	f^{-1}
07	LN
24	RTN
23	LBL
13	C
34 01	RCL 1
34 02	RCL 2
02	2
81	÷
61	+
32	f^{-1}
07	LN
24	RTN
23	LBL
14	D
32	f^{-1}
09	$\sqrt{x}$
34 02	RCL 2
32	f^{-1}
07	LN
01	1
51	–

CODE	KEYS
71	x
24	RTN
23	LBL
15	E
33 03	STO 3
31	f
07	LN
34 01	RCL 1
51	–
32	f^{-1}
09	$\sqrt{x}$
34 02	RCL 2
81	÷
02	2
81	÷
42	CHS
32	f^{-1}
07	LN
35	g
02	π
02	2
71	x
34 02	RCL 2
71	x
31	f
09	$\sqrt{x}$
81	÷
34 03	RCL 3
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	m	R_4	R_7
R_2	σ^2	R_5	R_8
R_3	x	R_6	R_9

WEIBULL DISTRIBUTION

CODE	KEYS
23	LBL
11	A
33 02	STO 2
35 07	g x⇄y
33 01	STO 1
24	RTN
23	LBL
12	B
33 03	STO 3
34 02	RCL 2
35	g
05	y^x
34 01	RCL 1
71	x
42	CHS
32	f^{-1}
07	LN
33 04	STO 4
35 00	g LST X
42	CHS
34 03	RCL 3
81	÷
71	x
34 02	RCL 2
71	x
24	RTN
23	LBL
13	C
34 04	RCL 4
24	RTN
23	LBL
14	D
41	↑
01	1
35 07	g x⇄y

CODE	KEYS
35 24	g x>y
00	0
81	÷
31	f
07	LN
34 01	RCL 1
81	÷
42	CHS
34 02	RCL 2
35	g
04	1/x
35	g
05	y^x
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	a	R_4	Q(x)	R_7	
R_2	b	R_5		R_8	
R_3	x	R_6		R_9	Used

BINOMIAL DISTRIBUTION

CODE	KEYS
23	LBL
11	A
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
33 04	STO 4
01	1
51	–
42	CHS
34 01	RCL 1
35	g
05	y^x
33 03	STO 3
00	0
34 02	RCL 2
35 22	g x≤y
00	0
81	÷
01	1
34 02	RCL 2
51	–
81	÷
33 02	STO 2
34 01	RCL 1
34 04	RCL 4
71	x
24	RTN
01	1
34 04	RCL 4
51	–
71	x
84	R/S
23	LBL
12	B
33 06	STO 6

CODE	KEYS
00	0
33 07	STO 7
35 23	g x=y
34 03	RCL 3
24	RTN
44	CLX
34 01	RCL 1
35 07	g x⇄y
35 24	g x>y
00	0
81	÷
32	f^{-1}
83	INT
00	0
35 21	g x≠y
00	0
81	÷
34 03	RCL 3
33 04	STO 4
33 05	STO 5
23	LBL
01	1
34 01	RCL 1
34 07	RCL 7
51	–
34 07	RCL 7
01	1
61	+
81	÷
34 02	RCL 2
71	x
34 04	RCL 4
71	x
33 04	STO 4
33	STO

CODE	KEYS
61	+
05	5
34 07	RCL 7
01	1
61	+
33 07	STO 7
34 06	RCL 6
35 23	g x=y
34 04	RCL 4
24	RTN
22	GTO
01	1
23	LBL
13	C
34 06	RCL 6
00	0
35 23	g x=y
34 03	RCL 3
24	RTN
01	1
34 05	RCL 5
35 24	g x>y
35 07	g x⇄y
35 01	g NOP
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	Used	R_7	Counter
R_2	p, p/(1 – p)	R_5	Used	R_8	
R_3	f(0)	R_6	x	R_9	Used

NEGATIVE BINOMIAL DISTRIBUTION

CODE	KEYS
23	LBL
11	A
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
35 07	g x⇄y
35	g
05	y^x
33 03	STO 3
01	1
34 02	RCL 2
35 23	g x=y
00	0
81	÷
24	RTN
23	LBL
12	B
34 01	RCL 1
34 02	RCL 2
81	÷
01	1
34 02	RCL 2
51	–
71	x
24	RTN
23	LBL
13	C
34 02	RCL 2
81	÷
24	RTN
23	LBL
14	D
33 06	STO 6
00	0
33 07	STO 7

CODE	KEYS
35 23	g x=y
34 03	RCL 3
24	RTN
35 07	g x⇄y
32	f^{-1}
83	INT
35 21	g x≠y
00	0
81	÷
34 03	RCL 3
33 04	STO 4
33 05	STO 5
23	LBL
01	1
01	1
34 02	RCL 2
51	–
34 07	RCL 7
34 01	RCL 1
61	+
71	x
34 07	RCL 7
01	1
61	+
33 07	STO 7
81	÷
34 04	RCL 4
71	x
33 04	STO 4
33	STO
61	+
05	5
34 07	RCL 7
34 06	RCL 6
35 23	g x=y

CODE	KEYS
34 04	RCL 4
24	RTN
22	GTO
01	1
23	LBL
15	E
34 06	RCL 6
00	0
35 23	g x=y
34 03	RCL 3
24	RTN
01	1
34 05	RCL 5
35 24	g x>y
35 07	g x⇄y
35 01	g NOP
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	r	R_4	Used	R_7	Counter
R_2	p	R_5	Used	R_8	
R_3	f(0)	R_6	x	R_9	Used

HYPERGEOMETRIC DISTRIBUTION

CODE	KEYS
33 02	STO 2
35 07	g x⇄y
33 01	STO 1
84	R/S
23	LBL
12	B
33 03	STO 3
34 02	RCL 2
35	g
03	n!
35 00	g LST X
34 03	RCL 3
51	–
35	g
03	n!
81	÷
34 01	RCL 1
34 02	RCL 2
61	+
35	g
03	n!
35 00	g LST X
34 03	RCL 3
51	–
35	g
03	n!
81	÷
81	÷
33 04	STO 4
24	RTN
23	LBL
13	C
33 07	STO 7
34 04	RCL 4
33 05	STO 5

CODE	KEYS
33 06	STO 6
00	0
33 08	STO 8
23	LBL
01	1
34 01	RCL 1
51	–
34 08	RCL 8
34 03	RCL 3
51	–
71	x
34 08	RCL 8
01	1
61	+
81	÷
35 00	g LST X
34 02	RCL 2
34 03	RCL 3
51	–
61	+
81	÷
34 05	RCL 5
71	x
33 05	STO 5
33	STO
61	+
06	6
34 07	RCL 7
01	1
34 08	RCL 8
61	+
33 08	STO 8
35 23	g x=y
34 05	RCL 5
24	RTN

CODE	KEYS
22	GTO
01	1
23	LBL
14	D
34 06	RCL 6
24	RTN
23	LBL
15	E
34 01	RCL 1
34 03	RCL 3
71	x
34 01	RCL 1
34 02	RCL 2
61	+
33 08	STO 8
81	÷
84	R/S
34 02	RCL 2
71	x
34 08	RCL 8
81	÷
34 08	RCL 8
34 03	RCL 3
51	–
71	x
34 08	RCL 8
01	1
51	–
81	÷
24	RTN

R_1	a	R_4	f(0)	R_7	x
R_2	b	R_5	Used	R_8	Counter, a + b
R_3	n	R_6	Used	R_9	Used

POISSON DISTRIBUTION

CODE	KEYS
23	LBL
11	A
41	↑
00	0
35 07	g x⇄y
35 22	g x≤y
00	0
81	÷
33 01	STO 1
42	CHS
32	f^{-1}
07	LN
33 02	STO 2
24	RTN
23	LBL
12	B
33 05	STO 5
00	0
33 06	STO 6
35 24	g x>y
00	0
81	÷
35 23	g x=y
34 02	RCL 2
24	RTN
35 07	g x⇄y
32	f^{-1}
83	INT
35 21	g x≠y
00	0
81	÷
34 02	RCL 2
33 03	STO 3
33 04	STO 4
23	LBL

CODE	KEYS
01	1
34 01	RCL 1
34 06	RCL 6
01	1
61	+
81	÷
34 03	RCL 3
71	x
33 03	STO 3
33	STO
61	+
04	4
34 06	RCL 6
01	1
61	+
33 06	STO 6
34 05	RCL 5
35 23	g x=y
34 03	RCL 3
24	RTN
22	GTO
01	1
23	LBL
13	C
34 05	RCL 5
00	0
35 23	g x=y
34 02	RCL 2
24	RTN
01	1
34 04	RCL 4
35 24	g x>y
35 07	g x⇄y
35 01	g NOP
24	RTN

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	λ	R_4	Used	R_7	
R_2	f(0)	R_5	x	R_8	
R_3	Used	R_6	Counter	R_9	Used

LINEAR REGRESSION

CODE	KEYS
23	LBL
11	A
34 06	RCL 6
34 02	RCL 2
34 04	RCL 4
71	x
34 01	RCL 1
81	÷
51	–
33	STO
09	9
34 03	RCL 3
34 02	RCL 2
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
81	÷
33 07	STO 7
34 04	RCL 4
34 07	RCL 7
34 02	RCL 2
71	x
51	–
34 01	RCL 1
81	÷
33 08	STO 8
84	R/S
34 07	RCL 7
24	RTN
23	LBL
12	B
34 07	RCL 7
34	RCL

CODE	KEYS
09	9
71	x
34 05	RCL 5
34 04	RCL 4
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
81	÷
24	RTN
23	LBL
13	C
41	↑
34 07	RCL 7
71	x
34 08	RCL 8
61	+
24	RTN
23	LBL
14	D
34 05	RCL 5
34 08	RCL 8
34 04	RCL 4
71	x
51	–
34 06	RCL 6
34 07	RCL 7
71	x
51	–
34 01	RCL 1
02	2
51	–
81	÷
31	f

CODE	KEYS
09	$\sqrt{x}$
24	RTN
23	LBL
15	E
34 03	RCL 3
34 02	RCL 2
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
31	f
09	$\sqrt{x}$
81	÷
34 03	RCL 3
34 01	RCL 1
81	÷
31	f
09	$\sqrt{x}$
35 07	g x⇄y
71	x
84	R/S
35 00	g LST X
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	Σy_i	R_7	a_1
R_2	Σx_i	R_5	Σy_i^2	R_8	a_0
R_3	Σx_i^2	R_6	$\Sigma x_i y_i$	R_9	Used

EXPONENTIAL CURVE FIT

CODE	KEYS
23	LBL
11	A
31	f
07	LN
33 07	STO 7
33	STO
61	+
04	4
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
05	5
35 07	g x⇄y
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
35 00	g LST X
34 07	RCL 7
71	x
33	STO
61	+
06	6
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
12	B

CODE	KEYS
34 06	RCL 6
34 02	RCL 2
34 04	RCL 4
71	x
34 01	RCL 1
81	÷
51	–
33	STO
09	9
34 03	RCL 3
34 02	RCL 2
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
81	÷
33 07	STO 7
34 04	RCL 4
34 07	RCL 7
34 02	RCL 2
71	x
51	–
34 01	RCL 1
81	÷
32	f^{-1}
07	LN
33 08	STO 8
84	R/S
34 07	RCL 7
24	RTN
23	LBL
13	C
34 07	RCL 7
34	RCL

CODE	KEYS
09	9
71	x
34 05	RCL 5
34 04	RCL 4
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
81	÷
24	RTN
23	LBL
14	D
41	↑
34 07	RCL 7
71	x
32	f^{-1}
07	LN
34 08	RCL 8
71	x
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	$\Sigma \ln y_i$	R_7	$\ln y_i$, b
R_2	Σx_i	R_5	$\Sigma (\ln y_i)^2$	R_8	a
R_3	Σx_i^2	R_6	$\Sigma x_i \ln y_i$	R_9	Used

POWER CURVE FIT

CODE	KEYS
23	LBL
11	A
31	f
07	LN
33 07	STO 7
33	STO
61	+
04	4
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
05	5
35 07	g x⇄y
31	f
07	LN
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
35 00	g LST X
34 07	RCL 7
71	x
33	STO
61	+
06	6
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN

CODE	KEYS
23	LBL
12	B
34 06	RCL 6
34 02	RCL 2
34 04	RCL 4
71	x
34 01	RCL 1
81	÷
51	–
33	STO
09	9
34 03	RCL 3
34 02	RCL 2
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
81	÷
33 07	STO 7
34 04	RCL 4
34 07	RCL 7
34 02	RCL 2
71	x
51	–
34 01	RCL 1
81	÷
32	f^{-1}
07	LN
33 08	STO 8
84	R/S
34 07	RCL 7
24	RTN
23	LBL
13	C

CODE	KEYS
34 07	RCL 7
34	RCL
09	9
71	x
34 05	RCL 5
34 04	RCL 4
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
81	÷
24	RTN
23	LBL
14	D
41	↑
34 07	RCL 7
35	g
05	y^x
34 08	RCL 8
71	x
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	$\Sigma \ln y_i$	R_7	$\ln y_i$, b
R_2	$\Sigma \ln x_i$	R_5	$\Sigma (\ln y_i)^2$	R_8	a
R_3	$\Sigma (\ln x_i)^2$	R_6	$\Sigma (\ln x_i)(\ln y_i)$	R_9	Used

LOGARITHMIC CURVE FIT

CODE	KEYS
23	LBL
11	A
33 07	STO 7
33	STO
61	+
04	4
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
05	5
35 07	g x⇄y
31	f
07	LN
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
35 00	g LST X
34 07	RCL 7
71	x
33	STO
61	+
06	6
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
12	B

CODE	KEYS
34 06	RCL 6
34 02	RCL 2
34 04	RCL 4
71	x
34 01	RCL 1
81	÷
51	–
33	STO
09	9
34 03	RCL 3
34 02	RCL 2
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
81	÷
33 07	STO 7
34 04	RCL 4
34 07	RCL 7
34 02	RCL 2
71	x
51	–
34 01	RCL 1
81	÷
33 08	STO 8
84	R/S
34 07	RCL 7
24	RTN
23	LBL
13	C
34 07	RCL 7
34	RCL
09	9
71	x

CODE	KEYS
34 05	RCL 5
34 04	RCL 4
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
81	÷
24	RTN
23	LBL
14	D
31	f
07	LN
34 07	RCL 7
71	x
34 08	RCL 8
61	+
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	Σy_i	R_7	y_i, b
R_2	$\Sigma \ln x_i$	R_5	Σy_i^2	R_8	a
R_3	$\Sigma (\ln x_i)^2$	R_6	$\Sigma y_i \ln x_i$	R_9	Used

LEAST SQUARES REGRESSION OF $y = cx^a + dx^b$

CODE	KEYS
33 02	STO 2
35 07	g x⇄y
33 01	STO 1
24	RTN
23	LBL
12	B
35 07	g x⇄y
33 03	STO 3
34 01	RCL 1
35	g
05	y^x
41	↑
41	↑
35 09	g R↑
71	x
33	STO
61	+
06	6
44	CLX
35 00	g LST X
34 03	RCL 3
34 02	RCL 2
35	g
05	y^x
33	STO
09	9
71	x
33	STO
61	+
04	4
44	CLX
34	RCL
09	9
71	x
33	STO

CODE	KEYS
61	+
05	5
35 08	g R↓
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
08	8
34	RCL
09	9
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
07	7
24	RTN
23	LBL
13	C
34 08	RCL 8
34 04	RCL 4
71	x
34 06	RCL 6
34 05	RCL 5
71	x
51	–
34 07	RCL 7
34 08	RCL 8
71	x
34 05	RCL 5
32	f^{-1}
09	$\sqrt{x}$
51	–
81	÷
33 03	STO 3
34 05	RCL 5

CODE	KEYS
71	x
34 06	RCL 6
35 07	g x⇄y
51	–
34 08	RCL 8
81	÷
33	STO
09	9
24	RTN
34 03	RCL 3
84	R/S
23	LBL
14	D
41	↑
41	↑
34 01	RCL 1
35	g
05	y^x
34	RCL
09	9
71	x
35 07	g x⇄y
34 02	RCL 2
35	g
05	y^x
34 03	RCL 3
71	x
61	+
24	RTN
35 01	g NOP

R_1	a	R_4	$\Sigma y_i x_i^b$	R_7	Σx_i^{2b}
R_2	b	R_5	Σx_i^{a+b}	R_8	Σx_i^{2a}
R_3	x_i, d	R_6	$\Sigma x_i^a y_i$	R_9	x_i^b, c

MULTIPLE LINEAR REGRESSION (CARD 1)

CODE	KEYS
23	LBL
11	A
41	↑
35 08	g R↓
33	STO
61	+
09	9
35 07	g x⇄y
71	x
33	STO
61	+
03	3
44	CLX
35 00	g LST X
33	STO
61	+
08	8
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
04	4
44	CLX
35 00	g LST X
35 07	g x⇄y
33	STO
61	+
07	7
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
06	6
44	CLX
35 00	g LST X

CODE	KEYS
71	x
33	STO
61	+
01	1
44	CLX
35 00	g LST X
71	x
33	STO
61	+
02	2
01	1
34 05	RCL 5
61	+
33 05	STO 5
24	RTN
23	LBL
12	B
41	↑
35 08	g R↓
33	STO
51	–
09	9
35 07	g x⇄y
71	x
33	STO
51	–
03	3
44	CLX
35 00	g LST X
33	STO
51	–
08	8
32	f^{-1}
09	$\sqrt{x}$
33	STO

CODE	KEYS
51	–
04	4
44	CLX
35 00	g LST X
35 07	g x⇄y
33	STO
51	–
07	7
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
06	6
44	CLX
35 00	g LST X
71	x
33	STO
51	–
01	1
44	CLX
35 00	g LST X
71	x
33	STO
51	–
02	2
34 05	RCL 5
01	1
51	–
33 05	STO 5
24	RTN

R_1	$\Sigma x_i y_i$	R_4	Σy_i^2	R_7	Σx_i
R_2	$\Sigma x_i z_i$	R_5	n	R_8	Σy_i
R_3	$\Sigma y_i z_i$	R_6	Σx_i^2	R_9	Σz_i

MULTIPLE LINEAR REGRESSION (CARD 2)

CODE	KEYS
23	LBL
11	A
34 05	RCL 5
34 06	RCL 6
71	x
34 07	RCL 7
32	f^{-1}
09	$\sqrt{x}$
51	–
33 06	STO 6
34 05	RCL 5
34 03	RCL 3
71	x
34 08	RCL 8
34	RCL
09	9
71	x
51	–
71	x
33 03	STO 3
34 05	RCL 5
34 01	RCL 1
71	x
34 07	RCL 7
34 08	RCL 8
71	x
51	–
33 01	STO 1
34 05	RCL 5
34 02	RCL 2
71	x
34 07	RCL 7
34	RCL
09	9
71	x

CODE	KEYS
51	–
33 02	STO 2
71	x
34 03	RCL 3
35 07	g x⇄y
51	–
34 06	RCL 6
34 05	RCL 5
34 04	RCL 4
71	x
34 08	RCL 8
32	f^{-1}
09	$\sqrt{x}$
51	–
71	x
34 01	RCL 1
32	f^{-1}
09	$\sqrt{x}$
51	–
81	÷
33 03	STO 3
34 02	RCL 2
34 01	RCL 1
34 03	RCL 3
71	x
51	–
34 06	RCL 6
81	÷
33 02	STO 2
34	RCL
09	9
34 03	RCL 3
34 08	RCL 8
71	x
51	–

CODE	KEYS
34 02	RCL 2
34 07	RCL 7
71	x
51	–
34 05	RCL 5
81	÷
33 01	STO 1
84	R/S
23	LBL
12	B
34 02	RCL 2
84	R/S
23	LBL
13	C
34 03	RCL 3
84	R/S
23	LBL
14	D
41	↑
34 03	RCL 3
71	x
35 07	g x⇄y
34 02	RCL 2
71	x
61	+
34 01	RCL 1
61	+
24	RTN
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Σy_i^2	R_7	Σx_i
R_2	Used	R_5	n	R_8	Σy_i
R_3	Used	R_6	$\Sigma x_i^2, n\Sigma x_i^2-(\Sigma x_i)^2$	R_9	Σz_i

PARABOLIC CURVE FIT

CODE	KEYS
23	LBL
11	A
33	STO
61	+
09	9
35 07	g x⇄y
33	STO
61	+
07	7
71	x
33	STO
61	+
02	2
35 00	g LST X
71	x
33	STO
61	+
03	3
35 00	g LST X
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
06	6
33	STO
61	+
08	8
35 00	g LST X
71	x
33	STO
61	+
01	1
35 00	g LST X
71	x
33	STO

CODE	KEYS
61	+
04	4
34 05	RCL 5
01	1
61	+
33 05	STO 5
24	RTN
23	LBL
12	B
33	STO
51	–
09	9
35 07	g x⇄y
33	STO
51	–
07	7
71	x
33	STO
51	–
02	2
35 00	g LST X
71	x
33	STO
51	–
03	3
35 00	g LST X
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
06	6
33	STO
51	–
08	8
35 00	g LST X

CODE	KEYS
71	x
33	STO
51	–
01	1
35 00	g LST X
71	x
33	STO
51	–
04	4
34 05	RCL 5
01	1
51	–
33 05	STO 5
24	RTN
23	LBL
13	C
33 04	STO 4
34 03	RCL 3
71	x
34 02	RCL 2
61	+
34 04	RCL 4
71	x
34 01	RCL 1
61	+
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Σx_i^3, a_0	R_4	Σx_i^4, x	R_7	Σx_i
R_2	$\Sigma x_i y_i$, a_1	R_5	n	R_8	Σx_i^2
R_3	$\Sigma x_i^2 y_i$, a_2	R_6	Σx_i^2	R_9	Σy_i

PAIRED t STATISTIC

CODE	KEYS
23	LBL
11	A
00	0
33 01	STO 1
33 02	STO 2
33 03	STO 3
24	RTN
23	LBL
12	B
51	–
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
13	C
34 02	RCL 2
34 01	RCL 1
81	÷
84	R/S
34 03	RCL 3
34 02	RCL 2
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷

CODE	KEYS
51	–
34 01	RCL 1
01	1
51	–
81	÷
31	f
09	$\sqrt{x}$
24	RTN
23	LBL
14	D
34 01	RCL 1
31	f
09	$\sqrt{x}$
81	÷
81	÷
84	R/S
34 01	RCL 1
01	1
51	–
24	RTN
23	LBL
15	E
51	–
33	STO
51	–
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
03	3
34 01	RCL 1
01	1
51	–
33 01	STO 1

CODE	KEYS
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4		R_7	
R_2	ΣD_i	R_5		R_8	
R_3	ΣD_i^2	R_6		R_9	

t STATISTIC FOR TWO MEANS

CODE	KEYS
23	LBL
11	A
00	0
33 01	STO 1
33 02	STO 2
33 03	STO 3
24	RTN
23	LBL
12	B
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
13	C
33 07	STO 7
84	R/S
34 01	RCL 1
33 04	STO 4
34 02	RCL 2
33 05	STO 5
34 03	RCL 3
33 06	STO 6
11	A
24	RTN
23	LBL

CODE	KEYS
14	D
34 06	RCL 6
34 05	RCL 5
32	f^{-1}
09	$\sqrt{x}$
34 04	RCL 4
81	÷
51	–
34 03	RCL 3
61	+
34 02	RCL 2
32	f^{-1}
09	$\sqrt{x}$
34 01	RCL 1
81	÷
51	–
34 01	RCL 1
34 04	RCL 4
61	+
02	2
51	–
33 08	STO 8
81	÷
31	f
09	$\sqrt{x}$
01	1
34 01	RCL 1
81	÷
01	1
34 04	RCL 4
81	÷
61	+
31	f
09	$\sqrt{x}$
71	x

CODE	KEYS
34 05	RCL 5
34 04	RCL 4
81	÷
34 02	RCL 2
34 01	RCL 1
81	÷
51	–
34 07	RCL 7
51	–
35 07	g x⇄y
81	÷
84	R/S
34 08	RCL 8
24	RTN
23	LBL
15	E
33	STO
51	–
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
03	3
34 01	RCL 1
01	1
51	–
33 01	STO 1
24	RTN
35 01	g NOP

R_1	n_1, n_2	R_4	n_1	R_7	D
R_2	$\Sigma x_i, \Sigma y_i$	R_5	Σx_i	R_8	$n_1 + n_2 - 2$
R_3	$\Sigma x_i^2, \Sigma y_i^2$	R_6	Σx_i^2	R_9	

CHI-SQUARE EVALUATION

CODE	KEYS
00	0
33 01	STO 1
33 02	STO 2
33 03	STO 3
32	f^{-1}
51	SF 1
84	R/S
23	LBL
11	A
33 03	STO 3
51	–
32	f^{-1}
09	$\sqrt{x}$
34 03	RCL 3
81	÷
33	STO
61	+
02	2
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
12	B
33 03	STO 3
51	–
32	f^{-1}
09	$\sqrt{x}$
34 03	RCL 3
81	÷
33	STO
51	–
02	2
34 01	RCL 1

CODE	KEYS
01	1
51	–
33 01	STO 1
24	RTN
23	LBL
13	C
33	STO
61	+
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
14	D
33	STO
51	–
02	2
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
03	3
34 01	RCL 1
01	1
51	–
33 01	STO 1
24	RTN
23	LBL

CODE	KEYS
15	E
31	f
61	TF 1
22	GTO
01	1
34 02	RCL 2
24	RTN
23	LBL
01	1
34 01	RCL 1
34 03	RCL 3
71	x
34 02	RCL 2
81	÷
34 02	RCL 2
51	–
84	R/S
34 02	RCL 2
34 01	RCL 1
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4		R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	

2 x k CONTINGENCY TABLE

CODE	KEYS
23	LBL
11	A
31	f
43	REG
24	RTN
23	LBL
12	B
33 08	STO 8
35 07	g x⇄y
33 07	STO 7
41	↑
41	↑
71	x
35 08	g R↓
33	STO
61	+
01	1
33	STO
61	+
04	4
35 07	g x⇄y
33	STO
61	+
02	2
33	STO
61	+
04	4
61	+
41	↑
35 08	g R↓
35 07	g x⇄y
35 08	g R↓
81	÷
33	STO
61	+

CODE	KEYS
05	5
35 08	g R↓
34 08	RCL 8
41	↑
71	x
35 07	g x⇄y
81	÷
33	STO
61	+
06	6
01	1
34 03	RCL 3
61	+
33 03	STO 3
24	RTN
23	LBL
13	C
34 04	RCL 4
34 05	RCL 5
71	x
34 01	RCL 1
81	÷
34 04	RCL 4
34 06	RCL 6
34 02	RCL 2
81	÷
71	x
61	+
34 04	RCL 4
51	–
33 07	STO 7
24	RTN
23	LBL
14	D
34 03	RCL 3

CODE	KEYS
01	1
51	–
24	RTN
23	LBL
15	E
34 07	RCL 7
34 04	RCL 4
34 07	RCL 7
61	+
81	÷
31	f
09	$\sqrt{x}$
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	N_A	R_4	N	R_7	a_i, χ^2
R_2	N_B	R_5	$\Sigma a_i^2/N_i$	R_8	b_i
R_3	k	R_6	$\Sigma b_i^2/N_i$	R_9	0

BARTLETT'S CHI-SQUARE STATISTIC

CODE	KEYS
23	LBL
11	A
31	f
43	REG
24	RTN
23	LBL
12	B
33 01	STO 1
33	STO
61	+
03	3
35	g
04	1/x
33	STO
61	+
04	4
35 08	g R↓
41	↑
41	↑
34 01	RCL 1
71	x
33	STO
61	+
08	8
35 07	g x⇄y
31	f
07	LN
34 01	RCL 1
71	x
33	STO
61	+
07	7
34 05	RCL 5
01	1
61	+

CODE	KEYS
33 05	STO 5
24	RTN
23	LBL
13	C
34 08	RCL 8
34 03	RCL 3
81	÷
31	f
07	LN
34 03	RCL 3
71	x
34 07	RCL 7
51	–
34 04	RCL 4
34 03	RCL 3
35	g
04	1/x
51	–
34 05	RCL 5
01	1
51	–
33 02	STO 2
03	3
71	x
81	÷
01	1
61	+
81	÷
84	R/S
34 02	RCL 2
24	RTN
23	LBL
14	D
33 01	STO 1
33	STO

CODE	KEYS
51	–
03	3
35	g
04	1/x
33	STO
51	–
04	4
35 08	g R↓
41	↑
41	↑
34 01	RCL 1
71	x
33	STO
51	–
08	8
35 07	g x⇄y
31	f
07	LN
34 01	RCL 1
71	x
33	STO
51	–
07	7
34 05	RCL 5
01	1
51	–
33 05	STO 5
24	RTN
35 01	g NOP
35 01	g NOP

R_1	f_i	R_4	$\Sigma 1/f_i$	R_7	$\Sigma f_i \ln s_i^2$
R_2	df	R_5	k	R_8	$\Sigma f_i s_i^2$
R_3	Σf_i	R_6	0	R_9	0

SPEARMAN'S RANK CORRELATION COEFFICIENT

CODE	KEYS
23	LBL
11	A
00	0
33 01	STO 1
33 02	STO 2
24	RTN
23	LBL
12	B
51	–
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
02	2
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
13	C
01	1
34 02	RCL 2
06	6
71	x
34 01	RCL 1
32	f^{-1}
09	$\sqrt{x}$
01	1
51	–
34 01	RCL 1
71	x
81	÷
51	–
24	RTN

CODE	KEYS
23	LBL
14	D
34 01	RCL 1
01	1
51	–
31	f
09	$\sqrt{x}$
71	x
24	RTN
23	LBL
15	E
51	–
32	f^{-1}
09	$\sqrt{x}$
33	STO
51	–
02	2
34 01	RCL 1
01	1
51	–
33 01	STO 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4		R_7	
R_2	ΣD_i^2	R_5		R_8	
R_3		R_6		R_9	

MANN-WHITNEY STATISTIC

CODE	KEYS
23	LBL
11	A
33 02	STO 2
00	0
33 01	STO 1
33 03	STO 3
24	RTN
23	LBL
12	B
33	STO
61	+
03	3
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
13	C
34 02	RCL 2
34 01	RCL 1
01	1
61	+
02	2
81	÷
61	+
71	x
34 03	RCL 3
51	–
24	RTN
23	LBL
14	D
34 01	RCL 1
34 02	RCL 2
71	x

CODE	KEYS
02	2
81	÷
51	–
34 01	RCL 1
34 02	RCL 2
61	+
01	1
61	+
34 01	RCL 1
71	x
34 02	RCL 2
71	x
01	1
02	2
81	÷
31	f
09	$\sqrt{x}$
81	÷
24	RTN
23	LBL
15	E
33	STO
51	–
03	3
34 01	RCL 1
01	1
51	–
33 01	STO 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n_1	R_4		R_7	
R_2	n_2	R_5		R_8	
R_3	ΣR_i	R_6		R_9	

KENDALL'S COEFFICIENT OF CONCORDANCE

CODE	KEYS
00	0
33 01	STO 1
33 02	STO 2
33 03	STO 3
33 04	STO 4
84	R/S
23	LBL
11	A
33	STO
61	+
02	2
34 01	RCL 1
01	1
61	+
33 01	STO 1
24	RTN
23	LBL
12	B
34 01	RCL 1
33 05	STO 5
34 02	RCL 2
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
03	3
34 04	RCL 4
01	1
61	+
33 04	STO 4
00	0
33 01	STO 1
33 02	STO 2
34 04	RCL 4
24	RTN

CODE	KEYS
23	LBL
13	C
34 03	RCL 3
01	1
02	2
71	x
34 05	RCL 5
32	f^{-1}
09	$\sqrt{x}$
81	÷
34 04	RCL 4
81	÷
34 04	RCL 4
32	f^{-1}
09	$\sqrt{x}$
01	1
51	–
81	÷
34 04	RCL 4
01	1
61	+
03	3
71	x
34 04	RCL 4
01	1
51	–
81	÷
51	–
24	RTN
23	LBL
14	D
34 05	RCL 5
71	x
34 04	RCL 4
01	1

CODE	KEYS
51	–
71	x
84	R/S
34 04	RCL 4
01	1
51	–
24	RTN
23	LBL
15	E
33	STO
51	–
02	2
34 01	RCL 1
01	1
51	–
33 01	STO 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	j	R_4	n	R_7	
R_2	ΣR_{ij}	R_5	k	R_8	
R_3	$\Sigma(\Sigma R_{ij})^2$	R_6		R_9	

BISERIAL CORRELATION COEFFICIENT

CODE	KEYS
23	LBL
11	A
31	f
43	REG
33 01	STO 1
24	RTN
23	LBL
12	B
33	STO
61	+
04	4
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
06	6
01	1
33	STO
61	+
02	2
34 03	RCL 3
61	+
33 03	STO 3
24	RTN
23	LBL
13	C
33	STO
61	+
05	5
32	f^{-1}
09	$\sqrt{x}$
33	STO
61	+
06	6
34 03	RCL 3

CODE	KEYS
01	1
61	+
33 03	STO 3
24	RTN
23	LBL
14	D
34 04	RCL 4
33	STO
61	+
05	5
34 03	RCL 3
71	x
34 05	RCL 5
34 02	RCL 2
71	x
51	–
34 03	RCL 3
81	÷
34 01	RCL 1
81	÷
34 03	RCL 3
34 06	RCL 6
71	x
34 05	RCL 5
32	f^{-1}
09	$\sqrt{x}$
51	–
31	f
09	$\sqrt{x}$
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
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35 01	g NOP
35 01	g NOP
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35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	a	R_4	$\Sigma' y_i$	R_7	0
R_2	n_1	R_5	Σy_i	R_8	0
R_3	n	R_6	Σy_i^2	R_9	0

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