

FP041-15 Scientific Programming and Mathematical Modelling

22/23

Department

Warwick Foundation Studies

Level

Foundation

Credit value

15

Module duration

10 weeks

Assessment

100% coursework

Study location

University of Warwick main campus, Coventry

Description

Introductory description

FP041-15 Scientific Programming and Mathematical Modelling

[Module web page](#)

Module aims

To develop an understanding of the basic principles of mathematical models and demonstrate basic competence in computer programming.

This is an interdisciplinary module which links Mathematics, Data Science, and Computer Science.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

1. Introduction to data science and scientific programming in Python
 - What is data science?
 - Introduction to Python
 - The use of Python for data scientist

Variables and data types

Operation and function

Python data science libraries: numpy, panda, matplotlib

2. Introduction to Mathematical Modelling

Different types of model

Mathematical model

Applications and classifications of mathematical model

Limitations of mathematical model

4 stages of mathematical modelling

Applying mathematical modelling to provide insights and predictions to real world problems

3. Modelling using functions and structured data

Mathematical expression, equations, and functions

Understanding the difference between equations and functions

Recognizing functions from relations, graph, structured data, and word problem

Constructing a linear function from structured data and word problem

System of linear model

4. Basics of descriptive and inferential analysis

Empirical data and statistics

Using measures of central tendency and measures of spread to summarize and describe data

Population and samples

Using interval estimates and hypothesis testing to make inferences about the population from which the sample is drawn

P-value and confidence interval

Limitations of descriptive and inferential statistics

5. Statistics fundamentals with Python

Importing data sets to analyse in Python (datasets, csv files, and excel spreadsheet)

Using describe and summarize function in python to do descriptive analysis

Illustrate data using data visualization tools

Using statistical functions in Python for measures of central tendency and spread

Measures of correlations between pairs of data

6. Modelling with linear regression

Introduction to simple linear regression

Dependent and independent variables

Coefficient estimate

Using Ordinary Least Square method to estimate the values of the coefficients

Making predictions with simple linear regression

7. Big data analytics with python

What is big data?

Importing and analysing large data sets in Python

Model development

Preparing data for linear regression in Python

Using python to build a linear regression model from large data sets.

Making predictions based on the model developed.

Learning outcomes

By the end of the module, students should be able to:

- Critically observe a real-world problem and applying the 4-stages of mathematical modelling (building, analysing, validating, and applying) to provide insights and predictions.
- Demonstrate understanding of basic mathematical concepts in data science, relating to linear function, descriptive analysis, inferential analysis, and linear regression.
- Utilize Python to prepare data for analysis, perform simple data analysis, create meaningful data visualization, and make prediction from data.
- Produce a rigorous analytical report which considers a broad range of mathematical and statistical methods to describe, analyse, extrapolate, and apply big data.

Indicative reading list

Bender, E.A., 2012. An introduction to mathematical modeling. Courier Corporation.

Hill, C., 2016. Learning scientific programming with Python. Cambridge University Press.

Langtangen, H.P. and Langtangen, H.P., 2009. A primer on scientific programming with Python (Vol. 2). Berlin, Germany: Springer.

[View reading list on Talis Aspire](#)

Interdisciplinary

This module has links between Mathematics, Data Science, and Computer Science.

Subject specific skills

Mathematical Skills

Analytical Skills

Problem-solving skills

Investigative Skills

IT Skills

Transferable skills

Mathematical Skills

Analytical Skills

Problem-solving skills

Communication Skills

Investigative Skills

IT Skills

Study

Study time

Type	Required
Lectures	12 sessions of 1 hour (6%)
Seminars	12 sessions of 3 hours (19%)
Private study	110 hours (59%)
Assessment	30 hours (16%)
Total	188 hours

Private study description

Private Study.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group A3

	Weighting	Study time
Questions set 1	30%	7 hours
Series of questions incorporating programming related to Mathematical Modules (approximately 800 words)		
Questions set 2	30%	7 hours
Series of questions incorporating programming related to Mathematical Modules (approximately 800 words)		
Case Study	40%	16 hours
Analyse a data set using a board range of mathematical and Statistical Methods, producing an analytical report.		

Weighting**Study time**

(Approximately 1.5 pages)

Feedback on assessment

Written feedback provided on Tabula

Availability**Courses**

This module is Core for:

- Year 1 of FIOE Warwick International Foundation Programme