CEG2002: Statistics for Civil Engineers
Learning outcomes – Chap 3

1. Confidence Intervals

You should understand:

- What a **point estimate** is
- What an **interval estimate** (**confidence interval**) is
- What the Central Limit Theorem is

You should be able to:

- Construct various confidence intervals for the population mean, when
  - σ is known
  - σ is unknown

2. Hypothesis tests

You should

- Understand the concept of a **hypothesis test**
- Know the 5-step process of any hypothesis test
- Know what a *p*-value is, and how to interpret it

You should

- Know when to, and how to, perform a one-sample *z*-test
- Know when to, and how to, perform a one-sample *t*-test

3. Two sample problems

You should:

- Know when, and how, to perform
  - a two sample *z*–test
  - a two sample *t*–test
- Know the assumptions implicit in each of the tests listed above
- Be aware of the commands to perform these tests in `Minitab`

Formulae used in Chap3

Confidence Intervals

A confidence interval for the population mean μ is given by

$$\bar{x} \pm z_{\alpha} \times \frac{\sigma}{\sqrt{n}},$$ (population standard deviation *known*)

$$\bar{x} \pm t_{\nu} \times \frac{s}{\sqrt{n}}$$ (population standard deviation *unknown*)

Hypothesis tests

The one-sample *z*-test

The test statistic is

$$Z = \frac{\bar{X} - \mu_0}{\sigma / \sqrt{n}} \sim N(0,\ 1)$$

The one-sample *t*-test

The test statistic is

$$T = \frac{\bar{X} - \mu_0}{s / \sqrt{n}} \sim t_{n-1}$$

The two-sample *z*-test

The test statistic is

$$Z = \frac{\overline{X}_1 - \overline{X}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \sim N(0,\ 1)$$

The two-sample *t*-test

The test statistic is

$$T = \frac{\overline{X}_1 - \overline{X}_2 - (\mu_1 - \mu_2)}{S \times \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \sim t_{n_1+n_2-2},$$ where

$$s = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

CIV2002: Statistics for Civil Engineers
Learning outcomes – chap 4

1. Correlation

You should:

- Be able to construct and interpret a scatter diagram
- Know how to comment on the relationship between two variables
- Know how to calculate the sample correlation coefficient
- Know how to *interpret* the sample correlation coefficient
- Know how to check the *significance* of the sample correlation coefficient in `Minitab`

2. Regression

You should:

- Know the difference between correlation and regression
- Be able to *fit* a simple linear regression model to bivariate data
- Be aware of the assumptions underlying any regression analysis
- Be able to perform a simple linear regression analysis in `Minitab`, and check the residual assumptions
- Know how to test the significance of the slope parameter in `Minitab`
- Be able to make predictions from a well-fitting regression model

Formulae used in Chap4

The Pearson Product Moment Correlation Coefficient

$$r = \frac{S_{XY}}{\sqrt{S_{XX} \times s_{YY}}},$$

Where

$$S_{XY} = \left(\sum xy\right) - n\bar{x}\bar{y},$$

$$S_{XX} = \left(\sum x^2\right) - n\bar{x}^2, \quad \text{and}$$

$$S_{YY} = \left(\sum y^2\right) - n\bar{y}^2.$$

Simple linear regression model

This is given by

$$Y = \alpha + \beta X + \varepsilon,$$

where $\{\varepsilon_i\}$ are independent $N(0, \sigma^2)$ and the least squares estimates of α and β are

$$\hat{\beta} = \frac{S_{XY}}{S_{XX}} \quad \text{and} \quad \hat{\alpha} = \bar{y} - \hat{\beta}\bar{x}.$$