ECON2125 / ECON8013

Lecture 1

John Stachurski

Semester 1, 2015

Course Title(s)

- Optimization for Economics and Financial Economics

  and

- Mathematics for Economists A

  and

- Mathematical Techniques in Economics I

Today

Organization

Administrative topics

Course content

Motivation

Background material

Instructor

Name: John Stachurski

Office: Room 2006, HW Arndt Building 25a

Email: john.stachurski@anu.edu.au

Contact hours: Monday 9:00–11:00 AM.

Timetable

- Lecture A: Wednesday 10–11 AM, CBE BLD LT2
- Lecture B: Thursday 9–10 AM, CBE BLD LT2
- Lecture C: **None for now**

Important: Lecture C is

- Not running until I say otherwise
- only for ECON8013 (graduate students) if at all

Online:

- Audio recordings (when they work...)
- Lecture slides (comprehensive) and other PDFs

Course Webpages $=$ GitHub Plus Wattle

1. Wattle: http://wattlecourses.anu.edu.au/
2. GitHub: https://github.com/jstac/econ-2125-8013

Remarks

- PDFs will go up on the GitHub site first
- GitHub site can be found through Wattle

Tutorials

Enrollment opens after this lecture via ETA

- https://eta.fec.anu.edu.au/

Tutorial questions

- posted as PDFs on GitHub one week prior to tutorials
- not assessed — to help you learn and prepare

Please note

- Tutorials start **next** week

Tutors

Qingyin Ma (head tutor)

- Email: qingyin.ma@anu.edu.au
- Room: 1125 Copeland Building
- Office hours: 16:00–17:00 Friday

Guanlong Ren

- Email: guanlong.ren@anu.edu.au
- Room: 2018 HW Arndt Building
- Office hours: 17:00–18:00 Friday

Prerequisites

See course guide

What you actually need to know:

- basic algebra
- basic calculus
- some idea of what a matrix is
- etc.

$\approx$ content of EMET1001 from last year

Focus?

Is this optimization or a general math-econ course?

Answer:

- A general course on mathematical modeling for economics and financial economics
- Optimization will be an important and recurring theme

Part of a sequence with ECON2127/ECON8014 in semester 2

- The latter will focus more on applications
- This course will focus more on technical foundations

Assessment

A mid-term and final exam

Weighting:

| Mid-term Exam: | 40 % |
| Final Exam: | 60 % |

Remarks:

- Final grade might not be exact sum of these scores
- 8013 and 2125 students assessed in separate pools

Questions

Please refer all administrative questions to course administrator
Karissa Carkeet

- Email: karissa.carkeet@anu.edu.au
- Room: 1013, HW Arndt Bulding

Please refer general content related questions to tutors

- I don't understand why this function is convex...

Other questions to John S

- I'm working hard but still can't keep up
- Can we please have more practice questions on XYZ...

Other

Please don't use email for <u>instructional</u> purposes

- Instead make use of tutorials / office hours

Attendance at tutorials is highly recommended

- Exam questions will be "similar" to tute questions

Attendance at lectures is recommended but not mandatory

Comments on the Lecture Slides

Cover exactly what you are responsible for knowing

- Programming the exception — not assessable

In particular, you need to know

- The definitions from the slides
- The facts from the slides
- Have some ability to apply the facts and definitions

If a concept is not in the slides then it's not assessable

Definitions and Facts

The lecture slides are full of definitions and facts

Example. Function $f \colon \mathbb{R} \to \mathbb{R}$ is called **continuous at** x if, for any sequence $\{x_n\}$ converging to x we have $f(x_n) \to f(x)$

Possible exam question: Show that if functions f and g are continuous at x, then so is $f + g$.

Start answer with the definition of continuity:

"Let $\{x_n\}$ be any sequence converging to x. We need to show that $f(x_n) + g(x_n) \to f(x) + g(x)$. To see this, note that..."

Facts: In the lecture slides you'll often see something like

Fact. The only N-dimensional subset of $\mathbb{R}^N$ is $\mathbb{R}^N$

Means any one of

- theorem
- proposition
- lemma
- true statement

All well know results

Need to remember, have some intuition for, be able to apply

Comments on Assessment

Assessable = definitions and facts in slides + EMET1001 level
maths + a few simple steps of logic

Exams will reward

- Hard work
- Broad understanding

For a typical question there will be an "easy" way to solve it if you
know all the relevant facts and definitions

Reading Material

Primary reference

- Lecture slides – as discussed above

Readings other than lectures slides all supplementary

- **Mathematics for Economists** by Simon and Blume
- PDF file **ECON2125/8013 Maths Notes** (see GitHub)

Key Points on Admin and Procedures

- Lecture C not running unless otherwise advised

- Tutorials start **next week**, please enroll this week

- Course content $=$ what's in lecture slides

- Lecture slides will be made available on GitHub

- Optimization is a recurring theme but not the only topic

Motivation

Why we need technical skills in

- Economics
- Finance
- Business and business administration

Key questions:

- What kinds of technical skills do I need?
- How might I use such skills in the future?

Option 1: Do Good

Case study: North Star Alliance

- Founded by TNT Express and UN WFP in 2007
- Delivers basic health services in sub-Saharan Africa
- Services delivered via mobile clinics

But where to locate the clinics?

Developed a specialized optimization program called POLARIS

Determines optimal locations

Served 1/4 million people in 2012

What technical skills did they use?

- optimization theory
- linear algebra
- algorithms and computer programming

What we treat: Foundational elements of the first two

Why is this economics?

- Because the outcome depends on human choices
- Because the objective criterion is human welfare

Option 2: Get Rich (or Die Tryin')

Case study: Myron Scholes

1962: Undergraduate degree at McMaster University

1968: PhD at University of Chicago

- Studies lots of advanced maths

1973: Publishes fundamental results in the new field of option pricing

1993: Co-founds hedge fund Long Term Capital Management

1997: Wins Nobel Prize for this work

Stephen Belloti, during heydey of LTCM: "What do you have more of Myron — money or brains?"

Myron Scholes: "Brains, but it's getting close"

– Roger Lowenstein, When Genius Failed, 2001

Postscript: LTCM crashes and dies in '98 Russian financial crisis

...but Myron is still doing fine

What technical skills did he use?

- probability theory
- dynamics
- optimization

We cover:

- An introduction to all of these topics

Remark: His work interesting for econ as well as finance

The price of an asset is the outcome of

- the way markets function
- human choices, expectations, etc.

Option 3: Get Rich a Different Way

In mid 1990s, PhD students Larry Page and Sergey Brin begin a research on search engine algorithms

They realized that

1. Internet search is mainly about ranking
2. Ranking requires a measure of "importance"

Importance is something to do with number of inbound links

But inbound links should be weighted by their own "importance"

Recursion: rank of page X depends on ranks of pages that link to it

How can we solve such problems?

- Using fixed point theory

Page and Brin

- Used these methods to generate rankings — PageRank
- In 1996, Page and Brin found Google

Connection to economics?

Economists use very similar techniques to solve their problems

Example: Asset prices are recursive

- Price today depends on expected return tomorrow
- Expected return depends on expected price

Recursion: Today's price depends on tomorrow's price

We'll learn how to solve these kinds of problems

Option 4: Get Rich the New Way

Pricing derivatives is still a lucrative job but somewhat eclipsed by the rise of the data scientists

- Data analytics
- "Big data"
- Statistics
- Algorithms
- Machine learning

Data analytics continue to revolutionize many fields of business

What technical skills required?

- Probability theory

- Linear algebra

- Optimization (prediction that minimizes error)

- Functional analysis

We treat the first three (fourth is too advanced)

Option 5: Understand the World

The stable marriage problem, from Wikipedia:

> *Given n men and n women, where each person has
> ranked all members of the opposite sex with a unique
> number between 1 and n in order of preference, marry
> the men and women together such that there are no two
> people of opposite sex who would both rather have each
> other than their current partners.*

Studied by economists David Gale and Lloyd Shapley

In 1962 they

- Show this is always possible
- Provide an algorithm that derives the solution

Sounds esoteric, but

Alvin E. Roth and co-authors later use this algorithm to

- Radically improve matching between students and high schools in NYC
- Match kidney donors to kidney recipients

Roth and Shapely win 2012 Nobel Prize in Economics for their contributions

What technical skills?

- Logical thinking
- Basic algebra
- Analysis of algorithms

What do we cover?

- Elements of all, particularly logical thinking

Summary of Course Topics

1. Basic optimization
   - problems and techniques
2. Linear algebra
   - solving systems of equations, etc.
3. Intermediate analysis
   - continuity, convexity, fixed points, etc.
4. Probability
   - distributions, expectations, etc.
5. Dynamics
   - deterministic systems, stochastic systems
6. Orthogonal projections
   - least squares, optimal projections