Programme Timetable

All workshops run from 9:30am to 5:00pm unless stated

Room	Friday 24 March	Monday 27 March	Tuesday 28 March
1	BT: Mathematics of Communication Systems	HSBC: Machine Learning in Financial Markets	CCFE: Solving problems in fusion plasma
2	NPL: Machine learning crash course		

Room	Wednesday 29 March	Thursday 30 March	Friday 31 March
1	Vironix: Introduction to Machine Learning in Production	Tesco: Forecasting in Retail	Macquarie: Mathematical Modelling of Commodity markets
2		NAG: Using the NAG Library for Python (9:30 to 13:00)	

University of Oxford

Mathematical Institute

One-day introduction to Mathematics of Communication Systems

Subjects covered

- Basics of digital communications; concepts of information theory, IP protocol stack, TCP.
- Radio propagation modelling.
- Management of system resources: distributed heuristics for optimal resource allocation.
- Basics of current 4G and 5G cellular systems.
- Convex optimization applied to various telecommunication problems.

Logistics

Hardware required: laptop – We will code and run some examples using python.

Manual supplied : no – only copy of slides

Course preparation: Please ensure you have python3, numpy, and cvxpy on your laptop

Course Structure: 1 day; lectures and hands-on coding exercise.

Learning Objectives

At the end of this course you will be able to:

- Understand the basics of modern digital communications.
- Appreciate the fundamental role which various fields of mathematics play in making these systems work.
- Be aware of current research challenges in the field.
- Solve practical convex optimization problems with modern software.

Course deliverer

Keith Briggs,
BT Applied Research
http://keithbriggs.info

Solving problems in fusion plasma

1-day introduction to fusion plasmas

Subjects covered

- Introduction to fusion plasmas
- Equations required to model the plasma
- Tokamak basics
- Equilibrium and stability in a tokamak
- Challenges for fusion

Logistics

Hardware required: No

Course preparation: None required

Course Structure: Lectures, problem classes

Logistics Notes: None

Learning Objectives

At the end of this course you will have:

- An understanding of some of the issues in fusion plasma
- A familiarity with the physics and understanding of the equilibrium and stability of tokamak plasmas
- An understanding of the challenges for fusion

Course deliverer

Christopher Ham,
Fusion Plasma Theorist,
at CCFE

Machine Learning in Financial Markets

HSBC

InFoMM
Industrially Focused
Mathematical Modelling

1-day introduction to machine learning in financial markets, covering both predictive models and natural language processing

Subjects covered

- Do you really understand your data..?
- The importance of explainable techniques
- Predictive models on tabular data
- Machine learning models for text data

Learning Objectives

By the end of this course, you will:

- Understand the ways in which Machine Learning is used in financial markets
- Appreciate the importance of data quality
- Have experience of building a predictive model for high-frequency trading
- Apply Natural Language Processing techniques to central bank communications

Logistics

<u>Hardware required</u>: Laptop with internet connection

<u>Manual supplied</u>: No

<u>Course preparation</u>: At least basic knowledge of python

<u>Course Structure</u>: A 1-day course with significant practical component

<u>Logistics Notes</u>: None

Course deliverer

Mark McDonald
Head of Data Science and Analytics
HSBC Global Research

EPSRC Centre for Doctoral Training in Industrially Focused Mathematical Modelling

Mathematical Modelling of Commodity markets

Introduction to mathematical modelling in commodity markets

Subjects covered

- Introduction to commodity markets
- Multi-factor models
- Optimization in energy markets
- Calibration of financial models
- Hedging and Greeks in practice

Learning Objectives

By the end of this course, you will:

- Understand the salient features of commodity markets
- Understand the need for multi-factor models in commodity markets
- Have an understanding of how derivative models are calibrated in practice
- Have implemented a realistic asset valuation model using optimization

Logistics

Hardware required: Laptop – We will code and run some examples using python.

Manual supplied : no

Course preparation: python interpreter with numpy/scipy/pulp

Course Structure: 1 day; 3 lectures and hands-on coding exercise.

Course deliverers

Macquarie Quant Strat:
Annabel Alexander
Emmanuel Gincberg
Vincent Guffens

Using the NAG Library for Python

University of Oxford

Mathematical Institute

Half-day introduction to the NAG Library for Python and how to avoid common mistakes when using its mathematical optimization routines, which can be used as building blocks for your own programs or applications.

Subjects covered

- Overview of the structure and contents of the NAG Library
- How to avoid common pitfalls when using mathematical optimization techniques, and how to get the most from optimization solvers
- Using and modifying NAG example programs
- Hands-on problem-solving exercises

Logistics

Hardware required: Laptop running Windows, Linux or MacOS

Software required: Python (version 3.x). Installation of a copy of the NAG Library should be done prior to the class

Course Preparation: Basic knowledge of programming in Python is assumed

Course Structure: Lecture and demonstrations, with exercises

Learning Objectives

By the end of this course, you will be able to

- Find information about relevant NAG routines
- Decide which NAG routines to use for which application
- Improve mathematical optimization techniques
- Use the NAG Library to help solve some basic but realistic exercise problems

Course deliverer

Dr. Shuanghua Bai

Software Engineer (Numerical Optimization), Research and Development, Numerical Algorithms Group Ltd. Oxford

EPSRC Centre for Doctoral Training in Industrially Focused Mathematical Modelling

Machine learning crash course

1-day course giving an overview of some of the fundamentals of supervised and unsupervised learning.

Subjects covered

- What is machine learning (ML) and how does it relate to mathematical modelling?
- Methods for supervised learning
- Methods for unsupervised learning
- Practical examples of ML using Matlab

Learning Objectives

By the end of this course, you will be able to
- Understand what ML is and what problems it can solve
- Have a grasp of the wide range of ML algorithms available.
- Implement regression and classification algorithms ML algorithms in Matlab
- Make decisions about which ML approach is suitable for a given problem

Logistics

Hardware required: Yes – Laptop, with Matlab installed

Manual supplied: No

Course preparation: Install the Statistics and Machine Learning toolbox in Matlab

Course Structure: Two sessions of lectures in the morning, and a practical tutorial in the afternoon

Logistics Notes: None

Course deliverer

Andrew Thompson
Data Science Department
National Physical Laboratory

EPSRC Centre for Doctoral Training in Industrially Focused Mathematical Modelling

Forecasting in Retail

TESCO

InFoMM
Industrially Focused
Mathematical Modelling

1-day course that covers the use of predictive analytics in retail at Tesco

Subjects covered

- Introduction to forecasting applications in Tesco
- Measuring/evaluating forecasting systems
- Applying forecasting methods in practice

Learning Objectives
By the end of this course, you will:

- Understand the retail industry
- Demonstrate an awareness of issues involved in forecasting products sales
- Measure whether a decision is good or not
- Assess forecasting accuracy
- Deal with large data sets
- Apply appropriate analytical techniques
- Assess Impacts of decision architecture

Logistics

Hardware required: Yes – Laptop

Manual supplied: No

Course preparation: Ability to open and manipulate csv files. Python, matlab or similar is useful

Course Structure: Lectures and case studies, short exercises, and team based practical exercise.
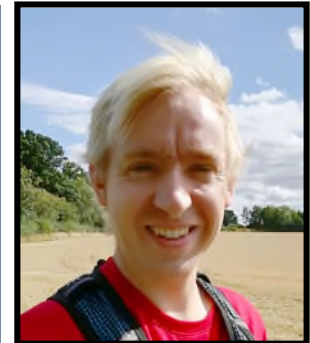
Course deliverer

Trevor Sidery
Data Science Team
Tesco Plc

Introduction to Machine Learning In Production

1-day introduction of the ML life-cycle and how to put mathematical models into production. The course will cover topics beyond the ML "lab" and experimentation phase.

Subjects covered

- An overview of the components of the ML life-cycle
- General considerations when transitioning to production use cases.
- Building ML CI/CD deployment pipelines
- Cover various deployment strategies.
- Monitoring ML models once they are running in production.
- Hand-on tutorials on the above topics (e.g. serving ML models as a web microservice)

Learning Objectives

By the end of this course, you will:

- have a comprehensive understanding of the ML life-cycle and ML-Ops
- become proficient in the challenges and considerations of placing ML models in production use-case.
- be able to communicate effectively with software and product teams in your organization.
- export your models as a web microservice

Logistics

Hardware required: Laptop with Unix shell

Manual supplied: Yes

Course preparation: Knowledge of Python is helpful & background on ML. It's helpful to already know how to build a ML model using scikit learn.

Course Structure: Lecture, and practical exercises

Course deliverer

Botros Toro, PhD
Product Architect and Data Scientist
Vironix Health Inc
Texas, USA