# University College London ECON0114 Computational Methods for Economists

### Aims

This module covers intermediate mathematical methods presented in contexts relevant for economists and students of connected subject fields. It aims to equip students with operational skills in applying intermediate, applied-mathematical methods to problems taken from various contexts in Economics and Social Sciences; and to train students in planning and systematically executing lengthy calculations both on paper as well as using software aids such as Mathematica/Matlab/Python.

### **Required Software**

You are required to install Mathematica on your laptop / desktop or use UCL cluster-room computers where Mathematica is pre-installed. You will be able to download a copy of Mathematica from the ISD Software Database under the UCL campus license for free.

The module will be taught using Mathematica, but students are welcome to submit their solutions to assignments and exams using Python, R, C++, or MatLab. Teaching will however only use Mathematica. Office hours will be on Zoom.

# **Textbook & Lecture notes**

Usually, weeks 1 through 10 use a set of detailed lecture-notes but weeks 6 through 10 can also be followed using the following book:

Estrada, E. & Knight P.A, A first course in Network theory, Oxford University Press (2015)

You are strongly advised to get your own copy, which is available on Amazon.

# Example of weekly topics

### Dynamics and dynamical Optimization

- Week 1: Simple dynamics
- Week 2: Linear models: matrix methods
- Week 3: Dynamic optimization I
- Week 4: Dynamic optimization II
- Week 5: Dynamic Optimization III

#### **Network Theory**

- Week 6: Networks I: Paths, Powers and the Adjacency matrix
- Week 7: Networks II: Subgraph counting and Centrality
- Week 8: Networks III: Subgraph correlations, Clustering & Assortativity

- Week 9: Networks IV: Network rewiring & evolving networks
- Week 10: Networks V: Network optimization & Classification

# General structure of the Course

Teaching and Learning in ECON0114 is different from that in most modules. You might need to get used to this during the first few weeks of term. How you choose to work for ECON0114 will matter at least as much as how much you choose to work.

#### Learning-by-Doing

The only efficient way to learn computational methods and the 'coding' that comes along with it is by doing it. Don't waste time re-reading lecture-notes or re-watching recorded classes. There is simply no substitute for struggling through solving problems. In fact, some concepts, tools and ideas that may seem incomprehensible when read or watched in a lecture can become crystal clear when deployed as a means of solving an actual problem or answering a question.

Students that do well in ECON0114 are those that start doing things themselves early. Students that hesitate or wait too long will struggle to catch-up. Always remind yourself: this module is hands-on!

### Independent vs Group work

Group work on this module can be extremely efficient. Developing ideas how to solve a problem, how to 'code' a particular calculation, how to find alternative ways of doing something, are all activities that will benefit from doing them with 2 to 4 peers. However, you will find that to really master the concepts and tools that you can learn in ECON0114 you will also need to spend enough time on them on your own.

The general recommendation is to do some of the work with some of your peers, but to also spend enough time on your own writing your own code and your own solutions. Especially "copying code" from peers is not only a way to get low marks and perhaps end up being caught for plagiarism and collusion, but also a way to effectively prevent yourself from learning anything.

#### Key skills

Three of the key skills you will need in computational economics, or data science, or AI, are the following:

- the ability to define a precise, computational, problem on the basis of interpreting uncertain/ambiguous questions or instructions;
- the ability to find new and original ways of turning that computational problem into a set of working commands / code in a way you can explain;
- the ability to analyse the output (numbers or graphs) of your commands in terms of your assumptions, the characteristics of your code and computational approach;

All of this requires creativity, precision, attention to detail and originality. The most difficult aspect of ECON0114 is typically learning which of these you need when during the problem-solving.

An immediate consequence of the fact that ECON0114 will teach, train and assess you in these key skills is that the marking-schemes will reward creativity, precision, attention to detail and originality. The problems in exams and problem sets will typically ask you to define the problem, interpret a question/instruction, explain your approach (or code), and analyse the results.

Reproducing (and somewhat understanding) stuff from the lectures, the internet or your friends is probably going to allow you to pass or achieve a II.2, but will not be enough for a II.1 or higher.

Classes Every week, typically, there will be

- one 2-hour in-person lecture class, and
- one 2-hour in-person practical class.

### Workload

Every 15 credit UCL module is considered to have a total work-load of 150 hours. Typical workload for the ECON0114 module is as follows:

- The ECON0114 Take-Home exams have a workload of approximately 8 hours each, i.e. 16 hours in total;
- The weekly problems have a workload of 4 hours each, i.e. 40 hours in total;
- Class hours are 2 2-hour classes a week + about 1 hour of preparation & recorded material per class, i.e. 50 hours in total
- The remaining 44 hours are distributed as follows:
  - 4 hours a week of self-study during term time;
  - 4 hours of revision for the final Take-Home Exam;

Note that this will mean that, during the 10 weeks of term (excluding Reading week) you will be spending on average 13 hours each week on ECON0114. That can \*feel\* like 2 to 3 days a week when you bunch it too much in inefficient lengthy blocks.

# Summative & Formative Assessment

Typically, every two weeks students will be able to submit a "short problem" solution for feedback and an A-F mark that indicates the class of the solution given. Submission is voluntary and draft solutions of the problems are also posted on Moodle.

As summative assessment usually there are 2 Take-Home Exams, each weighing 50%.

### Summative Assessment

The Take-Home Exams typically have a workload of around 15 hours each and consist of 3 "short problems".