Mathematics at Queen Mary

Thomas Prellberg

School of Mathematical Sciences
Queen Mary, University of London

College Open Day Presentation 2009

Topic Outline

Outline

Why You Should Study Mathematics

Good Reasons for Studying Mathematics

- You are really good at maths
- You like problem solving
- You could get into business school (or law, or ...)
- You want to keep your career options open

Bad Reasons for Studying Mathematics

- Your language skills are really weak
- You like memorising formulas
- Your marks are to weak to get you into ...
- You haven't yet figured out what you're good at

The Best Reason for Studying Mathematics

- You love doing maths

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Mathematics is not

- just "doing things with numbers and letters and other symbols"
- just a collection of facts and rote recipes
- just computational and arithmetic skills

Mathematics is

- a way of thinking
- the language of science
- a creative discipline
- a source of pleasure and wonder
- a means of problem solving

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Transferable Skills

- Analytical abilities
- Ability to work independently
- Ability to manage your own time
- Highly developed numerical skills
- Effective communication skills
- Apply mathematical modelling to real-world problems
- Practical computational skills

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Career Opportunities

- Academic Research
- Aerospace
- Biotechnology
- Business and Finance
- Chemicals
- Construction
- Defence
- Electronics
- Energy
- Environment
- Health Care
- Management
- Marketing
- Materials
- Pharmaceuticals
- Retail
- Teaching
- Transport

Career Opportunities

- Academic Research
- Aerospace
- Biotechnology
- Business and Finance
  - Accountant: 19-25K
  - Actuary: 23-28K
- Chemicals
- Construction
- Defence
- Electronics
- Energy
- Environment
- Health Care
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- Management
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- Construction
  - Surveying: 17-25K
- Defence
- Electronics
- Energy
- Environment
- Health Care
- Management
  - Consultant: 25-30K
- Marketing
  - Market Researcher: 19-24K
- Materials
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- Materials
- Pharmaceuticals
  - Medical Statistics: 19-30K
- Retail
- Teaching
  - Teacher 20-25K
- Transport

Career Opportunities

- Academic Research
  - PhD Scholarship: 15K
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  - Actuary: 23-28K
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Outline

Three-Year BSc Degree Courses

Title	Code	Req.
Mathematics	G100	320
Pure Mathematics	G110	320
Mathematics and Statistics	GG31	320
Mathematics, Statistics, and Financial Economics	GL11	320
Mathematics with Finance and Accounting	G1N4	320
Mathematics with Business Management	G1N1	320
Mathematics with Business Management and Finance	GN13	320
Mathematics and Computing	GG14	320
Mathematics and Physics	FG31	320

A=120, B=100

Other Degree Courses

Degree	Years	Title	Code	Req.
MSci	4	Mathematics	G102	340
MSci	4	Mathematics with Statistics	G1G3	340
BSc	*3*	*Computer Science with Mathematics*	*GG41*	*320*
BSc	*3*	*Economics, Mathematics, and Statistics*	*LG11*	*340*
	1	Science & Eng. Foundation Programme	FGH0	180

- All Queen Mary degrees are honours (including pass degrees)
- Course unit system instead of joint or combined honours

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BSc	*3*	*Computer Science with Mathematics*	*GG41*	*320*
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Course Unit System

Advantages:

- Flexibility
- Opportunities to take modules in other departments
- Freedom to shape your programme of study
- Specialisation in penultimate and final year

Typically,

- take 8 modules in first year (no choice)
- choose 8 of 16 modules in second year
- choose 8 of 24 modules in third year

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Example: G100 Mathematics

Study Programme Structure

- Core modules
- + Optional core modules
- + Elective modules

Streams withing G100 include

- Algebra and Discrete Mathematics
- Analysis and Geometry
- Probability and Statistics
- Applied Mathematics

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- Algebra and Discrete Mathematics
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G100 Mathematics – First Year

Semester 1	Semester 2
Calculus I	Calculus II
Probability I	Introduction to Statistics
Geometry I	Differential Equations
Introduction to Mathematical Computing	Introduction to Algebra

Four modules per semester - no choice

G100 Mathematics – First Year

Semester 1

- Calculus I
- Probability I
- Geometry I
- Introduction to Mathematical Computing

Semester 2

- Calculus II
- Introduction to Statistics
- Differential Equations
- Introduction to Algebra

Four modules per semester - no choice

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Four modules per semester - no choice

G100 Mathematics – Second Year

Semester 3

- Linear Algebra I

Take two of

- Convergence and Continuity
- Calculus III
- Dynamics of Physical Systems
- Probability II
- Mathematical Writing

Semester 4

Take three of

- Algebraic Structures I
- Complex Variables
- Geom. II: Knots and Surfaces
- Statistical Modelling I
- Intro. to Numer. Comp.
- Algorithmic Graph Theory
- ...

8 modules out of a choice of 16

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G100 Mathematics – Third Year

Semester 5

Options include

- Combinatorics
- Algebraic Structures II
- Chaos and Fractals
- Linear Algebra II
- Intro. to Math. Finance
- Relativity
- Metric Spaces
- Linear Operators and Differential Equations
- ...

Semester 6

Options include

- Coding Theory
- Complex Analysis
- Fields and Galois Theory
- Number Theory
- Cryptography
- Mathematical Problem Solving
- Design of Experiments
- Fluid Dynamics
- Project
- ...

8 modules out of a choice of 24

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The Academic Year

late September mid December	Teaching Semester A (12 weeks)
early January late March	Teaching Semester B (12 weeks)
late April early June	Examination Period (6 weeks)

Teaching

- 4 modules per semester
- 3 hours lectures + 1 hour exercise class (per module and week)
- $4 \times 4 = 16$ timetabled hours per week

Assessment

- Modules count 1:3:6 to final degree
- 20% in-term assessment + 80% final exam
- 3 attempts (resit exam or retake module)

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School of Mathematical Sciences:

- Personal Academic Advisers (academic matters)
- Study Programme Directors
- Pastoral Tutor (pastoral matters)
- Senior Tutor, Director of Undergraduate Studies
- PASS (Peer Assisted Study Support)

College:

- Advice and Counselling Service
- Health Centre
- Disability Coordinator
- Careers Service
- The Students Union
- Student Accomodation

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Seven Million Dollars Prize Money

7 Prize Problems, selected by Clay Mathematics Institute in 2000

- Birch and Swinnerton-Dyer Conjecture
- Hodge Conjecture
- Navier-Stokes Equations
- P vs NP
- Poincaré Conjecture
- Riemann Hypothesis
- Yang-Mills Theory

These are hard problems (it might be easier to rob a bank...)

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Solved Problems in Mathematics

Some "recently" proved problems:

- Fermat's last theorem (1637, proved 1994): If an integer n is greater than 2, then the equation

$$a^n + b^n = c^n$$

  has no solutions in non-zero integers a, b, and c.

  For $n = 2$, this is of course possible, for example

$$3^2 + 4^2 = 5^2 \ .$$

- The four colour theorem (1852, proved 1976): Given any plane separated into regions, such as a political map of the states of a country, the regions may be coloured using no more than four colours.

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Solved Problems in Mathematics

Some "recently" proved problems:

- Fermat's last theorem (1637, proved 1994): If an integer n is greater than 2, then the equation

$$a^n + b^n = c^n$$

  has no solutions in non-zero integers a, b, and c.

  For $n = 2$, this is of course possible, for example

$$3^2 + 4^2 = 5^2 \ .$$

- The four colour theorem (1852, proved 1976): Given any plane separated into regions, such as a political map of the states of a country, the regions may be coloured using no more than four colours.

Open Problems in Mathematics

Some unsolved problems:

- Goldbach's conjecture (1742): every even integer greater than 2 can be written as the sum of two primes.

  For example, $18 = 5 + 13 = 7 + 11$.

- The twin prime conjecture (300 BC): there are infinitely many primes p such that $p + 2$ is also prime.

  For example, 17 and 19 are twin primes.

- How many different Sudoku squares of size $n \times n$ are there? There are

  $$6,670,903,752,021,936,960$$

  valid 9×9 Sudoku squares. The problem is to find a formula for general n.

There are many more well-known open problems, see e.g. http://en.wikipedia.org/wiki/Unsolved_problems_in_mathematics

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> *"The history of mathematics is a history of horrendously difficult problems being solved by young people too ignorant to know that they were impossible."*

Freeman Dyson, "Birds and Frogs", AMS Einstein Lecture 2008

The 3n+1 Problem

Consider the following operation on an arbitrary positive integer:

- If the number is even, divide it by two.
- If the number is odd, triple it and add one.

$$f(n) = \begin{cases} n/2 & \text{if } n \text{ is even,} \\ 3n+1 & \text{if } n \text{ is odd.} \end{cases}$$

Form a sequence by performing this operation repeatedly, beginning with any positive integer.

- Example: $n = 6$ produces the sequence

$$6, 3, 10, 5, 16, 8, 4, 2, 1, 4, 2, 1, \ldots$$

The Conjecture is:

This process will eventually reach the number 1, regardless of which positive integer is chosen initially.

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Some Examples

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- $n = 11$ produces the sequence

$$11, 34, 17, 52, 26, 13, 40, 20, 10, 5, 16, 8, 4, 2, 1.$$

- $n = 27$ produces the sequence
27,82,41,124,62,31,94,47,142,71,214,107,322,161,484,242,121,
364,182,91,274,137,412,206,103,310,155,466,233,700,350,175,
526,263,790,395,1186,593,1780,890,445,1336,668,334,167,502,
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719,2158,1079,3238,1619,4858,2429,7288,3644,1822,911,2734,
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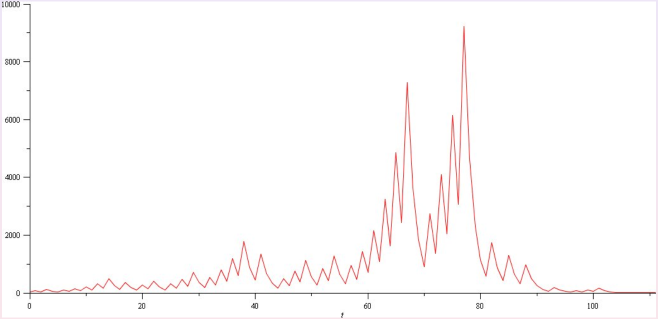
Graphing the Sequences

A graph of the sequence obtained from $n = 27$



This sequence takes 111 steps, climbing to over 9000 before descending to 1.

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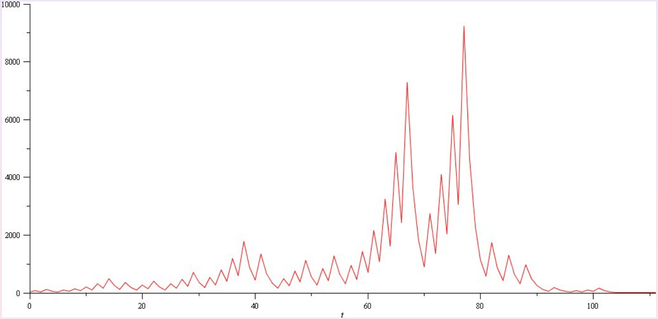

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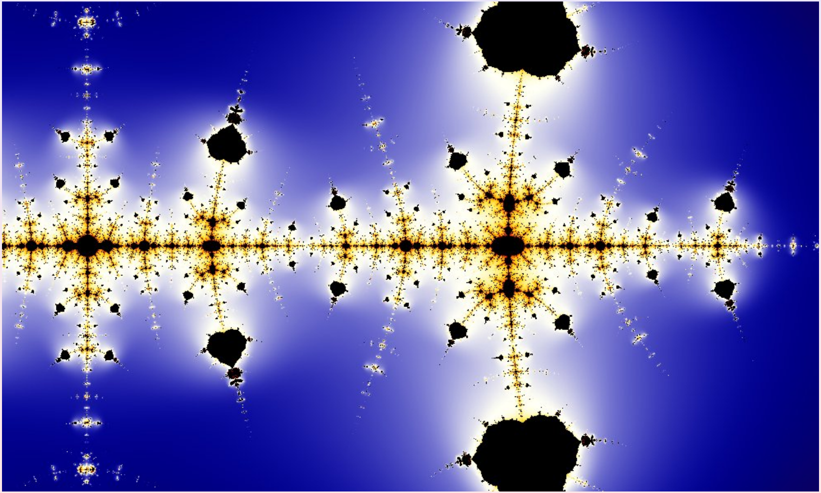
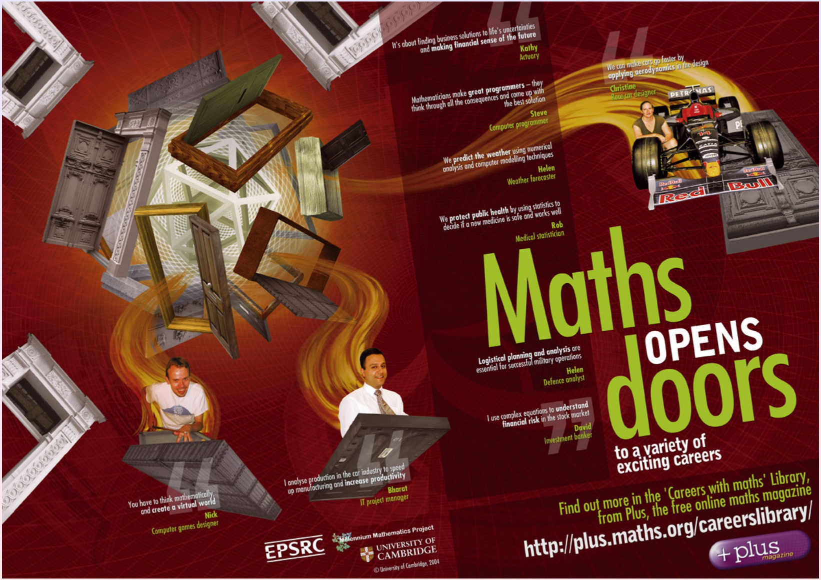
Iterating on Complex Numbers




It's about finding business solutions to life's uncertainties and making financial sense of the future
Kathy
Actuary
Mathematicians make great programmers – they think through all the consequences and come up with the best solution
Steve
Computer programmer
We predict the weather using numerical analysis and computer modelling techniques
Helen
Weather forecaster
We protect public health by using statistics to decide if a new medicine is safe and works well
Rob
Medical statistician
We can make cars go faster by applying aerodynamics in the design
Christine
Race-car designer
Maths OPENS doors
to a variety of exciting careers
Logistical planning and analysis are essential for successful military operations
Helen
Defence analyst
I use complex equations to understand financial risk in the stock market
David
Investment banker
I analyse production in the car industry to speed up manufacturing and increase productivity
Bharat
IT project manager
You have to think mathematically and create a virtual world
Nick
Computer games designer
Find out more in the 'Careers with maths' Library, from Plus, the free online maths magazine
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The End