ECON0114 Computational Methods for Economists

Lecturer: Dr. Frank Witte

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

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 for £27. The lecture notes will be available on Moodle at least a week prior to the week in which the corresponding material is relevant.

The topics per week

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. Especially when you are a year-2 student *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.

Week Schedule

My recommendation for working on ECON0114 is to *choose a pattern of work that is regular*, means you spend time on ECON0114 in frequent, short, sessions rather than rare but lengthy sessions. Choose those short sessions when the time is quality time, avoid rushed, last-minute ditches. Team up with a couple of peers and spend time outside of the "scheduled hours" talking about stuff you do for ECON0114 in your independent working-hours. Make sure that at least half of your hours on ECON0114 are "independent learning" rather than group work. In the schedule below I will indicate which parts are particularly suitable for a group work approach.

The weekly schedule of working in ECON0114 will look something like the following (recommended) schedule.
- **Monday**: 2h-3h (*suitable for group work*)
    - Have a look at this week's *assignment* (released at 9h am) before the Monday class to check whether you have questions (30 minutes);
    - Go over this week's lecture notes before the class (30 minutes);
    - Monday class (1 to 2 hours);
- **Tuesday**: 2h (*suitable for group work*)
    - Work on this week's *assignment*;
- **Wednesday**: 2h
    - Work on this week's *assignment* and submit by 23h59m (UK time);
- **Thursday**: 2h

- Work on this week's lecture material, including some of the practice problems in the notes;
- **Friday**: 3h (*suitable for group work*)
    - In weeks **1-4** and **6-9**: Have a look at this week's "Talk Sheet" for the Friday class (1 hour);
    - In weeks **5** and **10**:
        - Have a look at this week's "Talk Sheet" for the Friday class (30 minutes);
        - Have a look at the Take-Home Exam and check whether you have any immediate questions (30 minutes);
    - Friday class (1-2 hours)
- **Weekend**: 1-2h
    - Set apart some time (30 min) to look at the feedback on last week's problem set. It pays off to try and find different ways of solving the same problems and/or alternatives for the code/commands you used;
    - Set apart some time (30 min) to think of how you can apply *what you have learned in the module so far* to questions/problems/issues you have encountered in other modules, in wider reading or in other contexts. Make a brief attempt at figuring out a computational approach to one example of such a question/problem;
    - Set apart some time (1 hour) to do some research by:
        - exploring commands in Mathematica's Help Browser,
        - going online to find some applications of Mathematica in Economics,
        - using "Google Scholar" to find academic papers about topics from class you find interesting, and/or
        - looking back at past assignments / coding and analysing whether you could have written code that is more efficient, faster or more accurate.

Summative & Formative Assessment

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 typically there are 2 Take-Home Exams, each weighing 50%.

Summative Assessment

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

Dates:
Mid-Term Take-Home Exam:
Weight: 50%.
Material: The Mid-Term Take-Home Exam will cover the material of weeks **1** through **4**.

Final Take-Home Exam:
You will be completing the Exam over week 1 of term 2.
Weight: 50%.
Material: The Final Take-Home Exam will cover the material of weeks **5** through **10**.