HERIOT WATT UNIVERSITY

The Maths Newsletter

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@HeriotWattMathsNewsletter

maths-newsletter@hw.ac.uk

Department News and Events

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With Support from the Jack Carr Fund

Department News and Events

Joshua Whitby and Megan Ongley

Community

Maths Society: A new society open to all students with any sort of interest in Mathematics - Maths students, students opting to study a Maths elective, or those who enjoy Maths. For more information, see https://www.hwunion.com/societies/8948/ or contact maths.society@hw.ac.uk

Maths Café - The Maths Cafe is a peer supported initiative that allows maths students to seek help, ask questions or just chat about maths with their peers. The sessions are organised and guided by peer mentors who are year 3/4/5 maths students – it is relaxed, friendly and a great place to meet other students. Sessions take place on Wednesdays from 2-5pm in EM1.82.

Piscopia: The Piscopia society is a female-led initiative to encourage more female and non-binary students to consider further academic study in Mathematics and to increase social connections between students. They organise a number of events and talks throughout the year. You can find out more information about Piscopia and sign up to their mailing list at https://piscopia.co.uk.

HWU Post Graduate open evening Wed 30th Nov 16:00 to 18:30 https://www.hw.ac.uk/uk/events/postgraduate-open-evening.htm

LEAPS - https://leapsonline.org/volunteers/join-us

Seminars

These seminars are aimed at postgraduate research students. For a full list of upcoming seminars, see the QR code.

Heriot-Watt Seminar Calendar

- **Maxwell PG Colloquium**, Fridays 14:00 at the Bayes Centre. Contact: Juan Carlos. jcm2000@hw.ac.uk

- **This Week's Finds Seminar**, Thursdays 3pm https://math.ucr.edu/home/baez/twf/ Contact: Tom Leinster Tom.Leinster@ed.ac.uk

Puzzle: Making Music

Puzzle by Stefanie Zbinden

There is a square table with a hole in each corner. In every hole there is a coin which is either heads or tails (but you don't know which). If all coins are the same then music will start to play. You like music! You can change the coins as follows:

1. you will be blindfolded and the table will be turned (it might be turned, 90, 180, 270 or 360 degrees).
2. Then you can pick any two holes and: check whether they were heads or tails and put them back deciding for each to show either heads or tails.

What is a strategy which can guarantee that after at most 10 steps music will be playing?

Careers

Interested in internship opportunities and graduate roles across many areas? For more information please visit https://www.abrdn.com/corporate/careers/early-careers/summer-internships-and-graduate-programmes.

Interested in learning more about a career in teaching? Want to find out more about our postgraduate teaching qualifications for secondary Maths, English, Biology, Chemistry and Physics at Edinburgh Napier University? Please view this short presentation, and if you want to find out more, email programme leader Colin McGill c.mcgill3@napier.ac.uk

Previous Careers Content

Careers Advice Lindsey Wilson	MACS Careers Advisor	Issue 3
Alumni Interview Jakub Stoeck	Researcher with British Antarctic Survey	
Alumni Interview Efthalia Tzitzili	Risk Scenario Modeller at a UK Bank	Issue 4 

"Mathematics is neither science nor art, it is simply mathematics." with Jonas Latz

By Shitikshu Vyas, Miraal Sarki, Daniel Hinds, Clara Flegel

Jonas Latz is an assistant professor in the AMS department at Heriot-Watt University since September 2021. Previously, he worked as a research associate in the image analysis group at Cambridge, following up from his PhD on inverse problems in Germany. His journey didn't start in mathematics, but surely got there through a series of detours in subjects like Economics, Maths with Economics, and finally to Applied Mathematics. His interest in inverse problems and physical models was ignited during his time at the University of Warwick, while pursuing the scientific computing program.

On Twitter, Jonas reveals that a major influence on his choice in becoming a mathematician was the 'IMAGINARY' programme in Oberwolfach, Germany. The programme aims to intrigue pupils by presenting them with fun maths articles written by researchers. Amusingly, he draws comparison to the crime-drama, 'Numb3rs'! *"You have to be honest about these things",* he laughs. In the interview, Jonas also opened up about the importance of his high school maths teacher, who always maintained an optimistic attitude and encouraged inquisitive curiosity.

"Now I want everybody to become a mathematician."

The programme made such an impression on him that today he is one of its contributors. In one article he wrote for the programme, he gives an exposition of one of his main research interests, inverse problems. To read his full article, please scan the QR code attached here.

The goal of inverse problems is to find an unknown parameter based on (noisy) data. The general form of an inverse problem is: $f(x) = d$, where d could be the measured output of a physical system, and the aim is to find x by using the function f and the value d. As a simple example, suppose $f(x) = x^2$ and $d = 9$. This implies that x has two solutions, $+3$ and -3. Having two possible solutions is actually bad! We are looking for one particular x but the data doesn't allow us to distinguish between 3 and -3.

In the interview, Jonas mentioned that applications of inverse problems show up in any scientific field with data and models, including geophysics, medicine, and chemistry. In 1990 the Hubble Space Telescope was launched into space, but due to a faulty mirror, all the images came back blurry! However, the reconstruction with inverse problem techniques, allowed scientists to still use them after all: shorturl.at/kTXY9.

In medical imaging, external factors like physical equipment, contribute noise to the final image. This is expressed by a new equation which takes noise into account: $f(x) + n = d$. To solve the inverse problem, we now have to find both n and x. In this situation, there is an infinite number of solutions, which is typical and a consequence of the fact that inverse problems are not 'well-posed' problems.

Of course, we asked him if it would ever be possible to perfectly predict future patterns, such as the weather, which is another example of an inverse problem. Sadly, his answer to our question was: No. Weather is a chaotic model. It is unstable, since the smallest disturbance could really alter the future. So, over the course of a longer period of time, outcomes might differ drastically.

Here is how weather prediction works mathematically: To be able to fit their mathematical model of weather to the observed data, meteorology departments measure, for example, the temperature at a certain point in space and time. This value would represent the value d and the model would represent the function $f(x)$. This function is theoretically able to tell us the temperature d at any given point in space and time, given the correct parameter vector x. Thus, we need to adjust the parameter x to represent the current 'environment'. Given some specific value of d the corresponding value of x can be found by solving the inverse problem. Although this model $f(x)$ is chaotic, i.e. sensitive to small disturbances in the determined value of x, most weather predictions tend to be sensible in the short term and only start diverging significantly in the longer run. To prohibit these long-term effects, the process of estimating x needs to be repeated continuously by feeding the model with new data.

Jonas finishes this intriguing conversation about weather laughing, *"Of course I only work on cool AND interesting problems."* He mentions that most of his inspiration comes from working with people from different backgrounds, most of whom he met at conferences all around the world. He gives an example about a student who reached out to him, after she learned about Jonas via the One World Seminar he gave. This has turned into a fruitful professional relationship, now that they have written two papers together.

Travelling around the world has allowed Jonas to build a strong network and team to collaborate with. This enables him to work on a variety of projects simultaneously — supporting his curiosity, but also his strong research output. This is an insight on the importance of networking, but also on how social maths can be. Interestingly, Jonas has a map on which he pins the places he's already visited through his work.

"I believe that scientists have the duty to explain to society what we are doing. I want people to learn from the results of my research."

Of course, Jonas' development as a mathematician did not start with his research but his experiences in undergrad also played a pivotal role. He tells us, on a serious note, it was during this time that his mathematical mindset began to mature, and when he obtained the technical knowledge that would allow him to begin working on bigger problems. His experiences show how people can train their mindset and work in synergy with others to produce enthralling papers like the ones Jonas has. A personal motivator for him is solving problems, which give him the encouragement to keep going and try solving riddles that are even more challenging.

To add on to his mathematical attributes and achievements, Jonas is a free-style painter and a keen musician, who loves to pick up the bass in his spare time! Moreover, he is an enthusiastic photographer who grew up with cameras, and is fascinated by their interiors and how they work. He believes that contrary to maths, art has no rules and allows you to express yourself freely, safe in the knowledge that no art is 'wrong'.

Final Year Projects with David Bourne

By Yukan Perumal, Penny Premsuriya, David Taylor

By now people will have chosen their final year project for next year. How would you go about tackling a final-year project?

Start writing up as soon as possible, maybe even in the first week. It's nice if you do it in overleaf (Online LATEX software) so you can share your tex file with your supervisor. And it's worth learning some Latex as well. You can also put some originality in your presentation. It's not a research project and you don't have to prove any new theorems. But if you can, put in some of your own examples. Either new examples or solve some exercises from a textbook. In the end, the project mark is based on what you produced, not what you learned.

Watch The Full Interview Here

What would you say the most important thing someone should get out of the project is?

It's your chance to choose what to study. Along the way, you're gonna learn important skills like presentation, writing, and presenting. But yeah, you should just have fun with it.

Have you ever used your degree outside of maths?

When I was an undergraduate, I did an internship with a software company -- they were called Romax -- It was software for designing gearboxes. That was in my final year as an undergraduate. I used a lot of tools including Linear Algebra and ODEs to help make software for modelling noise and vibration in gearboxes. So that really cool, especially Linear Algebra and just how useful it was. Then later on, I've done various problems with industry. I did one with the Maritime Research Institute in the Netherlands on the designer ships that was using quite a lot of ODE's and dynamical systems again. And then currently I work with Tata Steel Research and development using optimization theory to help them essentially design new alloys. So, yeah, definitely there's applications that matter everywhere. And it's for me, it's been really useful.

Is there something you don't like about maths?

It's a technical, challenging subject, it's not easy. It's obvious a lot of students struggle with maths, but maybe they'll be relieved to hear that the faculty do as well. Over the years with experience, you develop mathematical muscle memory. So, it does get easier, but still, it's something we must work out very hard.

What is your favourite part of your current work?

There's a lot more to it than many students realize. Of course, teaching is a big part of the job. We also do research and we're expected to publish one or two research papers a year. We must find grants to fund our research. It's a bit like being in a band. When a band releases a new album, they go on tour to promote it. We must go on tour to promote our research. So, there's a lot of travelling too. This year, I was in Paris in March, talking about my research. And this year I've still got trips to Durham, Liverpool and Munich. So that's nice as well to go in and meet people.

What should you get after finishing an undergraduate degree in maths?

Hopefully, we've convinced you that maths is interesting, beautiful, and useful. I think it's probably one of the most important things you'll learn. It's not perhaps so much the individual theorems or the tools, but it's more the problem-solving skills.

Jack Carr Fund. Small Grants Scheme. Academic Year 2022/2023.

The Jack Carr Fund invites applications for a limited number of small grants not expected to exceed £500. Larger grants may be awarded in special cases including those for mathematical projects. The scheme is open to Heriot-Watt University undergraduate and postgraduate students currently registered in Edinburgh for a degree normally in the mathematical sciences. MACS post-doctorates may also apply. Applications should be submitted to June Maxwell j.maxwell@hw.ac.uk throughout the Academic Year 22/23 but preferably by the closing dates of Monday 31 October 2022, Tuesday 28 February 2023, and Wednesday 31 May 2023. Examples of what might qualify for an award include:

1. Academic study (excluding costs of student exchange visits and class trips.)

2. Extra-curricular study in the mathematical sciences including participation in workshops, and short study visits in the UK and elsewhere.

3. Care and caring costs.

4. Certain living costs.

5. Musical activity.

Further information can be obtained via this link: https://www.hw.ac.uk/uk/schools/mathematical-computer-sciences/departments/maths/jack-carr-scholarship-fund.htm Prospective applicants may wish to informally consult with Professor Robin Knops convener of the Jack Carr Fund Board. (r.j.knops@hw.ac.uk)