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Warming up

1.1 What is the Problem?

1.2 Quality and Types of Errors - part 1

1.2 Quality and Types of Errors - part 2

1.3 Elements of the Estimation Problem

**Assessment**Graded Assignment due Feb 8, 2017 17:30 IST 

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## Module 1 Assessment - Part 1

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The following questions are part of the graded assignments for the assessment of module 1. The number of points per question is indicated. The total number of points you can earn in this module is 18.

Note, the second part of the assessment is a MATLAB exercise (next unit).

### Systematic bias

1/1 point (graded)

True or false: if we take repeated distance measurements, a systematic bias will not influence the sample mean and standard deviation.

✔ Answer: False

You have used 1 of 1 attempt

✔ Correct (1/1 point)

- ▶ 3. Least Squares Estimation (LSE)
- ▶ 4. Best Linear Unbiased Estimation (BLUE)
- ▶ Pre-knowledge Mathematics
- ▶ MATLAB Learning Content

## Outlier

1/1 point (graded)

Assume the precision of our measurements is  $\sigma_y = 1$  meter. We take  $m$  repeated measurements and calculate the mean. The set of measurements contains one outlier of 2 meters, all other measurements are only affected by random errors.

Which of the following statement is true?

- ☐ the influence of the outlier on the mean does not depend on the number of measurements  $m$
- ☐ the influence of the outlier on the mean will be larger if  $m$  is larger
- ☒ the influence of the outlier on the mean will be larger if  $m$  is smaller ✓

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You have used 1 of 1 attempt

## Covariance matrix

2.0/2.0 points (graded)

Which of the following matrices is the covariance matrix with these inputs: correlation coefficient  $\rho_{12} = 0.7$ , standard deviations  $\sigma_1 = 0.2$ ,  $\sigma_2 = 0.3$

☐ 
$$\begin{bmatrix} 0.2 & 0.7 \\ 0.7 & 0.3 \end{bmatrix}$$

☒ 
$$\begin{bmatrix} 0.04 & 0.042 \\ 0.042 & 0.09 \end{bmatrix}$$

☐ 
$$\begin{bmatrix} 0.2 & 0.042 \\ 0.042 & 0.3 \end{bmatrix}$$

☐ 
$$\begin{bmatrix} 0.04 & 0.7 \\ 0.7 & 0.09 \end{bmatrix}$$



### Explanation

The diagonal elements are the variances, i.e. the SQUARED standard deviations.

$$\sigma_{ij} = \rho_{ij}\sigma_i\sigma_j$$

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You have used 1 of 2 attempts

True or false?

2/2 points (graded)

Which of the following statements is/are true?

☒  $\sigma_y = \sigma_e$ ☐  $\sigma_e$  is a measure for the accuracy☒ precision is not affected by systematic biases and outliers☐ there is a 95% chance that random errors are within a range of  $\pm 1\sigma_e$ **Explanation**

$\sigma_e$  is a measure for the precision; there is a 68% chance that random errors are within a range of  $\pm 1\sigma_e$

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You have used 2 of 2 attempts

✓ Correct (2/2 points)

**Understanding knowns, unknowns and observations**

3/3 points (graded)

Consider a point ***R*** at a height of 10 meters. We want to know the heights of points ***A*** and ***B***: using a technique called levelling we can measure the height difference between points ***R*** and ***A***, and the height difference between points ***A*** and ***B***.

What is/are the unknown(s)?

☐ The height of point ***R***

☒ The heights of points ***A*** and ***B***

☐ The height differences between points ***R*** and ***A***, and between points ***A*** and ***B***



What is/are the observation(s)?

The height differences between points ***R*** and ***A***; and between points ***A*** and ***B*** ▾



**Answer:** The height differences between points ***R*** and ***A***; and between points ***A*** and ***B***

What is/are the known(s)?

☒ The height of point ***R***

☐ The heights of points ***A*** and ***B***

☐ The height differences between points ***R*** and ***A***, and between points ***A*** and ***B***

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You have used 1 of 3 attempts

### Identifying deterministic values

1/1 point (graded)

Let's look at the same problem as above once again. Inspect the different variables of this problem carefully. Based on what you've learnt, try to identify which variables are deterministic.

*"Consider a point  $R$  at a height of 10 meters. We want to know the heights of points  $A$  and  $B$ : using a technique called levelling we can measure the height difference between points  $R$  and  $A$ , and the height difference between points  $A$  and  $B$ ."*

Which of the following variable(s) is/are deterministic?

☒ The height of point  $R$ ☒ The heights of points  $A$  and  $B$ ☐ The height differences between points  $R$  and  $A$ , and between points  $A$  and  $B$ 

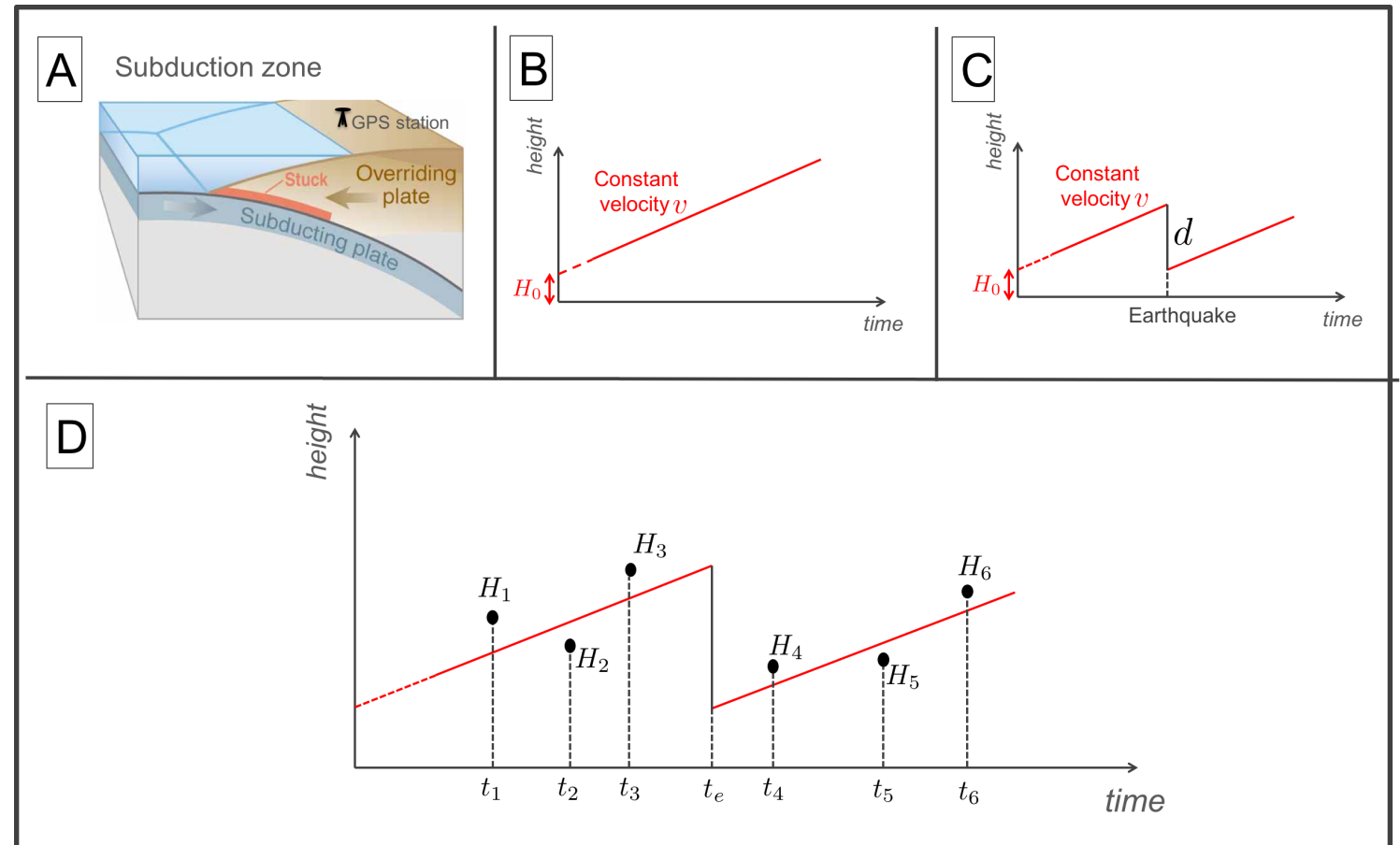
You have used 1 of 1 attempt

### Case study: subduction zone

3/3 points (graded)

In subduction zones, two tectonic plates collide, and the denser plate is forced down under (or subducts) the less dense one, as can be seen in Figure A. This subduction results in the uplift, usually of constant speed, of points on the overriding plate. Figure B shows the height change of one point.

Every now and then, the accumulated stress between plates is released, resulting in an earthquake and a relatively rapid deformation of the surface. Note that the point moves with constant velocity (denoted by  $v$ ) before and after the earthquake due to the subduction mechanism, and the earthquake event results in a jump in the time series, denoted by  $d$  (Figure C). Using GPS we are monitoring the height of the GPS station in order to determine how that point moves, which is illustrated in Figure D (where  $t_e$  is the time at which the earthquake takes place).



For each of the following parameters indicate whether it is an observation, known or unknown.

GPS heights  $H_i$

Observation ▼

✓ Answer: Observation

Initial height  $H_0$

Unknown ▼

✓ Answer: Unknown



Deformation  $d$ 

Unknown ▼

✓ Answer: Unknown

Various times  $t_i$ 

Known ▼

✓ Answer: Known

Velocity  $v$ 

Unknown ▼

✓ Answer: Unknown

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You have used 3 of 3 attempts

✓ Correct (3/3 points)

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