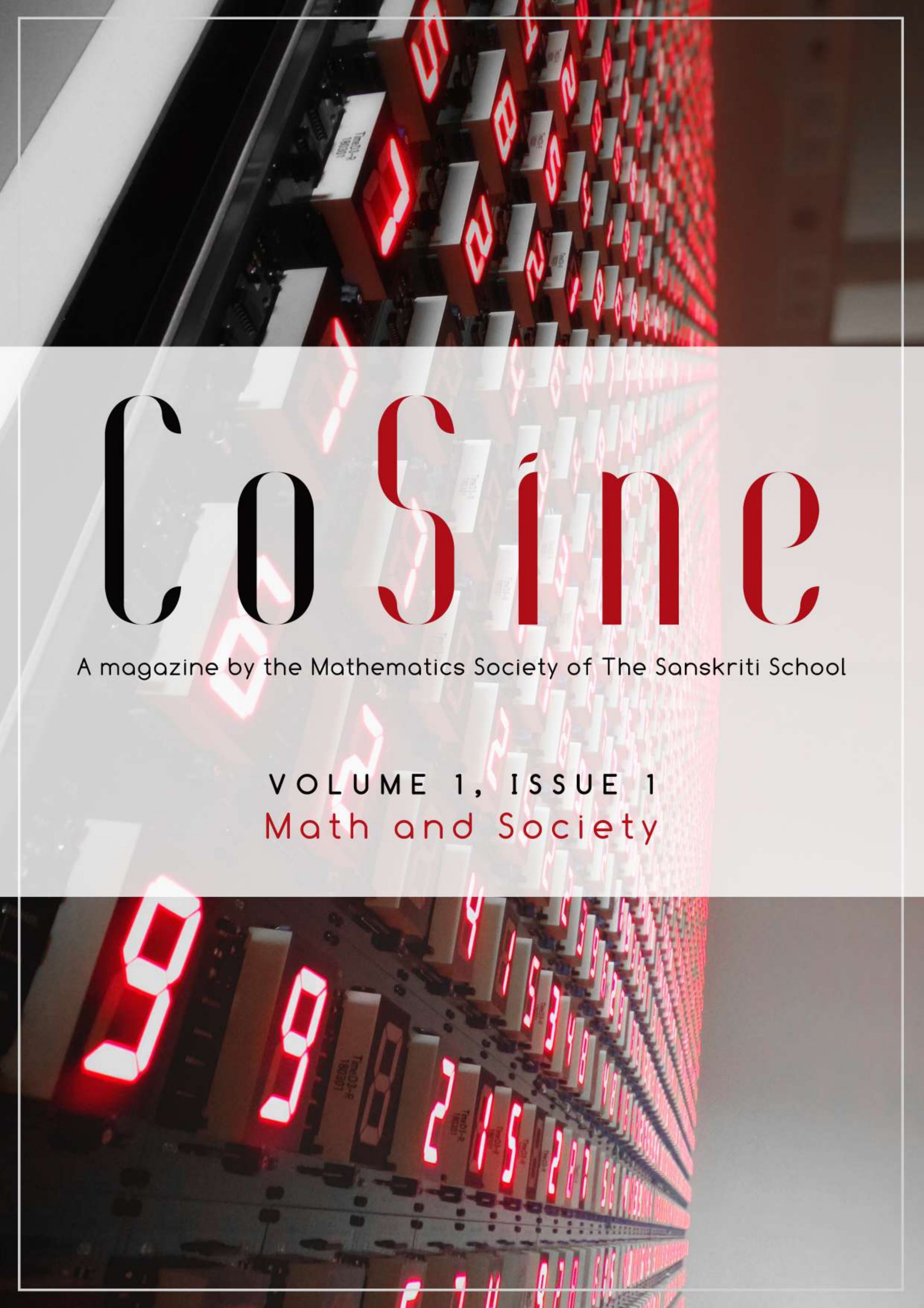

CoSine

A magazine by the Mathematics Society of The Sanskriti School

VOLUME 1, ISSUE 1

Math and Society

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Foreword

Mathematics is considered by most to be a universal language. But is it as universal as we believe it to be? How many people throughout the world use math, with its Western concepts, methods of understanding, and quantitative understanding? Do people in the most rural regions of developing countries see mathematics as universal -- or is it limited to the localized notions of counting and collation that is rooted in specific cultural contexts?

The Piraha, for instance, an Amazonian tribe, has a language that does not have number words. Due to this, people of the tribe struggle with performing common quantitative tasks, as defined by the modern and globalized world. Here, they do not have a knowledge of the English language, not even in the smallest bit. The case of the Piraha tribe shows up ooull uklkyooqs the extent to which language shapes our perception of reality, and the flaws of considering math to be a universal language. They are considered to be one of the few groups in the world that are entirely anumeric -- meaning that they have no number system in their language.

Perhaps this case study can inspire us to introspect further, on the complex yet beautiful interconnection between Mathematics and society. How will our understanding of math change if we were in a different culture, speaking a different language? Some of this is captured by the task of number system conversion, yet even this is something we do not usually think of. How would life be if our numbers weren't organized the way they are? What if they were in base 5 or base 20, as opposed to our base 10 system? Would we understand them as easily as we do now? Would our computers run the same? How differently will we consider quantity or size -- would one million still be considered a big amount, if it was 8 units in another number system?

This edition of CoSine seeks to engage with such questions by positing problems, facts, questions, and inquiries into the intersection between mathematics, technology, news and culture. We hope to question what we, as students, have otherwise considered to be objective truths, by deconstructing their biases and viewing them from a critical perspective. Mathematics is an ocean of potential, applicable to every part of our lives, yet perhaps we can improve it by applying our subjective, felt experiences, along with the social sciences, to its understanding.

We hope for many more editions to come, and are certain that these critical journeys into a vast discipline will be well received.

-Addea Gupta *(Vice President)*

Math Phenomena

While maths can be tough and tricky sometimes, it requires just a bit of perspective to see how remarkable and marvellous it can be. Some maths results and phenomena might just change your perception towards the subject, while others integrate it with nature. Here are some
popular results, facts and mind-boggling phenomena from the world of maths:

1nfinity?

Infinity was already pretty difficult to grasp. Now, the situation is worse, as it's actually more complicated. There isn't just a single infinity- there are 'countable infinities' and 'uncountable infinities'. But, as it turns out, there are even more levels of uncountable
infinity after that. How many? An infinite number, of course.

Six weeks last exactly 10! Seconds

Even though time does seem to be running faster than ever, this does not mean ten excited seconds. 10! Is ten factorial, i.e 10*9*8*7*6*5*4*3*2*1. In the same manner, there are 5! seconds
in two minutes.

If you really shuffle the cards in a deck, there's a good chance you end up with a configuration no one ever created

If you know about P&Cs, it means that there are 52! possible combinations for cards. This is an incredibly large number- astronomically large. This means that there is a unusually high
chance of you making a whole new permutation.

11 multiplied by any two digit number-

When 11 is multiplied by any 2 digit number xy, the product is x x+y y . Confused? Don't be.

11*45 = 4 9 5

11*27 = 2 9 7

Similarly,

11*58 = 6 3 8 (Add tens digit to the x placeholder)

BIZZARE PROOFS!

1/3 is equal to 0.33333... However, 0.333... Multiplied by 3 gives 0.999... Since we are dividing and multiplying the same number, the value must be the same.

=> 1 = 0.999999...

BONUS!

The volume of a pizza with radius 'z' and height 'a' is Pi*z*z*a, as Pizza is a cylinder with a low height. (pi*r^2h)

Sanchit Mahajan

Mathematics & Machine Learning (AI)

There is often a misconception in our community regarding the connection between mathematics and Artificial intelligence. When people read and learn about Artificial Intelligence, they assume that AI and math are two different fields that have no relation to each other whatsoever.

They are proved wrong when they research deeper on the field of AI. In theory, Artificial Intelligence has the objective of designing systems that behave intelligently in the eyes of humans i.e. if someone is to interact with AI their first assumption would be that they are interacting with an intelligent human being!

Instead of delving deep into the more complicated areas of Artificial Intelligence, today we will be looking at one of the most common everyday applications of AI. Text Classification: When seen from a layman's eyes, text classification might seem like any other classification problem. Classification in machine learning (which is a subset of AI) is assigning a correct label on input data but in the case of text classification. In the case of text classification, the labeling can vary depending on the scenario. It not only provides us with a conceptual view of documents but also has important applications in real life.

Some examples of it are :
- The detection and classification of spam emails
- Categorizing a review as positive or negative
- Identifying a piece of article as sports, politics and etc.

Text Classification typically deals with high dimensional data sets that can become difficult to maintain over time. Instead of relying on manually crafted rules, text classification with machine learning learns to make classifications based on past observations. By using pre-labeled examples as practice data, a machine learning algorithm can learn the different associations between pieces of text and the output expected for a particular input.

[Machine Learning theory is a field that converges statistical, computer science and algorithmic aspects from learning from data and finding insights which can be used to build intelligent applications.]

Despite the endless possibilities that this type of machine learning holds, there is a need for a thorough understanding of mathematics to grasp the workings of the algorithm and to get good results.

Linear Algebra is a branch of mathematics that lets you describe coordinates and interactions of planes in higher dimensions and perform operations on them. Think of it as extending algebra into multiple dimensions. This proves to be the building blocks for Artificial intelligence and is necessary for anyone who wants to contribute to the field.

There are multiple uses of Linear algebra in Artificial intelligence and here are a few of them:

1) Linear algebra is key to understanding calculus and statistics that are needed in machine learning.

2) Understanding linear algebra in multiple dimensions creates an understanding of vectors that improve your intuition in how machine learning works.

3) Linear algebra also creates a deeper understanding of algorithms that allows us to customize its applications an use it more efficiently

4) It can describe complex operations used in machine learning using the notation and formalisms

5) Linear algebra is also required for the implementation of machine learning algorithms from scratch

Arya Abhisri

Math Research

A new study shows that bees can understand zero and do basic math .Their tiny insect brains may be capable of connecting symbols to numbers. Researchers have trained honeybees to match a character to a specific quantity, disseminating that they are able to associate a symbol with a numerical amount.

It's a finding that sheds new light on how numerical abilities may have evolved over millennia' and even opens new possibilities for communication between humans and other species. The discovery found bees get the concept of zero and can do simple arithmetic, also points to new approaches for bio-inspired computing that can replicate the brain's highly efficient approach to processing.

While humans were the only species to have developed systems to represent numbers, like the Arabic numerals we use each day, the research shows the concept can be grasped by brains far smaller than ours. We take it for granted once we've learned our numbers as children, but being able to recognise what &'4' represents actually requires a sophisticated level of cognitive ability.

Studies have shown primates and birds can also learn to link symbols with numbers, but this is the first time we've seen this in insects. Humans have over 86 billion neurons in our brains, bees have less than a million, and we're separated by over 600 million years of evolution. But if bees have the capacity to learn something as complex as a human-made symbolic language, this opens up exciting new pathways for future communication across species.

Mini brains, maximum potential: what the bees learned

Studies have shown that a number of non-human animals have been able to learn that symbols can represent numbers, including pigeons, parrots, chimpanzees and monkeys. Some of their feats have been impressive -- chimpanzees were taught Arabic numbers and could order them correctly, while an African grey parrot called Alex was able to learn the names of numbers and could sum the quantities. The new study for the first time shows that this complex cognitive capacity is not restricted to vertebrates.

The results have implications for what we know about learning, reversing tasks, and how the brain creates connections and associations between concepts. Discovering how such complex numerical skills can be grasped by miniature brains will help us understand how mathematical and cultural thinking evolved in humans, and possibly, other animals. Studying insect brains offers intriguing possibilities for the future design of highly efficient computing systems. When we're looking for solutions to complex problems, we often find that nature has already done the job far more elegantly and efficiently. Understanding how tiny bee brains manage information opens paths to bio-inspired solutions that use a fraction of the power of conventional processing systems.

Tanush Sawhney

Arrow's Impossibility Theorem

After the 2019 general elections, politics has been the topic of discussion in recent times. Some have criticised the return of the ruling party a second time, while some favour it. For the Lok Sabha elections in India, plurality voting system is used, in which the party with the majority forms the government.

While, for electing the President of India, the two-round runoff system is used. In this system, whoever gets more than 50% of the votes wins. If no party manages to get the required number of votes, then another round of elections are held between the top two vote- scoring parties. There
are a lot of voting systems used all around the world.

The major ones include Plurality, Two-round runoff, Instant runoff and the Borda count. Kenneth Arrow, an American economist, mathematician and political theorist, devised a theorem, known as the Impossibility Theorem or Arrow's paradox, which stated that there is no ranked voting electoral system in a democracy with 3 or more distinct alternatives (choices) that meets the specified sets of criteria. The criteria are:-

- Unanimity, which means if every voter ranked X over Y, then the final ranking will also rank X over Y

- Independence of irrelevant alternatives, which means that the ranking of Z should not affect the relative position of X and Y, ranked by the group

- Non-dictorial, which means that the preference of a single voter should not determine the group preference

Proof shows that none of the above voting systems meet all the criteria given. This shows that none of the voting systems meets the group preference. Kenneth Arrow said once that "One way of looking at Impossibility Theorem is that we proposed some criteria for what a good system should be: what is it you want from a voting system, and impose some conditions. And then ask: can you have a voting system that guarantees that?"

Gunika Singh
IX-F

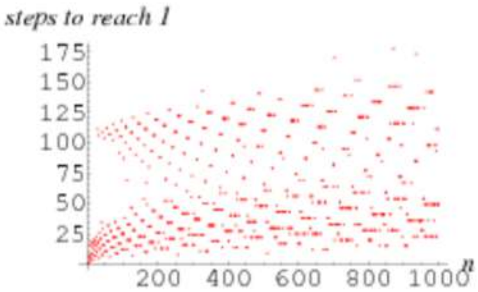
Mathematic Phenomenon

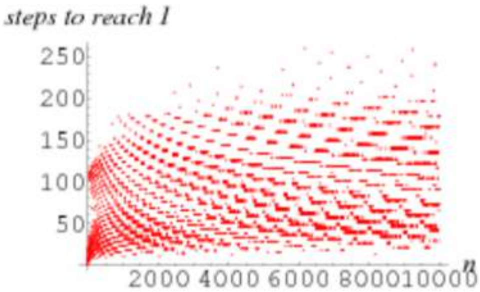
Mysteriour Path of 1

Do you like to play with numbers? If yes, then this is the game for you. Create a sequence or list of numbers using the following rules:

- Start with any integer, let's call it x.
- Now, if the integer is odd, then multiply it by 3 and add 1 to the result i.e. (3x+1) to get the next number in the sequence.
- If the integer is even, divide it by 2 to get the next number in the sequence i.e. x/2.
- Keep repeating it for each term.
- Take different integers and create sequences with them.

Resulting sequences will astonish you!
Let's play this game together starting with 3. Since 3 is odd, we will multiply it by 3 and add 1 to get the next term. Therefore it will be (3 X 3) + 1= 10
Now as 10 is even, we will divide it by 2 to get the next number. 10/2=5
As 5 is odd, so (3X5)+1=16
Continuing this pattern, we get the following sequence
3,10,5,16,8,4,2,1
Similarly if we start with 5 then,
5,16,8,4,2,1
If we start with 6 then,
6, 3,10,5,16,8,4,2,1
Or 10 then, 10, 5,16,8,4,2,1





Notice that in all the above series we eventually arrive at 1! Isn't it mystifying?

In mathematics, the fact that this specific type of sequence always appears to arrive at 1 (irrespective of integer we start with) is called the Collate Conjecture.

The collate conjecture is a fascinating conjecture in mathematics. Proving the conjecture is said to be the most difficult problems in mathematics. Paul Erdos, a well known mathematician once said that 'Mathematics is not ready for such problems' when discussing the conjecture and its proof.

No matter where you start and no matter where this weird prime shuffling action of adding one takes you, eventually the act of pulling out 2s takes enough energy out of the system that you reach 1. Concluding, the collate conjecture seems to say that there is some sort of abstract quantity like 'energy' which cannot be arbitrarily increased by adding 1.

Alankrita Malhotra
9 D

The Calendar Formula

Have you ever wondered what day you were born on? Well, you could just type on the internet and get the answer in a second. But let us assume for some time that the internet never existed (assuming we could survive without it). In such a universe, it would take us hours to figure out the day on a particular date. Well, here's a formula from Vedic Maths that will help find out the day on a particular date:

$$f=k+(13m-1)/5 +d+d/4+c/4-2c$$

Here,
- f : day code (0-Sunday, 1-Monday.....6-Saturday)
- k : date
- m: month code (normal month number minus 2, March-1,April-2......Jan-11, Feb-12)
- d : last two digits of the year given (20***19***)
- c : first two digits of the year given (***20***19)

If the month code is 11 or 12 (Jan or Feb), the predecessor of the year is taken.

In the division part, for example: d/4, only the quotient is considered and the remainder is ignored. This means that 19/4 will just be considered as 4.

If the value of F comes to be more than 6, then we can divide the number by 7, and consider the remainder as the day code. And if it's negative, we have to keep adding 7 to the number until it becomes positive.

Phew, this must seem complicated, but try this out!

Gunika Singh
IX-F

Problems of the Month

Problems to Think About...

Beginner

1) When Nick shoots a basketball, he either sinks the shot or misses. For each shot Nick sinks, he is given 5 points by his father. For each missed shot, Nick's Dad takes 2 points away. Nick attempts a total of 28 shots and ends up with zero points (i.e., he breaks even). How many shots did Nick sink?

2) Joan is an experienced jigsaw puzzler. On average, she will correctly place a puzzle piece every 30 seconds.
   a) How long in hours, should it take Joan to finish a 3000 piece puzzle?
   b) How long in hours and minutes, should it take Joan to finish a 10 000 piece puzzle?
   c) Joan works on a puzzle from 7:00 p.m. to 9:00 p.m. every weekday. (She does not work on her puzzle on Saturday or Sunday.) If she started a new 10 000 piece puzzle on January 15, 2020, on which date would she finish

Intermediate

1) A bag contains circular disks. In the bag, there are 5 blue disks, 6 red disks, 3 green disks and 2 yellow disks. Several orange disks are added to the bag. All the disks in the bag are identical except for colour. A disk is now randomly selected from the bag. The probability of a blue or green disk being selected is now 2/7 . How many orange disks were added to the bag?

2) Don Ater and Cole Lector have a team fundraising goal that they are determined to reach. The team goal is 60% more than the amount Don has raised and 80% more than the amount Cole has raised. After Don and Cole combine the amounts they collected, what percentage (correct to one decimal place) above their goal did they collect?

Advanced

1) Determine a_n if $a_n+1=2a_n+n$ and $a_0=1$.

2) How many different sums are possible if ten standard dice are rolled?

3) A spinner is divided into 15 equal sections. Each section is coloured either red, green, or yellow. An arrow is attached to the centre of the spinner. Jordan spins the arrow 3 times. If there is a 48.8% chance of landing on red in at least one of the three spins, how many red sections are there?