0. Getting Started

1. Introduction to Observation Theory

2. Mathematical model

Warming Up

2.1 Functional Model

2.2 Properties of Functional Models

2.3 Stochastic Model

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

Q&A Forum

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3. Least Squares Estimation (LSE)

Exercises: The functional model: connecting the elements

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True or false?

2/2 points (ungraded)

In a linear model of observation equations, if there are m observations and n unknowns, the design matrix A has m columns and n rows.

false ✔ **Answer:** false

Explanation

The other way around: A has m rows and n columns, i.e. it is an $m \times n$ matrix.

If the expectation of the vector of errors is not equal to the null-vector, the standard model of observation equations will be imperfect.

true ✔ **Answer:** true

Explanation

Since $\underline{y} = Ax + \underline{e}$ we have that $E\{\underline{y}\} = Ax + E\{\underline{e}\}$. In this case, the last term would not be equal to zero, and then $E\{\underline{y}\} \neq Ax$

- 4. Best Linear Unbiased Estimation (BLUE)
- Pre-knowledge Mathematics
- MATLAB Learning Content

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✔ Correct (2/2 points)

Family Jones

3/3 points (ungraded)

The family Jones has three daughters. Both parents measure the lengths of their daughters.

What is the number of unknowns?

3 ✔ **Answer:** 3

3

What is the number of observations?

6 ✔ **Answer:** 6

6

Explanation

We are interested in the length of each daughter (3). The length of each daughter is measured twice (=2x3).

What is the correct design matrix A?

- $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ ✔

- $A = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}$

- $A = \begin{bmatrix} 1 & 0 \\ 1 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 1 \\ 0 & 1 \end{bmatrix}$

$$A = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{bmatrix}$$

Explanation

We know that A must be an $m \times n$ matrix, in this case 6×3. There are two measurements for each daughter, so there must be two 1's in each column relating that observable to the corresponding unknown length. For the correct A-matrix this means for instance that the first and fourth observable correspond to the length measurements of the first daughter.

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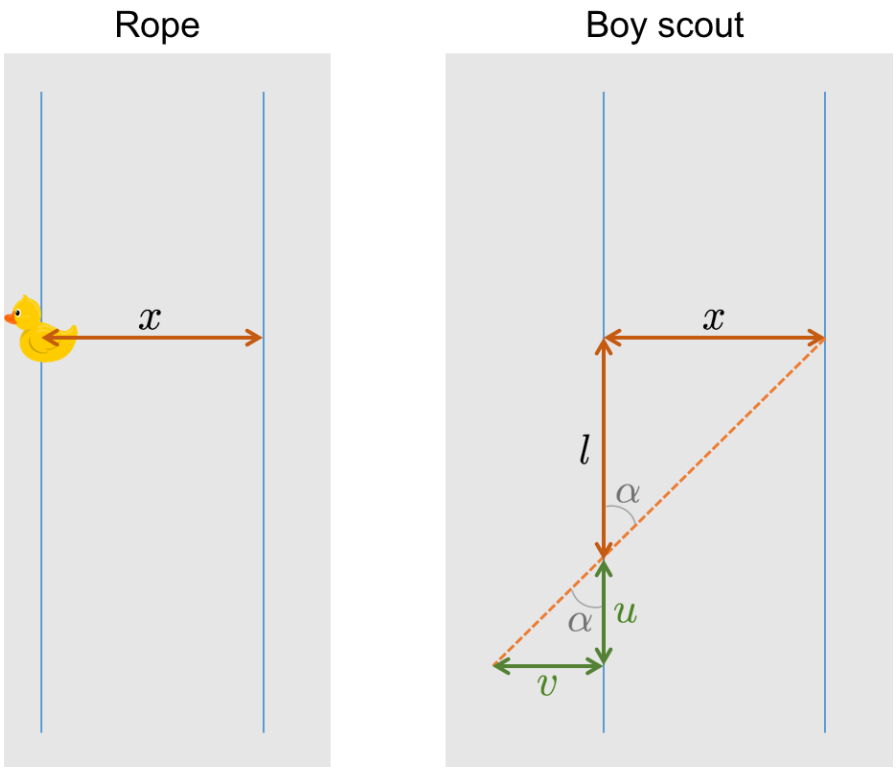
✔ Correct (3/3 points)

Canal width

1/1 point (ungraded)

Remember the canal width measurements (first video in module 1). We are interested in the unknown canal width x.



What is the function model if we take 2 observations with the rope (left figure), and 2 observations using the boy scout method (right figure). For the boy scout method: the side lengths u and v are both equal to 0.5 m, the length l is measured.

What is the correct functional model?

- $E\{\underline{y}\} = \begin{bmatrix} 1 & 0.5 \\ 1 & 0.5 \end{bmatrix} x$

$$E\{\underline{y}\} = \begin{bmatrix} 1 \\ 1 \\ 0.5 \\ 0.5 \end{bmatrix} x$$

$$E\{\underline{y}\} = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} x$$

$$E\{\underline{y}\} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} x$$ ✔

Explanation

We will have 4 observations, 1 unknown. With the rope method we measure the width of the canal directly. With the boy scout method we measure l, and we know that $\frac{u}{v} = \frac{l}{x}$ and thus $l = \frac{u}{v}x$.

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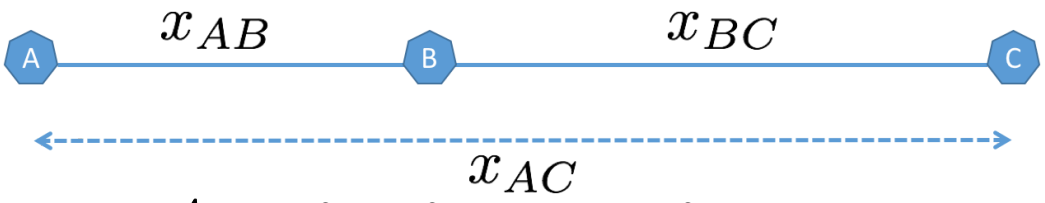
✔ Correct (1/1 point)

Three points on a line

2/2 points (ungraded)

Let's assume there are 3 points on a line, as in the figure. We are interested in the distance between points A and B, and between points B and C. The surveyor takes one measurement of the total distance between points A and C.



What is the $\boldsymbol{A}$-matrix for the functional model for this problem?

- $\boldsymbol{A} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$
- $\boldsymbol{A} = \begin{bmatrix} 1 & 1 \end{bmatrix}$ ✔
- $\boldsymbol{A} = \begin{bmatrix} 0.5 & 0.5 \end{bmatrix}$
- $\boldsymbol{A} = \begin{bmatrix} 0.5 \\ 0.5 \end{bmatrix}$

Will it be possible to find a solution for the unknown distances?

- Yes, there will be a unique solution.
- Yes, there will be many different solutions. ✔
- No, there will not be a solution.

Explanation

We should have $y = x_{AC} = x_{AB} + x_{BC} = [1 \;\; 1] \begin{bmatrix} x_{AB} \\ x_{BC} \end{bmatrix}$

In fact, there will be an infinite number of solutions. For instance, if we have $y = 1$ m, then we could have $x_{AB} = x_{BC} = 0.5$ m, or $x_{AB} = 1$ and $x_{BC} = 0$ m, or $x_{AB} = 0.873$ and $x_{BC} = 0.127$ m. In the next part of this module we will discuss 'solvability' and 'uniqueness of the solution'.

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✔ Correct (2/2 points)