Queen Mary University of London

SCHOOL OF MATHEMATICAL SCIENCES

DIVERSIFYING THE MATHS CURRICULUM

Audrey Tang (THEY/SHE)

A PROGRAMMER AND POLITICAL ACTIVIST

Audrey Tang is a self-taught Taiwanese software programmer and political activist.

"I was doing a science fair project when I was 14 [years old], working on artificial intelligence and natural language processing ... I wrote emails to the leading researchers in that field asking them questions, and they all replied very kindly.

*Now, they didn't know that **I was 14 years old**, they didn't know that **my English was not that good at all**".*

Their love for computers and the improving Internet speeds and search engine software during their youth were the keys to their self-education.

They first rose to prominence in 2014 as a hacker supporting government protests advocating for democratic governance and transparent working practices, such as the Sunflower Protests.

*"When we see the Internet of Things, let's make it an **Internet of beings**. When we see virtual reality, let's make it a **shared reality**. When we see machine learning, let's make it **collaborative learning**. When we see user experience, let's make it about **human experience**. Whenever we hear that a singularity is near, let us always remember that **plurality is here**"*

THE FIGHT AGAINST MISINFORMATION

In response to the protests, Tang was appointed the **first Digital Minister of Taiwan**, being notably the **first transgender and nonbinary** official in the Taiwanese government. They have applied their skills to implement programs on digital platforms to combat misinformation and fake news.

*"I don't think many people see democracy as a set of technologies yet, but I think that's a very useful view, … when you analyse **democracy in terms of social technology**, then new modes of thought become more natural".*

Tang was responsible for "hacking the coronavirus" in Taiwan, providing up-to-date information on where to access masks, inventing a digital method of contact tracing, and tapping into social media and meme culture to spread facts.

Audrey Tang visiting the National Sun Yat-sen University in 2021, for discussing trends in social innovation.

OPEN-SOURCE RESOURCES FOR EVERYONE

Tang is a prominent user of the Haskell and Perl programming languages and made many contributions to free software programming.

```
# No floating point noise:
say 0.1 + 0.2 == 0.3;          # OUTPUT: True
say (1/13 + 3/7 + 3/8).raku; # OUTPUT:  <641/728>

# Infinite list of primes:
my @primes = ^∞ .grep: *.is-prime;
say "1001st prime is @primes[1000]";

# Lazily read words from a file
.say for '50TB.file.txt'.IO.words;
```

Lines of Raku code for manipulating rational numbers, produce a list of primes and read words from a file.

They were responsible for hundreds of projects in the early 2000s, some of which led to the creation of what is now the Raku language. They have also made significant contributions to the internationalization and localization of open-source software.

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Ruth Fairclough (SHE/HER)

RESILIENCE IN MATHS

Ruth Fairclough is a mathematician and former actuarial analyst, working at the University of Wolverhampton.

She grew up with dyslexia, and since an accident at the age of 17, she has been using a wheelchair. When she was at the hospital recovering from the accident, her maths teacher would visit her and run A level maths classes with her.

*"I couldn't do any hospital visit classes for physics or chemistry because of the lab aspects, but **I could carry on with maths**".*

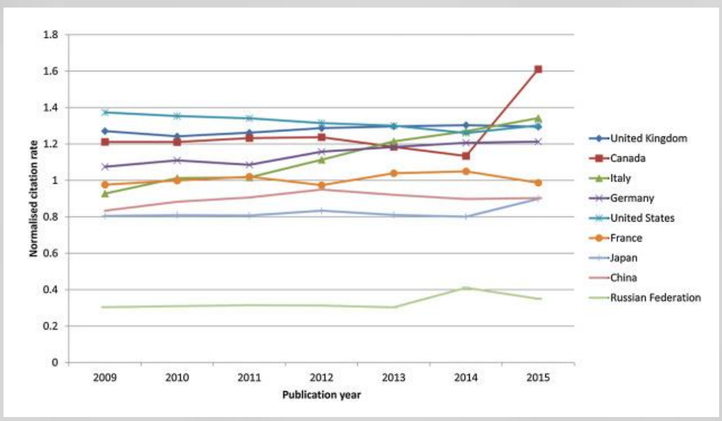
*"There is an **elegant beauty to mathematics**, you see patterns in the word. I love taking simple problems and interrogating the complex theory behind them"*

RESEARCHER AND TEACHER

As a lecturer, Fairclough taught modules in financial maths, statistics, and probability. She is the head of the department of mathematics, and holds this role with her BSc (hons) from Cardiff University.

In the university, she has found a more accessible support. Her research is in statistical cybermetrics, where she develops software and statistical methods to analyze web-based sources for social science research.

In particular, her research group has produced programs that determine the sentiments expressed on social media posts, which they use for sociological research.



Fairclough's result from the paper "National research impact indicators from Mendeley readers" [1], comparing the research impact of countries. The figure shows the average normalised citation count for 26 Scopus subjects by authorship country and year. The world average is 1.

AN UNCONVENTIONAL PATH

After studying an undergraduate module on analytic number theory, Fairclough was turned off of the idea of studying maths further and instead searched for a job in the finance industry.

"The thought of going into academia and doing a PhD just filled me with horror, so I went off and got a job in the actuarial profession."

She held this job for several years and enjoyed the financial security it bought. Due to facing discrimination and struggling to balance work with a growing family, she returned to university to be a lecturer.

*"I'm a wheelchair user and so do everything with my upper body, and I do get more tired. [In the job] we all had to work seven-day, 100-hour weeks. I couldn't keep it up because I didn't have the weekends to recuperate. I gave it a good go, working there for several years, but I knew **the culture wasn't sustainable for me**".*

*"**Maths is huge** ...*
*The nineteen-year-old me at university thought that stats was boring, but from the day I graduated all I've done is stats … They get interesting when you're doing them for **real**, with a **purpose**".*

LEARN MORE **CONTACT**

[1] Ruth Fairclough et al. "National research impact indicators from Mendeley readers". In: *Journal of Informetrics* 9.4 (2015), pp. 845–859

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Fatma Moalla (SHE/HER)

WHY MATHS?

"Mathematics corresponded more to my character:

I adore rigor, precision and honesty. I hate cheating. And this is mathematics! …

In mathematics, one learns to become fair by treating all cases equally, and one learns to become humble and to move away from human vanity by measuring his own limits in front of the difficulty of the problems to solve".

Prof Fatma Moalla in a tribute ceremony to Tunisian women mathematician by the Association des Femmes Tunisiennes Mathematiciennes in 2016.

EARLY CAREER

Prof. Fatma Moalla is a Muslim mathematician born in Tunis, Tunisia during WWII. She graduated in mathematics at the Institut des Hautes Études à Tunis in 1960.

In October of 1960, she obtained her French diploma for studies of higher geometry.

Regardless of the tense conflict between France and Tunisia in 1961, she became the first Tunisian to receive the Aggregation Award in France.

BECOMING A MATHEMATICIAN

After her French diploma, Fatma wanted to do research in mathematics and for this she needed a PhD. She was awarded a scholarship by the Tunisian government, and moved to Paris, where she earned the Certificate of aptitude for secondary school teachers.

BACK IN TUNISIA

Fatma returned to a recently independent Tunisia, and was appointed by Minister Messaâdi as a Mathematics Teacher in the Lycée de la Rue du Pacha (1961-62). She was also appointed as an assistant at the Faculté des Sciences Mathématique, Physiques et Naturelles, where she taught students sometimes older than her.

She continued working towards her doctorate thesis, which she defended in 1965 in Paris, becoming the first Tunisian woman to earn this doctorate.

*"**I wanted to continue my studies**, but I could no longer do it in Tunis …*

President Bourguiba and Minister Mahmoud Messaâdi were enlightened and encouraged the education of both boys and girls …

As for my father, who was very conservative, he agreed to send his daughter abroad …
*My father always wanted girls to be educated. **My father and mother did not want us to stop our studies for marriage** …*
How they were ahead of their time! "

LEGACY

During her career she published four papers on Finsler spaces in prestigious journals, such as Annali di Matematica Pura ed Applicata.

She dedicated her life until retirement to shape future generations of Tunisians by teaching at The Faculty of Sciences of Tunis. Right now, generations instructed by Fatma are leading the university and continue to promote the study of mathematics.

In 2017 the Tunisian Women Mathematicians' Association created an award carrying her name: **International Fatma Moalla Award for the Popularisation of Mathematics**. Fatma being a very private person, she accepted the award to associate her name as a tribute to her father, who always wanted girls to be educated too.

*"**I have always been serious in everything I have undertaken** … I also enjoyed my work, and, after all it is a pleasure to do the work that you love. I have **great memories** of brilliant students … and an excellent memory of colleagues I have worked with among whom often **remarkable women's teams**".*

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Luis Caffarelli (HE/HIM)

EARLY LIFE

Luis Caffarelli is the first South American winner of the Abel Prize. He was born in the city of Buenos Aires, Argentina. Family was a huge factor in Cafferelli's early life, and would inform his attitudes towards collaboration and community in his later years. To Caffarelli, **family and friendship** would always be a strong presence in his working life going forward.

*"I have **truly enjoyed** every moment of my mathematical career. My career and collaborations have been a constant source of **joy** and **inspiration**"*

ENTERING ACADEMIA

In 1968, he applied for a PhD position at Universidad de Buenos Aires. He was accepted under the tutelage of Calixto Calderón, who played the most crucial role in Caffarelli's development as a mathematician.

In 1972 his thesis *On Conjugation and Summability of Jacobi Series* was accepted by the university, and he became a Doctor of Mathematics.

*"I came to the United States to the University of Minnesota in 1973. There was no email, no fax, and even the telephone was very expensive. But I found at Minnesota and in the Midwest an **extraordinary group of people**".*

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A NEW DIRECTION

In 1974, the mathematician Hans Lewy delivered a lecture series at the University of Minnesota on nonlinear partial differential equations and free boundary problems. Caffarelli instantly became inspired, and asked Lewy for some extra problems to work on.

OBSTACLE TO SUCCESS

The Obstacle Problem is an example of a free boundary problem. These are equations that model situations for which the boundary of a given medium may change over time, for example, a block of ice melting into water.

Caffarelli made several contributions to this field, again demonstrating smoothness and stability of the solutions to such equations.

*"**Fantastic** intuition, just **remarkable** … I had a hard time keeping up with him. He somehow immediately sees things that other people don't see."*

- Louis Nirenberg

EBB AND FLOW

In the early 1980s however, Caffarelli, along with Robert Kohn and Louis Nirenberg, managed to prove that any such solution of the Navier-Stokes Equations could only be infinite on a set of zero-dimensional points, i.e. if the flow becomes infinitely fast, it does so only instantaneously.

AWARDS AND ACCLAIM

The Navier-Stokes breakthrough cemented Caffarelli as one of the great mathematical minds of the modern era, and the awards followed soon thereafter:

- AMS Bôcher Prize (1984)
- International Congress Speaker (2002)
- AMS Steele Prize (2009)
- Wolf Prize (2012)
- AMS Steele Prize (2014)
- Shaw Prize (2018)
- Abel Prize (2023)

Luis Ángel Caffarelli receiving the Abel Prize from King Harald V of Norway at the University of Oslo.

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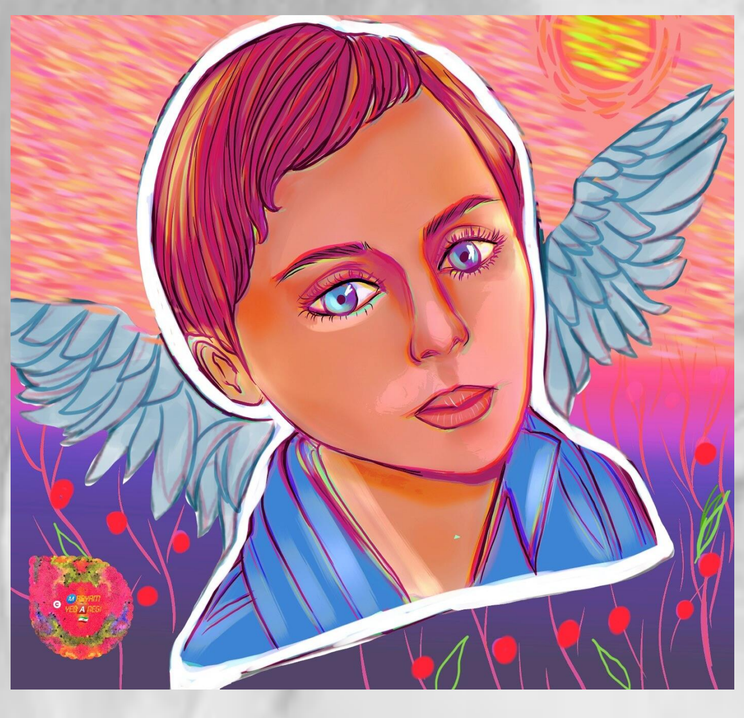
Maryam Mirzakhani (SHE/HER)

EARLY LIFE

Maryam Mirzakhani was an Iranian mathematics genius. She was the first woman to receive the Fields Medal. Born in Tehran, she was raised in a family with an interest in mathematics, as her father was an electrical engineer.



*"As a kid, I dreamt of becoming a writer ... **I never thought I would pursue mathematics** before my last year in high school … My first memory of mathematics is probably the time that [her brother] told me about the problem of adding numbers from 1 to 100".*

ACADEMIC JOURNEY

Maryam was awarded a degree in Mathematics from Sharif University of Technology in 1999. It was at Harvard University where she obtained a PhD for contributions in Riemannian surfaces in 2004 under the supervision of Curtis McMullen, who was a winner of the Fields Medal himself.

*"As a graduate student at Harvard, I had to explain quite a few times that I was allowed to attend a university as a **woman** in Iran".*

In 2008, she was appointed as Professor of Mathematics at Stanford University. There she met Jan Vondrák, a theoretical computer scientist and applied mathematician who would become her husband.

A NEW DESTINY

In 2004 she was offered a junior fellowship at Harvard, but turned down the offer since something better awaited her.

That same year she was awarded a Clay Research Fellowship and was appointed as Assistant Professor of Mathematics at Princeton University.

*"I don't think that everyone should become a mathematician, but I do believe that many students don't give mathematics a **real chance** … I can see that without being excited, mathematics can look pointless and cold.*

*The **beauty** of mathematics only shows itself to more **patient** followers"*

*"The Clay Fellowship gave me the freedom to **think** about harder problems, **travel** freely, and **talk** to other mathematicians. I am a slow thinker, and have to spend **a lot of time** before I can clean up my ideas and make progress. So I really appreciate that I didn't have to write up my work in a rush".*

AWARDS

In 2014, Mirzakhani was awarded the prestigious Fields medal for her outstanding contributions to the dynamics and geometry of Riemann surfaces and their moduli spaces.

Maryam Mirzakhani receiving the Fields medal by the president of South Korea Park Geun-Hye.

Maryam Mirzakhani speaking after the awards ceremony at the International Congress of Mathematics 2014 in Seoul.

Mirzakhani was diagnosed with breast cancer in 2014. Her death in 2017 robbed mathematics of one of its **brightest stars** who, at the age of 40, was at the peak of her creativity.

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Nira Chamberlain (HE/HIM)

THE BEGINNING

Prof Nira Chamberlain OBE, a British-born mathematician of Jamaican heritage, has a renowned international career and is a chartered scientist based in Birmingham.

Nira always had a passion for mathematics throughout his studies. Despite the lack of encouragement from his teachers, who constantly urged him to pursue sports instead of mathematics, Nira received unwavering support from his family. He went on to study a BSc in Mathematics at Coventry Polytechnic (1991), followed by an MSc in Industrial Mathematical Modelling at Loughborough University (1993).

"The University Professor rejected my application [for the PhD] ... Defeated and discouraged I went home where my parents gave me these rousing words of advice: ***You don't need anybody's permission to be a great mathematician****!'"*

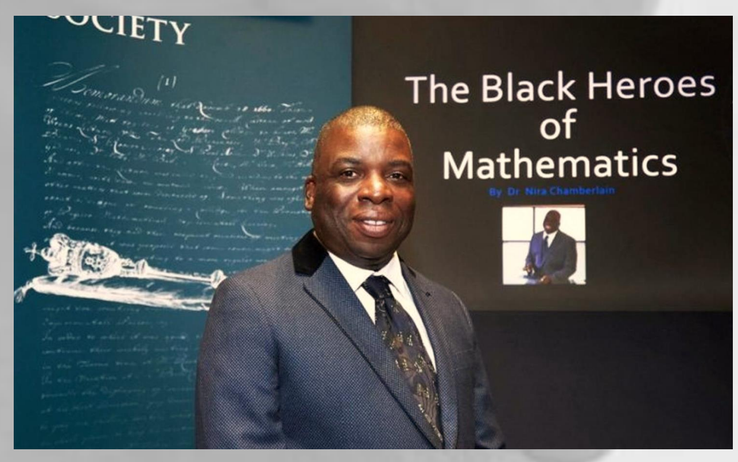
EARLY CAREER

While working several positions in industry, he did his part time PhD at Portsmouth University. His reason for pursuing a PhD was "to **challenge the stereotype** that Blacks are incapable of excelling in mathematics" and serve as a role model.

OUTREACH

Nira is the Principal Business Modelling Consultant at SNC-Lavalin Atkins and has been nominated for FIN Best of Africa - Mathematician of the Year (2023). He regularly gives public lectures debating the importance of mathematics.

Chamberlain founded the annual 'Black Heroes of Mathematics' conference, an international event aiming to highlight the talent of black mathematicians funded by the International Centre for Mathematical Sciences.



Prof. Nira Chamberlain at *The Black Heroes of Mathematics* conference at the Royal Society.

"Mathematics is indisputably the greatest subject in the world! Why? Because it is the language of the world. ***Mathematics crosses racial, geographical and cultural boundaries****."*

"My ***proudest professional achievement*** *... was the creation of a mathematical cost capability trade-off model for the HMS Queen Elizabeth... It not only earned plaudits for my employer but credited me to be in the American Encyclopaedia of Mathematics & Society – making me* ***one of only a handful of British mathematicians*** *to receive such an accolade."*

Chamberlain receiving the Degree of Doctor of Science *honoris causa* by the University of Bath.

Chamberlain received the Degree of Doctor of Science *honoris causa* by the University of Greenwich (2018), University of Bath (2022) and University of West England (2022). He is also an Honorary Professor at Warwick University. In 2022, he received an Order of the British Empire in the New Years Honours List for Services to Mathematical Sciences.

AWARDS

Nira is the recipient of multiple honours and awards, among which:

- Big Math Off - World's Most Interesting Mathematician (2018)
- 5th Most Influential Black Person in the UK, PowerList (2018)
- Top 100 Most Influential BAME Leaders in UK Tech Sector (2019)
- Honorary Member of the Mathematical Association (2020)
- Fellow of the African Scientific Institute (2021)
- The First Black (of African diaspora) President of The Mathematical Association (2023)

Nira with his parents and wife after receiving the Order of the British Empire (2022).

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