Contents for Statistics at the Bachelor in Aerospace Engineering (2022–2023)

Coordinating teacher: Ignacio Cascos

BLOCK 0: DESCRIPTIVE STATISTICS

0. Descriptive Statistics

0.1 Main definitions

- Population, sample, and variable
- Types of variables

0.2 Frecuencies and their tables

0.3 Grouped data

0.4 Measuring the location of the data

- Measuring central location: sample mean, median, mode,...
- Quantiles (quartiles and percentiles)

0.5 Measuring the spread of the data

- sample range, interquartile range, sample variance, standard deviation,...

0.6 Charts

- Bar chart, pie chart, box plot, histogram, frequency polygon,...

0.7 Measuring the shape of the distribution of the data

0.8 Simulateneous description of two variables

- Marginal and conditional distributions and statistical independence
- Simple linear regression (ordinary least squares) and correlation

BLOCK I: PROBABILITY

1. Introduction to Probability

1.1 Introduction

1.2 Random phenomena

- Events, operations with events and their properties

1.3 Definition of probability and properties

- Definition of probability
- Interpretations of the probability and elementary properties

1.4 Assessment of probabilities in practice

- Equiprobability, Laplace rule, combinatorics

1.5 Conditional probability

- Independence between events
- Definition of conditional probability

1.6 Bayes Theorem

- Total probability rule and Bayes Theorem

2. Random variables

2.1 Definition of random variable

2.2 Discrete random variables

- Probability (mass) function
- Cumulative distribution function of a discrete random variable

2.3 Continuous random variables

- Density (mass) function
- Cumulative distribution function of a continuous random variable

2.4 Characteristic features of a random variable

- Location parameters
- Scatter parameters
- Shape parameters

2.5 Transformations of random variables

2.6 Independence of random variables

BLOCK II: PARAMETRIC MODELS AND INFERENCE

3. Probability models

Discrete probability models

3.1 Binomial distribution

3.2 Geometric distribution

3.3 Poisson distribution

Continuous probability models

3.4 Uniform distribution

3.5 Exponential distribution

3.6 Normal distribution

    – Central Limit Theorem

4. Statistical Inference

4.1 Introduction

4.2 Estimators and their distribution

    – Distribution of the sample mean
    – Sampling distributions for normal populations

4.3 Confidence Intervals

    – Sample size

4.4 Hypothesis testing

    – Generalities
    – Critical region and p-value
    – Confidence Intervals and hypothesis tests

4.5 Particular tests for a single sample

    – Inference for the mean (proportion) in big samples
    – Inference for the mean of a normal population with unknown variance
    – Inference for the variance of normal populations

4.6 Comparison of two populations

BLOCK III: APPLICATIONS

5. Quality Control

5.1 Introduction, control charts

5.2 Variables charts, $\overline{X}$-chart

    – Capability and Process Capability Ratio

5.3 Attributes control charts, p and np charts

6. Linear Regression

6.1 Introduction

6.2 Simple linear regression

    – Least squares estimators
    – Inference in simple linear regression
    – Adequacy of the regression model

6.3 Multiple linear regression

    – Least squares estimators
    – Inference in multiple linear regression
    – Multicollinearity
    – Dummy variables