HERIOT WATT UNIVERSITY

MACS Newsletter

Looking for Editors

See Inside

Department News and Events

Volunteers Needed

Virtually In Person

with Thomas Wong

An Insight into Research

By Andy White

With Support from the Jack Carr Fund

Department News and Events

Heriot-Watt Actuarial Careers Fair, sponsored by GAAPS: Wednesday November 4, 1.00 - 4.00pm

Vincent Borrelli: A Corrugation Odyssey: This Public Lecture will employ computer generated visualisations to help explain recent developments in geometry and differential equations, based on a method for everting a sphere inside out using smooth but special corrugations. It will convey the excitement they have caused and confirm the perceptive remark by geometer and topologist, William Thurston, who said: "The real satisfaction from mathematics is in learning from others and sharing with others."www.eventbrite.co.uk/e/2021-a-corrugation-odyssey-tickets-157241552717

Maths Department Christmas Lecture: Keep an eye out for more information about this year's MACS Christmas Conference! www.macs.hw.ac.uk/students/pgr/news-events

The RI Events: In conversation with Sir Roger Penrose Sir Roger Penrose is Emeritus Rouse Ball Professor at Oxford, and brother of Heriot-Watt Emeritus Professor Oliver Penrose. He won the Nobel Prize in Physics and the Wolf Prize in Physics and was appointed to the Order of Merit. His work spans general relativity, black holes, cosmology, tiling theory and the theory of mind.www.rigb.org/whats-on/events-2021/october/public-in-conversation-with-sir-roger-penrose

Volunteers Needed

We are always looking for interested undergraduate and postgraduate volunteers to help us with the editing and writing work! Get in touch through our email here: maths-newsletter@hw.ac.uk

Maths Gym and Maths Café

Emma Coutts

The new academic year has got off to a roaring start in the Maths Gym. The one-to-one appointments have been more popular than ever and the drop-in sessions have been well used. As we head towards the exam period we look forward to seeing you at the Maths Gym to flex your brain muscle :)

All details on our website www.mathsgym.hw.ac.uk or send us a message on mathsgym@hw.ac.uk

Maths Café Talks

The Maths Café and the Maths Gym are very happy to introduce short talks on different mathematical topics aimed at an undergraduate audience.

- WK 8 (Nov 3rd) Thomas Wong www.eventbrite.co.uk/e/192799507517
- WK 10 (Nov 17th) Jonathan Sherratt www.eventbrite.co.uk/e/192804221617

Recordings of previous talks can be found here, including a talk from Emma Coutts given in week 4 of this semester: www.mathsgym.hw.ac.uk/past-maths-cafe-talks

Piscopia

Are your friends starting to think about jobs after university? Have you been enjoying your studies so far and want to continue studying maths? We've been in that situation and we're here to help! All students from Maths or any STEM subject are very welcome to attend. (https://piscopia.co.uk/)

We will be running our local Heriot-Watt event on October 20th at 2pm (on teams). We will talk about what it is like to be a PhD student in Maths and how to approach the application process. We will have current PhD students and staff from MACS at the event, as well as a short careers seminar. **Register here**: www.eventbrite.co.uk/e/piscopia-phd-information-event-tickets-185038032737

You can also check out our PiWORKS seminar series: www.piscopia.co.uk/piworks-seminar-series **featuring women and non-binary researchers from UK universities.**

Maths Society

Jaan Kalder

The Student Mathematics Society of Heriot-Watt is happy to announce the upcoming talk by Professor Minhyong Kim on 4th November. Kim is the Whittaker Professor of Mathematics at both Heriot-Watt University and the University of Edinburgh and Director of the International Centre for Mathematical Sciences. And his area of research is arithmetic geometry, including its connections to topology and mathematical physics.

We are looking forward to what he has prepared! To get to know more about the Student Mathematics Society, either join Maths Cafe Discord at (QR above) http://tiny.cc/2n6kuz or send email to jk190@hw.ac.uk

School Officer

Lucy Welford

I'm happy to announce we've now got a full set of Class Reps in place who will be representing the voices and opinions of your year group within the department. The Class Reps for each year are as follows:

Y1: Jake Douglas and Kira Malde
Y2: Isobel Matthew
Y3: Megan Ongley and Eshveer Singh
Y4: Mahsa T Manzari and Renzo Wijngaarden
Y5: David Taylor
MSc: Shane Butt and Laura Thomson

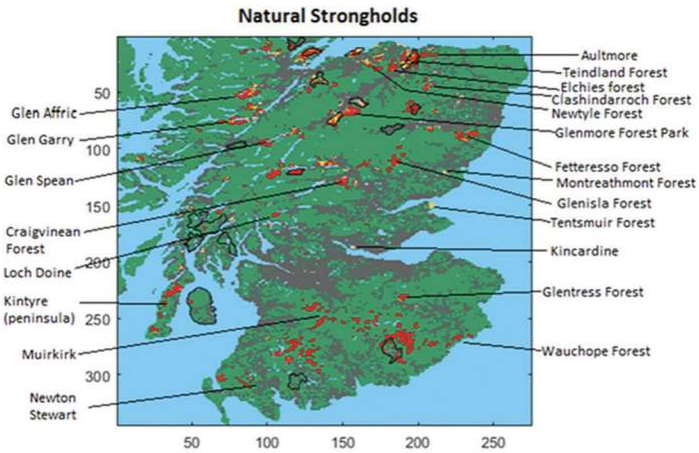
If you have any issues or concerns about your studies so far, feel free to reach out to either your class reps or myself at any point.

Using Mathematics to Understand the Natural World

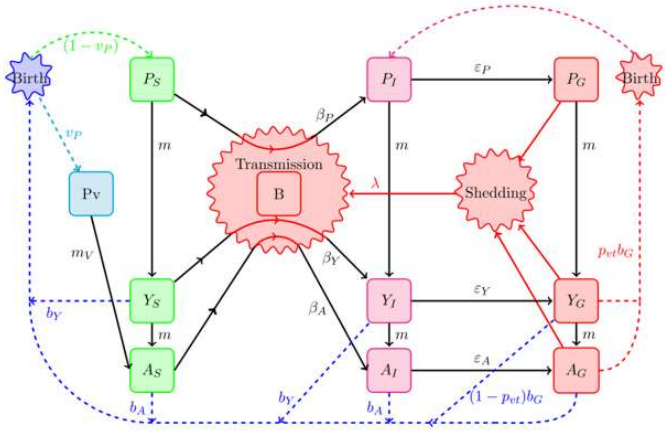
Andy White

First a bit of background. I undertook a BSc and MSc in Mathematics and a PhD in Ecological Modelling, and this led to a job as an ecosystem modeler for the Centre for Ecology and Hydrology, Edinburgh. Here I was part of a team that modelled how the world's vegetation would respond to climate change, highlighting that the predicted changes to climate could lead to the catastrophic collapse of ecosystems in some Tropical and Mediterranean regions, and informing the UK Government in advance of the United Nations Climate Change Conference, COP3, Kyoto 1997 (COP26 will take place in Glasgow in November 2021). In 1999 I was appointed at Heriot-Watt University, and this has allowed me to follow two passions – teaching mathematics, in particular how mathematics can be used to understand the natural world, and undertaking research in modelling ecological systems.

At Heriot-Watt my research focuses on understanding the ecological, evolutionary and infectious disease dynamics of natural systems. A long-standing research topic uses mathematical models as tools to inform conservation strategies to protect endangered red squirrels in the UK (and you'll hear me talk about this research and the underlying modelling methods in the final year Mathematical Biology A course). The mathematical models (systems of ordinary differential equations) have been used to show how squirrel pox disease - carried by, but harmless to, grey squirrels and lethal to red squirrels - has led to the rapid replacement of red squirrels by greys in England and Wales. Squirrel pox reached the Scottish border in 2007 and the model systems were adapted to represent squirrel interactions and dispersal over the 'real' landscape and showed how the disease could spread rapidly and was difficult to contain in southern Scotland. The model suggested that the disease would not spread to northern Scotland as here the large conifer-dominated forests would only support low density squirrel populations that were below a threshold that allows the disease to persist (linked to the now well-known 'R' number of an infectious disease). In fact, large conifer forests may provide an advantage to red squirrels and recent modelling research has identified 'natural strongholds' where red squirrels can persist even if threatened by invading greys.



Beyond squirrels my mathematical modelling work is used to understand and manage infectious disease in a range of wildlife species. A specific example has focused on understanding tuberculosis (TB) infection in wild boar in Spain. TB is a particular problem in the cattle industry and while TB infection can be managed in farmed animals it is much more difficult to manage in wildlife species which act as a reservoir to allow the disease to persist. In Spain (and other regions worldwide) wild boar are the primary reservoir species for TB. We have developed a model that includes the key stage structure of the wild boar system (piglets, yearlings and adults) and the key infection status of individuals (susceptible, infected, super-spreader). Our mathematical models have shown that transmission between wild boar and livestock is likely to occur through environmental contamination at shared water holes and, interestingly, that predation by wolves can reduce the prevalence of TB in wild boar - a result that matches data which shows that TB is lower in regions with established wolf populations in areas of northern Spain. Here the mathematical work uncovered the potential role of predators as disease control agents, and this has wide ranging implications in ecology. And guess what, it also has implications for red squirrel conservation. Here the resurgence of pine marten, which preferentially predates on grey squirrels over reds can reduce grey squirrel density to levels where the population can no longer support squirrel pox, and in some regions pine marten predation can eradicate grey squirrels altogether and allow the re-establishment of red squirrels. The mathematical models of the squirrel system are being adapted to explore this exciting development.



A schematic of the mathematical model of wild boar-TB dynamics

I hope this gives you a taste of my research work. For me a key ingredient is to undertake my work in collaboration with biological scientists and/or conservation experts as this ensures that the mathematical results have direct impact for managing wildlife systems and provides an endless range of new topics for which mathematics can be used to help explain the natural world.

Virtually in Person

with Thomas Wong

Recently we sat down to have a chat with Thomas Wong about the return to in-person lectures. You can watch the full interview on YouTube here: https://youtu.be/9n2UFI9iMPE

How does it feel to be back?

I really enjoy it. There are parts of the interaction of teaching that you really don't get online. It is really a social element of meeting other students who are struggling with the same things you are. That part is missed online because you are isolated. The discussion boards, the live lessons and synchronous sessions help, but it doesn't convey things on the same level. I think it is important to know you are not the only one learning and struggling with this and to know that there is a community involved.

What is the benefit for us of going to class in person?

The ability to just lean over and ask your neighbours if they got this question or how they are tackling it. I find the interactive, social element is the main advantage of coming into campus. It is easier to share and see what other people are doing. Although we have a lot of tools in the digital environment like screensharing, there is just something nice about a low-tech way - like writing your ideas down on a piece of paper. For me as teaching staff, it is also just the ability to go around the room and say 'hi' to the students one-to-one.

How do we best use the current mix of online and in-person?

Heriot-Watt and the maths department in general has done a really good job in terms of balancing between online and in-person. The part in which the teaching staff is just talking at you is better done online because the students can go back and listen to it again. Accessibility tools can help to better understand that part of the content. But attending in person - having the discussion and the interactive element - can't be replaced online. Those aspects should be the focus of the lessons on campus. Sometimes, students have difficulties with different parts of the course. For the bits you are comfortable with there is no need to sit for the full 20 minutes and have someone talk at you. You can skip what you understand but look at one specific bit twice because you don't understand it. This is leveraging the power of the online medium in terms of content delivery.

Do you have any advice for students who are staying just online?

For those online I recommend having a set schedule. In that way, you have time to really concentrate but also to take a break. The other part is to form communities online and to seek out others who are trying to learn the same things, so it feels less isolating. I would advise students to find ways to connect with others who are struggling with the same things via the discussion boards, the Maths Gym or Maths Café or various WhatsApp and Discord groups. Just as a general point, we as the teaching staff do our best to teach stuff in a way that we think is clear. But for many staff it has been a long time since we've learned this. So we might not always hit the mark in terms of what the students are struggling with, but the people who understand best what you are struggling with are the peers around you. Even just repeating and reiterating the questions is very helpful.

What is your advice for students to get back in the flow of in-person lectures?

Talk to the teaching staff. Those who have had the on-campus experience actually know how to talk to the lecturers at the end of class or attend office hours. The thing with academia is that everyone has to walk that same path. Everyone has gone from a terrified undergraduate to a terrified masters, to a terrified PhD, to a terrified postdoc and to a somewhat less terrified academic. For the teaching staff there is that level of empathy because they once were in the same shoes. When I look at a student, for me the biggest difference is that I have made a lot more mistakes. I don't have all this wisdom or knowledge. What I have is the perception about all these mistakes I made and the things I did to correct them. As an undergraduate, masters or PhD student you should think of yourself as a collaborator. If you have a good idea - and even if you are not sure about it - talk to someone about it.

Which teaching changes do you think will stay and which will definitely go?

One thing that will definitely stay is the content delivery. A lot of teaching staff have gone through the effort of producing very good teaching videos, so even with a completely on-campus experience those videos will have a place as a supplementary learning tool. I also think that parts of the online environment like the discussion boards or the asynchronous learning will stay. I would like that because the students can ask their questions right away and don't have to wait a week until the next tutorial.

I think what will definitely go is the online synchronous content. With being back on campus there is no need to mimic the actual lessons.

What's good about this transition between in-person and online teaching is that we are forced to think about alternative ways of teaching. I hope that this broadened view of teaching and the new mentality will also stay.

Do you have any general words or wisdoms for us students?

Although the pandemic is really bad there are some positive aspects coming out of it and we as teaching staff and students should build on these.

It is very important to get in touch with other peers, work in groups and to realise that you are not alone. Get in touch with the teaching staff if you are struggling with some topics.

And don't forget to take breaks and go for a walk or grab a coffee!

Solution: A Proof?

The following is a solution to the puzzle from the last issue (found with the QR code to the right or this link: www.mathsgym.hw.ac.uk/wp-content/uploads/newsletter_1-1.pdf).

In this proof by induction the inductive argument is constructed from the fact that sets of size *n* should be built from *n-1* pairwise intersecting sets. This allows us to deduce that all members of these sets must have the same age.

The problem is that a person *x* contained in the set *{x}* of size one of course agrees with their own age, and so with all the people in the set. This does not, however, allow us to conclude anything about the age of any other person *y* contained in a set *{y}* of size one, as there is no non-trivial intersection possible between these two sets.

In our "proof", the base case was chosen to be sets of size one. This is where the issue lies, as we cannot conclude anything meaningful about the sets of size two, which breaks the induction argument.

Games and Fun

Topology game

Here is a fun topology game. Try and see if you can match the surfaces to their formal descriptions!

Infinite Squirrels

In this puzzle we have a (countably) infinite number of squirrels that are each randomly given one of two kinds of nut, but they do not know which kind they have.

The squirrels hop into line, each facing in the same direction so that they can see the type of nuts of the squirrels in front of them have, but not the squirrels behind them.

Each Squirrel simultaneously guesses the type of nut it has. If a squirrel guesses correctly the type of nut it has it may eat the nut and must leave the line (to possibly find more nuts). Otherwise, it may eat the nut, but it cannot leave the line (unable to find more nuts).

Before the squirrels hop into line, they have a chance to talk between themselves and decide on a strategy to guess what type of nut they have.

Can the squirrels come up with a strategy that ensures only a finite number of them have to stay in the line?

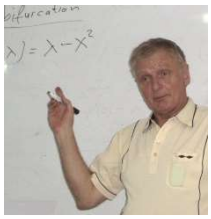
(Hint: Think about equivalency classes of certain sequences.)

Send us your best solution for a small prize!

Jack Carr Fund. Grants Scheme.

Robin Knops

Applications under the above scheme are invited at any time for grants not exceeding £500 and should be submitted by email to June Maxwell *j.maxwell@hw.ac.uk*. The Departmental webpage provides further particulars and also an Application Form for use if preferred. Alternatively, applicants should send an email stating name, degree course and year, brief description of intended use of the grant, and estimated cost. The scheme is open to Heriot-Watt University students currently registered in Edinburgh for an undergraduate or postgraduate degree normally in the mathematical sciences.



For informal advice, please consult Professor Robin Knops *r.j.knops@hw.ac.uk*

Maths Newsletter

We are always looking for interested undergraduate and postgraduate volunteers to help us with the editing and writing work! Get in touch through our email below.

We would like to give a huge thank you to everyone who made this project possible. A special mention to Andy White, Thomas Wong, Jonas Lotter, and everyone else who took the time to contribute and help us in producing this issue. Thank you to Michael Driscoll for the amazing artwork and Lewis Dukelow and Alexander Robb for the video equipment, editing lessons and general creative feedback. Thank you also to the Jack Carr Fund for supporting us in this endeavour.

We hope you are as happy with the final product as we are.

The *Maths Newsletter* team

The Team

Clara Flegel

David Taylor

Mahsa Manzari

Heiko Gimperlein

maths-newsletter@hw.ac.uk

www.mathsgym.hw.ac.uk/maths-cafe/maths-cafe-newsletters