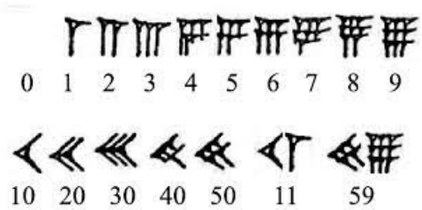
How on Earth, or as we'll see later, not on Earth, did we develop the mathematical methods that we have today? We all remember the times in primary school when the mere mention of the word "algebra" would strike fear into our hearts, even though at that stage in our life all algebra was, was a word that would be mentioned on TV from time to time. But now that we have gone to the trouble to learn more about it, have we ever stopped to consider that someone at some point in time had to create, (or discover) algebra in itself? Let's take it back to the start and explore the history of the mathematical techniques we have created.

The first homo-sapiens, with brains like ours, are estimated to have lived around 100,000 years ago. This means that we have had around 100,000 years to develop our mathematical knowledge to the level that it is currently at. So where did we start? Whether we're talking about the first thing we do every morning, the first thing on my mind as soon as I finish this article or the first thing we applied maths to, the answer is always the same. Food! Now, I'm not talking about finding the circumference of a mushroom pie, what I mean here is that humans would consider how to share their food so that their kin had ample.

Interestingly, it has been shown, using food, that certain animals such as monkeys can also understand maths to a certain extent. (Source: https://www.theverge.com/2014/4/22/5638320/harvard-medical-school-study-rhesus-monkeys-math-human-brains) As other animals also encounter maths, we may be led to believe that maths isn't invented by us, but instead that it's already present in the world waiting for us to discover it. We may therefore believe that what we create are methods to find mathematical truths that must be part of the world. Anyhow, in early human history, we used maths for small, practical uses and we had not created systems to simplify and understand it.

The natural next step up from applying maths to food, a necessity for the body, is, of course, applying maths to the tremendous, seemingly infinite world of celestial bodies in the sky, astronomy! Approximately 95,000 years after the first anatomically similar humans, maths had progressed from something that was only for practical applications, to being recognised as something that presented intriguing challenges for the human mind to adapt to and solve. The Babylonian Empire, which reigned around this time, were the first people, in known history, to invent the magic that is algebra, the part of maths in which symbols are used to represent quantities, known or unknown. Accompanying this innovation was a more detailed knowledge about space. They used a base 60 numeral system, which they had taken from the Sumerians who began their reign 1000 years before them and are recognised as the first to devise written geometry, written mathematical systems and arithmetic. "Base-60" is a different way of writing numbers. In Britain we use "base-10" where the first unit, unit meaning where it is located in the number (the 1st unit's the furthest right, the 2nd is the 2nd furthest right and it continues,)represents any integer 1-9, the second unit represents any integer 1-9, but with the added to twist that it is multiplied by 10 and the third represents 1-9 multiplied by 10x10, with the pattern continuing. So 523 is 3 plus 2x10 plus 5x10x10. Base-60 works in the same way that the first unit represents an integer 1-60, the second represents an integer 1-60 multiplied by 60 and it continues.The numerals (digits e.g. 1,2 or 3) used are different to ours, below an image is included. 60 might seem like a bizarre number to fall upon as it's 6 times bigger than our current base 10 system, however it's quite a useful numeral system which was formed by the merging of two civilisations. One of these civilizations had a base 5 system, as there are 5 fingers on one hand, while the other had a base 12 system, which is advantageous because 12 is highly composite (divisible by more numbers than any number smaller than it). Upon uniting, they traded in a base 60 system as this was functional for both parties given that this is the lowest common multiple of 12 and 5. On top of that, it's no coincidence that there are 60 seconds in a minute. Base-60 simply corresponds well with reality in so many ways, and so even in the modern day we have opted to keep it to measure time. The Sumerians treated metrology, the study of measurement, and maths as one unitary concept and thus the vast majority of their discoveries centred around geometry. On the other hand, the Babylonians developed a way to form and solve equations, making use of pre-calculated tables such as the square roots which they identified through brute force division, that was bizarrely done by multiplying by the reciprocal, and averaging. Their method for multiplication was much less direct than ours as they used the formula $ab=[(a + b)^2 - (a - b)^2]/4$ and referred to the pre-calculated squares table. With such a square reliant system it may not come as a surprise that the Babylonians discovered Pythagoras' theorem although they didn't manage to prove it. This is a testament to how far we have come within mathematics and shows that what may seem obvious now only seems that way due to the brilliant systems that we have concocted to cater to the ways that our minds work. Yet for its time, The Babylonian Empire was flourishing with mathematical skills and this led to it developing groundbreaking methods to discern astronomical patterns and details, including predicting the movement of Jupiter through the sky.



Cuneiform - how Babylonians would write their numbers. Base-60. Different shaped marks represented different quantities similar to how 1, 2, 3 etc, are different.

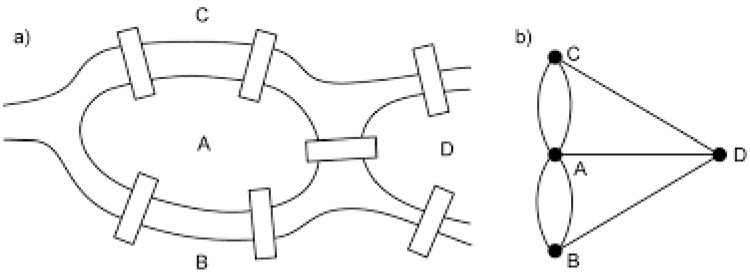
One person who did manage to prove Pythagoras' theorem, nearly 2400 years ago, in Ancient Greece, was Euclid "the Father of **Geometry**," the part of maths concerned with shapes, their properties and their relations. That's right, this was a one man job, no civilisation was necessary this time. This can be attributed either to the fact that the Ancient Greek maths system was comparatively so superior to the Babylonian, that only one person was required, or to the realisation that Babylonian history may not have been recorded well enough for us to pinpoint the individuals who made all mathematical advancements. Euclid took his axioms, a small set of 5 self-evident rules that could not be broken down further, similar to prime numbers, and used them to prove many other geometrical truths in a treatise called "the Elements" that was, fittingly, broken down into 13 books.

In the 17th century, Rene Descartes had the extraordinary idea to combine algebra and euclidean geometry into one. This is personally the single most impressive mathematical manoeuvre that I have come across. He did this by taking equations such as y=mx+c (where m and c would be replaced by constant numbers) and plotting on a set of "axes" all the

points that represented these equations. This depiction helps our minds to connect with the maths and detect patterns.
https://www.desmos.com/calculator If you are not already familiar with cartesian coordinates then head to this website, type “y=mx+c” and change m and c to numbers to find out if you can spot any patterns yourself!

There are many, many marvellous mathematicians that I could talk about from over the years, so many in fact, that if one picture is worth one thousand words, I’m not sure that a thousand pictures could tell you all their stories. Therefore I will briefly introduce 3 of the most important more modern mathematicians.

The first is Leonard Euler (1707-1783). The most important thing about Euler is that you must pronounce his name correctly or the whole mathematical community will be after you! (pronounced “Oi-ler”) As silly of a sentence as that is, it is indicative of the impact that Euler had on maths globally. Euler’s speciality was turning seemingly practical problems, such as the Bridges of Konigsberg (map found below), into mathematical information that make them easier to solve. He discovered, without walking around Konigsberg, that it would not be possible to walk around the town crossing each bridge once and only once, by forming a new mathematical invention called graph theory, that simplified down the map of Konigsberg into a network that consists only of the relevant points and connections. This is just one of hundreds of his discoveries, across all fields of mathematics, some of which were still being published 50 years after his death.



a) Is a map
b) is a network that depicts the possible bridge routes. It can be seen that at least one bridge must be crossed twice.

Could you, with no formal training in mathematics, be invited to become a scholar at Cambridge by the leading mathematician in England? That is exactly what Srinivasa Ramanujan did. After moving to England from India, Ramanujan faced many social challenges, including racism, being separated from his family and subsequently mental health issues, all of which lead to a suicide attempt and eventual death by tuberculosis at the age of 33 in 1920. Amid all of these problems Ramanujan had still managed to make his name as possibly the most naturally talented mathematician in all of history. This signifies that maths is not of an objective difficulty. In the same way that some people's minds make answers more accessible to them, some mathematical methods also make answers more accessible to all minds.

After all of these paragraphs about mathematicians from hundreds of years ago, you’re probably excited to hear about someone of the twenty-first century. Terence Tao, born in 1975, competed in the IMO, a worldwide competition for people below 20 who haven’t yet gone to university, and won at the age of 13. He is yet another prodigy who has participated in many discoveries. However, the real benefit of contemporary maths is that we have computers that can assist us with problems. For example if we wanted to find out how many prime numbers there are between 1 and 100,000 we could run a code that checks for us. Similarly to how this is a tool that we can use, algebra, graph theory and geometry are also different ways to look at the same problem. Each practice has its limits, computers, for example, cannot reason and so they can't tell us why a finding occurs. In other words a computer can tell us that there are 9592 primes beneath 100,000, but it cannot explain why.

Framing maths is like crafting a story. It has been passed down from person to person, society to society, culture to culture, over millennia, sometimes the story has a real world application and other times the story gets straight to the point, with no depth or detail. Crucially, no one believes that we have found the definitive, superlative way to tell a story, it is obvious that the best story is yet to be written. This can too be applied to maths. We still do not know if we use the best base system. In the same way that teachers explain maths to teach it, we must create new mathematical methods to communicate it to our brains. In another world we may look at things from a completely different angle, no pun intended, because these structures are just ways of relaying information and making it accessible to our minds. This can even be seen in different societies' multiplication methods. There could still be an abundance of remarkable techniques waiting for us and we need to make sure that monkeys don't beat us to it!

By Zach Ali