M A T R I X

University of Leeds
1st to 3rd September 2016

PRESENTATIONS

Open lectures

Tadashi Tokieda, Universities of Cambridge & Stanford
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A world from a sheet of paper

Starting from just a sheet of paper, by folding, crumpling, sometimes tearing, we will explore a variety of phenomena, from magic tricks and geometry to elasticity and the traditional Japanese art of origami. Much of the show consists of table-top demos, which you can try later with friends and family.

So, take a sheet of paper...

Hannah Fry, Centre for Advanced Spatial Analysis, University College London
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The Mathematics of Love

You'd be forgiven for thinking that love and maths don't naturally sit well together. Equations and proofs seem pretty poorly equipped to capture and describe the thrill of romance or the world ending despair that love can bring.

But that doesn't mean that mathematics doesn't have anything to offer. Because love - as with most of life - is full of patterns which mathematics is uniquely placed to describe.

What are my chances of finding love? What profile picture should I use to maximise my chances in online dating? When should I settle down? And how can I avoid divorce? While sometimes serious and sometimes playful, Dr Hannah Fry will show you the answers and take you on a tour through the most talked about subject in history - using mathematics as our guide.

Conference Presentations

Adam Atkinson
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The Samaritani Formula

As presented today, the Samaritani Formula is a piece of pseudomathematics used by people trying to sell advice on which lottery numbers to play in Italy. I and others investigated this about 20 years ago when we first came across it and learned that Samaritani himself wasn't trying to do what his modern "followers" claim he was doing. The talk will include pseudomathematics, some real mathematics, detective work (including a visit to the National Library in Rome), and restoring the good name of Samaritani.

Bruce J. Bayly and Shane C. Passon, University of Arizona
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The Arizona Mathematics Road Show: A Mobile Outreach Program

All over the world, formal education mathematics suffers from a lack of connection to the rest of the world, and its presentation is frequently less than exciting to the young students who are asked to learn it. In 2011 a group of informal educators who had been successful with a mobile informal science education program ("The Physics Factory, USA", www.physicsfactory.org) started a mathematics program based on physical demonstrations with engaging mathematical content. Areas represented include 3d geometry and topology, probability, airflow and pressure, sound and vibration. We will also briefly discuss practical aspects of running a mobile outreach program.

Albrecht Beutelspacher, Mathematikum, Giessen
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The Power of Mathematical Experiments

Mathematical experiments provide an ideal first step into mathematics: They start from real experience ("hands-on"), they stimulate thinking ("minds-on"), they are emotionally rewarding and strengthen the personality ("hearts-on").

John Bibby
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Maths Year 2020?
The speaker was actively involved in the UK in QED Books, MatheMagic, Maths Year 2000 and Count On. He will address the recent history of maths popularisation and will ask how we have moved on. Should we aim for another Maths Year in 2020, and if so how should it differ from what went before?

Michael Borcherds, Geogebra
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The Use of GeoGebra to enhance hands-on exhibits
GeoGebra (www.geogebra.org) is a very open, rich mathematical environment that allows students to explore mathematical concepts in algebra, geometry and statistics but it can also be used as a rapid-authoring tool to create closed interactives/demonstrations. GeoGebra Materials (www.geogebra.org/materials) is an online portal which allows GeoGebra worksheets to be combined (with other objects like LaTeX formulae, images, PDFs, videos) into "GeoGebraBooks". I will show a few ideas and examples of how GeoGebra & GeoGebra Materials could be used to enhance hands-on exhibits. (GeoGebra is **free for non-commercial use (see www.geogebra.org/licence).**

Margaret Brown & Geoff Wain, MATHSWORLDuk
margaret.brown@kcl.ac.uk; g.t.wain@geowain.demon.co.uk
Towards creating an Exploratorium: the vision of MATHSWORLDuk
We will outline the ambitions of MATHSWORLDuk to establish a Mathematics Exploratorium in a major UK city which will be mainly aimed at school and family groups. We will discuss the steps on the way to achieving this, the need for partnership and the progress so far.

Chris Budd, University of Bath & the Royal Institution
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1) Creative and Playful Maths
Maths is the ultimately playful subject, with puzzles and games based on maths in great demand. However the creative and playful aspects of maths are not always present in the way that it is taught. In this presentation I will explore the creative side of maths, showing its links to art, sculpture, magic, film production, quilt making and origami. I will also demonstrate how this aspect of maths is perfect for showing off in hands- on

exhibitions. As a finale I will demonstrate, with the aid of maths and radio, why many birds (in New Zealand) have names beginning with the letter K.
2) Conveying the Power of Big Data
This will not be a presentation but a discussion about how the mathematical power of 'big data' can best be conveyed to the public through exhibits, displays, dynamic images etc.

Tom Button & Phil Chaffe, MEI (Mathematics in Education and Industry)
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The Further Mathematics Support Programme
The Further Mathematics Support Programme (FSMP) runs mathematics enrichment events for over 10,000 school students annually. In addition to this we provide professional development and resources for teachers to help them include extension and enrichment ideas in the classroom. In this presentation we will share some of our experiences.

Kieran Clenaghan
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Sequence Algebra in Calculus and Combinatorics, its Haskell implementation, and as a Mathematical play-thing.
Sequence algebra subsumes Formal Power Series algebra as presented by I Niven, ``Formal Power Series'' (AMM, 1969). A succinct Haskell implementation is given by MD McIlroy, ``Power series, power serious'' (JFP, 1999). This implementation is effortlessly derived using coinductive-style reasoning, as expounded by JJMM Rutten, ``A coinductive calculus of streams'' (MSCS, 2005). The implementation is small enough for students to type up and take ownership of through development and experimentation. This can have wide-ranging benefits because it can support the (elementary) study of differential equations, combinatorial enumeration, matrix manipulations, automata theory, and general concepts in algebra and programming. A Cayley used sequence algebra in 1859 to count Catalan trees, and Niven's paper can be seen as justifying Cayley's manipulations.
The presentation will illustrate sequence algebra and give examples from the presenter's 200-page (draft) monograph on the topic. In particular, examples will show how experimentation can support the study of combinatorial enumeration, as in RL Graham, DE Knuth and O Patashnik, ``Concrete Mathematics'' (1994), and P Flajolet and R Sedgewick, ``Analytic Combinatorics'' (2009).

Rebecca Cotton-Barratt & Mareli Grady, University of Oxford
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The Maths of Outreach

From encouraging gender diversity to increasing STEM uptake amongst students, there are many reasons to undertake mathematical outreach. It's much harder to work out whether your outreach is having the impact you want. In this talk we look at freely available online datasets with practical advice on how to evaluate outreach, and give the University of Oxford Mathematical Institute and Department of Statistics as a case study.

John Dore, University of Kent
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Domineering: a game of no chance

Domineering is a simple two-player game that involves the placement of dominoes on a square grid of arbitrary size; one player places their dominoes vertically and the other, horizontally. The players play alternately and the first player who is unable to place a domino on the board has lost – there cannot be a draw. The game on a 5 x 5 or 6 x 6 board takes less than ten minutes to play and involves a number of strategic considerations. I have used it in maths masterclass events with success. For novice players, the results tend to be roughly equally distributed but it is a game of no chance and the result is therefore defined even for quite large boards. The presentation will describe the game and allow people to try their skill in practical play.

Samantha Durbin, The Royal Institution, London
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Royal Institution Masterclasses

Royal Institution Mathematics Masterclasses are series of extra-curricular enrichment workshops designed to inspire and encourage students to think more deeply about the wonders and applications of mathematics. Students are selected by their teachers to attend an entire series of six sessions, allowing them to really explore a range of topics and inspiring them to continue their interest in this far-reaching subject. With over 140 Masterclass series across the country, we support local volunteers from industry, academia and teaching to develop and deliver their own Masterclasses. Come along to have a go at a Masterclass activity and find out more about how we work with mathematicians to help them turn their favourite topic into a 2.5 hour Masterclass.

Rob Eastaway, Maths Inspiration
rob@eastaway.demon.co.uk

Reaching Uninspired Teenagers

By the time they are fifteen, many teenagers are looking forward to the day that they can give up maths – a subject that can seem abstract and irrelevant to their future lives. Rob Eastaway, Director of Maths Inspiration, gives examples of how these theatre-based shows can influence those teenagers whose mathematical sparks have not yet been ignited.

Charlie Gilderdale, NRICH, Cambridge
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Engaging secondary students with eNRICHing problem

The NRICH website nrich.maths.org offers thousands of free mathematical resources for school students, parents and teachers. We believe that:

- People are naturally curious about mathematics.
- Gaining mathematical understanding is intrinsically satisfying.
- Everyone should have the opportunity to grapple with problems that they do not yet know how to solve.

This interactive presentation will introduce delegates to some favourite "Low Threshold, High Ceiling" activities from the Secondary NRICH collection. These resources were originally designed for students working alone, and now also have supporting material to enable teachers to use them in their classrooms. This makes them ideal resources for use at outreach events, and for students to explore after an event. Charlie will give a brief taste of the range of resources available, and how to find them on the site. This presentation is one of three offered by the NRICH team during this year's Matrix conference.

Noel Jackson, International Centre for Life, Newcastle
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Hands-on , Minds-on, Hearts-on Maths

Educational experiences work best when they are hands-on, minds-on and hearts-on. When you hit the sweet spot where activities are physically interactive, mentally stimulating and emotionally engaging, one delivers deep learning and memorable experiences . In this session I propose to explore what makes activities appeal to various audiences and demonstrate some examples of rich tasks and other maths activities which have been successfully used at Life, Newcastle. My goal would be to stimulate delegates to consider exciting and engaging ways in which important maths concepts can be delivered to a variety of audiences.

Jakub Jernajczyk, Academy of Art and Design, Wroclaw
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Geometric cognitive metaphors – the coexistence of mathematics, philosophy and art
This presentation focuses on the classical and contemporary epistemological metaphors which describe various models in the development of both common and scientific knowledge. These metaphors are based mainly on the geometrical properties of the circle, in particular the ancient method of approximating the area of a circle – *the exhaustion method*. It is assumed that the method nowadays called 'the antique integral', was discovered by Eudoxus. Euclid described it in his *Elements* while Archimedes perfected its use. Referring to the geometrical deliberations of the ancient mathematicians, Nicolas of Cusa, a scientist from the end of the middle ages presented the model of an infinite tending by the intellect towards truth. In the contemporary philosophy of Quine and Heller, we can also find evolutionary models of human knowledge based on geometric intuition. The visual presentations of the cognitive issues arising from geometrical analyses have created a new field for the interpretation of artistic character in which mathematics meets, not only philosophy, but also art. Among other elements, during the presentation I plan to present my own model of epistemological evolution based on the discrete structure of a digital image.

Vanessa Krummeck, Technische Universitat, Munich
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Storytelling in mathematics - fo(u)r example(s)
This talk will give insights in projects where fairytales and detective stories enriched mathematical experience.

Philipp Legner
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Technology and Creativity
New technology has had a tremendous impact on education: in schools, at home, and even in museums. But there is so much more yet to come: How can we provide personalised content for every student? How can we let students explore and discover rather than just memorise algorithms? And how can we create more interactive and engaging and applicable content?

Ems Lord, NRICH, Cambridge
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Welcome to the Wild Side!
Wild Maths is a brand new, innovative website brought to you by the NRICH team. This free resource is designed to encourage creativity with mathematics. At NRICH we strongly believe that mathematics is a creative subject which involves spotting patterns, making connections, finding new ways of looking at things and using what you already know in new contexts. Creative mathematicians play around with examples, draw pictures, have the courage to experiment and ask good questions.
In this interactive presentation, led by Director of NRICH, delegates will experience a range of Wild Maths activities aimed at older secondary students and those considering studying mathematics at university. We will explore games, investigations, stories and spaces where we know there are discoveries to be made. This workshop is one of three offered by the NRICH team during this year's Matrix conference.

Andreas Matt, IMAGINARY, Berlin/Oberwolfach
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Hilbert - an open source framework for interactive exhibits in maths museums
IMAGINARY is an international mathematics outreach project by the Mathematisches Forschungsinstitut Oberwolfach focusing on interactive mathematics exhibits for exhibitions, museums and schools. Over the last years it has organised more than 150 exhibitions in 50 countries and 24 languages with local partners. A key element of the project are its open licensed software exhibits, which are distributed to exhibitions and museums via a dynamic framework. The framework has been extended over the last years and will be officially launched in a new version called Hilbert. Hilbert is an open source operating system for mathematics (and science) museums, which includes power management, monitoring and dynamic distribution of software based exhibits for museums. It offers special software layers for users (tracking, interactivity) and dynamic scheduling of exhibits on the fly (update of exhibits, change of content for special occasions). It is developed in collaboration with the HITS institute in Heidelberg for the new Astronomy museum ESO Supernova in Munich, Germany, opening mid 2017, connecting around 150 computer exhibits. In our talk we will present Hilbert and its potential for mathematics museums.

Guido Ramellini, Josep Rey & Daniel Ramos, MMACA Catalonia/ IMAGINARY Berlin
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An Exhibition in a Suitcase

What distinguishs materials and activities designed for an exhibition from those designed for a workshop or a classroom?

How to connect the experience of a math exhibition to school routines and the established curriculum?

We propose a set of fast-deploy activities that aim to bring the world of math exhibition and the world of school education closer.

The "Exhibition in a suitcase" project consists on a series of inexpensive, reproducible and portable materials that can be installed virtually anywhere to deploy a math exhibition that can bring a continuity between the exhibition experience and classroom practice.

The suitcases contain materials that can be used by school teachers to organize instant math exhibition for special events in their school or even daily class routines.

The project is born from collaboration between the MMACA, the math museum of Catalonia, devoted to enrich formal education in mathematics through meaningful hands-on experiences, and IMAGINARY, the world-leading travelling exhibition of modern mathematics.

In a special dedication, this project is also supported by the African Institute of Mathematics (AIMS) to bring instant math exhibitions to African schools and international education projects.

Toby Parkin, Lead Curator, Wonderlab: The Statoil Gallery and
David Rooney, Lead Curator, Mathematics: The David and Claudia Harding Gallery,
The Science Museum
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Toby.Parkin@sciencemuseum.ac.uk

Mathematics and the public: Science Museum approaches to hands-on and history

By the end of 2016, the Science Museum, London, will have opened two major new permanent galleries presenting mathematical ideas and histories to a general public audience. One is a hands-on interactive and immersive gallery aimed at school groups and families, presenting scientific and mathematical concepts. The other is an object-based gallery showcasing the Museum's historical collections, presenting histories of mathematical practice over the past 400 years. In this illustrated presentation, the lead curators of both gallery projects will outline the Museum's strategy for engaging the public with mathematics and will consider what the Museum has learned from long-term and systematic audience research.

Matthew Scroggs, University College London
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Building a MENACE machine

In 1961, Donald Michie build MENACE (the Machine Educable Noughts And Crosses Engine), a machine built from matchboxes and beads that was able to learn how to play noughts and crosses. In this talk I will explain how it is possible to make matchboxes learn and I will show off the copy of Michie's machine that I have built.

Emil Simeonov, Technikum, Vienna
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minimath – Early Mathematics Education in Austria since 1998

The minimath-project started in 1998 with vocational mathematics courses for 4 to 7 year olds. Meanwhile it has transformed to 'minimath - The Institute of Early Mathematics Education' which offers mathematics courses for children in nurseries, special courses for Austrian nursery and primary teachers, a Train-the-Trainer programme for Vienna's public nurseries as well as the production of workbooks for nursery teachers. The approach is based on the assumption that mathematical abilities and attitudes can be trained and that this training can start at a very early age. In the talk the approach and the practical experience will be presented.

Simon Singh, author and speaker
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What the heck was the point?

Science writer Simon Singh reflects on his 25 years of popularising maths and science, on television, on radio, on the stage and in books. Was it largely a waste of time? Simon looks ahead to his latest project and explains why he is going back to school.

Ben Sparks, SparksMaths
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Moving Maths

We can make mathematics communication even more effective by keeping it Moving. Exploiting animation and dynamic geometry, and raising awareness of the emotional aspect of mathematics are both extremely useful. We'll explore the common emotional reactions to maths, and check out some moving demonstrations.

Katie Steckles, StandUpMaths

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Adventures in Maths Public Engagement

Dr Katie Steckles is a mathematician based in Manchester, who delivers talks and workshops on mathematical topics. She's also been involved in various large-scale mass-participation public engagement projects with mathematics, and will be sharing the stories of how those projects came about, what happened and what her next adventure will be...

James Tanton

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THE GLOBAL MATH PROJECT: Uplifting mathematics for all

A collaborative effort is underway to transform how the world perceives and enjoys mathematics. During the week of 10.10.2017, the Global Math Project (www.theglobalmathproject.org) plans to thrill one million students, teachers, and adults with an engaging piece of mathematics and have that reach grow significantly each year thereafter. We will show how to de-clutter mathematics content to reveal its meaning, its story, and its joy. It's an audacious plan, but there is momentum behind it for sure! In this session, James Tanton will describe the program and briefly share some of the exciting mathematics of its first roll-out experience: Exploding Dots!

Hamish Todd, research student, University of Edinburgh

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Viruses, origami, and computer models

Of all living things, viruses are the most "mathematically perfect", and are a major example of mathematics facilitating medical breakthroughs. Constructing viruses in origami is a natural way for laypersons to come to understand viruses - the analogy is so strong that dozens of origamists have "accidentally" come out with designs that mimic viruses. While creating origami to illustrate virus structure, we came upon the work of MIT's computational origami group, and found that software of theirs could be adapted to study HIV. We will be showing several pieces of origami, and three programs that let users "play" with viruses.

Becky Warren, NRICH, Cambridge, UK

roadshow@maths.cam.ac.uk

Behind the scenes at the NRICH Roadshow

What are the key elements required to lead a successful maths roadshow? This highly interactive presentation will draw out the key elements behind the NRICH Roadshow experience through exploring our activities aimed at Early Years and primary-aged pupils. There will be plenty of opportunities to try your hand at some of our NRICH Roadshow challenges yourself and reflect on the learning activities that they offer pupils of different ages and attainment in mathematics. The NRICH Roadshow has travelled to primary, junior, infant, middle, prep, secondary and international schools in both the state and independent sectors, and also overseas, including trips to Zurich, Gibraltar and Bratislava (and has many other exciting ventures to come!).

This workshop is one of three offered by the NRICH team during this year's Matrix conference.

Joe Watkins, University of Kent, UK

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University Mathematics Outreach programmes

Although there are many HE institutions with established STEM Outreach programmes, it is not yet understood how such work will influence HE recruitment or the uptake of STEM subjects at any level of education. Given the recent Government papers on this topic and with the TEF looming large, which stresses the theme of Widening Participation, these matters will soon be very important to HE institutions. In this session we will discuss preliminary findings based on the Maths Outreach programme at the University of Kent, giving an outline of what works and what doesn't in terms of Outreach and HE recruitment.

Simon White & Laura Bonnett , Cambridge Institute of Public Health, UK

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Showcasing Statistics

Understanding evidence, specifically data, is a key skill for the 21st Century and statistics is the branch of mathematics that teaches critical analysis and insight through data. The Royal Statistical Society has recently established an Education Committee whose remit includes statistical education in practice, promoting careers in statistics, and developing statistical literacy. In line with these aims the Committee is co-ordinating the development of hands-on statistical activities for its Fellows, and STEM Ambassadors within STEMNET, who are invited into careers fairs, schools and science clubs to run sessions or workshops. Often seen as the boring sibling to (pure) 'maths' and mechanics. This talk will discuss statistical activities – what defines them and how to make them fun and interactive – and demonstrate an example to showcase existing resources.