MAJORITY OF MATHEMATICIANS HAIL FROM JUST 24 SCIENTIFIC 'FAMILIES'

Evolution of mathematics traced using unusually comprehensive genealogy database.

Anecdotally many mathematicians report a shared genealogy with Swiss mathematician Leonhard Euler, born in 1707. Credit: INTERFOTO/D. H. Teuffen/Mary Evans Picture Library

Most of the world's mathematicians fall into just 24 scientific 'families', one of which dates back to the fifteenth century. The insight comes from an analysis of the Mathematics Genealogy Project (MGP), which aims to connect all mathematicians, living and dead, into family trees on the basis of teacher–pupil lineages, in particular who an individual's doctoral adviser was.

The analysis also uses the MGP — the most complete such project — to trace trends in the history of science, including the emergence of the United States as a scientific power in the 1920s and when different mathematical subfields rose to dominance1.
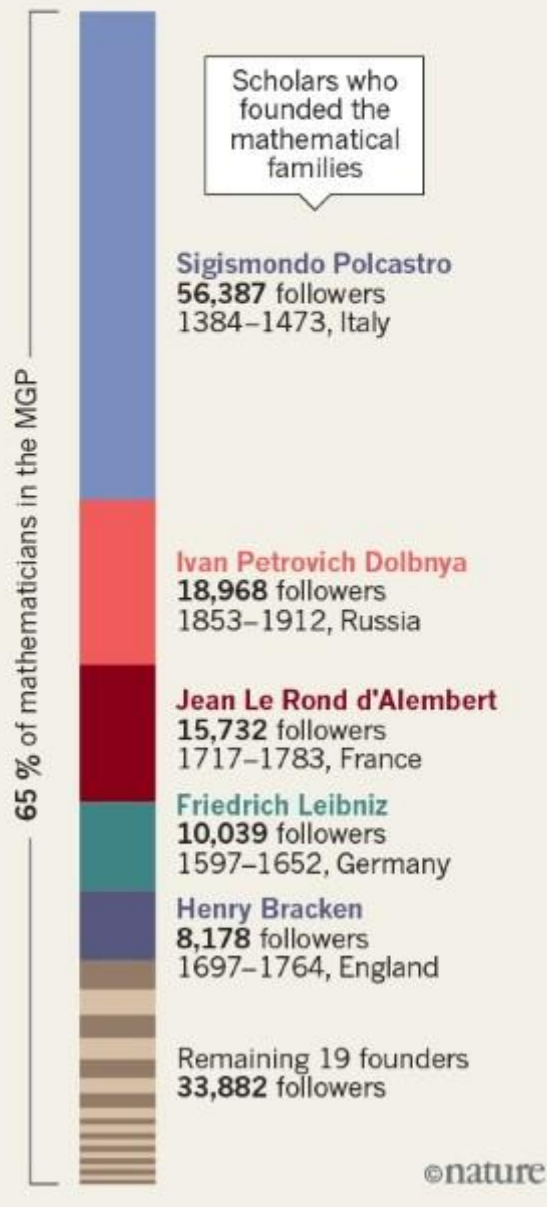
 "You can see how mathematics has evolved in time," says Floriana Gargiulo, who studies networks dynamics at the University of Namur, Belgium and who led the analysis.

The MGP is hosted by North Dakota State University in Fargo and co-sponsored by the American Mathematical Society. Since the early 1990s, its organizers have mined information from university departments and from individuals who make submissions regarding themselves or people they know about. As of 25 August, the MGP contained 201,618 entries. As well as doctoral advisers (PhD advisers in recent times) and pupils of academic mathematicians, the organizers record details such as the university that awarded the doctorate.

Distinct families

MATHEMATICAL CLANS
Two-thirds of mathematicians in the Mathematics Genealogy Project (MGP) belong to just 24 distinct academic families, according to an analysis that assigns 'parenthood' based on teacher-pupil relationships.

Scholars who founded the mathematical families

Sigismondo Polcastro
56,387 followers
1384–1473, Italy

Ivan Petrovich Dolbnya
18,968 followers
1853–1912, Russia

Jean Le Rond d'Alembert
15,732 followers
1717–1783, France

Friedrich Leibniz
10,039 followers
1597–1652, Germany

Henry Bracken
8,178 followers
1697–1764, England

Remaining 19 founders
33,882 followers

65 % of mathematicians in the MGP

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Credit: Source: Gargiulo et al./MGP

Previously, researchers had used the MGP to reconstruct their own PhD-family trees, or to see how many 'descendants' a researcher has (readers can do their own search here). Gargiulo's team wanted to make a comprehensive analysis of the entire database and divide it into distinct families, rather than just looking at how many descendants any one person has.

After downloading the database, Gargiulo and her colleagues wrote machine-learning algorithms that cross-checked and complemented the MGP data with

information from Wikipedia and from scientists' profiles in the Scopus bibliographic database.

This revealed 84 distinct family trees with two-thirds of the world's mathematicians concentrated in just 24 of them. The high degree of clustering arises in part because the algorithms assigned each mathematician just one academic parent: when an individual had more than one adviser, they were assigned the one with the bigger network. But the phenomenon chimes with anecdotal reports from those who research their own mathematical ancestry, says MGP director Mitchel Keller, a mathematician at Washington and Lee University in Lexington, Virginia. "Most of them run into Euler, or Gauss or some other big name," he says.

Although the MGP is still somewhat US centric, the goal is for it to become as international as possible, Keller says.

Peculiarly, the progenitor of the largest family tree is not a mathematician but a physician: Sigismondo Polcastro, who taught medicine at the University of Padua in Italy in the early fifteenth century. He has 56,387 descendants according to the analysis. The second-largest tree is one started by a Russian called Ivan Dolbnya in the late nineteenth century.

Tracking history

The authors also tracked mathematical activity by country, which seemed to pinpoint major historical events. Around the time of the dissolution of the Austro-Hungarian Empire in the First World War, there is a decline in mathematics PhDs awarded in the region, notes Gargiulo. Between 1920 and 1940, the United States took over from Germany as the country producing the largest number of mathematics PhDs each year. And the ascendancy of the Soviet Union is marked by a peak of PhDs in the 1960s, followed by a relative fall after the break-up of the union in 1991.
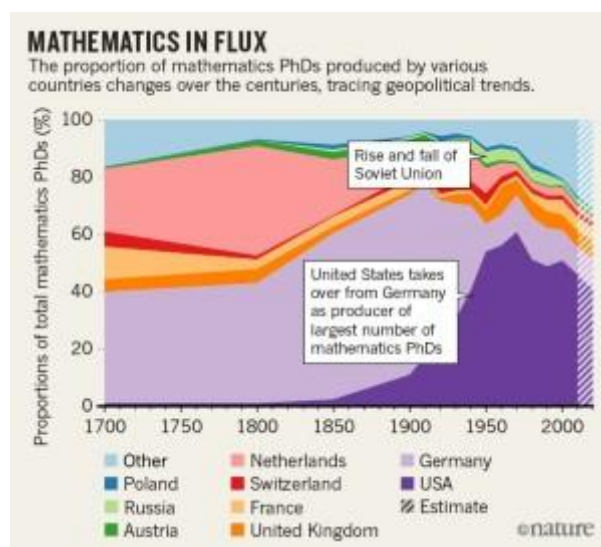
Credit: Source: Gargiulo et al./MGP

Gargiulo's team also looked at the dominance of mathematical subfields relative to each other. The researchers found that dominance shifted from mathematical physics to pure maths during the first half of the twentieth century, and later to statistics and other applied disciplines, such as computer science.

Idiosyncrasies in the field of mathematics could explain why it has the most comprehensive genealogy database of any discipline. "Mathematicians are a bit of a world apart," says Roberta Sinatra, a network and data scientist at Central European University in Budapest who led a 2015 study that mapped the evolution of the subdisciplines of physics by mining data from papers on the Web of Science2.

Mathematicians tend to publish less than other researchers, and they establish their academic reputation not so much on how much they publish or on their number of citations, but on who they have collaborated with, including their mentors, she says. "I think it's not a coincidence that they have this genealogy project."

At least one discipline is trying to catch up. Historian of astronomy Joseph Tenn of Sonoma State University in California plans by 2017 to launch the AstroGen project to record the PhD advisers and students of astronomers. "I started it," he says, "because so many of my colleagues in astronomy admired and enjoyed perusing the Mathematics Genealogy Project."