Exercises: Precision and covariance matrix

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Correlation coefficient

1/1 point (ungraded)

Given is the following covariance matrix \(Q_{xx}\) of four variables.

$$Q_{xx} = \begin{bmatrix} 1 & 0 & -1 & 2 \\ 0 & 4 & 0 & -2 \\ -1 & 0 & 3 & 0 \\ 2 & -2 & 0 & 1 \end{bmatrix}$$

What is the correlation coeffecient of the second and fourth variable (give your answer with 1 decimals)?

-1

✔ **Answer:** -1.0

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✔ Correct (1/1 point)

True or false

2/2 points (ungraded)

Negative covariance means negative correlation and vice versa

- (•) True ✔
- ( ) False

Answer

Correct: Well done.

A large constant systematic bias (i.e. each measurement contains the same systematic bias) will result in a larger standard deviation

- ( ) True
- (•) False ✔

Answer

Correct: Well done.

Submit

✔ Correct (2/2 points)

Calibration Campaign (1)

7/7 points (ungraded)

Suppose some students want to take measurements of a certain calibrated distance of exactly 15 meter. Using three different measurement techniques they obtain the following measurements (5 measurements for each technique).

Laser (m)	Rope (m)	BoyScouts (m)
15.0005	15.0754	14.8532
15.0001	15.0300	14.8077
14.9980	14.9899	15.0756
14.9996	14.9376	14.8973
14.9999	15.0263	15.0530

In this first exercise we will compute the mean and standard deviation. The expressions for the mean and standard deviation are as follows:

Mean:

$$\overline{y} = \frac{1}{m}\sum_{i=1}^{n} y_{i}$$

Standard deviation:

$$\sigma_y = \sqrt{\frac{1}{m-1}\sum_{i=1}^{m} (y_{i}-\overline{y})^{2}}$$

Please provide your answers in meters, with 4 significant digits after the decimal seperator.

Mean of laser measurements:

14.99962 ✔ **Answer:** 14.9996

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Standard deviation of laser measurements:

0.0009628084 ✔ **Answer:** 0.0010

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Mean of rope measurements:

15.01184 ✔ **Answer:** 15.0118

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Standard deviation of rope measurements:

0.0514093669 ✔ **Answer:** 0.0514

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Mean of boy scout measurements:

14.93736 ✔ **Answer:** 14.9374

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Standard deviation of boy scout measurements:

0.1203976038 ✔ **Answer:** 0.1204

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Which technique is most precise?

- (•) laser ✔
- ( ) rope
- ( ) boyscout

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✔ Correct (7/7 points)

The following file is used in the next problem and provided for you to use in MATLAB Online (or desktop), or other data analysis software of your choice.

A single ZIP file containing:

- the 2 vectors in a single MATLAB .mat file (laser_measurements.mat),
- or, the 2 vectors in the two column of a CSV file (laser_measurements.csv)

If you would like to use non-MATLAB software, you may do so, but you will have to enter the results from that software at the location in the MATLAB code below and submit your answers for assessment.

CALIBRATION CAMPAIGN (2) (EXTERNAL RESOURCE) (1.0 points possible)

These measurements are stored in the following variables:

```
y_La    % 1000 measurements laser device 1
y_Lb    % 1000 measurements laser device 2
```

Plot the measurement errors (by subtracting the known calibration distance from the measurements) of both devices. For this you only have to modify line 5 and line 6 of the script.

What do you see in the resulting plots?

Your Solution

Save Reset MATLAB Documentation (https://www.mathworks.com/help/)

```
1  %% laser measurements: y_La and y_Lb (vectors of size 1000x1)
2  load laser_measurements
3
4  %% measurement error laser device a and b
5  m = 150;
6  e_a = y_La - m;    % Replace 0 with formula to compute measurement error of laser
7  e_b = y_Lb - m;    % Replace 0 with formula to compute measurement error of laser
8  %% NOTE: leave the semi-colon after your expression! This will avoid that Matlab
9  %% will show the output (in both cases a vector of 1000x1).
10
11 figure;
12 plot(e_a)
13 ylabel('measurement error Laser a [mm]')
14 grid on; grid minor;
15
16 figure;
17 plot(e_b)
18 ylabel('measurement error Laser b [mm]')
19 grid on; grid minor;
```

Run Submit for Assessment

Assessment Tests: Correct

✔ is e_a correct?

Systematic bias

1/1 point (ungraded)

As you can see in the previous question, the errors of laser device b (y_Lb) show a systematic bias.

What is the effect of this systematic bias on the sample mean and sample standard deviation?

- (•) The mean and standard deviation will both be larger. ✔
- ( ) The mean is larger, the standard deviation is not affected.
- ( ) The mean is not affected, the standard deviation will be smaller.

Explanation

The bias is increasing in time, and therefore will result in a larger sample mean. Also the deviations from the sample mean will be larger in this case, resulting in a larger sample standard deviation.

Submit

✔ Correct (1/1 point)