MA3077 (DLI) Operational Research

Lecture 1 – Introduction

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Module convener – Dr Neslihan Suzen

About me: I am a Lecturer in Applied Mathematics and a Data Scientist with a PhD in Natural Language Processing (NLP).

My research focuses on using Text Mining, Machine Learning and Semantic Analysis in developing mathematical and computational frameworks to design AI and NLP systems and automated decision support.

Module organisation

Lectures:

- Lectures start on 12th September. Zoom link to lectures and tutorials is available on BB.
- There will be weekly 'revision lectures' that will summarise the main topics that we have covered each week.
- Recordings of the lectures will be available at *'Reflect' Recordings* on Blackboard.

Tutorials:

- Every week there will be 1h live tutorial via Zoom on Friday.
- We will discuss solutions to the self-study exercises given at the end of each set of slides and answer any questions you may have.

Module organisation

Questions:

- You can ask questions during the live tutorial sessions.If you have questions outside of lectures, please use the dedicated forum in the *Discussions* menu on Blackboard. If you have private matters to discuss, please send me an email at ns553@Leicester.ac.uk

Learning materials:

- Powerpoint slides will be uploaded regularly on the Blackboard page.

Module organisation

Assessment:

- 40% coursework (2 problem sheets) and 60% final exam in January.

Coursework:

- Each problem sheet counts 20% towards the final mark. The submission deadlines are:
  1. Problem sheet 1: TBC at 12pm (midday) on Blackboard
  2. Problem sheet 2: TBC at 12pm (midday) on Blackboard

Module content and plan at a glance

Linear programming

Queueing theory

Problem Sheet 1

Nonlinear optimization

Problem Sheet 2

Revision/self-study

Mock exam

Prerequisites

- The **main prerequisites** needed to follow this module are:
  - Linear algebra (mostly operations with vectors and matrices)
  - Calculus (mostly continuity and multivariate differentiation)
  - Elementary probability theory
  - Basic coding skills (mainly to solve large problems)

- **Coding:** some exercises require numerical computations. In this module we use Matlab. If you need to refresh your Matlab, have a look at this MathWorks tutorial (you may need to create a mathworks account to access it).

Recommended reading

The recommended textbooks are:

- Hillier and Lieberman, *Introduction to Operations Research,* McGraw-Hill
- Naadimuthu, R. Bronson, *Operations Research*, Schaum's Outlines
- Nocedal and Wright, Numerical optimization, Springer
- Bosch, *Opt Art: from Mathematical Optimization to Visual Design*, Princeton University Press

These are available on Blackboard (go to *Readings and Sources*).

Other useful websites are:

- https://docs.mosek.com/modeling-cookbook/index.html#
- https://www.theorsociety.com/
- https://www.informs.org/
- http://www.pitt.edu/~jrclass/or/or-intro.html
- http://people.brunel.ac.uk/~mastjjb/jeb/or/intro.html

What is operational research?

Definition/description*:

"operational research is a discipline that deals with the development and application of advanced analytical methods to improve decision-making.“

"Employing techniques from other mathematical sciences, such as modeling, statistics, and optimization, operations research arrives at optimal or near-optimal solutions to complex decision-making problems. “

"Operations research is often concerned with determining the extreme values of some real-world objective: the maximum (of profit, performance, or yield) or minimum (of loss, risk, or cost).“

"Originating in military efforts before World War II, its techniques have grown to concern problems in a variety of industries."

* From wikipedia, accessed on 14 September 2021.

Operational research in practice

The key steps of operational research are:

- Understand the problem to be solved
- Formulate a mathematical model
- Collect relevant data
- Compute the solution to the mathematical model
- Validate the solution and possibly perform sensitivity analysis.

Next Lecture outline

Today's goal is to:

- introduce the concepts of optimization and linear programming,
- learn how to solve linear programming problems using a graphical method,
- learn how to write a linear programming problem in standard form,
- and learn how some nonlinear functions can be modeled in a linear fashion.

Today's lecture is loosely based on chapters 2.1 and 2.2 of the Mosek Cookbook.