

The Festival of Mathematics and its Applications

In celebration of the 50th anniversary of the IMA



School of Mathematics
Alan Turing Building
University of Manchester
3rd - 4th July 2014



The University of Manchester

www.ima.org.uk

www.maths.manchester.ac.uk

The Festival of Mathematics and its Applications

Welcome to the School of Mathematics at the University of Manchester. We hope you enjoy your visit, and that it helps you gain a better understanding of how useful and exciting mathematics is. The Festival is part of the 50th Anniversary celebrations of the Institute of Mathematics and its Applications.

On the ground floor of the Alan Turing building there are stands, hands-on activities, and a series of popular talks and workshops given by well-known communicators of mathematics and its applications. The fascinating and stimulating talks and displays are widely accessible, and will show in an engaging way that we live in a mathematical world which influences and enhances the lives of everyone. Mathematics, as well as being a fascinating subject in its own right, is nothing less than the foundation of our modern technological society.

The presentations are structured into three parallel sessions of talks in the lecture rooms π (π), e and i , a series of hands-on **Workshops** and a **Maths at Work** event inspired and developed by the IMA. The timetable of presentations is given on the following pages (abstracts are available at <http://tinyurl.com/ManchesterMathsFestival>). The stands and hands-on activities will run from 10am to 4pm each day, and are located in the Atrium and the Workroom of the Alan Turing Building. The layout is shown on the diagram on the inside-back cover of this booklet. Please note that these events are all subject to change without notice.

Puzzles to Try

Have a go at these problems, just for fun:

1. Which three-digit number has three different primes as digits and is a multiple of all of these three primes? Factors may be repeated in the multiplication.
2. Which gives a tighter fit: a square peg in a round hole or a round peg in a square hole? (Thanks to plus.maths.org for this and the following question.)
3. There are 100 prisoners in 100 separate locked cells. During the night each of 100 prison officers visits the cells. The first officer visits every cell. The second officer visits cells 2,4,6,... etc (every 2nd cell), the third officer visits cells 3,6,9,...etc (every third cell), the fourth officer visits every fourth cell, and so on until the 100th officer visits the 100th cell. On a visit each officer unlocks the door if it is locked or locks the door if it is unlocked. If the cell remains unlocked after all officers have completed their rounds, the prisoner can escape. In the morning, how many prisoners have escaped and why?

Become an IMA e16⁺ Student!

The Institute of Mathematics and its Applications (IMA) exists to promote mathematics in all its many forms to all sections of society. It does so through its involvement with schools, universities, industry and commerce, Parliament and Government. But how does this affect you?

To those at the start of their careers it does so by introducing people to the extraordinary variety of rewarding careers that are open to those with a qualification in mathematics. Academia, finance and teaching of course... but an ability in mathematics is highly valued in every imaginable sector; the career choices are virtually limitless. So your first involvement with the IMA should be to visit the MathsCareers website (MathsCareers.co.uk) and see for yourself....

Convinced? Then your next step is to sign-up, completely free of charge, as an e16⁺ student. Just send an email to e16Plus@ima.org.uk. Aimed at students studying maths at Highers, AS or A Levels, this will give you free access, six times a year to a newsletter which will continue to inform you about the world of mathematics. In these newsletters, you will learn more about the types of careers involving maths, profiles of practising mathematicians including those who have recently qualified, short articles that show how maths is used in the real world, mathematics history, links to related websites and a wealth of useful advice.

If you go on to take maths at university, you can keep your link with the IMA by signing up as an e-Student. The idea is the same as the e16⁺ but the material is focused on university students. Or, you could join as a Student Member and receive the IMA's magazine, Mathematics Today, six times a year. Joining as a Student Member is the next step on a career path that could see you become a Chartered Mathematician....

But this is for the future. The first step is to open your eyes to the amazingly rich and varied opportunities that a qualification in mathematics can lead to. And you begin this journey by joining the IMA as an e16⁺ student - <http://tinyurl.com/IMA16Plus>

Good luck with your career in Mathematics!



We are grateful to the following sponsors for their generous support of the IMA's 50th Anniversary and The Festival of Mathematics:



The Festival of Mathematics and its Applications

Thursday 3rd July

	Talk: pi (π)	Talk: e	Talk: i	Workshop	Maths at Work
10:30-11:30	Charles Walkden <i>Shuffling Around: Why you shouldn't play cards with a mathematician</i>	Ron Knott <i>Food, figures and phi – The Fibonacci numbers in plants</i>	Garrod Musto <i>Operation Mulberry: STEM in action 70 years ago</i>	Snezana Lawrence <i>Can curves be eccentric?</i>	Academic talk on applications of maths Makhan Singh 10:30-10:45 <i>Careers in maths: IMA website</i> Dave Percy 10:45-11:30 <i>Mathematics in Sport</i>
11:30-12:30	Katie Steckles <i>The Number Matrix: The Hidden Maths of Technology</i>	Chris Budd <i>Climate change, does it all add up?</i>	Rachel Thomas <i>Postcards from the world of mathematics</i>	Sue Pope <i>Folding mathematics</i>	Business and Industry speakers Andrea Donafee <i>The secret world of cash</i> Panayiotis Frangos <i>Applied mathematics in the nuclear industry</i> Omar Bouamra <i>Outcome prediction modelling and performance comparison between hospitals</i>
12:30					Q&A John Begg 12:25-12:35
1:30-2:30	Steve Mould <i>Weird and wonderful maths</i>	Alan Champneys <i>Bumps, blips and bulges, the mathematics of localised things</i>	David Acheson <i>Maths, magic and the electric guitar</i>	Sue Pope <i>Folding mathematics</i>	Academic talk on applications of maths Makhan Singh 1:30-1:45 <i>Careers in maths: IMA website</i> Dave Percy 1:45-2:30 <i>Mathematics in Sport</i>
2:30-3:30	Rachel Thomas <i>Postcards from the world of mathematics</i>	Katie Steckles <i>The Number Matrix: The Hidden Maths of Technology</i>	Steve Lynch <i>Brain inspired computing</i>	Colin Wright <i>Maths in a twist</i>	Business and Industry speakers Andrea Donafee <i>The secret world of cash</i> Panayiotis Frangos <i>Applied mathematics in the nuclear industry</i>
					Q&A John Begg 3:25-3:35

Friday 4th July

	Talk: pi (π)	Talk: e	Talk: i	Workshop	Maths at Work
10:30-11:30	Hugh Hunt <i>Boomerangs, Bouncing Balls and Spinny Things</i>	James Grime <i>Enigma and the secret world of code breaking</i>	David Acheson <i>Maths, magic and the electric guitar</i>	Katie Steckles <i>The domino computer</i>	Academic talk on applications of maths Makhan Singh 10:30-10:45 <i>Careers in maths: IMA website</i> Geoff Evatt 10:45-11:30 <i>Applying Applied Maths</i>
11:30-12:30	Rob Eastaway <i>From Pepsi to peace deals</i>	Colin Wright <i>The mathematics of juggling</i>	Charles Walkden <i>Patterns in the Unpredictable: Why random behaviour is surprisingly non-random</i>	Noel-Ann Bradshaw <i>Maths Arcade</i>	Business and Industry speakers Andrea Donafee <i>The secret world of cash</i> Panayiotis Frangos <i>Applied mathematics in the nuclear industry</i> Omar Bouamra <i>Outcome prediction modelling and performance comparison between hospitals</i>
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2:30-3:30	James Grime <i>Enigma and the secret world of code breaking</i>	Chris Budd <i>Eight great reasons to do maths</i>	Steve Lynch <i>Brain inspired computing</i>	Katie Steckles <i>The domino computer</i>	Business and Industry speakers Andrea Donafee <i>The secret world of cash</i> Panayiotis Frangos <i>Applied mathematics in the nuclear industry</i>
					Q&A John Begg 3:25-3:35

Popular Talks – Abstracts

David Acheson – *Maths, magic and the electric guitar*

What's so special about the number 1089? Can mathematics explain the Indian Rope Trick? And what has all this got to do with the electric guitar? To find out, we take an off-beat look at some of the most surprising ideas in mathematics, with practical examples and live experiments.

Omar Bouamra – *Outcome prediction modelling and performance comparison between hospitals*

Trauma is the leading cause of death among the young population. It is therefore important to put in place tools that monitor and improve trauma care for patients. One of the tools are data recording and data analysis, through statistical prediction modelling. This enables us to compare hospitals Outcome performances.

Noel-Ann Bradshaw – *The Maths Arcade*

A fun session designed to promote strategic and mathematical thinking through the playing of a wide variety of board games. Maths Arcades have been started in over ten universities and several secondary schools. More information about them can be found on the IMA's website: <http://tinyurl.com/MathsArcadeIMA>

Chris Budd – *Eight great reasons to do maths*

Mathematics lies at the heart of all modern technology, from the mobile phone to the internet and from Google to the iPod. In this talk I will show you why maths is so important by linking it to the eight great technologies identified as the leading drivers of future innovation.

Chris Budd – *Climate change, does it all add up?*

We hear a lot about climate change, but is it really happening, what can we do about it, and what has this to do with maths? In this talk I will tell you a bit about the sort of models that are used to predict the future of the climate and the sort of mathematics that they rely on to work. I will also show you why any climate model has its limitations. Be prepared for a bit of chaos, polar bears and see how to save the world with a cup of coffee.

Alan Champneys – *Bumps, blips and bulges, the mathematics of localised things*

Bumps, blips or bulges are aberrations, almost by definition, exceptions from the norm. So says popular wisdom when observing the behaviour of most natural or man-made systems. We are used to equilibrium, steady progress, or even to periodic trends and cycles. But, given a freak wave, a market crash, an isolated disaster, a hot-spot or an eerie lull, we are inclined to look for a localised cause, a scapegoat. In this talk I shall show how localised waves and disturbances are the norm. I shall explore some of the simple mathematics behind these ideas and how they are connected to the theory of ship capsizes, pendulums and chaos theory. I shall also draw on the history of the subject, revealing some of the colourful characters from science's back pages.

Andrea Donafee – *The secret world of cash*

Not many people realise how cash ends up in ATMs, banks, building societies and shops. This talk will explain how maths is used to make sure the right amount of cash is in the right place at the right time enabling you to spend your money when you want to.

Rob Eastaway – *From Pepsi to peace deals*

A famous Coca Cola advertisement used the line 'I'd like to teach the world to sing in perfect harmony'. Yet Coca Cola and Pepsi have been competing viciously with each other for decades. Collaboration and competition are everywhere around us, and mathematics and game theory can tell us a lot about why peace, harmony and love are not quite as easy to achieve as the songs might suggest.

Geoff Evatt – *Applying Applied Maths*

The study of Applied Mathematics, and the reality of *applying* mathematics can be two very different processes. Here I shall give a warts-and-all overview of what an applied mathematician does when it comes to applying their maths. I shall highlight the fun, disasters and successes one can expect from being an applier of applied mathematics.

Panayiotis Frangos – *Applied mathematics in the nuclear industry*

Simulation modelling is the process of creating and analysing a digital prototype of a physical model to predict its performance in the real world. The use of applied mathematics and an intelligent 3-Dimensional software drive the development of a virtual model to help management or clients visualise the real environment.

James Grime – *Enigma and the secret world of code breaking*

For as long as we have had secrets we have had secret messages. We present a look at the fascinating history and mathematics of codes and code breaking – from ancient Greece to the present day – including a demonstration of an original WWII Enigma Machine!

Hugh Hunt – *Boomerangs, Bouncing Balls and Spinny Things*

Lecture with live demonstrations! Spinning things are strange. Why does a spinning top stand up? Why doesn't a rolling wheel fall over? Why is top-spin so effective in tennis? How does a falling cat always manage to land on its feet? How can the Hubble Space Telescope turn around in space? What do ice-skaters do to spin so fast? We'll look closely at the common threads that link all spinning things, and that means we'll have to talk about gyroscopes. Don't worry, there won't be any maths. Everything will be demonstrated live with lots of toys and videos. And we'll even throw a few indoor boomerangs – hoping not to break any windows!

Ron Knott – *Food, figures and phi – The Fibonacci numbers in plants*

There is a series of numbers you eat every day! Why does nature use this series in plant patterns? What is the number behind the patterns? Are flowers really computers? You'll never view your five-a-day in the same way again.

Snezana Lawrence – *Can curves be eccentric?*

Snezana will talk about conic sections and how they can, and have, found applications in architecture. The talk will be therefore illustrated by many examples from the world of architecture and the delegates will be asked to help with drawing some curves whose eccentricity will be examined.

Steve Lynch – *Brain inspired computing*

A simple invention by Manchester Metropolitan University mathematicians could lead to a paradigm shift in computing. Inspired by brain dynamics, the talk will cover topics from maths, biology, physics, chemistry and computing. There are two main avenues of research – the invention could lead to the development of super-cooled, low power,

super-fast computers. Additionally, biological neuron-based calculator logic and memory circuits could be used to test drugs for neurological disorders such as Alzheimer's disease, Parkinson's disease and epilepsy.

Steve Mould – *Weird and wonderful maths*

Some things in life are obvious. And some things are complicated. And some things look obvious until you speak to a mathematician. In this talk, Steve looks at the maths that confounds our expectations and laughs in the face of our intuition. If you thought you knew the shape of a wheel or how to measure a coastline, think again. Find out how many numbers in the universe start with a 1, how to cheat on your homework and other mathematical surprises.

Garrod Musto – *Operation Mulberry: STEM in action 70 years ago.*

70 years ago the coast of Normandy was a hive of activity with the off loading of troops, equipment, supplies and vehicles to support the allies advance inland post D-Day. This was made possible by an engineering miracle; the creation of two artificial 'mulberry harbours' which were fabricated in the UK and towed across the channel. This session will give you an overview of 'Operation Mulberry' and illustrate how it can be used to inspire STEM students.

Dave Percy – *Mathematics in Sport*

As the science of space, number, quantity and arrangement, it is no surprise that mathematics has many applications in sport. This talk uses probability theory and other mathematical methods to investigate tactics, rules and results for sports that include badminton, snooker, darts and skiing. It also investigates problems associated with drug testing and match fixing. There will even be opportunities to win the lottery and compete for a medal!

Sue Pope – *Folding mathematics*

Folding paper is an intriguing starting point for mathematical exploration. In this workshop you will find out how folding allows you to tackle problems that can't be done easily with Euclidean geometry and illustrate standard mathematical results in memorable ways.

Makhan Singh – *Careers in maths: IMA website*

Mathematics is everywhere – however, a question often asked by students is 'What sort of careers are there in Mathematics?' Studying mathematics seriously prepares you for almost any career and this talk will look at the wonderful and varied careers that studying mathematics can lead to.

Katie Steckles – *The Number Matrix: The Hidden Maths of Technology*

There are numbers all around us that make our modern lives possible. From rescuing your lost words in text messages to protecting your Facebook profile, we rely on numbers to transmit and protect information – not just numbers, but text, pictures and sound – every day. In this session, your eyes will be opened to the ubiquitous sea of numbers we all live in.

Katie Steckles – *The Domino Computer*

From a very early age we are taught to count and calculate in a denary (base 10) number system, but this is not the only one possible. Modern computers use only two digits in a binary number system. In this workshop, using binary arithmetic, students will build a basic computer out of only dominoes!

Rachel Thomas – *Postcards from the world of mathematics*

Come along on a guided tour through the mathematical landscape via the familiar stepping stones of the numbers. We'll visit some of my favourite sites and hear stories of ancient mathematicians, recent ground breaking results, applications that affect all our lives and most importantly, experience the beauty and power of mathematics.

Charles Walkden – *Shuffling Around: Why you shouldn't play cards with a mathematician.*

What is the best way to shuffle a pack of cards? How many times should you shuffle a pack to ensure that the pack is 'random' (and what does random mean anyway)? What can go wrong if you don't shuffle properly? In this talk we'll show that there is a surprising amount of mathematics hidden away inside a pack of cards – and how this can be exploited to perform card tricks.

Charles Walkden – *Patterns in the Unpredictable: Why random behaviour is surprisingly non-random.*

Most people are very bad at behaving randomly. (For example, would you prefer to pick 1,2,3,4,5,6 as your lottery numbers or 3,17,18,21,33,46? Or if, when tossing a coin, it has come down heads seven times in a row, does that mean that tails is overdue?) What many people do not realise is that true random behaviour often contains a surprising amount of hidden structure. This talk gives some examples of this phenomenon, including why certain numbers appear far more frequently in the real world than you think they should, how to detect fraud, and how to read other people's minds!

Colin Wright – *Maths in a twist*

Many students are introduced to the idea of the Möbius Strip, that wonderfully perplexing strip with a half twist that has only one side and one edge, and which when cut in half doesn't do what you might expect. In this workshop we don't just stop there, but explore what happens with other possible twists and turns, and try to find a way of understanding how this works, what else is possible, and whether we can make sense of it all.

Colin Wright – *The mathematics of juggling*

Juggling has fascinated people for centuries. Seemingly oblivious to gravity, the skilled practitioner will keep several objects in the air at one time, and weave complex patterns that seem to defy analysis. In this talk the speaker demonstrates a selection of the patterns and skills of juggling while at the same time developing a simple method of describing and annotating a class of juggling patterns. By using elementary mathematics these patterns can be classified, leading to a simple way to describe those patterns that are known already, and a technique for discovering new ones. This talk is suitable for most ages. Those with some mathematical background will find plenty to keep them occupied, and those less experienced can enjoy the juggling as well as the exploration and exposition of this ancient skill.

Key to Stands and Hands-on Activities

Stand	Activity	Presented by
0	Registration Desk	University of Manchester
1	Foam Cube Challenge	IMA
2	IMA Activities	IMA
3	Maths of Card Tricks	QMUL
4	Maths Beyond the Classroom	Dr Maths
5	Complex World and Climathnet	University of Bath
6	Cryptography Competition	University of Manchester
7	Codebreaking & Problem Solving	GCHQ
8	Maths of Cows	University of Essex
9	Complex Dynamics	University of Liverpool
10	Maths Exploratorium Exhibits	MathsWorldUK
11	NRICH Maths Roadshow	NRICH
12	Sierpinski's Triangle	FMSP
13	Juggling Exhibition	University of Kent
14	Funny Fluids and Soft Stuff	University of Leeds
15	Maths Arcade	University of Greenwich

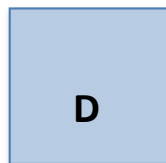
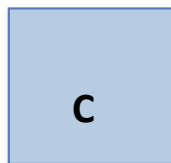
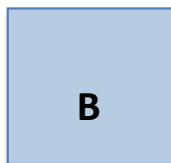
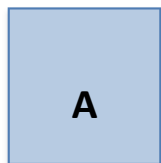
More Puzzles to Try

Have a go at these problems, just for fun:

4. I choose an integer from 0 to 15 inclusive. You are allowed to ask me seven yes or no questions. I must answer them all, but I am allowed to tell one lie. (I am not required to tell a lie but I have the option).

Can you always determine my number? If so, provide a flow chart or graph showing how to do it. If not, explain why not.

5. Four distinct letters are written (labelled a, b, c, d) and four associated distinct envelopes are addressed (labelled A, B, C, D) ready for posting. If one and only one letter is placed in each envelope, in how many ways can all the letters be placed in wrong envelopes?



Is the answer: 6

7

8

9

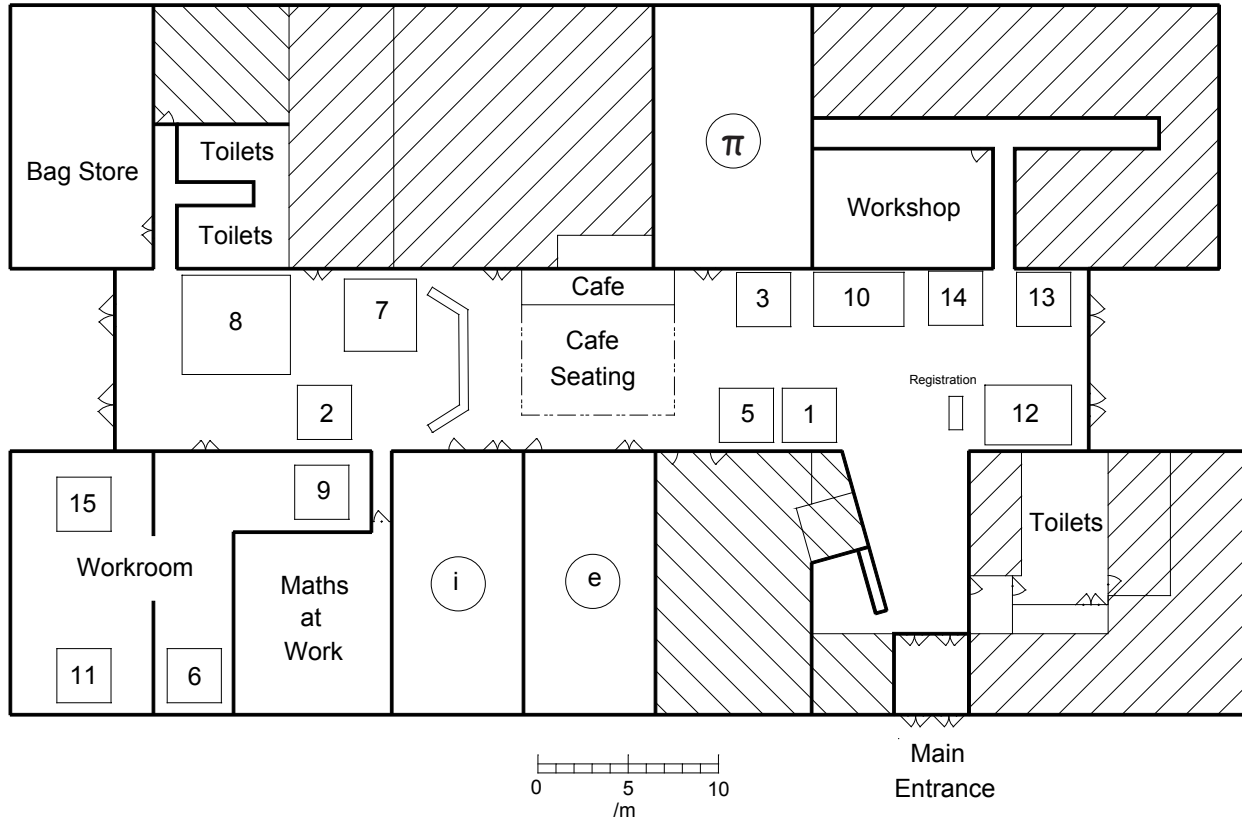
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11

or

12?

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IMA MATHS CAREERS

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