HSMA 3 Module Descriptors

All students must complete all core sessions of modules, and at least 7 of the option sessions available. Students are welcome to complete as many additional option sessions as they wish.

Introduction to OR and Data Science
Core Sessions : Introduction to OR and Data Science (3 hours)
Option Sessions : /
Module Lead : Daniel Chalk
Operational Research (OR) uses modelling, simulation and analysis techniques to provide evidence that can inform operational decisions. Data Science uses techniques such as Machine Learning and data analysis to generate insights from data. In this opening session, students will learn all about the potential and limitations of these methods, "what if?" analysis, how to manage a modelling project, the modelling cycle, structuring messy problems into focused research questions, concepts of validation and verification of models, and an introduction to probability distributions.

Principles of Programming
Core Sessions : Principles of Programming (3 hours)
Option Sessions : /
Module Lead : Daniel Chalk
Programming skills are required for the vast majority of the methods we cover in this training programme. In this single session module, we introduce students to the fundamentals of programming and the core concepts that are common to all programming languages. Students will learn concepts including instructions, functions, variables, input and output, condition logic, loops, lists, comments, libraries and error handling.

Python Programming
Core Sessions : Python Programming Part 1 (6 hours), Part 2 (6 hours), Part 3 (6 hours)
Option Sessions : /
Module Lead : Daniel Chalk
Having learned about the core principles of programming in *Principles of Programming*, over the course of three six hour sessions students will be taught how to program in Python – one of the most commonly used programming languages in the world. Students will start by learning Python syntax and how to implement the basics, and will eventually advance to learning about Object Oriented Programming and how to implement this programming structure in Python.

Programming in R
Core Sessions : Getting to Grips with Programming in R (6 hours)
Option Sessions : Advanced R (6 hours)
Module Lead : Sean Manzi
R is a programming language with a rich heritage in statistical computing, and is increasingly being adopted in NHS analytics. Students will be introduced to R in an initial 6 hour core session, which will cover syntax, data types, useful functions, data transformation, user defined functions, basic statistics and basic plotting. In an optional 6 hour advanced session, those wishing to learn more about R will learn about the R Shiny package, which allows for the creation of interactive web apps, as well as advanced statistics and advanced plotting.

Discrete Event Simulation
Core Sessions : Discrete Event Simulation (3 hours)
Option Sessions : SimPy Part 1 (3 hours), SimPy Part 2 (3 hours)
Module Lead : Daniel Chalk

Discrete Event Simulation (DES) is a simulation method that allows for the modelling of queuing-type problems, and is particularly well suited to modelling health and social care pathways, and the associated resources needed at each stage of the pathway. For example, we can DES models to answer questions such as "what would happen to waiting times if we change our process in this way?" or "how many doctors do we need at various times of the day to meet incoming demand?". In the core session, students will be introduced to the key components and principles of DES models, and they will have a chance to see some real-world DES models in action. Those wanting to try building a DES model should choose the Option sessions, where they will be taught how to build such models using the Python-based SimPy framework.

Geographic Modelling
Core Sessions : Geographic Visualisation using QGIS (3 hours)
Option Sessions : More QGIS (3 hours)
Module Lead : Kerry Pearn
Geographic Modelling methods allow us to answer "what if?" questions relating to geographic configurations of facilities or services, such as where to best locate services, or predicting the impact of removing services. A vital component of interpreting the output from a geographical modelling project is visualising the geographical outputs. In this module, we focus on the use of QGIS – a popular Free and Open Source Geographic Information System that allows for powerful visualisation of geographic data to help inform decisions. In the core session, students will be introduced to QGIS and shown the basics (becoming familiar with the software environment, adding basemaps, adding your own data and adding symbology). Those wishing to learn more about QGIS can join the Option session, which will cover some of the more advanced features and tips to maximise the effectiveness of their geographic visualisations.

System Dynamics
Core Sessions : System Dynamics (3 hours)
Option Sessions : InsightMaker (3 hours)
Module Lead : Daniel Chalk
System Dynamics is a modelling approach that allows us to understand the inherent dynamics occurring between elements of a (typically) large-scale or whole system. For example, we may want to try to understand how a public health intervention campaign is likely to affect behaviour. In the Core Session, students will learn the core principles of System Dynamics modelling, including concepts such as Reinforcing and Balancing Loops, Stocks and Flows. Those wanting to build their own System Dynamics models can join the Option session, where they will be taught how to use InsightMaker – a Free and Open Source web-based framework, where users can build System Dynamics models easily using a simple drag and drop interface.

Network Analysis
Core Sessions : Introduction to Network Analysis (3 hours)
Option Sessions : Advanced Network Analysis Part 1 (3 hours), Part 2 (3 hours)
Module Lead : Sean Manzi
Network Analysis is a type of graph theory that allows us to understand the relationships between elements within a system to gain a better understanding of the structure of a system, particular where such structures are complex and dependent on many inter-connecting relationships. For example, we may want to better understand the many inter-connecting relationships between mental health services in order to better understand provision of these vital services and assist planning. In the core session, students will learn about the basics of graph theory and how to transform and prepare data ready for network analysis, and will be shown how to build their first network graph. Those interested in pursuing Network Analysis further can learn more about it in the two 3 hour Option sessions, which will cover graph metrics and interpretation, graph structure over time, and interactive graphing with the plotly and holoviews packages.

Agent Based Simulation

Core Sessions : Agent Based Simulation (3 hours)
Option Sessions : MESA (3 hours)
Module Lead : Daniel Chalk

Agent Based Simulation (ABS), sometimes referred to as Individual-based Modelling (IBM), is a modelling method where the behaviours and interactions of individuals within a system are captured, in order to understand how individual-level behaviours lead to emerging population-level dynamics. ABS is useful wherever individual-level behaviours are important to capture – for example, in the current climate, ABS models can be used to predict the spread of disease throughout a population based on the movements, behaviours and interactions of individuals. In the core session, students will be taught the basics of Agent Based Simulation, including the key building blocks of an ABS. In the Option session, those wishing to dive further will be taught how to use the Python-based MESA framework to build an Agent Based Simulation, using the example of a model of disease spread.

Machine Learning

Core Sessions : Machine Learning (3 hours)
Option Sessions : Deeper into Machine Learning (3 hours)
Module Lead : Mike Allen

Machine Learning techniques use Artificial Intelligence methods to build systems that can learn to predict an output or outcomes from a given set of inputs. For example, can we teach a machine to emulate a stroke consultant, and learn which stroke patients are suitable for receiving clot-busting treatment? In the core session, students will be taught some of the key aspects of machine learning, including its potential and challenges. Those interested in learning more about machine learning can take the 3 hour Option session which will introduce Neural Networks and show students how to start building machine learning systems in Python using advanced libraries that allow users to tap into complex advanced methods more easily. ***Please note – those wishing to undertake the Option session for Reinforcement Learning "Deeper into Deep RL" must complete the "Deeper into Machine Learning" Option session here first, as well as the core Deep Reinforcement Learning session***.

Natural Language Processing

Core Sessions : Natural Language Processing (3 hours)
Option Sessions : Named Entity Recognition (3 hours), Sentiment Analysis (3 hours)
Module Lead : Daniel Chalk

Natural Language Processing (NLP) methods are focused on getting machines to understand natural language for the purposes of extracting information. In this module, we focus on AI-based NLP, which seeks to apply methods that can automatically extract information from free text using AI approaches such as the use of Neural Networks. For example, can we get a machine to automatically identify which of our patient surveys are positive and negative, and what are the kinds of things that come up in positive and negative surveys, respectively. Or, can we automate the process of seeing what people are saying our hospital on social media? In the core session, students will be introduced to the principles of Natural Language Processing, such as grammar, part-of-speech (POS) tagging, noun phrases, regular expressions and Neural Networks. Those wishing to learn more about NLP can choose to dive into two 3 hour Option sessions. The first Option session will introduce Named Entity Recognition, where we teach a machine to automatically extract named entities (such as people, places, organisations etc) from free text data. The second Option session will teach students how to teach a machine how to automatically identify the 'sentiment' of free text to determine whether it is 'positive', 'negative' or 'neutral' in tone, which can be particularly useful for automatically analysing patient survey or social media data, for example.

Forecasting

Core Sessions : Forecasting (3 hours)

Option Sessions : Simple Forecasting (3 hours), Advanced Forecasting (3 hours)

Module Lead : Tom Monks

Forecasting methods are focused on trying to predict future patterns of activity based on historical information. Forecasting methods are very important when trying to ensure services are sufficiently prepared for expected levels of demand. In the core session, students will learn the basics of forecasting, and how to prepare time series data in Python ready for forecasting. In the two 3 hour Option sessions, students will be shown how to use progressively more advanced forecasting methods, techniques for estimating the potential error of a forecast, and how to compare forecasts.

Deep Reinforcement Learning

Core Sessions : Deep Reinforcement Learning (3 hours)

Option Sessions : Deeper into Deep RL (3 hours)

Module Lead : Mike Allen

Deep Reinforcement Learning combines the fields of Deep Learning (using deep Deep Neural Networks) with Reinforcement Learning (modelling agents taking actions within an environment, who are rewarded for taking actions that bring them closer to a 'goal'). A relatively new field, this area has huge potential for application to dynamic health service decision making – for example, can we build a system that combines a Discrete Event Simulation of an Emergency Department with a Deep RL system that can make dynamic decisions about whether to add or remove beds in the hospital, so as to learn when these decisions should be made? In the core session, students will be given a broad introduction to the field that will showcase the potential of these exciting new methods to transform decision support. Those wishing to learn more about how to develop such systems can choose to dive into a more hands-on session in the 3 hour Option session. ***Please note – those wishing to undertake the Option session for Reinforcement Learning "Deeper into Deep RL" must complete the "Deeper into Machine Learning" Option session in the Machine Learning module first***.