

# Statistical Methods

<b>Unit code:</b>	MATH20802
<b>Credit Rating:</b>	10
<b>Unit level:</b>	Level 2
<b>Teaching period(s):</b>	Semester 2
<b>Offered by</b>	School of Mathematics
<b>Available as a free choice unit?:</b>	N

## Requisites

### Prerequisite

- [MATH10141 - Probability 1](#) (Compulsory)
- [MATH20701 - Probability 2](#) (Compulsory)
- [MATH10282 Introduction to Statistics](#) (Compulsory)

## Desirable

- Basic knowledge of the R statistical programming language

## Aims

- to introduce the general principles of likelihood-based inference and testing for general models (i.e. for both discrete and continuous distributions)
- to provide an introduction to linear regression models,
- to offer a first overview of Bayesian statistical inference, and
- to demonstrate corresponding computational procedures in R.

## Overview

This module provides students with the methodological foundations in model-based statistical learning, in particular likelihood estimation and inference and simple linear regression models. The theoretical and methodological discussions are complemented by practical computer application.

This module thus links the core level 1 module (Introduction to Statistics) and the optional theoretical and applied level 3 modules (Statistical Modelling, Statistical Inference, Extreme Values and Financial Risk, Time Series, Multivariate Statistics and Machine Learning, Medical Statistics).

## Learning outcomes

On successful completion of the course students will be able to:

- apply model-based approaches in statistical data analysis

- derive maximum likelihood estimates and compute corresponding confidence intervals
- perform statistical testing from a likelihood perspective
- analyse and fit linear regression models
- address simple inference problems from a Bayesian point of view
- use R to apply these techniques on actual data

### Assessment methods

- Other - 20%
- Written exam - 80%

### Assessment Further Information

- Coursework (1 in-class exam): weighting 20%
- End of semester examination: 2 hours weighting 80%

### Syllabus

- Likelihood-based inference (6 lectures): likelihood function, score function, maximum likelihood estimators (MLE), Fisher information, likelihood intervals, invariance principle, relationship to ordinary least-squares estimation (OLS).
- Generalised likelihood ratio tests (4 lectures): one and two sample problems, most powerful tests (Neyman Pearson lemma).
- Linear regression (6 lectures): standard linear regression model, OLS/MLE estimation of regression coefficients and their variances, coefficient of determination, prediction intervals, testing of regression coefficients, variable selection.
- Bayesian learning (6 lectures): Bayes' theorem, prior and posterior probabilities, information update, credible intervals, properties of Bayes' estimators, shrinkage effect, Bayes factor.

### Recommended reading

- Cox, D.R. 2006. Principles of statistical inference. Cambridge University Press
- Faraway, J. J. 2015. Linear Models with R (second edition). Chapman and Hall/CRC.
- Shalizi, C. R. 2015. Advanced data analysis from an elementary point of view. Cambridge University Press. Draft PDF available from <http://www.stat.cmu.edu/~cshalizi/ADAfaEPoV/ADAfaEPoV.pdf>
- Wood, S. 2014. Core Statistics. Cambridge University Press. Draft PDF available from <http://www.maths.bris.ac.uk/~sw15190/core-statistics.pdf>

### Feedback methods

Tutorials and computer labs will provide an opportunity for student to get feedback on their understanding from the instructor. The in-class test also offers an opportunity for students to receive

feedback. Students can also get feedback on their understanding directly from the lecturer, for example during the lecturer's office hour.

**Study hours**

- Lectures - 22 hours (11 x 2 hours)
- Tutorials - 10 hours (10 x 1 hours) - 2 tutorials will be computer-based sessions.
- Independent study hours - 68 hours

**Teaching staff**

Korbinian Strimmer - Unit coordinator