

HELM Statistics Workbooks

- Workbooks 35-39: Probability, Descriptive Statistics
- Workbooks 40-41: Basic Ideas of Inferential Statistics
- Workbooks 42-46: Inferential Statistics Topics

Workbooks 35-39: Probability, Descriptive Statistics

- 35 Sets and Probability
- 36 Descriptive Statistics
- 37 Discrete Probability Distributions
- 38 Continuous Probability Distributions
- 39 The Normal Distribution

Workbooks 40-41: Basic Ideas of Inferential Statistics

- 40 Sampling Distributions and Estimation
- 41 Hypothesis Testing

Workbooks 42-46: Inferential Statistics Topics

- 42 Goodness of Fit and Contingency Tables
- 43 Correlation and Regression
- 44 Analysis of Variance
- 45 Non-Parametric Statistics
- 46 Reliability and Quality Control

The Problem

- Uncertainty and variation for engineering students
- Problems where the “answer” is a statement about uncertainty
- Lack of physical analogy (“feel”)

Our Approach

- Frequentist or Bayesian?
 - Didn't attempt both. Frequentist approach used.
- Need for clarity in meaning
 - E.g. significance, confidence, population, sample, parameter, estimate, estimator.
- Can't cover everything: understanding basic concepts most important

Computer Use

- In practice we use computers.
- Still useful *educationally* to do some calculations without a computer.

Software

- Various statistical packages widely available, e.g. Minitab, R.
- HELM workbooks not specific to any one.
- Some students might prefer to use a spreadsheet.
- Other possibilities such as Matlab.

Workbooks 35: Sets and Probability

- Sets
- Elementary probability
- Addition and multiplication
- Conditional probability, Bayes' theorem

Workbook 36: Descriptive Statistics

- Frequency tables
- Histograms, bar charts, pie charts etc.
- Mean, median, mode, range, IQR, variance, standard deviation
- EDA: stem-and-leaf, box-and-whisker
- Outliers, skewness, multimodality

Workbook 37: Discrete Probability Distributions

- General ideas
- Binomial
- Poisson
- Hypergeometric

Workbook 38: Continuous Probability Distributions

- General ideas: Distribution function, Probability Density function
- Uniform
- Exponential

Workbook 39: The Normal Distribution

- Normal distribution, standard normal distribution, finding probabilities, intervals
- Normal approximation to the binomial distribution
- Sums and differences of random variables

Workbook 40: Sampling Distributions and Estimation

- Sampling distributions, particularly of the mean
- Point estimation: bias, variance
- Interval estimation (confidence intervals): normal mean (known variance/large sample)
- Confidence interval for normal variance: χ^2

Workbook 41: Hypothesis Testing

- Basic ideas of significance tests
- Test of a proportion (binomial, normal approximation)
- Tests for normal means: z , t
- Single sample, two sample, paired samples
- F -test for two variances

Workbook 42: Goodness of Fit Tests and Contingency Tables

- χ^2 test for goodness-of-fit, discrete and continuous distributions
- Contingency tables, χ^2 test

Workbook 43: Correlation and Regression

- Scatter diagrams
- Regression on a single covariate
 - Least squares etc, Significance test
- Quadratic and exponential regression functions (briefly)
- Correlation
 - Product-moment, Rank

Workbook 44: Analysis of Variance

- One-way ANOVA
- Two-way ANOVA, fixed and random effects
- Experimental design (brief comments)

Workbook 45: Non-parametric Statistics

- Introduction
- Sign test (single sample and paired samples)
- Wilcoxon signed-rank test (single sample and paired samples)
- Wilcoxon rank-sum test (two samples)

Workbook 46: Reliability and Quality Control

- Reliability
 - Lifetimes, hazard function
 - Exponential and Weibull models
 - System reliability

- Quality control
 - General discussion
 - Control charts for means and ranges
 - Pareto charts