How wrong is rwong mathematics ?

$$\frac{26}{65} = \frac{2\not{6}}{\not{6}5} = \frac{2}{5}$$
$$\frac{19}{95} = \frac{1\not{9}}{\not{9}5} = \frac{1}{5}$$
$$\frac{49}{98} = \frac{4\not{9}}{\not{9}8} = \frac{1}{2}$$

Is this right ? Or, is this wrong ?
Why ?

S. Parthasarathy
drpartha@gmail.com

How wrong is wrong mathematics ?

by S. Parthasarathy

Code: WRON – 45 – 122023hbb

First Published: June 2023

This book was created by the above author, using FOSS tools and LaTeX

Cover designed and created by the author.

Published by: S. Parthasarathy, Secunderabad, India.

Contents

Chapter 1

Synopsis

How wrong is wrong mathematics ?

This book is a sequel to the earlier book "Mind your mathematics" by this same author [1]. Read [1] before reading this current book.

The book *How wrong is wrong mathematics ?* is a collection of study material to help you while you explore and understand mathematics. It gives a curated list of reasons why your maths can go wrong, and the pitfalls you should avoid. It can be useful to you regardless of whether you are a student or teacher or a user of mathematics. Rather than examine case studies of the damage caused by wrong mathematics (see [6], [7]), this book examines some generic causes which lead to wrong mathematics. It avoids gory mathematical details and terminology, to help you appreciate mathematics.

The best way to explore and enjoy this book is to start from the "curtain raiser" webpage [13]:

https://drpartha.org.in/profpartha/wrongbook.htm. To make your discoveries easier, read the Synopsis (7 pages only) first. To make it easier for you appreciate this book, a generous list of bibliographic references, and an alphabetic index and TOC is given in this book. Click-sensitive hyperlinks make it easy for you to locate resources from the w-w-web.

Chapter 2

Mathematical systems

In this book, we present an overview of what a mathematical system is and how logic plays an important role in them.

Roughly, a mathematical system can be defined as follows.

Mathematical System: A mathematical system consists of:

- A set or universe, U.
- sentences

  Sentences explain the meaning of concepts that relate to the universe. Any term used in describing the universe itself is said to be undefined. All definitions are given in terms of these undefined concepts of objects.
- Axioms: assertions about the properties of the universe and rules for creating and jus-

tifying more assertions. These rules always include the system of logic that we have developed to this point. A fundamental condition for axioms is that the set of axioms used in a given context should be consistent.

- Theorems: the additional assertions mentioned above.

  A true proposition derived from the axioms of a mathematical system is called a theorem. A proof of a theorem is a finite sequence of logically valid steps that demonstrate that the premises of a theorem imply its conclusion. By extension, any theorem is proved on the basis of premises which may include other proven theorems and axioms (which are accepted without proofs).

Mathematical systems may be classified according to the underlying mathematics. Each branch of mathematics has its own collection of building blocks: universe of discourse, definitions, statements and rules, propositions, axioms, theorems. Any mistake in the use of any of the above, can result in erroneous mathematics.

Example : Euclidean Geometry

In Euclidean geometry the universe consists of points and lines (two undefined terms). Among the definitions is a definition of parallel lines, and among the axioms is the axiom that two distinct parallel lines never meet and Euclid's postulates [15].

Chapter 3

A comedy of errors

Mathematics is a rich and extensive domain. There are almost endless and innovative ways where you can go wrong with mathematics. In fact, maths itself cannot go wrong. Strictly speaking, maths can never be wrong. "Wrong mathematics" is a self-contradicting expression. By its genesis, maths can never go wrong. Every statement/rule in maths is build over existing rules/statements, each of which is built over existing rules/statements (aka axioms, theorems) which are themselves proven or accepted as true . It is not that maths is wrong, we are the ones who tried a wrong way to use maths. For example, in the above list, we used a list which does not match the claim made by the opening statement.

Maths blunders are seen everywhere. Sometimes they could have very expensive consequences [7]. That is why it makes sense to be cautious when dealing with mathematics.

Every concept in maths is recursively built over axioms and previously proven theorems. Any operation which causes a conflict or violates any of the founding axioms is reason enough for leading to what we call as wrong mathematics. One trespass is enough. All that follows will crumble like a castle made from a pack of cards. Any error we make in using maths will end up in a statement which contradicts or violates one or more of the basic axioms over which maths is built, and therefore lead us to ridiculous situations. Notice that the final answer you get may not be absurd, even if the steps you took were not right. This fact is illustrated in the cover page. We will now study the common reasons which cause the so-called "wrong mathematics".

You do not have to be a maths guru to commit any of the sins which lead to so-called wrong mathematics. A satirical overview of how mathematicians make it easy for others to fall into the habit of creating so-called wrong mathemaics may be found in [2] and [3]. Mistakes like this, make you go wrong until you are hopelessly lost and cannot find your way out.

Note: For reasons of brevity, we will call all "so-called-wrong mathematics" simply as "wrong mathematics".

3.1 Sources and categories

To err is human. Mathematics gives ample opportunity to realise this fact of life.

A combination of these **five** strategies can yield many innovative ways of creating wrong mathematics :

1. Careless usage of mathematical concepts
2. Blatant errors in usage of mathematical laws/rules
3. Reckless dropping names in mathematical texts
4. Shabby/shoddy usage of symbolic expressions

(Did you notice the error in the above list ?)

We can categorise the above as :

- Careless Errors
- Computational Errors
- Conceptual Errors

3.1.1 Careless usage

Albert Einstein once said: “Numbers don’t lie, but it’s easy to lie about them”

Sometimes, to give an impression of precision, we add needless mathematical concepts (usually numbers) to our daily conversation.The opening sentence of this Chapter is already an example of such usage. We are all familiar with the claim made by many marketing campaigns of cleaning agents (e.g. toothpaste) which claim to eliminate “99.9% of all the germs in your mouth” .

Here are a few common masterpieces :

1. It is 99.9 % done.
2. It is 50 % cheaper here.

3. A “steep” learning curve.

4. 99 % reliable.

5. 99 % of the days, this train comes in time.

6. There is a 30% chance of rain today.

7. Well begun is half done.

The list can go up to infinity (really ?). When we recklessly build up on such insanity, we create an Eifel Tower of wrong mathematics.

Somehow it seems honest, precise and believable when we throw in numbers. Yet, we indulge in “Lies, damned lies, and statistics” to use the persuasive power of statistics to bolster weak arguments. In fact, numbers form the raw material for creating pseuo-sciences like numerology, and astrology. After all, since numbers can never go wrong, these pseudo-sciences are also considered infallible.

3.1.2 Blatant errors

You can generate erroneus results by simple mistakes in using mathematical rules and laws. For instance, you may say

$$5 * 3 = 53$$

and build up on this mistake, do reach dramatic disasters. There may be many other subtle variants of this mistake. There are some more examples are given on the very first page of this book.

3.1.3 Reckless generalisations

In mathematics, induction is a powerful tool for proving things. Induction moves from a provable statement and extends it to more general levels. This can sometimes be fatal. Here is a common case study.

Let us list odd numbers starting from 1. We get

$$1, 3, 5, 7 \ldots$$

Notice that in the above list, all the numbers are also prime. We can generalise the above to claim that *all odd numbers are prime.* But a difficulty comes in when we extend the above sequence. The next obvious term in the above sequence would be 9, which is very obviously NOT a prime !

3.1.4 Reckless dropping names

A common source of confusion in maths comes when we use Proper names in mathematical texts, giving a pedantic touch to our narrations. For instance, every school child will understand us when we talk about Pythagoras' theorem (aka Pythagorean theorem). Ask them, or their teachers about Heron's formula, and you are most likely to get some bewildering silence. Both of these theorems pertain to triangles, but only one applies to all triangles (Heron's formula) whereas the other holds only for right-angled triangles (Pythagoras' theorem). An inappropriate choice could lead to inevitable errors.

An intriguing example of name dropping appears in " Fermat's last theorem " (see next section).

The potency of this theorem does not decrease if we choose to avoid the enigmatic name "Fermat" or the mysterious adjective "last". How many of us will relate this theorem to Fermat's "little" theorem ?

3.1.5 Shoddy usage of expressions

It is claimed that symbols are used in maths, to avoid ambiguities and misinterpretation.

Here is a simple example:

This is an intriguing story of what is called as Fermat's "last" theorem. It is strikingly similar to Pythagoras' theorem, and it challenged mathematicians for more than a century before it could be proved mathematically. The theorem can be stated as follows:

> *There do not exist four positive integers, the last being greater than two, such that the sum of the first two, each raised to the power of the fourth, equals the third raised to that same power.*

In case you are trying to figure out what that means, take a look at a mathematical version of the same statement:

> There do not exist positive integers x, y, z, and n, with $n > 2$, such that $x^n + y^n = z^n$.

Which version is clearer, concise and less confusing ? You be the judge. This is an example of symbolic expressions which make maths easier to understand and avoid errors.

Mathematical symbols fall into one of two large categories [10]:

- Alphabetical symbols (alphabet of any language)
- Geometric glyphs

Alphabetic symbols: The most striking symbol is the one we use to denote the set of integers $\mathbb{Z}$. many people do not know that the letter $\mathbb{Z}$ comes from the German word Zahlen(numbers). To make matters worse, we borrow heavily from many languages, especially Greek. A commonplace example would be π as used in the expression:

$$A = \pi * r^2$$

A pot-pourri of the two, can often become a lethal concoction.

Glyphs: Add to all this mess, the weird geometric shapes which are blended into symbolic expressions. Do they always improve clarity ? The answer is debatable.

Not all symbolic expressions are unambiguous. Symbols are also used, to confuse the reader and obfuscate the message we wish to give. Moreover, symbols do not guarantee the correctness/disambiguity of the underlying mathematics.

Here is a school-level example [4] :

QUESTION : $What\ is\ 6 \div 2 * (1 + 2) = ?$

$6 \div 2 * (1 + 2) =$
$6 \div 2 * (3)$
$= (6 \div 2) * 3$
=3x3 =9

Look at it another way:

$6 \div 2 * (1 + 2) =$
$6 \div 2 * 3$
$= 6 \div (2 * (3))$
$= 6 \div 6$
=1

The confusion arises because of the absence of parantheses at the appropriate places and an ambiguity in the precedence rule called PEMDAS [4]. Adding parentheses to force precedence can lead to conflicting results, as shown above.

Then we have people who add symbols recklessly, to create undecipherable junmbles of expressions. You get the same effect when you put a monkey in front of a piano keyboard.

3.1.6 Ignoring the fine print

Every mathematical rule has limits. Sometimes these limits are not explicitly or prominently mentioned. Trespassing these limits can lead to "wrong mathematics".

One of the first few things they taught us at school was how to multiply and divide numbers. They also taught us a lot of frightening things like multiplication tables, and division. But they did not tell us about the fine print of division, the perils of dividing by zero.In fact, whenever we make a division operation, it is necessary to make sure that the denominator is not zero (we often take this part for granted).

This reminds us of an episode in Ramanujan's life when he cornered his maths teacher with an innocent question about sharing zero fruits (or whatever) between zero children [11].Later on life, we learnt about the evil twin brother of zero – infinity and the paradox involving lodging an infinite number of guests in a hotel having an infinite number of rooms [8]

3.2 Some dramatic disasters

Maths–related errors may not be always harmless [7] or unnoticeable. Here are just a few case–studies derived from [7] .

These examples prove that mathematics- related blunders know no nationality or boundaries. It does not need a Nobel-winning brain to commit such blunders. Just like one wrong note can ruin an entire orchestra, simple errors can cascade into formidable disasters (as shown in these case–studies).

1. **Gulf war scud missile disaster**

   This disaster falls under the computational error category. On February 25, 1991, an Iraqi Scud missile struck a US Army base in

Dharan, Saudi Arabia, killing 28 soldiers and injuring 100 others. The error was traced to the software powering the clock of the system. The clock recorded time in deciseconds (one tenth of a second) but stored that data as an integer. It converted the time into a 24-bit floating point number to do this. However, rounding the times in order to convert them led to gradually increasing inaccuracy as the system operated. As a result, the system was not able to intercept missiles after 20 hours of continuous use. Historians add that the effect of the wind was worsened by the fact that the top of the ship was heavier than its bottom.

Here is an example which belongs to the carelessness category.

2. **Spains S-80 Submarine Program**

   This incident is one more example in the computational error category. The submarine ended up heavy after someone put a decimal point in the wrong spot during calculations. 70 tons heavier than it should have been. The Spanish navy feared the submarine would never surface if it went underwater. No one discovered the error until the first submarine was completed, and the other three were already under construction. Spain later signed a $14 million deal to help them reduce the weight of the 2,200-ton submarine.

3. **Air Canada Flight 143**

   In July 1983, an Air Canada Boeing 767 flying from Ottawa to Edmonton with 69 passengers and crew had to crash-land after running out of fuel at 12,500 meters (41,000 ft). The engines suddenly lost power, and the airplane started gliding to the ground. It glided for 100 kilometers (60 mi) before landing in Gimli, Manitoba. It came down on a racetrack that had originally been a runway. Luckily, there were no deaths. However, two people had minor injuries, and the nose gear was destroyed.

4. **Sinking Of The Vasa**

   On August 10, 1628, Sweden launched a new, heavily armed, and large warship: the Vasa. The vessel had barely sailed for 20 minutes when it sank less than a mile from shore. Historians measured the entire ship and discovered that its builders used two different units of measurement. One was the Swedish foot, and the other was the Amsterdam foot. A Swedish foot is 12 inches, while an Amsterdam foot is 11 inches. Historians add that the effect of the wind was worsened by the fact that the top of the ship was heavier than its bottom.

5. **Mars Climate Orbiter Crash**

   One more example of carelessness : The Mars Climate Orbiter was a $125-million joint project between Lockheed Martin and NASA/JPL. The project suffered an embarrassing end when the orbiter most likely crashed into Mars due to a simple conversion error in 1999. Lockheed Martin used the imperial system of measurement while programming software, but NASA used the metric system.

6. **Ariane 5 Rocket Explosion**

   On June 4, 1996, the European Space Agencys Ariane 5 rocket exploded 37 seconds after takeoff. Onboard the spacecraft were four satellites. The rocket and satellites cost $370 million. The accident was traced to an integer overflow error in the software used for launching the rocket.

   An integer overflow is a mathematical error that occurs when the figures generated by a system exceeds the memory of that system. The European Space Agency used the same software theyd previously used in Ariane 4 rockets. They had problems with the Ariane 5 because it was faster than the Ariane 4. Faster means larger figures. The software could not handle the large readings, causing the rocket to go rogue. Ground control ordered it to self-destruct.

7. **Bank Of Americas Dividend Payments And Stock Buybacks**

   Stress tests are necessary to determine if a bank is healthy enough to overcome a terrible recession or financial crisis.

   In 2014, Bank of America revealed that it had passed a Federal Reserve stress test for the first time since the 2008 financial crisis. The bank added that it was going to pay dividends to its shareholders and buy back $4 billion worth of stock. The bank later retracted the statement and revealed that it had made some mistakes.

Bank of America had not passed the stress test. It only thought it did because it had made a mistake in determining the values of some bonds owned by its subsidiary, Merrill Lynch. Shareholders werent happy, and the stock of the bank fell by $9 billion (five percent of its total value) the same day the error was revealed.

8. **The Laufenberg Bridge Problem**

   A while back, Germany and Switzerland agreed to build a bridge over the Rhine between their cities on either side, both named Laufenburg. As per the agreement, each country would start construction from their side of the river and meet in the middle. The bridge was nearing completion in 2003, when both nations realized that one half of the bridge was 54 centimeters (21 in) higher than the other.

   The error came up because of how each country defined the term sea level. Most countries have different methods of determining the sea level, considering that its not the same everywhere. Germany uses the North Sea to define its sea level, while Switzerland prefers the Mediterranean sea.

   There was a difference of 27 centimeters between the countries respective sea levels. Germany and Switzerland knew this, and had factored it into their calculations. However, someone did so in such a way that the disparity was doubled, causing one side of the bridge to rise by 54 centimeters more than it should have.

9. **Frances Oversized Train Problem**

   In 2014, Societe Nationale des Chemins de Fer francai (SNCF), Frances state railway operator, discovered its new high-speed trains were too wide for 1,300 stations across the country.

   Canard Enchaine, a weekly satirical paper, made a cartoon in which commuters on a platform were told to pull in their stomachs as one of the new trains approached the station.

   The error cost millions of euros. The error was noticed too late, as some trains had been delivered, and more were under construction.

10. **The Amsterdam City Councils 188 Million Housing Benefits Error**

    In December 2013, the finance office of the Amsterdam city council sent out 188 million to over 10,000 poor families living in the city. The city later discovered that it had made an error in the payments. It originally planned to send 1.8 million and not 188 million.

    The payment software was programmed in cents and not euros. Surprisingly, no one noticed the blunder until it was too late ! People received 15,500 instead of 155 and, in one case, 34,000 instead of 340.

11. **The Y2K problem**

    A recent nightmare shook the entire world due its potential to destroy the whole world. Y2K is a numeronym and was the common abbreviation for the year 2000 software problem. The acronym Y2K has been attributed to Massachusetts programmer David Eddy in an e-mail sent on 12 June 1995. He later said, "People were calling it CDC (Century Date Change), FADL (Faulty Date Logic). There were other contenders. Y2K just came off my fingertips." The year 2000 problem, also commonly known as the Y2K problem, Y2K scare, millennium bug, Y2K bug, Y2K glitch, Y2K error, or simply Y2K, refers to potential computer errors related to the formatting and storage of calendar data for dates in and after the year 2000. Many programs represented four-digit years with only the final two digits, making the year 2000 indistinguishable from 1900. Computer systems' inability to distinguish dates correctly had the potential to bring down worldwide infrastructures for computer reliant industries. The scare affected all computational machinerry from cash registers to main-frame computers to banking servers.A lack of clarity regarding the potential dangers of the bug led some to stock up on food, water, and firearms, purchase backup generators, and withdraw large sums of money in anticipation of a computer-induced apocalypse.

Fortunately, the computer world woke up early enough to fix the sleeping monster before it could cause any real disaster. All software and the systems where they would run were sanitised carefully and appropriate patches were applied, much before the 21st Centrury was born.

12. **Economic bubbles**

A more virulent disease stuck various sectors of the economy, and caused unmeasurable misery worldwide due to sudden and unexpected slumps in the economy. One such bubble, nicknamed the dotcom bubble, almost killed the information technology sector. Many enterprises were shut down, and many people lost their jobs. There was obviously major failures by statisticians and economists in the predictions they had made.

13. **International Day of Mathematics (IDM)**

The International Day of Mathematics (IDM) is a worldwide celebration, celebrated each year on March 14 in all countries [16]. It is a classic blunder promoted by the International Mathematics Union (IMU) :

- The date 3/14 is a weird date format used in USA, but here we use it for an "International" event.
- 3.14 is a very crude approximation for π. Mathematics is known for its adherence to precision, but here we choose an amputated value to represent IDM.

It is unusual for IMU, the Headquarters for all mathematics activities, to commit such a blunder. Instead of choosing π for denoting IDM, some people advocate a τ day to represent the IDM [17]. Not that τ is a better choice than π for IDM, since they both suffer from the same birth defects. Whichever way we choose, IDM remains to be a glaring example of wrong mathematics promoted by some right mathematicians.

The list can go on. Add to the above list, the jaw-dropping volume of errors in maths books for school children and teachers. Included among the blunders are incorrect computations and answer keys in the student versions of the books ! A macabre companion to this list [9] gives how many mathematicians found their end under unfortunate / unnatural circumstances.

Chapter 4

The humble pie

Matt Parker [6] presents a whole lot of miseries caused by maths-related lapses. In addition, we have two cases specifically related to pi given below: See Sec.4.1 and Sec.4.3.

4.1 The notorious pi

“ Pi is God’s telephone number. ”
– Alexander Graham Bell

Mathematicians seem to be a crazy tribe which prefers weird notations when there are easier and good-looking notations available. The case of units for angles is an excellent example. Or, is it ?

We saw in an earlier article why dividing a circle into 360 degrees was a bad idea[1], born out of an astronomical blunder and ignorance. We need a less

[1] https://bit.ly/3ytq5PH

defective (in origin) measure of angles. Enter **radian**, a unit for angles, defined by the international body SI.

The radian (SI symbol rad) is the SI unit for measuring angles, and is the standard unit of angular measure used in many areas of mathematics.

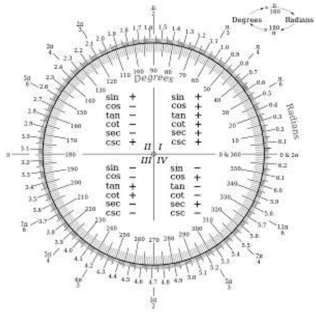


Figure 4.1: Convert degrees to radians

By definition, the length of an arc of a unit circle is numerically equal to the measurement in radians of the angle that it subtends. Since the circumference C of a circle of radius r is given by: $C = 2\pi r$, the complete circle subtends an angle of 2π radians. Thus a semicircle subtends π radians (which corresponds to 180°). Since π radians = 180° , we get the simple relation between radians and degrees as 180° / π = 57.295779513° .

We can thus move from degrees to radians (and back) by a simple arithmetic operation. However, in daily use, it is still more convenient to divide a circle into degrees. It is always easier to handle whole numbers (integers) rather than clumsy fractional numbers. The debate is similar to the choice between using metric units of length (metres) and imperial units (feet, inches). We still talk of milestones and not kilometrestones ! There is however, a (in fact, many) very good mathematical reason(s) why radians are used so commonly in mathematics and physics.

Radians are the most useful angular measure in calculus (and trigonometry), since radians have a mathematical "naturalness" that leads to a more elegant formulation of a number of important results. Most notably, results in analysis involving trigonometric functions are simple and elegant when the functions' arguments are expressed in radians.

They allow derivative and integral identities to be written in simple terms, For example,

$$\frac{d}{dx}\ sin(x) = cos(x)$$

for x measured in radians. With angles as radians, computation of areas, volumes and limits become straight forward.

The trigonometric functions also have simple and elegant series expansions when radians are used. For example, the following is the Taylor series for sin x (x in radians) :

$$\sin x = \frac{x^1}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} + \cdots .$$

If x were expressed in degrees, then the series would contain messy factors involving powers of $\pi/180$.

The following equation (Euler's identity) , considered to be the most lovely equation in mathematics :

$$e^{i\pi} + 1 = 0$$

would become a horrible-looking mess, if we use degrees in the exponent.

4.2 How big is π ?

If π radians make 180° , then how big is π exactly (expressed in decimal digits) ?

The history of calculating the value of π is long. The decimal approach to pi is an endless rabbit hole, but people have followed it right down to the present day. Now, of course, computers are used, and gazillions of decimal places have been computed. For a really long time, math wizards have been on a quest to figure out pi. Back in ancient times, folks like the Egyptians and Babylonians needed a decent pi for practical math stuff. Around 250 BC, a Greek math whiz named Archimedes came up with a cool way to get pi super accurately. Jump to the 5th century AD, and Chinese math buffs got right to seven digits, while Indian math brains hit five digits, both using cool geometric tricks. It took about a thousand years more for someone to discover a nifty formula for based on a never-ending series. In more recent times, the Indian genius Raamanujan had an innovative and interesting expression for $1/pi$ as an infinite sum .

The symbol π itself was introduced by William Jones in 1706, but not used universally until the late 19th century.

The first, and worst, estimate is $\pi= 3$, sometimes attributed to the Bible. This value comes from Kings 7:23, which mentions a "molten sea" made by King Solomon, "ten cubits from brim to brim" such that "thirty cubits would encircle it completely." If we assume that the object being encircled is indeed circular, this implies that $\pi = 3$.

Some school teachers make the classic blunder of writing (and teaching) $\pi = 22/7$, whereas they should be strictly using $\pi \approx 22/7$. They forget the fact thatπ is irrational. Writing it as p/q (where p, q are integers) would be a crime.They are usually ignorant of the fact there is a much better approximation to π. The value 355/113, due to the Chinese mathematician Zu Chongzhi in the 5th century CE, gives the value of π correct to six decimal places. Like Archimedes, Zu approximated the circle by polygons and knew that he had not found the exact value of π. The idea of approximating the circle by a polygon with a large number of sides can be pushed as far as one has patience to carry out the calculations involved. For a long time the record holder was Ludolph van Ceulen, an otherwise obscure 16th-century Dutch mathematician who calculated the first 35 decimal places of π by this method. Van Ceulen was remembered by the term "Ludolph's number" for π, long after his record had been surpassed.

It is, in any case, futile to write π in decimal representation, since π is "transcendental". The fractional part, written in decimal can go on forever. It is like trying to hold a million-legged octopus. π can be used as such, without ever having to express it as an approximation of the form p/q (remember π is irrational), or expressing it as a number with decimal digits (remember π is a transcendental number).

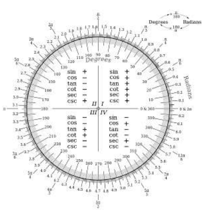
The downside of radians: Radians are admittedly clumsier than degrees. It is not easy to subdivide a radian into smaller, integer parts (like 1/3, 1/,4, 1/5, 1/6 etc.). Remember, π is an irrational number.

Moral of the story : Degrees are for schoolchildren, radians are for adults.

Closing remarks : Constructive comments, remarks and suggestions are always welcome.

4.3 A historic blunder

How a historical mathematical blunder is celebrated worldwide every year, and no one is complaining.



The New Year, according to our common Gregorian calendar, is celebrated on the 1st January every year. Mathematicians use this as an excuse to justify their biggest blunder ever. On every 1st Jan. they say, the earth just completed going around the sun once. We have just seen 365 (or 366) sunrises, since the last new Year's Day. There goes a story many of us have not heard of, or have forgotten. Early mathematicians who invented the science of "geometry""decided to divide a circle into 360 degrees. The word geometry itself is inspired from "geo" – earth, "metry"– measurements (just like the geo in geo-graphy, or geo-logy). They saw the earth going around the sun in some 360 days (according to their crude and primitive measurements).

Although, later this was proved wrong, we continue to stick to the 360 degrees rule of circles (each degree reminds us of one day in earth's annual excursion), a big blunder which the world has accepted since ages. So, every time we celebrate New Year, we must think of this historic blunder which we made several centuries ago.

Subsequent generations of mathematicians, corrected all this, giving rise to a bewildering variety of calendars. A good collection of calendar related information can be found at :::
http://www.hermetic.ch/cal_stud.htm

The science of geometry grew into the science of astronomy (now we start looking at the stars and planets). We have now come to the stage when we can actually hope to visit these celestial bodies and even colonise them !

Our common era (CE) calendar is a result of successive mathematical blunders and corrections and alterations. A whole Chapter is devoted to this "comedy of maths errors" in Matt Parker's book [6].

Is'nt it incredible that all this started with a faulty premise of 360 degrees to a circle ?

***

Chapter 5

Proof of the pudding

Proof is the heartbeat of mathematics. If you want your maths to be error-free, you must often use proof. Proof involves classifying any logical /mathematical statement into one of the two categories: True, False. Every proof can, in principle, be constructed using only certain basic or original assumptions known as axioms, along with the accepted rules of inference. The only peril involved would be that the proof itself may be wrong.

There are many ways to win an argument: argue using logic, or use any of the following fallacious proof strategies [12] . Using fallacious logic may leadd you to prove as true, any false statement. Or, it may lead you falsifying a fact. Either of the lapses can lead you to disasterous consequences.

Logical fallacies are likely as old as language itself, but they were first recognised and cataloged as such in the Nyaya-Sutras, the foundational text of the Nyaya school of Hindu philosophy.

The Greek philosopher Aristotle also wrote about logical fallacies and catalogued them. Being able to identify logical fallacies in others writing as well as in your own, will make you a more critical thinker, which in turn will make your mathematics more credible.

5.1 Wrong logic vs fallacious logic

5.1.1 Wrong logic

Using a wrong proof we can obtain incredible results. For instance, ignoring/forgetting simple maths rules can lead to weird consequences, like in the example below:

$$\begin{aligned}
-1 &= i \cdot i \\
&= \sqrt{-1} \cdot \sqrt{-1} \\
&= \sqrt{-1 \cdot -1} \\
&= \sqrt{1} \\
&= 1
\end{aligned}$$

By building on the above it is easy to prove that any number equals any other number, say $17 = 19$

.

5.1.2 Fallacious Logic strategies

The lengths to which people go, when they run out of logic and reason, is aptly depicted by a popular cartoon by Sydeny Harris [12]. These fallacious proofs apply to mathematics as well as common language.

1. Ad hominem

   An ad hominem fallacy is one that attempts to invalidate an opponents position based on a personal trait or fact about the opponent rather than through logic.

   Example: This theorem is wrong because the author does not brush his teeth daily.

2. Red herring

A red herring is an attempt to shift focus from the debate at hand by introducing an irrelevant point.

Example: Losing a tooth can be scary, but have you heard about the Tooth Fairy?

3. Straw man

   A straw man argument is one that argues against a hyperbolic, inaccurate version of the opposition rather than their actual argument. This strategy is similar to using a mythical and invisible scarecrow to divert the argument.

   Example: Erin thinks we need to stop using all plastics, right now, to save the planet from climate change.

4. Equivocation

   An equivocation is a statement crafted to mislead or confuse readers or listeners by using multiple meanings or interpretations of a word or simply through unclear phrasing.

   Example: While I have a clear plan for the campus budget that accounts for every dollar spent, my opponent simply wants to throw money at special interest projects.

5. Slippery slope

   With a slippery slope fallacy, the arguer claims a specific series of events will follow one starting point, typically with no supporting evidence for this chain of events.

Example: If we make an exception for Bijals service dog, then other people will want to bring their dogs. Then everybody will bring their dog, and before you know it, our restaurant will be overrun with dogs, their slobber, their hair, and all the noise they make, and nobody will want to eat here anymore.

6. Hasty generalisation

   A hasty generalisation (see Section 3.1.3) is a statement made after considering just one or a few examples rather than relying on more extensive research to back up the claim. It is important to keep in mind that what constitutes sufficient research depends on the issue at hand and the statement being made about it.

   Example: All odd numbers are prime (see Section 3.1.3)

7. Appeal to authority

   In an appeal to authority, the arguer claims an authority figures expertise to support a claim despite this expertise being irrelevant or overstated.

   Example: If you want to be healthy, you need to stop drinking coffee. I read it on a fitness blog.

8. False dilemma

   A false dilemma, also known as a false dichotomy, claims there are only two options in a given situation. Often, these two options are extreme opposites of each other, failing to acknowledge that other, more reasonable, options exist.

Example: If you don't support my decision, you were never really my friend.

9. Bandwagon fallacy

   With the bandwagon fallacy, the arguer claims that a certain action is the right thing to do because its popular.

   Example: Of course its fine to wait until the last minute to write your paper. Everybody does it!

10. Appeal to ignorance

    An appeal to ignorance is a claim that something must be true because it hasnt been proven false. It can also be a claim that something must be false because it hasnt been proven true. This is also known as the burden of proof fallacy.

    Example: There must be fairies living in our attic because nobodys ever proven that there arent fairies living in our attic.

11. Circular argument

    A circular argument is one that uses the same statement as both the premise and the conclusion. No new information or justification is introduced.

    Example: Peppers are the easiest vegetable to grow because I think peppers are the easiest vegetable to grow.

12. Sunk cost fallacy

    With the sunk cost fallacy, the arguer justifies their decision to continue a specific course of action by the amount of time or money theyve already spent on it.

    Example: I am not enjoying this book, but I bought it, so I have to finish reading it.

13. Appeal to pity

    An appeal to pity attempts to sway a reader's or listener's opinion by provoking them emotionally.

    Example: I know I should have been on time for the interview, but I woke up late and felt really bad about it, then the stress of being late made it hard to concentrate on driving here.

14. Causal fallacy (aka post hoc ergo propter hoc)

    A causal fallacy is one that implies a relationship between two things where one cant actually be proven. This is often known as "post hoc ergo propter hoc".

    Example: When ice cream sales are up, so are shark attacks. Therefore, buying ice cream increases your risk of being bitten by a shark.

15. Appeal to hypocrisy

    An appeal to hypocrisy, also known as a tu quoque fallacy, is a rebuttal that responds to one claim with reactive criticism rather than with a response to the claim itself.

    Example: You don't have enough experience to be the new leader. Neither do you!

Chapter 6

Wrapup

Details of Ramanujan, his life and his contributions can be found in [5]. Take a look.

This is a LaTeX document, created under Linux, using Kile.Texts marked in winered colour are click-sensitive hyperlinks. This document is released under a Creative Commons By Attribution - Non Commercial - ShareAlike 3.0 Unported License. You can get the LaTeX source of this document from drpartha@gmail.com. Please mention the Reference Code, and Version code, given at the top of this document.

Citation details of this book are given in [14]

If you found this text useful, or if you notice any flaws or blemishes, please send a note to the author at
drpartha@gmail.com . As always, suggestions and constructive comments are always welcome.

Exploring Ramanujan, is almost like exploring the vast oceans. This book is based on material published in several places, some of which is catalogued in the next Chapter (Bibliography). The reader is advised to refer to these resources, to get a complete picture of Ramanujan. The references marked in winered colour are click-sensitive hyperlinks (use a web-browser). cvcvcvcvvv

Chapter 7

Bibliography

[1] S. Parthasarathy,
Mind your mathematics,
https://drpartha.org.in/profpartha/MYM2book.htm.
This book borrows heavily from the above.

[2] Carl E. Linderholm ,
Mathematics Made Difficult, Pub.: WOLFE PUBLISHING LTD
10 Earlham Street London WC2
©CARL E. LINDERHOLM 1971

[3] G.H. Hardy,
A Mathematicians Apology,
Pub: University of Alberta Mathematical Sciences Society, Alberta , Canada, 1940.

[4] Presh Talwalkar,
https://mindyourdecisions.com/blog/2016/08/31/what-is-6%C3

[5] S. Parthasarathy
Remembering Ramanujan
https://drpartha.org.in/drpartha/ramanukumbak.htm

[6] Matt Parker,
Humble Pi, a comedy of maths errors,
Penguin Random House, UK, 2019.

[7] Oliver Taylor,
10 Simple But Costly Math Errors In History,
https://listverse.com/2019/08/30/10-simple-but-costly-mat

[8] Britannica,
Hilbert's hotel paradox of the Grand Hotel
https://www.britannica.com/video/186420/paradox-David-

[9] S. Parthasarathy
If you are a mathematician, read this
https://drpartha.org.in/profpartha/ifyouare.htm

[10] Gresham College,
Where do Mathematical Symbols Come From ?
https://www.youtube.com/watch?v=Edewyp87W-Q

[11] S. Parthasarathy
Glimpses of Ramanujan,
https://drpartha.org.in/profpartha/GORbook.htm

[12] Sidney Harris
You Want Proof? I'll Give You Proof!
Pub.: W H Freeman & Co (1990)

[13] S. Parthasarathy
Curtain raiser page, website of the book,
https://drpartha.org.in/profpartha/wrongbook.htm

[14] **Citation details for this book**:
S. Parthasarathy,
Glimpses of Ramanujan (GOR),
https://drpartha.org.in/publications/wrongbook.pdf.,
2023.

[15] Mathworld,
Euclid's Postulates
https://tinyurl.com/2d3rs69v

[16] IMU,
International Day of Mathematics
https://www.idm314.org/

[17] S. Parthasarathy,
Tau, or Pi ? You choose
https://drpartha.org.in/publications/tau-or-pi.pdf

***

Last Page

This page is deliberately blank, so that you can add your personal notes, if any, here.

Index

* * * WRON – 45 – 122023hbb