Exercises: error propagation (1)

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Precision of sum and difference

1/1 point (ungraded)

Two distances are to be observed, $\underline{y}_1$, and $\underline{y}_2$.

Assume that the precision of both observables is the same, and that they are independent.

Do you think the precision of the sum of the two observables, $\underline{y}_s = \underline{y}_1 + \underline{y}_2$, will be the same too?

no ▾ ✔ **Answer:** no

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✔ Correct (1/1 point)

Let's evaluate this with an example where each observation is repeated 10000 times. These observations are stored in the file distances.csv, where:

Graded Assignment due Feb 8, 2017 17:30 IST

Q&A Forum

Feedback

- 6. Does the estimate make sense?
- Pre-knowledge Mathematics
- MATLAB Learning Content

- Column 1 contains the 10000 realizations of the observable $\underline{y}_1$ in meters,

- Column 2 contains the 10000 realizations of the observable $\underline{y}_2$ in meters.

You can use the Matlab script below, or use your own favorite software to calculate the empirical precision (standard deviation) of:

- the observables $\underline{y}_1$, $\underline{y}_2$ (are they the same indeed?);

- the sum of the two observables $\underline{y}_s = \underline{y}_1 + \underline{y}_2$;

- the difference of the two observables $\underline{y}_d = \underline{y}_2 - \underline{y}_1$.

Compare all standard deviations.

PRECISION OF SUM AND DIFFERENCE (MATLAB) (EXTERNAL RESOURCE)

Precision of sum and difference (Matlab evaluation)

See previous introduction.

Your Solution

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

```
%% load the observation files
load distances

y1 = data(:,1);
y2 = data(:,2);

%% Calculate the sample standard deviations of the observables and their sum
sig_y1 = std(y1);
sig_y2 = std(y2);

%% calculate the sum of the observations and its standard deviation sig_ys
ys     = y1 + y2;
sig_ys = std(y1 + y2); % please complete this line

%% calculate the sum of the observations and its standard deviation sig_yd
yd     = y2 - y1; % please complete this line, use a semicolon (;) at the end
sig_yd = std(y2 - y1); % please complete this line
```

Run Submit for Assessment

Assessment Tests: Correct

✔ Are the standard deviations of y1 and y2 correct?

✔ Is the standard deviation of the sum y1+y2 correct?

✔ Is the standard deviation of the difference y2-y1 correct?

Precision of sum and difference (cont'd)

2/2 points (ungraded)

The precision of both observables is the same, but since the sample standard deviations have been computed based on only 10000 realizations, there is a some small difference in the results for σ_{y_1} and σ_{y_2} that you got.

In the following, assume that both observables have the same precision, i.e. $\sigma_{y_1} = \sigma_{y_2} = \sigma$.

Based on your results, which of the following do you think is correct for the sum of the observables:

- $\sigma_{y_s} = \sigma_{y_1} = \sigma_{y_2} = \sigma$
- $\sigma_{y_s} = \sigma_{y_1} + \sigma_{y_2} = 2\sigma$
- $\sigma^2_{y_s} = \sigma^2_{y_1} + \sigma^2_{y_2} = 2\sigma^2$ ✔

Explanation

In the next unit you will see that the last equation is correct. You can verify it by inserting the numbers you got, which should be equal to: $\sigma_{y_1} = 0.1511$, $\sigma_{y_1} = 0.1512$, $\sigma_{y_s} = 0.2150$ and $\sigma_{y_d} = 0.2125$ m. Note that the equality does not exactly hold for the computed standard deviations,

due to the limited number of realizations.

Based on your results, which of the following do you think is correct for the difference of the observables:

- $\sigma_{y_d} = \sigma_{y_1} = \sigma_{y_2} = \sigma$
- $\sigma_{y_d} = \sigma_{y_1} + \sigma_{y_2} = 2\sigma$
- $\sigma^2_{y_d} = \sigma^2_{y_1} + \sigma^2_{y_2} = 2\sigma^2$ ✔
- $\sigma_{y_d} = \sigma_{y_2} - \sigma_{y_2}$
- $\sigma^2_{y_d} = \sigma^2_{y_2} - \sigma^2_{y_1}$

Explanation
In the next unit you will see that for the difference the result should indeed be the same as for the sum (however, this is only true for independent observables as we will see later).

Submit

✔ Correct (2/2 points)