IMO 2017
RIO DE JANEIRO - BRAZIL
58th International Mathematical Olympiad
NEWS

RIO, THE CAPITAL OF MATHEMATICS

The first Brazilian Olympiad set a record of competitors from 111 countries

The IMO 2017 opening ceremony was a grandiose party. The reception welcomed 623 competitors, out of delegations from 112 countries. There was music, dance, clapping and a great deal of excitement. Also, Marcelo Viana, IMPA's director, invited all to honor the memory and work of Maryam Mirzakhani, the outstanding Iranian mathematician deceased three days prior.

Regarded as the world's leading mathematical competition for students, the IMO is hosted by Brazil for the first time. This year's IMO began on July 17, 2017 followed by two days of tests, which demanded hard work and concentration by its young participants.

For the event's six days, Rio de Janeiro became the international capital of mathematics.

IMPA would like to thank all of the IMO 2017 contestants for their significant participations.

Contestants on the second day

PHOTO BY DAVI CAMPANA/R2 FOTO/DISTRIBUTION

WELCOME, MATH OLYMPIANS

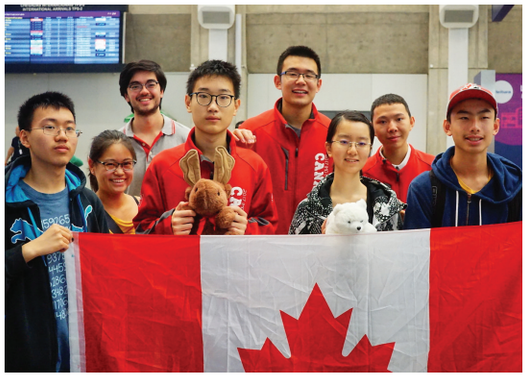
Further to months of preparations, the International Mathematical Olympiad has finally landed in Rio de Janeiro.

We are honored and thrilled to receive so many friends from all over the world. Math olympiads are highly regarded in Brazil. The country annually hosts the largest high school competition in the planet, with over 18 million 6th to 12th grade students as participants.

The IMO 2017 is not a one time event. Next year, the first International Congress of Mathematicians will be held in the Southern Hemisphere. This historical circumstance emboldened IMPA and the Brazilian Mathematical Society to launch the Biennium of Mathematics 2017-2018, an ambitious initiative to make mathematics more popular and accessible to the community at large.

We would like to welcome you to our "wonderful city" and to the 58th IMO and hope that you will enjoy your visit. Great success to all!

Marcelo Viana,
IMPA's director and IMO organizer



Mascots serve also as talismans for many IMO contestants, like those from Canada, South Africa, India and Germany

MASCOTS

IMO's participants do not just put their faith in numbers. They also believe in superstitions and lucky charms, especially in the shape of mascots. Several contestants have brought small stuffed animals in their luggage. Not only do the mascots represent the teams themselves, but they also serve as amulets.

The Indian delegation brought tigers whose names are a tribute to the mathematicians Srinivasa Ramanujan, Ariabata and Bhaskara. The Germans prefer a tigress, the "Mathematigerin", while students from South Africa walk around with a bear covered in IMO medals. The French do not fall behind and carry along a rooster.

A surprising mascot is Princess Canmoo, a moose that has accompanied the Canadian teams on trips to the IMO for the past twelve years. Truth be told, the mascot has gone missing a few times. However, it has been replaced and brings good fortune to the Canadian participants.

PHOTOS BY RAPHAEL GOMIDE/IMPA E LEONARDO COELHO/IMPA

Sole competitors

When Cuban participant Marcos del Riego took the stage at IMO's opening ceremony, he was applauded with a standing ovation by the public. The same gesture welcomed three other delegations that sent only one student each: Panama's Ilai Reshef, Trinidad and Tobago's Sanjeev Mahadeo and Ghana's Jonathan Akaba.

Cuban Riego, Ghanan Akaba and Panamanian Reshef were their countries' only representatives

Saudi Arabia had two women contestants, who wore a niqab, while Ukrainians featured their "vyshyvanka"

Traditional costumes at the Opening ceremony

The IMO 2017 was embellished by many of the competitors wearing their traditional costumes. Female contestants from Saudi Arabia wore a "niqab", a facial veil. Both the Saudi and Iraqi members displayed "thobes". Ukrainians sported an embroidered shirt called "vyshyvanka".

PHOTOS BY LÉO COELHO/IMPA E RAPHAEL GOMIDE/IMPA

There are 42 students in the Team Selection Test. Every student knows exactly 20 other students. Please show that we can divide the students into 2 groups or 21 groups so that the number of students in each group is equal and every two students in the same group know each other.

Vietnam TST 2012 - Problem 6

1

THAT'S WHAT THEY SAID

"Very complicated"

Mexican student **ISAAC JAIR JIMÉNEZ URIBE**, age 17, about the test

"It was very hard. But since I was expecting it to be very hard, that's ok"

LADINA FLAVIA WOHLWEND, age 17, from Liechtenstein, about her own test performance

"Problem number three was so difficult that I suspect even the Chinese didn't solve it"

KEVIN PUCCI, 15-year-old student, member of Portugal's team

"Playing at home is always an advantage. The supporters cheer for us with Brazilian warmth. Nevertheless, one of the best things about the IMO is putting you in touch with people who do what you love to do"

JOÃO CÉSAR CAMPOS VARGAS, age 19, Brazilian competitor

INTERVIEW

Avila says that the IMO gold medal has encouraged him

FIELDS AND IMO MEDALIST FROM BRAZIL

A good score at the Olympiad is a token, though not a guarantee of a successful career as a mathematician, says Artur Avila

In 1995, Brazilian-born Artur Avila, who had just turned 16, won the gold medal at the 36th IMO in Canada. Nineteen years later, Avila was awarded the Fields Medal in South Korea. In this interview, he speaks about how the IMO influenced him as a researcher by giving him focus and making mathematics alluring for him.

IMO NEWS: Fourteen winners of the Fields Medal have participated in the IMO, thirteen of which were actually IMO medalists. Do you see this as a first step towards a brighter future in math?

AVILA: There is not a single or ideal way to do Math. Mathematicians with contrasting styles can make substantial contributions. Also, people without talent for the Olympiads may become great mathematicians, whilst unable to attain high scores on the IMO test. The Olympiads are an efficient way for youngsters to be attracted to and encouraged to focus in Math. Several Math styles benefit from skills useful to solve problems common to the Olympiads. Thus, good IMO scores indicate the prospect of someone's future career success, although not guaranteed.

IMO NEWS: How did the IMO gold medal affect your career?

AVILA: It was a very important achievement. After winning, I was soon admitted to IMPA and developed the confidence to tackle courses in advanced theories. It also made me focus more on Math.

IMO NEWS: Why did you only participate in one IMO edition?

AVILA: I joined IMPA as a staff member soon after receiving the medal. When the IMO edition of 1996 took place, I had already reached another level in my education as a mathematician. The Olympiad fulfilled its purpose.

IMO NEWS: What is the best part of an event like this?

AVILA: Getting in touch with participants who share common interests and have very different backgrounds.

IMO NEWS: What does it mean to Brazil to host the IMO?

AVILA: The IMO should have taken place in Brazil a long time ago and IMPA's support was crucial in bridging this historical gap. To the outside world, we have now claimed our place in the mathematical community. It is ludicrous to splurge on sports events and not hold an educational one that is a thousand times more economical. From the domestic standpoint, we see an engagement between the IMO, students and teachers from all over Brazil. This positive effect will reverberate for years to come.

IMO NEWS: Where do you keep your IMO medal?

AVILA: All my Olympiad medals stay with my mother.

PHOTOS BY LÉO COELHO/DISTRIBUTION/IMPA

What about the test?

“I think the last day was harder than the first. The fourth problem was approachable but the other ones were very hard. I solved one for sure, so I will get an honorable mention, but I'm not sure about the bronze medal.”

ANNA ECONOMOU,
age 17, Cyprus

“Questions 1 and 4 were doable, and 5 was pretty interesting because you could try different strategies to solve it, like a game. Question 3 was way too hard for me.”

ANTONIA HUANG,
age 17, from Ireland

“The exam today was tough, but a little bit easier than on the previous day. Problem 4 was better than I expected. Problem 5 was quite challenging and 6 was really hard.”

SANJEEV AMRIT MAHADEO,
age 17, Trinidad and Tobago

“I was able to solve problems 1 and 5. Number 4 was geometry, which I don’t like. Number 6 had many variables: I’ll be surprised if even the big teams solved it.”

TANISH PATIL,
age 16, from Switzerland

GENTLE GEOFF

At the opening ceremony, IMO 2017's chairman Geoff Smith, from the UK, included a passage in Portuguese in his speech, giving rise to excitement by the audience. “Caros amigos brasileiros, obrigado pela calorosa hospitalidade. Tenho certeza de que a calorosa recepção será apreciada por todos os participantes da IMO. Muito obrigado”, he said, under applause. (“Dear Brazilian friends, thank you for the warm hospitality. I am sure that this warm welcome will be appreciated by all IMO participants. Thank you very much").

Geoff Smith charmed the Brazilian audience

2

What is the greatest number of positive integers lesser than or equal to 2016 we can choose such that it doesn’t have two of them differing by 1,2, or 6?

Brazil 2017 - problem 4

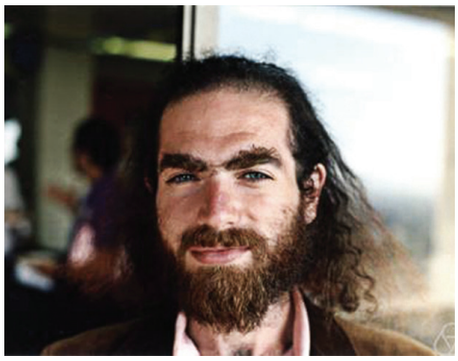
Genius misunderstood

After twenty years of hard work, Japanese mathematician Shinichi Mochizuki published the solution for the Oesterlé-Masser conjecture. His findings, however, have not been validated given that no one understood them. Prime number experts have held meetings to come to grips with Mochizuki’s solution. Within three years, they expect to be able to ratify his discovery.

Mochizuki’s solution is still to be validated

Problems worth one million dollars

In the year 2000, the Clay Mathematics Institute announced that it would pay US$1 million to anyone who solved each of the seven “Millennium Problems.” Grigori Perelman, a Russian gold medal winner at the 1982 IMO, succeeded in solving Poincaré’s conjecture. Yet, Perelman refused to accept the prize, and also declined the Fields Medal of 2006 that he had won. As of now, the Birch and Swinnerton-Dyer conjecture is about to be solved by the Catalan Francesc Castellà and the question remains whether he will dare take US$ 1 million home!

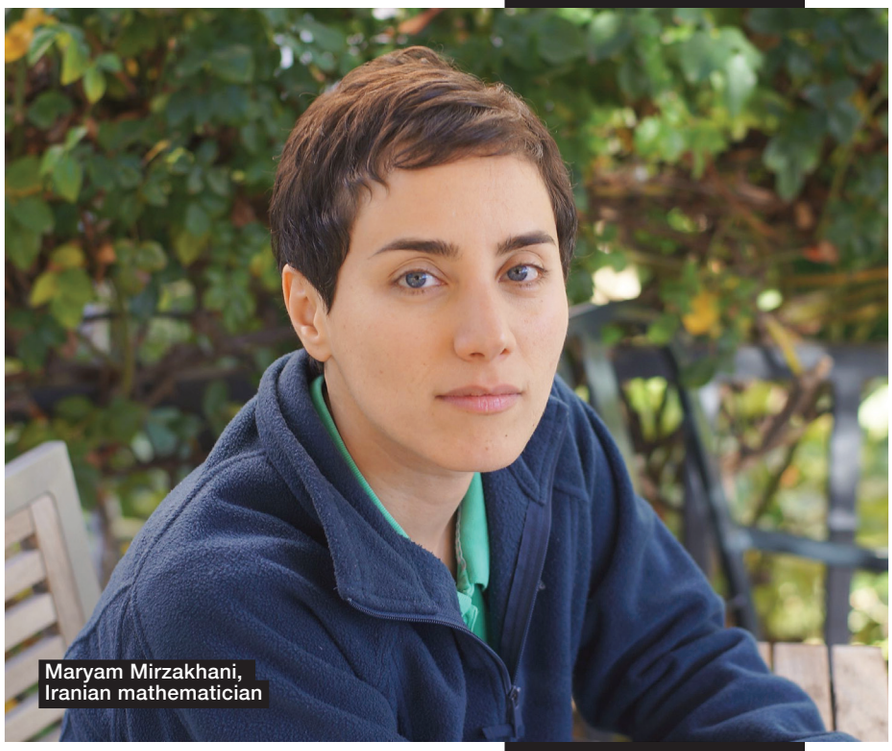


What can we say about Perelman? He declined the Fields Medal and US$ 1 million

PHOTOS BY IMPA/DISTRIBUTION, LÉO COELHO/IMPA, KYOTO UNIVERSITY E GEORGE M. BERGMAN/ BERKELEY

MARYAM'S LEGACY

The only female winner of the Fields medal, died at age 40



Maryam Mirzakhani, Iranian mathematician

When Maryam's six-year-old daughter saw her mom leaning over large sheets of paper and doodling calculations, she would say "Mommy is painting again!". Since this past July 15th, this scene became no longer possible.

Despite her premature death, Maryam left an important legacy including her research in complex geometry and dynamic systems. With a doctorate degree in mathematics from Harvard University, Maryam joined Stanford as a professor and was known for her outstanding intelligence and dedication. "It takes energy and effort to see the beauty of mathematics", she said in 2014.

Brazilian Artur Avila met Maryam in 1995, when they sat by each other after both had won the IMO gold medal (she made the perfect score). Maryam had already accomplished the award in the previous year. Avila and Maryam worked in similar areas, met at congresses and in 2014 the two of them were awarded the Fields Medal at the same time, again.

"Her work has had a profound impact in the field of math and set a starting point for new research", says Avila, depicting Maryam as a source of inspiration for younger generations. "Maryam was filled with true love for mathematics, she set out to discover as much as possible about the beautiful objects that are the subjects of our work. She boldly undertook problems considered unreachable by most of our colleagues."

About Liechtenstein and its all women delegation

Liechtenstein has sent a unique team to Brazil. All three of its competitors are women. The delegation stands out at the 58th IMO, where only 10% of the participants are female. Although the ratio leaves something to be desired, it is an improvement from the past. Since its inception in 1959 to the mid-80s, the number of female participants was kept below two digits. "This is a happy coincidence, because usually boys constitute the majority in these competitions," says Annika Oehri, 17, at her first IMO.

Vice-leader Jana and the students Nicole, Ladina and Annika, of Liechtenstein

HOW TO ENCOURAGE FEMALE PARTICIPATION AT THE IMO

Unfortunately there are not many women contestants at the IMO. However, new incentives could change this situation. To encourage female participation, IMPA has created an award for the top five female students who contribute the most to their respective team's score. The IMPA Olympiad Girls' Trophy will be offered in Rio de Janeiro for the first time this year. Additionally, it will be incorporated in future IMOs. The 2017 prize honors the brilliant mathematician Maryam Mirzakhani, a twice gold IMO medalist who passed away three days prior to the IMO.

PHOTOS BY STANFORD UNIVERSITY E KARINE RODRIGUES/IMPA

IMO = SPRINGBOARD FOR FIELDS MEDALS

The IMO is an important stage in the career of students with a knack for math. Throughout the competition's history, it has featured 14 mathematicians who won the Fields Medals. Ten of them were gold winners, thereby proving that skill and hard work are worthwhile and that IMO is a springboard for Fields Medals.

The average time span between IMO participation and the highest honor achievement in math is 20 years. At least one IMO medalist was among the recipients at the last seven ceremonies. We wish luck to all and that some of you succeed as winners too!

MATHEMATICIAN	IMO	FIELDS MEDAL
Artur Avila	1995 🟡	2014
Maryam Mirzakhani	1994 🟡 and 1995 🟡	2014
Elon Lindenstrauss	1988 🟤	2010
Ngô Báo Châu	1988 🟡 and 1989 🟡	2010
Stanislav Smirnov	1986 🟡 and 1987 🟡	2010
Terence Tao	1986 🟤, 1987 ⚪ and 1988 🟡	2006
Grigori Perelman	1982 🟡	2006 (declined)
Laurent Lafforgue	1984 ⚪ and 1985 ⚪	2002
William Timothy Gowers	1981 🟡	1998
Richard Borcherds	1977 ⚪ and 1978 🟡	1998
Jean-Christophe Yoccoz	1973 ⚪ and 1974 🟡	1994
Pierre-Louis Lions	1973 (no medal)	1994
Vladimir Drinfeld	1969 🟡	1990
Grigory Margulis	1962 ⚪	1978

A 9,3-million-digit prime number

Hungarian Szabolcs Peter recently discovered the 7th longest prime number. With 9,383,761 digits, it was found during an attempt to decipher one of six possible numbers of Sierpinski's problem, unsolved since 1960. State-of-the-art computers are needed for such calculations; volunteers have been facing the challenge for seven years. There are only five numbers left to crack Sierpinski's puzzle!

A matter of time

The Boolean problem of Pythagorean triples is a big one. It is so complex that reading its solution would take ten billion years. In 2016, Heule, Kullmann and Marek succeeded in reaching a solution with the help of Chinese supercomputer Sunway Taihu Light, the world's fastest machine. The actual answer takes 200 TB, the equivalent of 25.600 computers with 8GB of memory.

The ever-present countries

Romania and Bulgaria are the only two countries that have taken part in all 58 editions of the IMO. These comprised a group of socialist nations - also including Hungary, Poland, USSR, Czechoslovakia and German Democratic Republic – that created the first IMO in 1959. Each country sent a maximum of eight contestants to solve six problems following the same rules as at present, adding to a total score of forty points.

3

We put pebbles on some unit squares of a 2013x2013 chessboard such that every unit square contains at most one pebble. Determine the minimum number of pebbles on the chessboard, if each 19x19 square formed by unit squares contains at least 21 pebbles.

Turkey TST 2013 - problem 2

The private Math battle between USA and China

The last two IMO editions have seen the resurgence of the USA team as a striking force, challenging China's dominance. The American team was victorious in 2016 and 2015. Before that, the impressive Chinese had won 14 out of the last 19 IMOs they took part in. Ranking third place at IMO was their weakest result in that same period. South Korea has also been a top 3 in recent years.

The diverse American team came to Rio as a favorite

PHOTOS BY LÉO COELHO/IMPA

IMPA OPENS ITS ARMS FOR TALENTED STUDENTS

Brazilian Institute offers scholarships for IMO participants

IMPA's headquarters, in Rio

For most of you, this competition sets the end of a stage in your lives and the beginning of another as you move to college. As a result of your IMO participation, doors will open for you, including IMPA's.

IMPA is a leading institution in mathematics in Latin America and welcomes students from all over the world, offering special master and doctorate scholarships for IMO participants. In 2014, our MathSciNet's average was 1.81, thereby matching or surpassing those of UC Berkeley, Cambridge and Harvard. Since 2005, IMPA has promoted a national Math Olympiad with 18 million students.

The institute has played a crucial role in the development of math in Brazil. Following Artur Avila being awarded the Fields Medal in 2014 – he holds a master and a PhD degree from IMPA – Brazil will have the fifth largest delegation of invited speakers at the 2018 ICM, in Rio. At IMPA, students are allowed to undertake a PhD degree prior to completion of an undergraduate degree. Please send inquiries to ensino@impa.br.

ROMANIA WILL HOST THE IMO 2018

Next year, the International Mathematical Olympiad will be back to its origins. It is taking place in Romania, the Eastern European country that hosted the first IMO in 1959. The competition will be held in the city of Cluj-Napoca. In 2019, IMO's 60th anniversary will be celebrated in the United Kingdom.

4

A board is divided into corner-shaped figures of three cells. Prove that it is possible to mark one cell in each figure such that each row and each column will have the same number of marked cells.

Russia 2010 - grade 10 - problem 8

Tourist attractions and geek fun

From breathtaking landscapes to geek bars, there is a bit of everything for tourists in Rio. For sightseeing, the most panoramic spots are the Sugar Loaf and Corcovado mountains where the Christ, the Redeemer statue is located. Facing the Guanabara Bay, Museu do Amanhã ("Tomorrow's Museum") is devoted to science and also worth a visit. To unwind in geeky style, theme bars such as Barzinga and Bartman are recommended.

BARZINGA
A haven for anyone who loves comics, TV shows and RPG, with drinks and snacks named after them.
Address: *Rua Didimo 80*

RIO ANIME CLUB
The event takes place on Sunday, July 23, and brings together cosplayers, gamers and manga fans.
Address: *Rua das Laranjeiras 336*

CORCOVADO
One of the possible ways to get to Corcovado is by train. The scenic trip through lush forest takes around twenty minutes.
Corcovado Train Station Address: *Rua Cosme Velho 513*

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