10. Statistics

10.1 Mean and standard deviation – single data

The formula for the mean is $\bar{x} = \dfrac{\Sigma x}{n}$
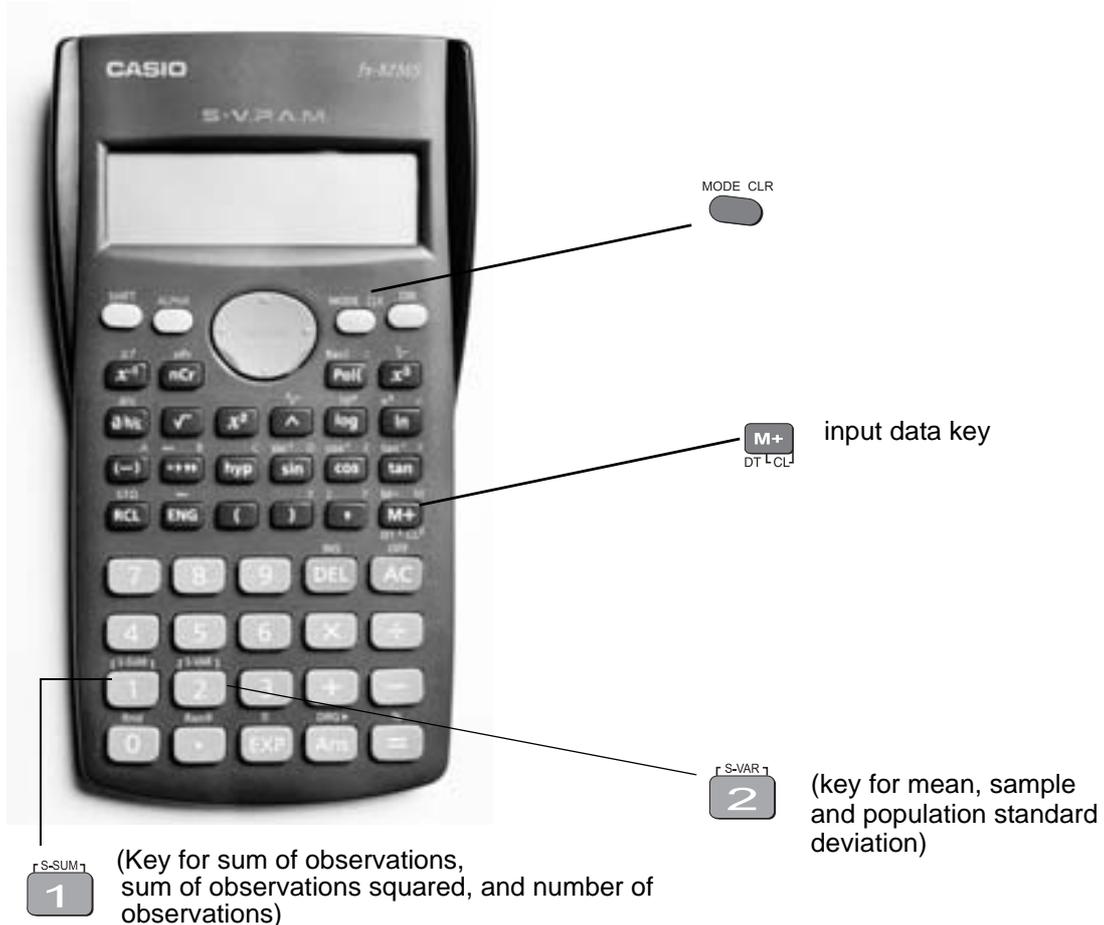
The formulas for the sample standard deviation are

$$\sigma_{n-1} \text{ or } s = \sqrt{\frac{\Sigma\left(x_1 - \bar{x}\right)^2}{n-1}}$$ (sample)

$$\sigma_n = \sqrt{\frac{\Sigma\left(x_1 - \bar{x}\right)^2}{n}}$$ (population)

Your calculator will calculate the mean and standard deviation for you (the population standard deviation σ_n or the sample standard deviation σ_{n-1} – in data calculations you will usually use the sample standard deviation.)

On the Casio *fx-82MS*, σ and *s* are found in *s*-VAR. The positions of keys needed are shown on the diagram below.

MODE CLR

input data key

S-VAR
2
(key for mean, sample and population standard deviation)

S-SUM
1
(Key for sum of observations, sum of observations squared, and number of observations)

To find the mean and standard deviation,

firstly you must access the statistics mode of the calculator by using the keys MODE CLR ⬭ once

followed by 2 SD will appear in the centre of the screen.

Note that once you are in the statistics mode, the keys shown within the blue lines are active. There are 3 such keys on the Casio *fx*-82MS. Make sure you can locate them. Before starting any computations always clear the statistic's memories using Scl. Press

SHIFT MODE CLR ⬭⬭ 1 =

I will use the data set A (–5, 2, 3, 4, 11) to demonstrate the use of the calculator. Note that I have shown the use of the SHIFT ⬭ key where necessary.

Step 1: Input the observations.

Use the M+ (DT CL) key to input data (no need to press SHIFT ⬭).

(−) 5 M+ (DT CL) 2 M+ (DT CL) 3 M+ (DT CL) 4 M+ (DT CL) 1 1 M+ (DT CL)

The display should read n = 5. (This means 5 observations have been input).

Step 3: Display the mean and standard deviation.

Press SHIFT ⬭ 2 (S-VAR)

the display shows three alternatives

$\bar{x}$	$x_{\sigma n}$	$x_{\sigma n\text{-}1}$
1	**2**	**3**

Press 1 = gives $\bar{x} = 3$

Press SHIFT ⬭ 2 (S-VAR) 2 = gives $x_{\sigma n} = 5.099019514$

Press SHIFT ⬭ 2 (S-VAR) 3 = gives $x_{\sigma n-1} = 5.700877126$

Example

Use your calculator to find the mean, standard deviation and variance for data set B: –18, 1, 3, 9, 20.

(the variance is the square of the standard deviation)

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After you are in the statistics mode and cleared the statistics memories, the keystrokes required are:

SHIFT ⌐S-VAR⌐ 2 1 =   and the display will read 3

SHIFT ⌐S-VAR⌐ 2 =   and the display will read 13.87443693

x^2 and the display will read 192.5

The mean is 3, the standard deviation is 13.87 and the variance is 192.5.

The SHIFT ⌐S-SUM⌐ 1 button accesses a number of extra statistical functions.

SHIFT ⌐S-SUM⌐ 1 1 = $= \Sigma x^2$ = 815

SHIFT ⌐S-SUM⌐ 1 2 = $= \Sigma x$ =   15

SHIFT ⌐S-SUM⌐ 1 3 = $= n$ =   5

If you have made an **error** with inputting your data you can correct it by using the REPLAY up and down key.

For example, you input

4, 5, 60, 7, 9 and you meant to input 6 instead of 60. Press the REPLAY key until the display

reads $x3 = 60$, then press 6 = . You now have the correct data.

In the example below, the progressive calculations are shown simply to give you some understanding of the underlying processes – you should do one or two examples in detail and then check them by calculator.

10.2 Mean and standard deviation of frequency distribution

Given below is the frequency table for the weights (kg) of a random sample of 30 first year university female students. Find the standard deviation, the variance and the mean.

Graduate's weight (kg)	Frequency	Cumulative frequency
60	2	2
61	14	16
62	8	24
63	1	25
64	5	30

The calculations needed to obtain the standard deviation without statistical keys for these data are:

$$\Sigma x^2 = 60^2 \times 2 + 61^2 \times 14 + 62^2 \times 8 + 63^2 + 64^2 \times 5 = 114\ 495$$

$$\Sigma x = 60 \times 2 + 61 \times 14 + 62 \times 8 + 63 + 64 \times 5 = 1\ 853$$

$$s = \sqrt{\frac{\Sigma x_i^2 - (\Sigma x_i)^2/n}{n-1}}$$

$$= \sqrt{\frac{114\ 495 - (1\ 853)^2/30}{29}} = \sqrt{\frac{114\ 495 - 114\ 453.6333}{29}} = \sqrt{1.4264}$$

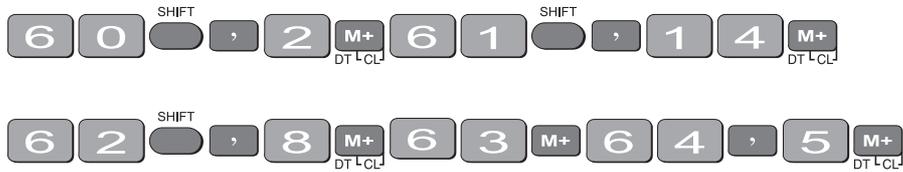Thus: $s = 1.2$ kg and $s^2 = 1.4$ kg^2

$$\bar{x} = \frac{\Sigma x}{n} = \frac{1853}{30} = 61.8 \text{ kg}$$

Note: In calculations like the above you should carry as many decimals as possible until the final result. The number of decimals to be retained at the end depends on the accuracy of the data values – one rule of thumb is to have one more decimal than in the original data.

Notice how the frequencies were used in the above calculation.

The calculator usage now has a small modification because we have been given the frequencies for the variable values. (There is no need to input each single observation.)

The keystrokes required are:

The display should read n = 30.

 and the display should read 61.766667

 and the display should read 1.1943353

 and the display should read 1.4264369
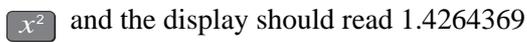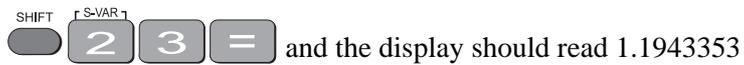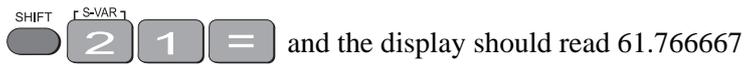
Thus, as expected

$s = 1.2$ kg, $s^2 = 1.4$ kg^2 and $\bar{x} = 61.8$ kg

Exercise 6

Find the mean, standard deviation and variance of

(a) The annual rainfall data for the years 1971 – 1990

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Rain (mm)	1 340	990	1 120	1 736	260	1 100	1 379	1 125	1 430	1 446
Year	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Rain (mm)	1 459	1 678	1 345	978	1 002	1 110	1 546	1 672	1 467	1 123

(b) The sample of snail foot lengths

Snail foot length (cm)							
2.2	4.1	3.5	4.5	3.2	3.7	3.0	2.6
3.4	1.6	3.1	3.3	3.8	3.1	4.7	3.7
2.5	4.3	3.4	3.6	2.9	3.3	3.9	3.1
3.3	3.1	3.7	4.4	3.2	4.1	1.9	3.4
4.7	3.8	3.2	2.6	3.9	3.0	4.2	3.5

Answers:

(a) Rainfall statistics

mean:

$\mu = 1\ 265.3$ mm

standard deviation:

$\sigma_{n-1} = 336.4$ mm

variance:

$\sigma^2 = 113141.7$ mm²

(b) Snail statistics

mean:

$\bar{x} = 3.4$ cm

standard deviation:

$s = 0.70$ cm

variance:

$s^2 = 0.49$ cm²