Module Specification

Jomar Alcantara

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

i) What is data science?
ii) Introduction to Python
iii) The use of Python for data scientist
iv) Variables and data types
v) Operation and function
vi) Python data science libraries: numpy, panda, matplotlib

2. Introduction to Mathematical Modelling

i) Different types of model
ii) Mathematical model
iii) Applications and classifications of mathematical model
iv) Limitations of mathematical model
v) 4 stages of mathematical modelling
vi) Applying mathematical modelling to provide insights and predictions to real world problems

3. Modelling using functions and structured data

i) Mathematical expression, equations, and functions
ii) Understanding the difference between equations and functions
iii) Recognizing functions from relations, graph, structured data, and word problem
iv) Constructing a linear function from structured data and word problem
v) System of linear model

4. Basics of descriptive and inferential analysis

i) Empirical data and statistics
ii) Using measures of central tendency and measures of spread to summarize and describe data
iii) Population and samples
iv) Using interval estimates and hypothesis testing to make inferences about the population from which the sample is drawn
v) P-value and confidence interval
vi) Limitations of descriptive and inferential statistics

5. Statistics fundamentals with Python

i) Importing data sets to analyse in Python (datasets, csv files, and excel spreadsheet)
ii) Using describe and summarize function in python to do descriptive analysis
iii) Illustrate data using data visualization tools
iv) Using statistical functions in Python for measures of central tendency and spread
v) Measures of correlations between pairs of data

6. Modelling with linear regression

i) Introduction to simple linear regression
ii) Dependent and independent variables
iii) Coefficient estimate
iv) Using Ordinary Least Square method to estimate the values of the coefficients
v) Making predictions with simple linear regression

7. Big data analytics with python

i) What is big data?
ii) Importing and analysing large data sets in Python
iii) Model development
iv) Preparing data for linear regression in Python
v) Using python to build a linear regression model from large data sets.
vi) 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.
- Matthes, E., 2016. Python Crash Course: A Hands-On, Project-Based, Introduction to Programming. No Starch Press.
- Nelli, F., 2015. Python Data Analytics: Data Analysis and Science using Pandas, matplotlib, and the Python Programming language. Apress.