Issue: June 2020

Pi-rate

The Welham Mathematics Magazine

From the Editor's Desk

Dear Reader,

It's quite unbelievable to bring out the first issue of the Pi-rate as the Editor-in-Chief, that too with a completely new outlook as an e-magazine! I have been reading the Pirate ever since the first edition came out and never thought I would one day be heading it.

What makes it even more special is the fact that amid the ongoing corona-virus pandemic our team has put in their best to make it as reader-friendly as possible. We hope this will motivate people to create and discover something new.

This edition of the Pi-rate covers a number of interesting topics such as the epidemic analysis, the power of something as simple as curvature, unknown facts such as the proofs of 0.999... being equal to 1, the math behind juggling, glacier melting and discoveries which people are unaware of.

It would have been impossible to complete this task without such a fine and co-operative editorial team and the support of Mr. Vishal Rawat.

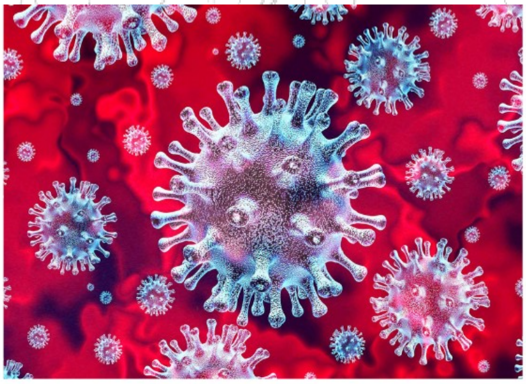
Stay Safe and Happy Reading!

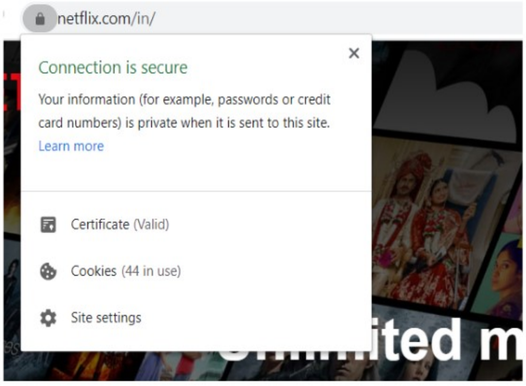
Prisha Manocha
Editor-in-chief

"Pure Mathematics is, in its own way, the poetry of logical ideas..."

-Albert Einstein

CONTENTS





netflix.com/in/
Connection is secure
Your information (for example, passwords or credit card numbers) is private when it is sent to this site.
Learn more
Certificate (Valid)
Cookies (44 in use)
Site settings

Coca-Cola
Coca-Cola
pepsi

ANALYSING THE EPIDEMICS

By Khushi Kathpal
AI-B

There are many questions that arise during an epidemic such as, "How widespread will it be?", "How will it develop over time?" and "When will it end?". A mathematical model is often used to answer these questions. These models use mathematical language and concepts to predict how the disease will spread which in turn help in predicting the future course of an outbreak and evaluating strategies to control an epidemic.

One of the most widely used mathematical models is the SEIR model that analyses data flow of people among these four situations: susceptible (S), exposed (E), infected (I), and resistant (R). These variables represent the number of people in those groups. Parameters are used to show how fast people move from being susceptible to exposed, from exposed to infected, and from infected to resistant. One of the important factors is the reproductive ratio(R0) of an infection. The reproductive ratio is the average expected number of cases that can be infected by an infectious person.

If R0<1, the epidemic dies whereas if R0>1, the epidemic spreads. The R0 of Coronavirus is about 3.28 which is higher than many other epidemics which the world has faced. The R0 in India is about 1.23 till now.

As COVID-19 spreads worldwide, the leaders are now relying on these mathematical models. The researchers are working on a new model with improved tracking of epidemics by calculating mutations. It will use data from doctors, health workers and social networks to make predictions about the development. All these models give leaders critical insights into the best steps they could take in the face of pandemics.

PUBLIC KEY CRYPTOGRAPHY

By Anushka Prakash

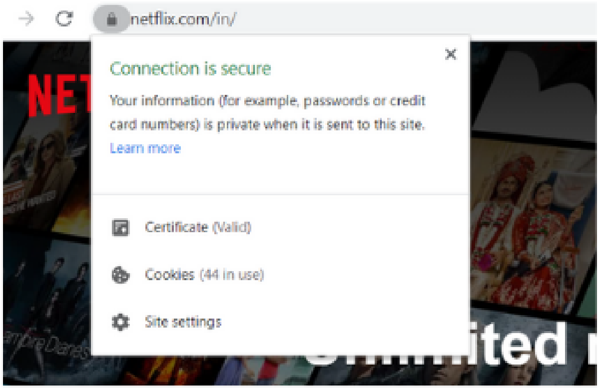
AI-B

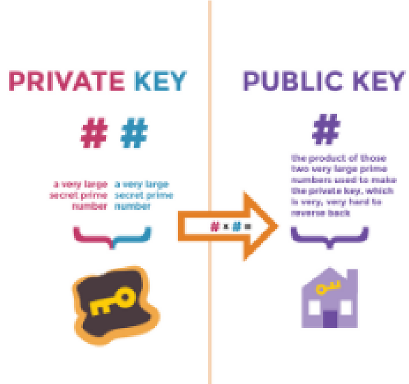
Computers are an integral part of our daily lives but as computers are becoming faster and smarter, hackers too are keeping pace. With almost all information available on a cloud today, the need for systems that will help keep this information confidential is paramount. No wonder, cyber security is one of the most pressing issues faced by our world today.

Cryptography is the practice and study of hiding personal information on the internet. Modern cryptography is a mix of mathematics, computer science, and electrical engineering- all brought together to keep information secret and safe. Most cryptography techniques rely on information known to both parties- the sender and the recipient. This information is called the "key". After mutually deciding a secret key, the sender and the receiver encrypt the message using the same key. However, it is not easy to share the key physically. The safest way is by encryption, taking a message and scrambling its contents in such a way that only authorized parties can access it and those unauthorized cannot. There are two types of encryption - Symmetric Encryption and Asymmetric Encryption.

Symmetric encryption is where the same key is used for encryption and decryption, where both the sender and the receiver have the private key. The problem here is that this key has to be stored securely as any hacker can decrypt easily after getting this key. This is where asymmetric encryption comes into play, where different keys known as public and private
keys are used for encryption and decryption.

Anyone using asymmetric encryption uses a private key number, and a "public key" that they can tell everyone. If someone else wants to send this person a message, they can use the public key they've been given to hide the message. Now the message cannot be revealed, even by the sender, but the receiver can easily reveal the message with his secret or "private key". Nobody else needs to know the secret key. Some third parties might be able to locate the message but they are unable to see its contents. A popular way of generating such keys is by using the RSA algorithm (named after its founders Ron Rivest, Adi Shamir and Leonard Adleman), which comes up with a set of a public and private key that are mathematically linked to each other.





The method to encrypt the keys depends on the fact that while it is easy to calculate the product of two large prime numbers. It is, for all practical purposes, impossible to find the factors of a large number if it has very large prime factors. Using this, the receiving computer thinks of two very large prime numbers (usually more than 100 digits) and publishes their product. The sending computer uses this product to encipher the message and sends it to the receiver. However, to go backwards and decipher the message you not only need to know the product but also the two original primes. It is impossible to factorise numbers of that size which means that to read the message you must already know the original primes - and only the receiving computer does.

You must have noticed a padlock icon next to a link while browsing on the internet. This indicates that public key encryption is in use, showing that any personal details entered on that website cannot be accessed by anyone else.

The computer has done its job by encrypting your documents and data, but it is now your job to keep your
respective private keys safe.

THE POWER OF CURVATURE!

By Palak Agrawal
SC-A

Have you ever wondered why some things are stronger than others? For example, why is it easy to crush paper and not a soda can?
The answer lies not with the material it is made of, but with its shape. This might sound a little far-fetched but it's really quite simple. Can you imagine supporting a small book on a sheet of paper? No, right? But fold the paper into a cylinder and behold! The book is easily supported by paper now. Is this magic or is it just math?
Who thought that shape defines strength? Carl Friedrich Gauss, one of the greatest mathematical geniuses of all time is the mastermind behind it. He called his theorem, Theorema Egregium , which is Latin for "excellent or remarkable theorem".
Gauss's theorem proves that if we take a surface and bend it, its Gaussian curvature remains the same, provided that we don't shrink, tear or stretch it. To understand his theorem, simply imagine an ant on a cylinder. To move, it can take any path. Now assume that the ant takes the most extreme paths. Naturally, the ant would go around the cylinder on the circle shaped path or go straight down on the flat path. Multiply the curvatures of the paths together. The number we get is the Gaussian curvature for the object. So, even when you bend the cylinder, the extreme paths for the ant would still remain the same, therefore, its Gaussian curvature doesn't change. And with this I will come to the main purpose of this article: Strength through curvature.
Curvature creates strength. For example, you can stand on an empty soda can, and it'll easily carry your weight. Yet the wall of this can is about as thick as a sheet of paper. The secret to a soda can's strength is its curvature. According to Gauss's theorem, the soda can's curvature won't change unless you stretch, shrink or tear it. Hence you only need to make a dent in that soda can to make it lose its curvature and strength. Even with a tiny dent, it'll buckle under your weight.
And it doesn't stop there! Another example is of the nuclear power plant cooling towers. They are curved in both directions. Why is it so? They could have been shaped like regular chimneys too, but, regular chimneys are like soda cans. They are curved in one direction but flat in the other. They would be strong, but ultimately not having enough curvature would make them easy to flatten. Hence, nuclear power plant cooling towers have a double curvature making them stronger than regular chimneys.
There are a large number of applications of Gauss's theorem, Strength through curvature being just one of them. Arched bridges, domes, and all other architectural marvels are based on this. Well, one can truly experience its magic simply by testing it on a soda can.

THE MATH BEHIND MELTING GLACIERS

By Prisha Manocha
SC-C

We all know that the melting polar icecaps have a major impact on the global sea level and climate. Sea ice is a very good reflector of sunlight and as it decreases, more sunlight is likely to be absorbed, thus, resulting in global warming. Have you ever wondered how mathematics can be used to analyze it? The environmental data can be analyzed with the help of Probability and Statistics. They can be used to analyze the ice thickness and composition.

Albedo, the ratio between reflected sunlight and incident sunlight helps in determining the melting of ice. The albedo decreases as more ice melts which leads to more absorption of the sunlight and thus the warming. It is the key to determining the future trajectory of sea ice.

The concept of thermodynamics and differential equations can also help scientists in finding out about the ocean currents, heat transfer and sea ice. The satellites give a very limited amount of information as they are able to only get a picture of what the ice looks like from above, which is why sonars are used to check from the underside. Modeling of the transitions of the melting of the sea ice has been difficult.

Mathematicians have found out that as the ice melts, ponds formed on its surface can be treated as mathematical patterns that mostly remain similar. They have found that as the smaller ponds connect to form larger ponds, their perimeter increases fast and the patterns show similarities. The melt ponds formed on the ice surface determine the albedo.

Additionally, pockets of liquid water in the ice, known as brine inclusions, have been modeled as their formation depends on the structure and temperature of the ice. The water drainage depicts the nature of the ice. It has been also been observed that the ice is effectively permeable to brine drainage for the brine volume fraction about 5 percent and increasingly permeable to it above 5 percent. They play a key role in glacier melting and thus, mathematicians have been trying to improve the models to be able to better analyze and collect data on the melting of the glaciers.

WHO LIVES AND WHO DIES- MATH DECIDES!

By Siddhi Verma
SC-C

Do you think money should be wasted in trying to save endangered species even though there is no rise in their population? Statistics suggest that a few species such as the Northern Spotted Owl have been continually funded for protection but there has still been a failure in the recovery of their population.

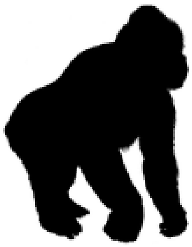
The Nature Conservancy's chief scientist, Hugh Possingham of Australia proposed an idea of economically and optimally saving endangered species. His proposal suggests a mathematical formula which would direct government money away from species on which tons of money has already been wasted with no recovery of their population. This money could rather be used on other endangered species which can be saved provided that the right amount of funding is available.

He describes the dilemma of working with a finite sum of money as a Knapsack Problem. The Knapsack problem states that: "Given a set of items, each with a weight and a value, determine the number of each item to include in a collection so that the total weight is less than or equal to a given limit and the total value is as large as possible." Given a knapsack with maximum capacity W and a set S containing 'n' items, each item 'i' has some weight 'wi' and value 'vi'.

The problem is how to pack the knapsack to achieve the maximum total value of packed items. In case of endangered species, 'i' will be the type of endangered species, 'xi' will be number of instances and 'vi' will be the funding required to save the species. The total limit should be comparable to that amount.

To better understand the formula, let's take a hypothetical situation where Amur leopards are the highly endangered species with only 60 alive. Let's consider Russia is spending $200 million every year in trying to remove them from the endangered species list but the numbers are still struggling. On the other hand, the formula suggests that it will take a total of $200 million in order to save gorillas, orangutans, sea turtles and Sumatran elephants with a better possibility of their population recovering.

So, shouldn't we be saving four species instead of focusing on one, which is still dying out - despite being provided support?



IS 0.999...=1?

By Nandini Aggarwal
SC-A

Whether 0.999… is equivalent to 1 or not has consistently been a topic for discussion by mathematicians worldwide. One proof of the equation 0.999... = 1 is if one draws 0.9, 0.99, 0.999, etc. on the number line, there is no place left for accommodating any number between these points and 1. As there is no room for any integer between 1 and these numbers, the point 1 must be the least point, and therefore 0.999... = 1.

Another easier method of proving this is the following:

If x= 0.999…

Then 10x= 9.999…

10x - x = 9.999… - 0.999…

9x= 9

x= 1/1= 0.999…

Therefore, it can be concluded that 1=0.999…

Isn't it amazing that what so many of us have been thinking all along that we round it off and make 0.999... as 1, we get to know is not an assumption but actually equal?

WAS PYTHAGORAS THEOREM INVENTED BY PYTHAGORAS?

By Manya Ohri
AIII-A

We all know that the Pythagoras Theorem was propounded by the Greek Philosopher, Pythagoras who stated that A^2+B^2=C^2 , where A=perpendicular, B= base and C=hypotenuse of a right angled triangle.

Pythagoras was a mathematician, teacher and philosopher who lived some 250 years ago but you will be surprised to know that the Babylonians had discovered the theorem way before that, around 1000 B.C.!

A number of Babylonian tablets have been found with pictures which are the proofs of the Theorem. The tablets say that the ratio of the diagonal of a square to one of its sides is equal to the square root of 2 which is in fact the Pythagoras theorem.

However, what still remains a mystery is that even though there is proof that Babylonians used the theorem then why is it named after Pythagoras?

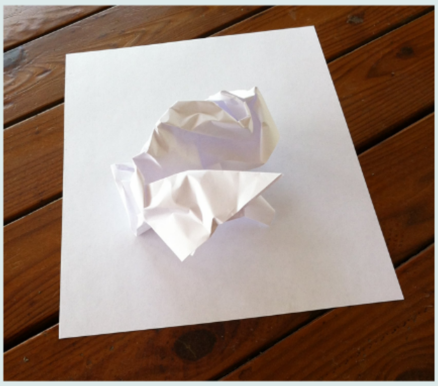
KIBBITZ

BROUWER'S FIXED-POINT THEOREM

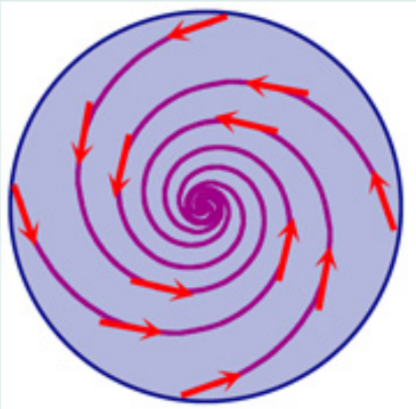
By Srishti Goyal & Tanishtha Poddar
SC-B

Brouwer's fixed point theorem comes from a branch of math known as Topology and had been perceived by Luitzen Brouwer, a Dutch mathematician and philosopher who lived from 1881 to 1966. He gave the first correct definition of dimension. He was also the founder of the mathematical philosophy of intuitionism, a revisionist foundation of mathematics.

His fixed point theorem uses a "portal" between topology and algebra - a fancier version of the interplay between geometry and algebra that we learn in high school mathematics. Shapes or lines on a graph correspond to coordinates which give us geometric equation for the shape or a line on the graph. While this theorem might seem to be pointless, it has various real world implications.



For example, take two sheets of paper, one lying directly above the other. If you crumple the top sheet and place it on top of the other sheet, then Brouwer's theorem proves that there must be at least one point on the top sheet that is directly above the corresponding point on the bottom sheet! This theorem states that every continuous function from a disc to itself has a fixed point. This outcome and its extensions play a vital role in analysis, optimization and economic theory among others.



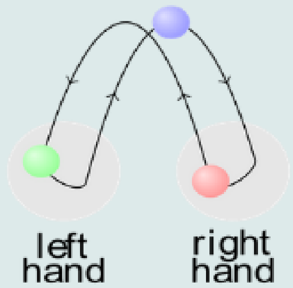
Brouwer's theorem is possible even in three dimensions. Imagine you have a cup of water and take a spoon and stir it up as much as you want. By Brouwer's theorem, there will be at least one water molecule that is in the exact same place as it was before you started stirring (though it might have moved around sometime in between). Moreover, if you tried to stir that point out of its original position, you can't help but stir another point back into its original position. No one can cheat Brouwer's theorem! Remember that the continuity of the function is of utmost importance. Therefore, if the paper is ripped or if you stir discontinuously, then there may not be a fixed point.

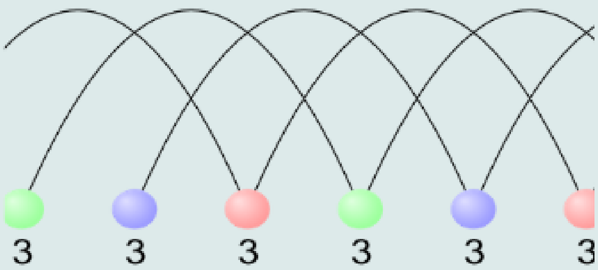
Brouwer's fixed point theorem is useful in a surprisingly wide context, with applications ranging from topology (being one of the most fundamental theorems there) to Nash equilibrium in economics and even cake cutting in Sperner's Lemma.

NO JUGGLING IF NOT FOR MATH!

By Annanya Garg
BI-B

Juggling has many patterns. One pattern is the 'site- swap notation'. Site swaps are a compact notation representing the order in which props are thrown and caught in each cycle of juggle, assuming throws happen in beats that are equally spaced in time. It assigns each throw a number. In the Cascade, which is a juggling pattern in which objects are thrown alternatively from one hand to another, the time between any two balls is 3 beats, so its swap is 33333, or just 3 for short. The easiest way to discover how the balls are actually tossed is to draw a diagram of semicircles on a numbered timeline.
Now as I have stated before, site swappers assign a number to each throw in a juggling routine. The higher the number, the higher the throw. For example, a 3 is a throw that only goes about chin high to stay in the air for 3 beats while a 6 goes over the head so that it stays aloft for 6 beats. Odd - numbered throws are passed from hand to hand, and even numbered throws stay in the same hand.





The world record for passing, juggling balls was set by Americans Joey Cousin and Bruce Sarafian, who kept 13 balls along for 54 catches in 1995 and for 176 catches in 1997. Sarafian also holds the record for the most balls juggled by one person: 11. He once had a car with a Florida license plate that read "11-BALLS '.
Mathematicians have been fascinated by juggling ever since. "I think it's a matter of making sense of the order that it's in the juggling patterns," said Jonathan Stadler, a math professor at Capital University in Ohio who started juggling as a teenager. "It has to do with understanding how things fit together."
Allen Knuston, mathematician at the University of California at Berkeley muses," You could even do a throw of -1. It would go backward in time and become antimatter."

CAUCHER BIRKAR:
MATHEMATICIAN PAR EXCELLENCE

By Tushti Arora
AIII-B

Take a peek into the life of this Kurdish Refugee who fled war and came to Britain and won the Fields Medal.

Caucher Birkar, born in 1978, is a mathematician and the most important contributor to birational geometry. He was awarded the Fields Medal, one of the most reputed awards in the field of Mathematics, in 2018. He received this award for his Fano varieties and other contributions including minimal model problems. As a mathematician, he has helped in getting order to the infinite variety of polynomial equations, the equations that have different variables raised to various powers. None of these equations are alike, but Birkar has helped in revealing that a large number of them can be easily categorized into a small number of families. Back in the days of his college, he used to admire pictures of fields medalists hanging up on the wall and wonder if he would ever be able to meet them, and today, he is one of them.

He had been interested in mathematics and logical reasoning questions since his childhood. Birkar's elder brother used to introduce him to the basic concepts of calculus and then, he would pick up his brother's textbook and try solving all those problems. His brother's words, "Knowledge can be exquisite", have always been imprinted in his mind. His family remembers him reading all types of math books late at night and at times even while listening to music, a habit he still maintains today. "I read all these books and I had this feeling that just reading things is not enough. I also wanted to create my own stuff, to create something new," he says. This is what actually inspired him to be who he is today.

"I read all these books and I had this feeling that just reading things is not enough. I also wanted to create my own stuff, to create something new"

INFINITY MATH COMPETITION

By Palak Agrawal, Shreya Gupta & Srishti Goyal (SCs)

EVENT

On 10th and 11th January 2020, we participated in the INFINITY mathematics competition. We were escorted by Mr. Vishal Rawat. INFINITY is an annual Inter-School Mathematics Competition organised by Aditya Birla World Academy. High school students across India and abroad take part every year in this exciting experience.

We were quite nervous but the energetic atmosphere soon made us forget our worries. The guest of honour was Dr. James Tanton, a mathematician from the Mathematical Association of America, who taught us the International Math Salute, which seemed simple but made us wrack our brains and finally ended in a round of laughter.

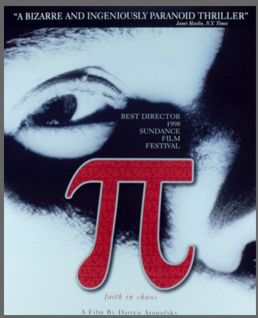
After the first individual round called ‘Clash of Mathematicians,’ we had the ‘Math Challengers’ team event. This included not only individual thinking but also great time management and collaborative work. After the rigorous rounds, we were glad to interact with the participants from other schools through the icebreaker activity. Next, we were asked to put on our creative hats for the poster-making round, ‘Bulb Your Ideas’.

The following day, we walked in for the anticipated relay round, ‘Pass The Baton’ where we had to work together to answer interlinked questions. It was a nerve racking round as one wrong answer by any member could jeopardise the entire team’s work.

Overall, the entire competition changed our views and perception about Math. We learnt a lot and realised that with the increasing standards at the international level, we need to think out of the box and constantly be ready to learn. Though INFINITY 2020 came to an end, the fun we had, the friends we made, and the memories we shared are going to last till “infinity and beyond”. There is no limit to dreams when they tend to infinity.

RECOMMENDATIONS

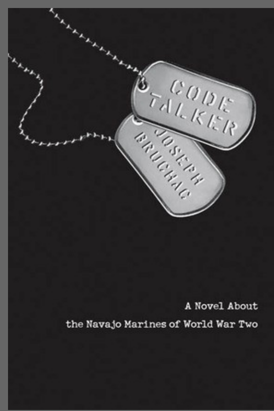
Pi: Faith in Chaos



Pi is an American psychological thriller film written and directed by Darren Aronofsky. A mathematician named Max attempts to find a pattern in the Stock market which will also unlock the universal patterns found in nature. However, hallucinations continue to hinder his path and as the film continues, it becomes more difficult to tell what's real and what isn't. Soon, Max finds himself the target of ill intentioned Wall Street agents bent on using the number discovered by him for profit.

Code Talker: A Novel about the Navajo Marines of World War Two

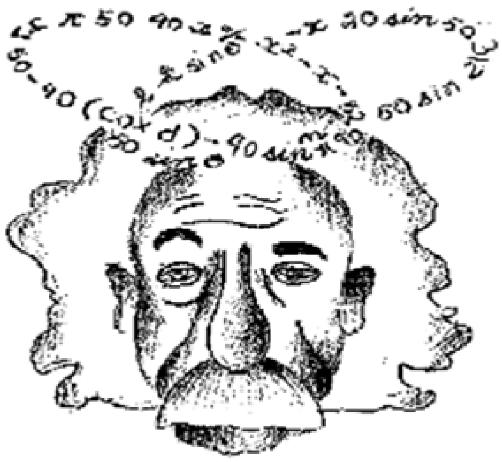
During World War II, the Japanese had managed to crack every code the United States used. But when the Marines turned to its Navajo recruits to develop and implement a secret military language, they created the only unbroken code in modern warfare. They braved some of the heaviest fighting of the war, and with their code, they saved countless American lives. This book follows the tale of Ned Begay, a sixteen-year-old Navajo boy who becomes a code talker. This deeply affecting novel honors all of those young men, like Ned, who dared to serve their nation in the face of war.



CREDITS

EDITOR-IN-CHIEF:
PRISHA MANOCHA

EDITORIAL BOARD:
PALAK AGRAWAL
SRISHTI GOYAL
TANISHTHA PODDAR



TEACHER-IN-CHARGE:
MR. VISHAL RAWAT

SPECIAL THANKS:
MRS. SHEFALI THAPLIYAL
ISHIKA AGARWAL

ILLUSTRATOR:
SHREYA GUPTA