BOTH SACRED AND PROFANE: THE UNAUTHORISED BIOGRAPHY OF NUMBER

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Introduction

Numbers and number systems have two or more kinds of lives. First as religious, mystical, mythically significant and philosophically rich concepts to enumerate seasons and star movements and regulate rituals and sacred practices. Second as systematic means to record, compute and regulate trade, taxes, tribute in organised societies and urbanised civilisations. We now believe that it was the sacred face of mathematics that came first. How could it be otherwise?

Oral numeration precedes written number by scores of millennia and was developed as part of a set of religious, mystical and ritual practices. Oral numeration is the source of both types of number uses, both sacred and profane, but the two have probably only coexisted for less than five millennia. Since then the parallel lives of the philosophical and practical, the outer and the inner, the sacred and profane views of number and mathematics have enriched each other, and continue to do so, but they are also sometimes in conflict over their joint child, Number Theory. Who does it most resemble? Is it sacred, mystical, outwardly fecund like its mother, spawning new meanings, always describing, linking with the universe, poetic and full of sense? Or is it inward, profane, always active, a whirlpool of symbols in a meaningless syntactic dance, numerals tumbling over each other like toy acrobats in a crazed adding machine, driven forward by necessary rules, like its father? It is both, outward meaningful and inwardly symbolic, sacred and profane, the secret of the universe and the curse of the schoolchild, the love object of the mathematician and language of control of the algorithm and the App.

In philosophy and elsewhere we talk about numbers as natural, integral, rational, real or complex. But this has a very different meaning than that found in modern mathematics. For each of these everyday terms names a whole universe of different numbers that is entire unto itself. They form a nested sequence of infinite sets of numbers, different but telescoping and serially enveloping systems of mathematics. Likewise, the three exceptional numbers zero, one and infinity have very different meanings in number theory and mathematics from their corresponding concepts in philosophy and everyday discourse, let alone in religion and mysticism. Each of these concepts – for they are not numbers until they have been disciplined and regularised - brings with it a whole train of associations, connotations, mysteries and paradoxes. When they are appropriated by mathematics they must be cleansed; shorn of some of their original mystical uses and meanings in order to be functionally unambiguous. For this is what the disciplines of number theory and mathematics require. Every concept must be unambiguous, although it can have different meanings in different theories or systems. Every function, operation and application may only have one answer for each set of inputs. These restrictions mean that from a mathematical perspective number and their operations can only have, that is, must have, unique, clear and unambiguous meanings. I am transgressing this stricture here, in this account, throwing meanings around wildly, with the multiplicity and abandon of a juggler or poet let loose in the maze of arithmetic. Refusing to go in the right direction towards the single and only exit. But my wild progress, extravagant metaphors and similes, anathema to the mathematician, is philosophical not mathematical. This means that I am able to offer new meanings, new insights, new perspectives on mathematics and its queen, Number Theory.

Here and below I wish to explore some of the originary meanings, connotations and associations that enrich number concepts before they are cut off and swept under the carpet in the name of mathematical precision. For mathematicians, mathematics and number theory live in the timeless present and are concerned only with current theories and formulations. History only leaves its mark in the names of results (Fermat's theorem), problems (The Riemann conjecture) or methods (Pascal's triangle, Cohen's Forcing). Mathematicians treat history teleologically, as the necessary and rational trajectory of the past as it becomes the preordained present.[1] But I shall show that all mathematics, sacred and profane, mystical and mundane, inwardly driven and outwardly applied, rests on irrational philosophies of belief. Irrational not because they are primitive, emotional, underdeveloped or crazy. They are irrational because they rest on ultimate assumptions that have been chosen and adopted contingently, and are not themselves the results of reason, in the sense of not resting on long chains of logic and justification. The assumptions on which we base our philosophies of mathematics are irrational in the same way that the axioms of our mathematical theories are. Just as a ladder needs the ground to stand on, all rational logical arguments need a foundation, and must stop at a set of assumptions. Failing that they are doomed to travel endlessly downwards in an infinite descent that seeks deeper and deeper justifications for a never-reached foundation (Lakatos 1962). Since logic is the science of truth-transmitting reasonings, if there is no initial injection of truth, then it cannot flow through the chain of derived consequences to vouchsafe their conclusion. Philosophy, mathematics and religion all rest on sets of assumptions, beliefs and commitments, some tacit and some explicit. Thus to fully understand the nature and basis of number and mathematics, beyond the truncated and dehistoricised rationalizations of mathematicians, we must explore the ideas, beliefs, practices and traditions on which they rest, irrespective of whether these historical foundations are rational, irrational, practical, spiritual, mystical, sacred or profane.

But all is not just pure religion and pure knowledge. Later after dividing number and mathematics into the sacred and profane I will look at the chilling development of profane number in the modern era. From its humble origins as servant of accounting and trade, number now has become elevated into chilling new gods, those of Dataism, Mammon and Moloch. But more of that later.

Let us first look then at where the intellectually troubling ideas of zero, one and infinity come from before they become mainstays of modern mathematics.

Zero

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[1] The philosophical basis for this is absolutism. If mathematics is absolute, universal, objective, eternal and superhuman then current developments are necessary and history could not have delivered a different mathematical science. It could be less or more complete but what has been developed could not have developed differently (Ernest 1998).

Zero emerges from Sunya, emptiness, nothingness. This fundamental and grounding idea is sacred and is found in Hindu, Jain, Buddhist, Zen, Dao (Tao), Jewish, Christian and Islamic texts, and those of other sacred religions and philosophies. This emergence creates the paradox of something (zero) coming from nothingness (emptiness). It is paradoxical, yet necessary, for zero may be the most important number of all. In modern formulations of Peano's axioms of arithmetic, zero is the only number given as a primitive, a starting point. All the rest are derived from it by succession. One is the unique successor of zero, two succeeds one, and so on. Looking ahead to the present, only zero and its unique successor one are needed for the vast universe of digital computing. This brings us the Apps, data and algorithms that shape and control the human world and much of the natural world.

Zero and Emptiness are Sacred Concepts. Perhaps the earliest written mentions are given by the Mesopotamian concept of the primordial state of nothingness preceding creation (Dalley 1991) and the Ancient Egyptian concept of Nun, the chaotic, formless waters existing before creation, embodying the idea of nothingness (Allen 1988).

In Mahāyāna Buddhism, śūnyatā (emptiness) is a central doctrine, signifying that all phenomena are devoid of intrinsic existence. This concept is pivotal in understanding the nature of reality and achieving enlightenment. Thus the Heart Sutra states "Form is emptiness, emptiness is form." (Williams, 2008, p. 68). The prominent Buddhist philosopher Nāgārjuna, elaborates on this in his seminal work Mūlamadhyamakakārikā "We state that conditioned origination is emptiness. It is mere designation depending on something, and it is the middle path." (Williams 2008, p. 69).

In certain Shaiva traditions of Hinduism, the concept of śūnya (void) is associated with the ultimate reality, transcending sensory and mental faculties. "The Absolute void is Bhairava who is beyond the senses and the mind, beyond all the categories of these instruments." (Singh, 1991, p. 29). Taoist philosophy also regards emptiness as a fundamental aspect of the Tao, the underlying principle of the universe. "The Tao is like … the eternal void" (Lao Tzu 1988, p. 10).

The ideas of Sunya or nothingness are not sufficient to found and lead to the full mathematical concept of zero, as history demonstrates (Ernest 2024). However, they may be necessary for its development.

One

One signifies both the unity of all into an integral, seamless whole, as well as the ur-unit, the small part that through repetition brings all of number and arithmetic into being. Thus, if not an actual contradiction, one has a definite ambiguity associated with its meaning, for it stands for both the whole and a tiny part of the whole.

With regard to these two meanings, the concept of "One" understood as unity is a sacred, foundational, and metaphysical principle that appears in many religious and philosophical traditions.

One as the totality of being first appears in the great Ancient civilisations of Mesopotamia and Egypt. In Mesopotamian cosmology, the primordial deity Apsu represents the fresh waters and is considered the origin of all things. The Enuma Elish, a Babylonian creation myth dating to the second millennium BCE, illustrates the concept of a singular, undifferentiated origin from which all creation emerges. In the Heliopolitan creation myth of Ancient Egypt, the god Atum emerges from the chaotic waters of Nun proclaiming "I am the Great God who came into being by himself." (Allen 2005, p. 99) and brings forth all other gods and creation. Again this is One as the primordial origin of being, the progenitor of all that exists.

Parmenides, in the 5th century BCE, argued that reality is One—eternal, unchanging, and indivisible. His radical metaphysical monism states "It is necessary to say and to think that Being is; for it is to be, but nothing is not." (Kirk et al, 1983, p. 269). For Parmenides, plurality and change are illusions. The One Being is the only truth—perfect and complete.

In Neoplatonism, especially in the works of Plotinus, the One is the supreme source of all reality—beyond being, ineffable, and perfect. "The One is all things and no one of them; the source of all things is not all things, but their cause." (Plotinus 1966, p. 209). The One is not just a number but a principle of unity and transcendence from which the multiplicity of the cosmos flows.

In the Hindu Philosophy of Advaita Vedānta, ultimate reality is Brahman, the non-dual One without a second. "There is no plurality here whatsoever" (Radhakrishnan, 1992, pp. 505–506). The sacred Oneness of Brahman underlies all appearances of diversity. Liberation (moksha) is the realisation of this unity.

Islamic theology asserts the oneness of God as its foundational concept. Sufi mysticism elaborates on this through metaphysical reflection. "There is nothing in existence but the One Reality" (Chittick, 1989, p. 130)

In Christian mysticism, God is often equated with Unity or the One. Meister Eckhart describes "God as the One beyond number, from which all things derive". (McGinn, 2006, p. 85)

In addition to one as unity, undivided wholeness, the totality of all that exists, there is also the concept of One as the foundational unit—an indivisible origin, the ur-unit from which all multiplicity arises. This has also been a central theme in various mystical and philosophical traditions.

The Pythagoreans regarded the monad (the number one) as the source from which all numbers and, by extension, all reality emerge. This monad is not merely a symbol of unity but the originating point of existence. According to Diogenes Laërtius

> "The monad is the origin of all things. From the monad evolved the dyad; from it numbers; from numbers, points; then lines, two-dimensional entities, three-dimensional entities, bodies, culminating in the four elements... from which the rest of our world is built up." (Fairbanks, 1898, p. 145)

In Neoplatonism, Plotinus (1966) describes the One, in the Enneads, as the ultimate principle from which all existence emanates. This One is beyond being and multiplicity, yet it is the source of all that exists. "For Number is not primal: before the Two, there is the One; and the Unit must precede the Dyad: coming later than the One, the Dyad has the One as the standard of its differentiation." (MacKenna & Page 1917, VI.6.9)

In Kabbalah, the Hebrew letter Aleph, is not only the first letter which has a numerical value of one, but also symbolizes the primordial point from which creation unfolds. It represents the potentiality inherent in the divine, the channel through which the infinite becomes manifest. Aleph symbolizes the oneness of God, the singularity from which all existence flows." (Kaplan, 1990, p. 45). "The letter Aleph represents the origin of the universe. It is the seed from which all creation grows." (Ginsburgh, 1995, p. 27). "

The philosopher Leibniz applies the concept of monads as the fundamental, indivisible units of reality. Each monad is a unique, simple substance that reflects the entire universe from its perspective.[2]

> "The Monad, of which we shall speak here, is nothing but a simple substance, which enters into compounds; simple, that is to say, without parts." (Leibniz 1714, §1)

The philosopher Hegel introduced the concept of dialectical reasoning and through it his "Determination of the Quantitative" establishing the conceptual foundations of number, from his perspective. His derivation proceeds in stages with him arguing that the first concept of metaphysics is Being. From this he derives successively: Nothing, Becoming, Presence, Something and Other, One, and Many Ones (Damsma 2011).[3] Considering those concepts under discussion here, first with regard to nothing he writes: "Nothing is, therefore, the same determination, or rather absence of determination, and thus altogether the same as, pure Being." (Hegel 2010, p. 59). Second, with regard to one as totality: "The One is the simple self-relation; it is the being-for-self that is not yet posited as excluding otherness." (Hegel 2010, p. 198). Third, he elaborates on the transition from One to Many Ones, leading to the concept of Number: "Number is the One as a plurality of Ones, the One and the Many in one concept." (Hegel, 2010, p. 203)

Hegel thus accommodates the three notions discussed above in his own account, namely nothingness, oneness as unity, and oneness as the unit of multiplicity. Although rejected by modern philosophers of mathematics because they do not satisfactorily explain number from a epistemological, ontological or mathematical perspective, his ideas are widespread in the thought of Marx, Engels, Lenin, Stalin, Mao and their followers, and as the bedrock of dialectical materialism.

Overall, these perspectives illustrate the profound reverence and complex interpretations of One both as the totality and as the foundational unit across various spiritual and philosophical systems.

The varying accounts given above reflect the structure of creation myths. (Leeming 2010). How out of nothing came something, the one, and out of one came the many, and then, ultimately all of creation, everything. This creation myth parallels the creation of the numbers in the Peano theory of arithmetic (Ernest 1997). This exemplifies the thought that "Every myth of origins is also an exemplary model for all later acts of creation" (Eliade, 1963, p. 18). Starting only with the zero element and the successor function, all of the numbers come into being through succession. Beginning with a few simple axioms and the principle of induction, first addition then all of the functions and operators of number are defined into existence.

[2] In this way, the universe of monads parallels the Net of Indra, a never-ending multi dimensional net which at every intersection has a multi-faceted diamond, which reflects the entire Net as a whole. "Each jewel of Indra's Net includes the reflections of all the other jewels; the significance of this symbolism is that each entity in the universe contains within itself the entire universe." (Malhotra, 2014, p. 13.)

[3] It is interesting to contrast Hegel's derivation of Nothing from Being, with Parmenides' direct derivation of One from Being.

Thus from the elementary beginnings of number the full architecture and universe of Number Theory is brought into being. Is it God who creates mathematics? Or the human mind? No, it is the spirit of Mathematics itself, brought into life like the Golem from a symbolic script, an incantation and summoning to life through the numbers One, Two, Three, …, repeated over millennia. Mathematics woke and said, let there be number. And thus Mathematics created itself, materialising from the sacred practices of humankind.

If this tale of origins seems overly fanciful, my overall argument in this chapter is that the history of number begins with the idea that God or gods, and the great spirit is in mathematics, is present throughout the practices that give rise to number. But in history this is reversed so that mathematics itself becomes god for mathematicians. Mathematics becomes something to be reverenced and worshipped for itself. It takes on a sacred life of its own. Thus we have the shift from God is mathematics, to Mathematics is god. Like all of culture, mathematics is made by people, it floats in the conceptual space created by people. But like much of culture it becomes independent of its makers, seemingly taking on a life of its own, so that its makers feel that it runs through them, takes them over and animates and drives their creative activities. Great musicians, composers, writers and artists all say this is how they feel, inspiration flows through them from something greater. So too do mathematicians. Ramanujan attributed his mathematical discoveries to visions from a deity, indicating his belief in external sources of inspiration (Aiello 2017). The great mathematician Carl Friedrich Gauss described his creative process as being guided by forces beyond the self. He made significant contributions to number theory (Bell 1937). The true mathematician like the true artist feels the spirit of her discipline, her art, flow through her veins, from the greater being, into the expressions of her art, her mathematics. They perceive themselves to be naught but conduits for the eternal. As Paul Dirac said "If you are receptive and humble, mathematics will lead you by the hand." (Farmelo 2009; p. 435).

Infinity

The next troublesome concept to consider is that of Infinity, the unbounded and ever-growing totality, overpowering everything in its god-like immensity. It can be signified by a sleeping 8 sign '∞'. To even dare to name infinity is to commit blasphemy, for only God can be ever-growing and without any limits. Throughout most of its history, infinity has been banished from arithmetic and is still not permitted in Number Theory. But in mathematics, around 1870, Cantor (1955) initiated the study of sets which opens up the science of infinity and transfinite arithmetic, and reveals that there are so many different infinities that they even exceed what any number system allows, permits or enables us to count. That is an awful infinite lot of infinities.

Cantor names two type of transfinite numbers the Alephs and the Omegas. In doing so takes a Christian name for God (the 'alpha and omega'), the first and last, drawn from the holy languages of Hebrew and Greek. His choice of names indicates that he is scaling the heavens, putting number's claim on the names of the deity. The infinity of the set of counting numbers is breathtaking. But it is rapidly overpowered by the infinity of infinities that explodes beyond the universe and even beyond our powers of imagination. This adds another paradox to the growing pile we are accumulating.[4] In mathematics we imagine the unimaginable, we

[4] Just the step from the first infinity Aleph null ($\aleph_0$) to the power of the continuum *c* is so huge that the number of points in p-dimensional space, which is the same as the number of points on the line between 10^{-100} and 10^{-101} can be represented as $2^{\aleph_0}$ which is unbelievably large compared to $\aleph_0$. And yet there is no known limit to the number of different and increasing numbers of infinities which way exceeds even *c*.

celebrate and even dare to touch the unreachable, while at the same time banishing the imaginings of philosophers, mystics, theologians and artists to the realm of the unreal.

Is infinity unreal? It is real, a cornucopia of excessive magnitudes in mathematics, an endless source of study from the denumerable natural numbers to inaccessible cardinals and beyond in the infinite space of set theory (Kanamori 2003).

In the world we only see the infinite in never-ending processes, such as a snail crossing half the remaining path width each day, or continuing forever in counting. Even Archimedes knew that counting all the grains of sand on the beach or in the whole world would someday finish. But to this day some howl at the blasphemy of claiming that the infinite exists (Abadou and Ernest 2022). Some claim to have tamed it and celebrate the banned division 1/0 which has in the past been equated to infinity ∞ (Ernest 2023). Some have even reconstructed mathematics to exclude all possibility of infinity, and condemn those who admit it as deranged (Bishop 1967). Thus infinity is both a blessing and a curse in mathematics. It unleashes huge power but also great anger.

Of course the concept of Infinity already holds profound significance in religious and philosophical traditions. Precursors of infinity can be found in the two great ancient civilisations of Mesopotamia and Egypt. While Mesopotamian texts do not explicitly discuss infinity in recognisably mathematical terms, their cosmology reflects an understanding of unending cycles of time and the eternal nature of the gods (Koch 2013). The Ancient Egyptian god Heh personifies infinity or eternity. "Heh was the personification of infinity or eternity in the … infinite realm of chaos as, in contrast with the finite created world." (Wikipedia 2025d).

Infinity is a sacred concept. In Christian theology, infinity is divine because God is Infinite. God's nature is described as infinite, because of His boundless attributes. “His understanding is beyond measure." (Bible 1989, Psalm 147:5)

The Neoplatonist philosopher Plotinus conceptualized 'The One' as the infinite source of all existence. "The One is all things and no one of them; the source of all things is not all things, but their cause." (Plotinus 1966, p. 209)

Jain philosophy presents a sophisticated classification of infinities, distinguishing between enumerable, innumerable, and infinite, each with further subdivisions. "The Jains were the first to discard the idea that all infinities were the same or equal." (Singh, 1987, cited in Wikipedia 2025e)

In Western mystical traditions, particularly within the Kabbalah, Christian mysticism and Western esotericism, the concept of infinity is central to understanding the divine and the cosmos. In Kabbalistic cosmology, the Sephiroth, the Tree of Life is preceded by the Three Veils of Negative Existence. The first veil, Ain, represents nothingness. The second veil, Ain Sof, represents the infinite aspect of the divine (International Order of Kabbalists n.d.). Thus the infinite is present in the veils surrounding the Tree of Life, the mystical structure of all being.

Gregory of Nyssa (1978), who lived c. 335–395 CE, was among the first theologians to articulate the idea of God's infinity. His main argument for the infinity of God is that since God's goodness is limitless, so too God is limitless (Mateo-Seco & Maspero 2010). Nicholas of Cusa (1440) delved deeply into the nature of the infinite and discusses the paradox of attempting to comprehend the infinite. He claims that to define the infinite is to make it definite, and thus it is no longer infinite.

Thus the key concepts of number including zero, one, and the often unwelcome guest infinity, have strong mystical associations and religious connotations. However, modern mathematics regards these meanings as superfluous superstitions and brushes them aside. But this dismissal raises the question, how far back do they stretch into history and pre-history? Does there come a point where mathematics becomes purely rational and does not have the two faces of sacred and profane? To answer this requires an excursion into the history of mathematics and indeed into its pre-history, before the dawn of written records.

It turns out that all the way back the earliest proto-mathematics number is primarily sacred. The sacred long precedes the profane, gave birth to it, and continues to live alongside it. Both have huge powers to shape the mind and through the mind and through human action, the world. This applies especially to what I call the profane, the utilitarian dimension of number and mathematics. But without the sacred origins of number we would have none of its profane worldly uses, so I must start with the more neglected sacred history of early number, the history of sacred proto-number, early measurement and proto-geometry.

Early Number, Geometry and its sacred history

From what little we know, if we examine the role of proto-arithmetic and sacred cosmology in prehistoric societies we find the deep embeddedness of number, ritual, and shamanic knowledge with what we now regard as practical calendrical knowledge. Thus the origins of proto-arithmetic and proto-geometry are deeply entwined with the spiritual and ritualistic practices of prehistoric societies. Far from being mere tools for practical tasks, early numerical systems emerged within a sacred cosmological framework, mediated by shamans and spiritual leaders. These proto-arithmetical practices—encompassing counting, pattern recognition, and spatial measurement, embedded in a sacred world view, and sacred practices —were integral to understanding celestial cycles, structuring communal rituals, guiding agricultural activities when they emerged, and triggering seasonal patterns of behaviour such as hunting and food gathering. Such knowledge was perceived as divine, transmitted through sacred traditions, and embedded within animistic worldviews. How many tens of thousands of years it took to chart the seasons, the patterns of sunrise and sunset at midsummer and midwinter, the wisdom for farming rituals and observances, the cycles of plants and animals, and to encode them in myths and narratives we may never know. Clearly there must have been initiations, transmission and communication practices where such oral knowledge was passed on embedded in sacred world views. Through what must be many millennia such knowledge was learned, developed, extended and then passed on to yet further sages and shaman in a never broken cycle.

There are indications that number and number words have been with us for a very long time. Linguist Merritt Ruhlen suggests that certain words, such as tik for "one" (or "finger") and pal for "two," appear across diverse language families, indicating a possible common ancestral origin. No less than eight of the twelve families show traces of tik ‘finger, one,’ (Ruhlen, 1994, p. 115). "The root pal meaning 'two' is also found in many language families, supporting the hypothesis of a common linguistic ancestry." (Ruhlen, 1994, p. 104)

Studies like these have shown that the words for numbers one through to five are among the most conservatively preserved across languages. Pagel et al. (2013) found that these numerals have replacement rates 3.5 to 20 times slower than the average rates for other words, and 10 to 130 times slower than the fastest-replacing words. Pagel and Meade (2017) found that the words for two, three, four, and five rank among the top five most stable words in Indo-European languages, with "two" being the most stable. This pattern is also evident in Bantu and Austronesian language families, indicating a widespread phenomenon. This indicates that low numeral terms are exceptionally resistant to change over time. “Basic number words are highly stable, and some may be retained for 10000 to over 100000 years” (Gray, Atkinson, & Greenhill, 2010, p. 3854).

Proto-arithmetic must be seen as sacred knowledge. The development of counting systems in prehistoric times was not for stripped back purely utilitarian purposes as we see them now, but was deeply rooted in spiritual beliefs. However, against such dualistic thinking one can argue that the animistic and spiritual world view, with its calendrical calculation, awareness of seasons, life cycles and heavenly movements was in fact deeply useful in enabling life and the development of human culture. The distinction between utilitarian and religious knowledge, between sacred and profane world views, did not really exist in prehistory.

There is some, if limited, evidence of proto-mathematical thinking in archaeological artefacts and cave paintings. Engravings found in Blombos Cave in South Africa, dated 70,000–100,000 BCE, consist of cross-hatched patterns on ochre pieces, and have been interpreted as indicating abstract and symbolic thought.

> “These engravings, with their deliberate and consistent geometric motifs, suggest the presence of symbolic traditions that predate the emergence of written language and imply the cognitive capacity for abstract representation.” (Henshilwood and Dubreuil 2009 p. 61)

Similarly, the geometric patterns in European Upper Palaeolithic cave art—grids, spirals, zigzags—may relate to entoptic phenomena experienced during trance states. Lewis-Williams and Dowson (1988) suggest that these geometric motifs “reflect attempts to encode and transmit sacred knowledge—perhaps cosmological in nature—through stylized numerical or geometric schemas” (p. 210).

The Lebombo Bone from Southern Africa, from around 42,000 BCE is a baboon fibula with 29 distinct notches. Its use is unknown, but its markings suggest to some that it may have functioned as a lunar calendar or even a menstrual cycle computing device. (Darling 2004)

The Ishango Bone, dated to approximately 22,000 years ago, exhibit notches that when counted provide sequences of numbers including the primes 11, 13, 17, 19. These patterns that have lead to a veritable industry of speculation including attributions of arithmetic sequences, calculating aids and lunar calendars (Marshack 1972). Kamalu (2021) even argues that the Ishango Bone functions as a primitive mathematical sieve for identifying small prime numbers. However Pletser & Huylebrouck (2008) cast strong doubt on this and Rudman, points out that the concept of prime numbers very likely emerged much later, around 500 BCE, after the development of division.

We must be very cautious about interpreting what we see as marks of numerosity for they serve unknown and hitherto unimaginable sacred purposes. Authors imputing arithmetical meanings to the marks may have succumbed to “the irresistible temptation of mathematical fiction” (Keller 2010). Anachronistic thinking can project back in time sophisticated modern arithmetic techniques, such as division and the identification of primes, which we now take for granted as simple, into a past where they had not developed the social and cognitive foundations, let alone the needs, for such modes of thinking.

Clearly there must have been some numerical observations and most likely these were interpreted through a sacred lens. The ability to predict celestial events, such as solstices and equinoxes, was perceived as a divine insight, reinforcing the spiritual authority of those who possessed this knowledge. As noted by Ruggles (2005, p. 19): "the sky played a central role in the cosmologies of many ancient cultures, and understanding its patterns was often considered sacred knowledge".

Shamans and spiritual leaders were central figures in the preservation and dissemination of proto-arithmetic knowledge. Through trance states and ritual practices, shamans connected with the spiritual realm to access their own knowledge and gain insights into celestial patterns and natural cycles. This knowledge was then transmitted orally through initiation rites and apprenticeships, ensuring its continuity across generations (Eliade 1964).

The integration of numerical knowledge into shamanistic practices is evident in various cultures. For instance, the use of rhythmic drumming and chanting in rituals not only facilitated trance states but also served as mnemonic devices for encoding and recalling complex numerical information related to astronomical observations (Winkelman 2021).

Animistic beliefs, which attribute spiritual essence to natural elements, provided a framework for interpreting numerical patterns in the environment. Celestial bodies, seasons, and natural phenomena were seen as manifestations of spiritual forces, and understanding their patterns was considered a form of communion with the divine. This perspective is reflected in the alignment of megalithic structures with celestial events, such as the solstices and equinoxes, indicating a sacred interpretation of astronomical observations (Ruggles, 2005). The construction of prehistoric monuments demonstrates the application of geometric principles informed by astronomical observations. Structures like Stonehenge and Newgrange are aligned with solar and lunar events, reflecting a sophisticated understanding of celestial cycles and pre-formal geometry. These alignments were not merely practical but held deep spiritual significance, serving as sites for rituals and ceremonies that connected communities with the cosmos (O'Kelly, 1982).

The geometric precision of these monuments and structures suggests that early societies possessed advanced knowledge of measurement and spatial relationships. This knowledge was likely transmitted through sacred traditions and embedded within the cultural and spiritual practices of the community. As Aveni (2001, p. 3) notes, "the integration of astronomy into the architecture of ancient societies reflects a worldview in which the heavens and the earth were intimately connected".

The integration of animism with proto-arithmetic practices underscores the holistic worldview of prehistoric societies, where numerical knowledge was not separate from spiritual understanding but was an expression of it. As noted by Harvey (2006), "animism is not a belief system but a way of being in the world, one that recognizes the personhood of all entities and the relationships between them" (p. 17).

Proto-arithmetic practices in prehistoric societies were deeply intertwined with spiritual beliefs and rituals. The development of counting systems, recognition of numerical patterns in celestial cycles, and the construction of geometrically aligned structures were not merely practical achievements but expressions of a sacred cosmology. Shamans and spiritual leaders played a crucial role in interpreting and transmitting this knowledge, embedding it within the cultural and spiritual fabric of their communities. Understanding the sacred dimensions of early proto-mathematical practices offers valuable insights into the holistic worldview of prehistoric societies, where the pursuit of knowledge was a path to communion with the divine.

Knight (1991) has argued that in hunter-gatherer societies,

> "counting and calendrical systems... were closely tied to ritualized performances, often transmitted through shamanic initiation rites that encoded numerical patterns into sacred cosmologies" (Knight 1991, p. 212).

However, caution must also be exercised before imagining that the sacred proto-geometric and proto-numeric knowledge and practices inevitably leads to the development of mathematical knowledge. They may be a necessary prerequisite, but they are far from sufficient.

Several prehistoric Aboriginal Australian rock art sites exhibit geometric patterns and repeated motifs that could be read as reflecting early numerical or arithmetical thinking. The Napwerte/Ewaninga Rock Carvings Conservation Reserve, which dates back 30,000 to 40,000 years, contains numerous petroglyphs, primarily consisting of circles, lines, and other geometric motifs (Wikipedia 2024). Koonalda Cave features extensive finger-marked geometric lines and patterns etched into its walls.

> "Thousands of square metres in the cave are covered in parallel finger-marked geometric lines and patterns, Aboriginal Australian artwork which has been dated as 20,000 years old." Wikipedia (2025a, p.1)

Although these petroglyphs and markings can be interpreted as exhibiting indicators of geometric and proto-numerical thinking, as we know, the Australian Aboriginals did not go on to develop what might be termed mathematics.[5] Because their societies did not develop towards large, hierarchically organised farming-based societies there was no need to develop the recording techniques of trade, tribute and tax that supported the development of complex records including written arithmetic.

Arithmetic and Mathematics in Early Historic Societies

The origins of written arithmetics in the early historic societies of Mesopotamia and Ancient Egypt are well known. It is accepted as very likely that small clay tokens representing amounts of (quantitative signs for) goods were used in trade. First the tokens were used as documents in themselves accompanying and recording the goods in transactions. Later their shapes were impressed on clay envelopes representing the tokens that were wrapped up within

[5] The proto-mathematical work and thinking can be characterised as ethnomathematical rather than mathematical.

(themselves representing quantities of goods). Finally the tokens were done away with and clay tablets directly bore the numerical inscriptions as pictograms. The pictograms were simplified over time and replaced by purely symbolic impressions of the stylus in the clay. Schmandt-Besserat (1992) describes this development as a sequence of abstraction:

> "The token system, used for more than 5,000 years before the invention of writing, was the first code to record economic data... numbers became signs on clay, abstracted from physical tokens" (Schmandt-Besserat 1992, p. 132).

According to this sequence of development arithmetic became a symbolic practice with notations, arithmetic procedures, and a trained body of scribes who practiced the art and trained future scribes. With its knowledge systematised for recording and passing on it may be characterized as a science, the early (and earliest) discipline of mathematics (Høyrup 1994).

Scholars have pointed out the utilitarian dimension of the emerging discipline. "[I]t is evident that the development of mathematics was closely tied to the practical demands of administration, architecture and commerce" (Bishop (1987) p. 23). However, utilitarian it might seem to modern eyes, this activity was dedicated to serving the gods and the rulers. In ancient Mesopotamia, the gods were considered to be the ultimate owners of land and wealth, with temples serving as their earthly residences and centres of economic activity. Human rulers and administrators acted as stewards, managing these divine estates on behalf of the deities (Snell 2007). Thus all of the work of priests and scribes, including accounting and arithmetic, were sacred activities.

Scribal education was comprehensive, encompassing literacy, numeracy, and specialized knowledge required for temple and state administration. Students learned to write cuneiform, memorize lexical lists, and perform complex calculations. Old Babylonian mathematical texts reveal a curriculum designed to produce proficient scribes capable of handling various administrative duties. These texts include problem-solving exercises that demonstrate the application of mathematical principles in real-world scenarios (Robson 2008).

The sacred dimension of scribal education is evident in the association of the goddess Nisaba with writing and accounting. Temples, as centres of both religious and economic activity, required scribes to maintain records of offerings, rituals, and resource management. The act of writing and calculating was thus intertwined with religious duties, reinforcing the sanctity of the scribes' work (Veldhuis 2014).
While much of the mathematical training was practical, evidence suggests that scribes also engaged with mathematics as an intellectual pursuit. Some mathematical texts present problems that are abstract and promote deeper engagement with mathematical concepts, not directly tied to administrative tasks, indicating a culture of scholarly inquiry (Proust 2010). Some complex problems suggest that the scribes were interested in demonstrating their skills and prowess beyond mere utilitarian applications that might occur in practice (Neugebauer & Sachs 1945). Here we have the first glimmers of mathematics for its own sake. When fully developed this will become a new type of sacrality for mathematics. Not arithmetic or mathematics for the spiritual or the gods, but mathematics itself as an object of intrinsic value and veneration.

The Mesopotamians developed a place value system based on 60. The Mesopotamians viewed numbers as imbued with cosmic significance. The sexagesimal (base-60) system, for example, was not merely a practical convenience but was tied to celestial and religious ideas. Numbers were associated with specific gods and divine principles. The number 60, for instance, was associated with the chief god Anu, representing perfection and completeness in the cosmos.

> "Numbers, in Mesopotamian thought, were not simply quantitative entities but had qualitative, symbolic meanings linked with divine forces" (Robson, 2008, p. 374).

Temples were constructed with dimensions based on sacred numbers. Their measurements often reflected cosmic harmony.

> "Temple architecture was fundamentally a reflection of cosmic order, and the mathematical precision with which they were laid out was part of their sacred function" (Friberg, 2007, p. 96).

The Ancient Egyptians developed comparable numerical and calculative systems without place value, as well as introducing fractional work.[6] They developed tables of doubling and halving as means to multiply and divide. In each case institutionalised bodies of scribes and priests performed calculations and passed on the knowledge to the next generation.

In Egypt, mathematics was essential to temple and tomb construction, which were themselves sacred acts of aligning the mortal world with divine order.

> "Egyptian geometry... was used primarily for sacred architecture, aligning tombs and pyramids to cardinal directions and stellar bodies. This was not mere engineering—it was ritual cosmography" (Gillings, 1982, p. 231).

The calendar was mathematically regulated and had sacred functions.

> "The Egyptian calendar, a mathematical construct, was essential to religious life, ensuring festivals aligned with cosmic rhythms, especially the heliacal rising of Sirius and the inundation of the Nile" (Clagett, 1999, p. 15).

The use of unit fractions (e.g., 1/2, 1/3, 1/4) was also linked with religious ideas of balance, proportion, and Ma'at—the principle of cosmic harmony.

Recovered Ancient Egyptian scrolls include the Rhind Papyrus of about 1500 BCE. This provides a compendium of methods, solutions and mathematical knowledge that indicate that mathematical practice, research and teaching were beginning to take on a life of their own, as a discipline of mathematics. The scribe Ahmes presents the papyrus as sacred, giving "Accurate reckoning for inquiring into things, and the knowledge of all things, mysteries... all secrets". (Clagett 1999, p. 11).

The great work of the invention and development of ancient mathematics took between three and six millennia, and includes the first half of the history of the discipline of mathematics. But it is a mistake to see it as increasingly mundane and thus profane. Although the vast majority of records primarily concern accounting, trade, taxes, these were sacred practices conducted for the glory and benefit of the temple. There were also further sacred mathematical practices involved in astrology, divination, and in the predictions of future good

[6] Apart from the special cases of 2/3 and ¾ all Ancient Egyptian fractions were unit fractions of the form 1/n where n is a whole (Natural) number. They treated other fractions as sums of unit fractions (Imhausen 2016).

and bad fortune Calculation and geometry play a large part in part in this sacred application of knowledge as systems for reading the heavens and predicting auspicious times for festivals, observances, actions and future events.

During the emergence of this discipline of mathematics some mathematics is practiced and developed for its own sake and thus we see a new sacredness emerging. This is the inner sacredness of mathematics practiced and developed for its own sake. At first it is not distinguishable from what I term the outer sacredness of mathematics, the religious, mystical and ritual aspects and contexts. We see this new emphasis sometimes evidenced in the solving numerical problems that far exceed practical purposes, and in making compilations of mathematical knowledge for the sake of records and study of the new discipline. In doing this they are thus laying the groundwork for a new form of sacredness in mathematics. This is the crystallization of mathematics for itself within the outer sacredness of mathematical practices. Mathematics for its own sake sees mathematics as a living entity, mathematics as an object of admiration and veneration, mathematics almost as an object of worship. Although at the time there was no clear division between the outer religious sacredness of all mathematical practices and the inner sacredness of the glorification of mathematics for itself. However, this distinction comes to be of growing significance, starting with the Ancient Greeks.

Greek mathematics

Against the backdrop of the majestic ancient civilizations of Mesopotamia, Ancient Egypt, and also ancient Hindu and Chinese civilizations, a pugnacious and jaunty young civilization (or rather set of civilizations) sprang up around Greece. Of course there was a large temporal overlap and the Ancient Greeks looked in wonder at these great mother civilizations with their vast knowledge and wisdom.[7] Scholars such as Thales of Miletus (approx. 624 - 547 BCE) studied in Egypt and brought back knowledge of astronomy and mathematics. Thales is credited with five theorems of elementary geometry and was an early contributor to Ancient Greek philosophy.

The practices of calculation were most likely adopted by the Ancient Greeks before Thales' time, during relations of trade and diplomacy. Such modified practices of calculation as the Greeks employed, for they used different languages for numbers and calculation, were adopted and continued within their own institutions and trading practices. However their beliefs about the significance of number and mathematics were quite different from the earlier ancients. Plato (c. 429–347 BCE) describes how logistics, as he termed the mundane and profane arithmetic of everyday life, was performed by tradesmen and slaves. His derogation of these practices as lowly, mundane and profane is well known. But at the same time he elevates the study of pure mathematics – geometry and arithmetic – as valuable, untainted, high minded, and conducive to the understanding of Truth, Beauty and the Good. Thus he regards pure mathematics as a sacred intellectual project and pursuit, understanding sacredness in the inner way delineated above. As he wrote in The Republic, "Arithmetic... draws the soul toward truth and forms the philosophical mind" (Plato 2007, 525c).

Plato had already been anticipated by approximately a century by Pythagoras (570 to ca. 490 BCE) and his followers. For the Pythagoreans, numbers had sacred metaphysical significance, with One as the source of all numbers. "The monad [One] is the beginning of everything.

[7] Indeed Plato (see his *Phaedo* and *Meno*) and others (e.g. Numenius of Apamea) believed that most if not all possible knowledge had already been found in the past and the work of the Greek philosophers was to try to recover this ancient wisdom (Silverman 2022).

From the monad proceeds the indefinite dyad, which is the principle of diversity." (Guthrie, 1987, p. 47). They viewed the One as divine unity, the origin of cosmic order and harmony.

In the Pythagorean tradition, numbers were seen as sacred realities that structured the cosmos. "The Pythagoreans held that 'all is number'... they saw in numbers the principles of harmony and order governing the heavens and human soul alike" (Heath, 1921, p. 157).

> "To the Pythagoreans, numbers governed not only earthly harmony but celestial motion; they saw mathematics as sacred, a means of accessing the divine structure of reality. Their ideas influenced court philosophers and mathematicians like Plato, and through him, wider Hellenistic scientific traditions." (Heath 1981, p. 201)

The Pythagoreans put pure number at the heart of their religious practices, and regarded the pure properties of number such as odd and even, triangular, square and rectangular as indicative of sacred dimensions of the world. They discovered the correspondence between number and music (halving the length of the string raises the note by an octave, etc). Their study of pure mathematics was sacred in itself, and it revealed the fundamental nature of reality. This is the pure and sacred mathematics, in the inner sense, so extolled by Plato, occurring within a context of the sacred in the outer, religious and mystical sense.

Thus with the Ancient Greeks we have a split between the profane arithmetic of accounting tax and trade, and the sacred arithmetic of pure mathematical ideas, logic, thought and philosophy. Here sacred is used in a non-religious way, to describe something of elevated and purely spiritual value, not necessarily associated with theistic beliefs and practices, although the Pythagoreans retained these.

However, It would be remiss to leave out the class dimension from this account. The philosophers, thinkers and pure mathematicians are from the elevated leisure classes including the aristocracy. The sacred, pure and high value mathematics is associated with this class. In contrast, the profane, everyday arithmetic is associated with tradesmen and slaves, that is with the bottom workaday layers of the society. Thus it can be argued that the difference between high (sacred) and low (profane) arithmetic and mathematics is not necessarily intrinsic to these subjects, but acquired, at least in part, through its association with the activities of high social classes of aristocrats and leisured, moneyed citizens as opposed to the lower classes of tradesmen, workers and slaves.

Plato explicitly draws the distinction between practical arithmetic used by trades people and higher, philosophical mathematics pursued by philosophers:

> "Arithmetic has a very great and elevating effect, compelling the soul to reason about abstract number, and withdrawing it from the world of sense and sight" (Plato 2007, VII, 525d).

Plato contrasts this with what he sees as the "vulgar" arithmetic used in business:

> "The vulgar arithmetician is a dealer in goods and wages, not a lover of wisdom; he uses arithmetic for buying and selling, not for contemplating the nature of number itself" (Plato 2007, VII, 525c–d).

Netz also notes the social and symbolic elevation of mathematics:

> "Greek pure mathematics arose not simply from logical developments but was intimately tied to elite education and status. Mathematics was seen as a pursuit worthy of free men, distinct from the counting and reckoning of slaves and tradesmen" (Netz, 1999, p. 11).

In addition the rulers also employed mathematicians as astronomers and astrologers, and these too would be classed as doing sacred mathematics.

> "In antiquity, the science of the stars was cultivated in the temples and at courts; it was closely associated with religion and prophecy. Greek rulers, especially in the Hellenistic and Roman periods, employed astrologers who drew on mathematical astronomy to cast horoscopes and determine divine omens." (Cumont 2007, p. 25)

In this case the sacredness is due to working with and as priests, soothsayers, and religious leaders as well as for the rulers. Their arithmetical and mathematical practices are sacred in the traditional sense of being allied with religious practices.

Lloyd (2004) also makes this point:

> "In Mesopotamia and Egypt, mathematics was used both for temple rituals and accounting—functions that involved both priestly elites and lower-status clerks. But the nature of the knowledge—how it was justified, transmitted, and respected—differed radically depending on whether it was sacred or utilitarian" (Lloyd, 2004, p. 112).

What can be said is that in the Ancient Greeks, and perhaps not before, we have a split between sacred and profane number (and mathematics as a whole).

Indian Developments in Arithmetic and Mathematics

In the Indian subcontinent there were developments in mathematics that led to giant leaps forward in Arithmetic. A very important milestone is the invention of zero as a number. This went through several stages in which the concept which is to become mathematical zero advances from its identity with non-existence via its negative conceptual precursors as nothingness, a lack, an absence, through to positive concepts of emptiness, a pregnant void, an empty but nascent space in the process of becoming and bringing contents into being. As a result of this, nothing or the void is something, an empty collection in which the concept of the space or collection itself (an existent entity) is distinguished from the contents of that empty space or collection (non-existent, lacking objects, signs or anything). Finally, analogous with but distinct from this qualitative concept is the number zero itself, a fully fledged number that reflects the cardinality of an empty collection, the number that immediately precedes one.

But there is more to zero than the numeral representing the empty set. For zero to become a fully fledged number in its own right it must have mathematical properties with respect to the rest of the integer numbers.

Thus the history leading to zero includes a shift, jump or sidestep from the world of philosophical, mystical and qualitative concepts of void, emptiness, non-existence into the domain of properly quantitative mathematical concepts. The resultant number zero fully participates in numerical relations and orderings, and, alongside positive and negative numbers, acts as the additive identity (n+0=n)[8], and lies within the range of possible answers to algebraic equations.

There are philosophies of emptiness that originate in many overlapping domains of theology, mythology, mysticism and philosophy across cultures and religions including Hinduism, Jainism, Buddhism, Taoism, Ancient Greece, Sufism, Judaism and the Kabbalah, and Christianity, over several millennia. In these belief systems there are philosophies of emptiness; nothingness is conceptualised as a lack, a void, nil, nothing, an absence. But these conceptions mean that although nothingness denotes a void, nothingness exists as a concept, so ‘nothingness’ is something, namely the name of nothingness. It is almost certain, that such conceptions are necessary prerequisites for the development of zero into a number concept. Nothing becomes something. It gains ontological status as something, even if it is devoid of content. This is perhaps necessary, although certainly not sufficient, for zero to emerge.

In the centuries preceding the 7th (CE), sometime after second century BCE negative numbers were used in India to represent debts, and positive numbers to indicate assets or ‘fortunes’[9] (Mattessich 1998). Thus a lack or a debt could be conceptualised as something real, alongside possession of something, which whether substantial or not, is real and countable. An economically and fiscally advanced culture was almost certainly necessary for the development of negative numbers as numbers on a par with natural (or positive) numbers. However, this involves a significant conceptual step beyond numbers as representing something materially present to the senses, or potentially so. For quantified ownership can be verified individually by the senses, whereas financial assets or debts can only be determined by reference to social agreements and documents recording them. Thus debts as negative numbers represents a significant conceptual advance in the development of number systems.[10] They represent an abstraction of the concept of number into an abstract realm of number, where number goes beyond what is materially present to the senses. Conceptually they pave the way for the acceptance of zero as a number, for that too is not materially present to the senses.[11]

These ideas took centuries to evolve, to crystallize out of numerical practices. The key player as far as we know in the invention of the number zero is the Indian mathematician, astronomer and astrologer Brahmagupta, who lived 598–668 CE. Brahmagupta was familiar with negative numbers when he articulated the properties of the numeral zero as a number in

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[8] Through its role as the additive identity Zero provides a foundation for subtraction, for a-b can be understood as $^{+}a+^{-}b$, where ^{-}b is the additive inverse of ^{+}b (= b) such that $^{+}b + ^{-}b = 0$.

[9] Negative numbers appear for the first time in recorded history in the *Nine Chapters on the Mathematical Art* (Jiu zhang suan-shu), which in its present form dates from the period of the Han Dynasty (202 BCE – CE 220), (Wikipedia 2021b) and in Jain mathematics, as I record subsequently.

[10] Rotman (1977) stresses how the emergence of zero parallels the emergence of paper money. Likewise the acceptance of negative numbers both parallels, and is irretrievably bound in with, and very likely originates with the acceptance of debts as something real, within the worlds of finance and governance.

[11] There is an irony, and inversion, even a paradox here, in that subtraction is necessary for the invention of zero, yet zero is used to define subtraction in terms of additive inverse numbers in the formalisation of arithmetic. Such inversions of conceptual history during the processes of formalisation are not uncommon in mathematics.

its own right. He defined it as the number you get when you subtract a number from itself.[12] He thus employed the conceptual step of abstracting numbers from the results of counting objects materially present to the senses. Beyond having the concepts of debt and of emptiness it is still a giant step to conceptualise zero as a number on a par with other numbers. The third and most important conceptual foundation for this development is the conception of number and operations as comprising a totality; an interconnected system of relationships and meanings.

It is evident that Brahmagupta held this view because he defined rules for all four operations with the number zero, as well as for combining signed numbers (debts and assets or fortunes as they were called). Thus he accepted that both 2-3 and 2-2 are legitimate operations and that each provides a recognisable number as a solution (-1 and 0, respectively). He created an elaborate theory including all of these components, thus more or less establishing the modern domain of integers (Z) as it stands today.

Brahmagupta also worked in algebra and regarded zero and negative solutions as acceptable and legitimate. Indeed, working with equations and their solutions provides a further impetus for acknowledging and treating zero and negatives as proper numbers so that equations always have the same number of solutions as their highest power.[13]

By bringing together and extending what was known about positive and negative numbers and zero and all of their relationships in the text Brahmasphuta Siddhanta, dated 626 CE, Brahmagupta was making a great synthesis and a giant leap forward. Brahmagupta is in many senses the Indian analogue of Euclid (Ernest 2024). Without the contribution of Brahmagupta bringing together and synthesising a new approach to arithmetic many subsequent developments in extended decimals, trigonometry and working with infinite series would not have been possible. Several other practices such as astronomy and astrological calculations also depended heavily on these numerical innovations.

The work of Brahmagupta (7th century CE) and his Indian contemporaries reflects a rich interweaving of mathematics, astronomy, astrology, and sacred ritual practices. In classical Indian knowledge systems, the boundaries between science and religion were fluid, and mathematics was often a tool to serve religious, cosmological, and ritual purposes. The seminal work of Brahmagupta, the Brāhmasphuṭasiddhānta, of 628 CE, translates to "The Correctly Established Doctrine of Brahma," indicating its religious significance (Brahmagupta, 1902). Brahmagupta's major work is a synthesis of astronomical and mathematical knowledge. It was explicitly composed for religious calendrical purposes and aligned with astrological and ritual needs (Datta & Singh, 1962)

> "The primary motivation for Indian astronomy and mathematics was religious—the need to determine auspicious times for rituals, sacrifices, and festivals" (Pingree, 1981, p. 3).

[12] There is an important difference between a negative number, such as $^-7$ and the operation of subtracting 7, even though we may incorrectly refer to both as 'minus seven'. Historically, the emergence of subtraction long preceded the recognition of negative numbers. Formally we would define the operation of minus seven as the addition of $^-7$, even though this is an inversion of the actual order of their historical emergence.

[13] The quadratic (power 2) equation $x^2+x=0$ has the two solutions x=0 and x=-1. Unless zero and negative solutions are allowed it will not have exactly these 2 distinct solutions in common with all quadratic equations.

Brahmagupta's calendrical computations were used to determine eclipses, lunar phases, and planetary positions, all of which were crucial for sacred rituals and astrological predictions.

> "Brahmagupta's astronomical theories were formulated within a Brahmanical religious framework, wherein planetary motions were believed to influence both individual fate and ritual timing" (Yano, 2003, p. 130).

Indian mathematics and astronomy were largely contained within the discipline of Jyotiṣa, which served a ritual calendrical function. Jyotiṣa was one of the six Vedāṅgas (limbs of the Veda), specifically developed to support the correct performance of Vedic rituals.

> "Jyotiṣa, as part of the Vedāṅgas, was not secular science but sacred knowledge, aiding the priest in timing sacrifices in accordance with the heavens" (Kak, 2000, p. 88).

Brahmagupta, though a mathematician, operated within this sacred context, using numerical methods to calculate the timing of celestial events for religious purposes. Astrology, specifically Hora, the predictive branch, was deeply tied to mathematics. Planetary positions calculated using Brahmagupta's algorithms were used in horoscopes, medical decisions, agricultural planning and ritual timing.

> "The calculation of planetary conjunctions and eclipses served both religious festivals and astrological divinations, demonstrating the unity of sacred and mathematical knowledge" (Filliozat, 1961, p. 26).

Although more associated with earlier Vedic texts (like the Śulba Sūtras), the use of mathematics in designing altars and sacred spaces remained influential. The legacy of sacred geometry likely influenced Brahmagupta and his era's worldview.

> "The tradition of sacred geometry laid the conceptual groundwork for later developments in mathematical astronomy and algebra in India" (Sen & Bag, 1983, p. 49).

Bhāskara I, a 7th-century mathematician, further developed the place value system, (Bhāskara I, 1960, p. 45). These developments were crucial for performing complex astronomical computations required for religious observances.

Indian mathematicians exhibited remarkable proficiency in dealing with very large and very small numbers. The Jain mathematical tradition, for instance, classified numbers into enumerable, innumerable, and infinite categories, reflecting a philosophical and religious engagement with the concept of infinity (Plofker, 2009). This classification was not merely theoretical but had practical applications in cosmology and ritualistic contexts.

The Hindu commitment to very large durations of time and very large numbers in general, in order to support their theological speculations about the universe, led them to develop the means or recording huge decimal numbers long before such capacities were developed in Europe. Thus these were stimulated by spiritual considerations and interests. For example, around 750CE lists of powers of ten up to ten to the 23rd power were made. Twenty four was a sacred number, so the list stopped before taking the blasphemous step of reaching that power (Gupta 2022).

Bhāskara II, a 12th-century mathematician, demonstrated the use of large numbers in his work Līlāvatī, where he presented problems involving massive quantities, showcasing the advanced state of Indian mathematics in handling large-scale computations (Bhāskara II, 2002).

These developments make up what is known as The Golden or Classical Period of Indian Mathematics spanning from approximately 400 CE to 1200 CE (Joseph 1991). During this time, Indian mathematicians made foundational contributions to number systems, algebra, geometry, and trigonometry that deeply influenced later Islamic and European mathematics. However their contributions did not cease around 1200 CE.

The Kerala School of mathematics, flourishing between the 14th and 16th centuries, made groundbreaking contributions to the development of infinite series. Madhava of Sangamagrama (1973), a prominent figure of this 14th century school, derived infinite series expansions for trigonometric functions, anticipating concepts of calculus centuries before Newton (Plofker 2009). These mathematical advancements were primarily motivated by the need for precise astronomical calculations to determine auspicious timings for religious rituals. The school's focus on precise astronomical measurements underscores the sacred motivations behind their mathematical endeavours.

Indian mathematics from the post-Brahmagupta era (after 670 CE) to the pre-Newtonian period (before the 17th century) witnessed significant advancements, deeply intertwined with sacred and religious contexts. This period saw the development of sophisticated mathematical concepts, including number theory, place value systems, large and small numbers, and infinite series, often motivated by astronomical and ritualistic needs (Plofker 2009, pp. 56–60).

The development of Zero

The development of Zero provides an interesting case study in the relationships and interplay between sacred and secular arithmetic, and between arithmetical advances and the religious outlook.

The word zero retains clear signs of its Hindu and Arabic roots. The Indian name for zero was Sunya, meaning 'empty', and the underlying concept originated in Hindu, Buddhist and Jain sacred philosophies. When the Arabs adopted Hindu-Arabic numerals, they also adopted the numeral zero under the name of 'sifr'. Some Western scholars turned sifr into a Latin-sounding word, 'zephirus', which is the root of the word zero. Other Western mathematicians termed zero 'cifra', which became 'cipher'. Because of the import of zero for the new set of numbers, people started calling all numbers ciphers. This gave the French their term 'chiffre', digit, as well as the modern English-speaking world their name 'cipher' for code (Seife 2000).

In considering the mystical and sacred uses of number alongside the purely mathematical perspective of number it is interesting to note certain traditions outside of mathematics. One such example is the Jewish mystical study of the Kabbalah. In this system Zephirus, the medieval term for zero, is also the origin of the Kabbalistic name 'Sephiroth', the tree of life. The creation myth for this begins with Ayin (zero, the void), from which comes Ayin Sof (God, the infinite) who gives off an emanation of golden light Ayin Sof Aur that brings the tree of life into being, with its ten nodes corresponding to the numbers 1 to 10. Thus, the Kabbalah, which at its very heart is numerological, is based on a creation myth that starting from 0 creates the numbers 1 to 10, and through them, creates the whole universe, seen and unseen.

According to Seife (2000) and others, neither zero or negative numbers were acceptable in Europe for several hundred years. He argues that the acknowledging the void, as acceptance of zero implies, and which is part of several oriental philosophies, challenges Aristotle's doctrines and the medieval beliefs of Christianity built on Aristotelian roots. It was only in the 12th century that these anti-void doctrines were rejected and not long afterwards Leonardo of Pisa (Fibonacci) introduced zero and negative numbers in his book Liber Abaci, published in 1202. The lesser known Nemorarius also introduced zero to Europe (Joseph 2008). Fibonacci was thus among the first two known Europeans to accept zero and negative numbers as permitted solutions to quadratic equations. Like Brahmagupta, Fibonacci interpreted negatives as debit quantities.

The history of zero illustrates how widespread ideological and religious orientations can shape, even hinder or block, certain developments in mathematics. In the middles ages in Christian Europe zero was not accepted as a legitimate number for religious and philosophical reasons. The doctrine that God is everywhere meant that no true vacuum or empty region can exist (as asserted by Aristotle). Since zero purports to denote an empty count or empty set it is blasphemous to assert its existence. It contradicts this accepted Christian doctrine and so is forbidden. Thus religion (Christianity) forbade the consideration of the concept of zero as it was considered blasphemous. Yet we now know that zero is the lynchpin of number systems, especially the historically important decimal system, as well as being the basic and necessary additive identity. Furthermore, this abstract concept coexists unproblematically with the fact that there is probably no true vacuum in nature (Gobets & Kuhn 2024).

The acceptance of Hindu-Arabic numerals, the related methods of computation and new additions like zero and negative numbers took several hundred years. As is well known the traditional abacists (using the abacus with material tokens) were trusted more than the new fangled algorists (who used the new abstract algorithms and zero) in trade and business.[14]

While these developments dominate the traditional secular histories of mathematics there are parallel hidden knowledge traditions and practices outside of the academy. I have indicated how the Kabbalah is based on number mysticism and numerology.

In addition, from the medieval period through the Renaissance and into early modernity, numbers in Western astrology continued to carry profound symbolic and mystical meaning. They were embedded in philosophical, cosmological, and theological systems that interpreted numbers not just as tools for measurement, but as manifestations of divine order.

In the medieval period, astrology was central to natural philosophy and medicine, and numbers governed astrological computations through planetary cycles, zodiacal divisions, and aspects. These numerical relationships were viewed as reflecting divine harmony. As Lynn Thorndike notes:

> "Medieval astrology was steeped in a numerological mysticism, whereby the heavens were believed to operate in accordance with sacred numerical laws" (Thorndike, 1923, p. 85).

[14] Very likely there were similar forms of resistance in Mesopotamia when the clay tokens used in trade were replaced first by marked clay envelopes and later by mere markings on clay tablets.

The number seven, representing the seven classical planets, was especially venerated. It was associated with the seven days of the week, the seven metals, and even the seven ages of man — forming a sacred framework for interpreting the cosmos. Frances Yates explains:

> "The seven planets were deeply embedded in the sacred numerology of the time, forming part of a divinely ordered system of correspondences that extended from the heavens to human physiology and ethics" (Yates, 1964, p. 102).

In the Renaissance, astrology and number mysticism merged within a broader revival of Hermeticism and Neoplatonism. Heinrich Cornelius Agrippa, in his influential Three Books of Occult Philosophy (1533), wrote:

> "All things are disposed according to number… nothing exists in the world that does not partake of numerical harmony" (Agrippa, 1993, p. 116).

Agrippa and other Renaissance thinkers believed that numbers were divine archetypes, and that astrology revealed their application to worldly events through precise calculations of planetary motion, angles, and time divisions.

In the early modern period, figures like Johannes Kepler transformed the mystical approach into a more scientific cosmology, while still retaining deep numerological commitments. Kepler saw planetary motions as expressions of divine geometric design:

> "The chief aim of all investigations of the external world should be to discover the rational order and harmony which has been imposed on it by God and which He revealed to us in the language of mathematics" (Kepler, quoted in Field, 1988, p. 123).

Kepler's Harmonices Mundi (1619) proposed that musical, geometric and numerical harmonies governed planetary orbits, exemplifying the fusion of mystical numerology and emerging mathematical astronomy.

Sacred, Pure, and Profane Number in the Modern Era

The development of number and number theory in the modern era (approximately from the 17th century onward) has proceeded along three distinct but often interrelated paths: (1) religious, mystical sacred uses of number, (2) pure mathematics as a quasi-sacred intellectual pursuit, and (3) profane or secular applications. Each trajectory is shaped by distinct philosophical commitments, yet they remain historically interwoven and entangled.

First, there is the religious and mystical sacred Number tradition. While Enlightenment rationalism marginalized overt numerological and astrological practices, mystical associations of number persisted in esoteric traditions such as Kabbalah, Theosophy, and Christian mysticism. These systems saw numbers as metaphysical keys to divine reality. For example, Kabbalistic numerology (gematria) continued to influence thinkers into the modern period, asserting that "numbers are the sacred vessels through which divine energies flow" (Faivre, 1994, p. 65).

In the 19th century, mathematical mysticism experienced a revival through figures like Rudolf Steiner, who viewed numbers as spiritual archetypes. As Antoine Faivre explains:

> “Modern esotericists did not abandon number symbolism; rather, they transformed it into a system of inner perception — a contemplative tool to access spiritual realities” (Faivre, 1994, p. 67).

These mystical uses of number remained marginal to mainstream science but provided a spiritual counterpoint to the increasingly secular direction of mathematical sciences.

Second, there is Pure Mathematics as Inner Sacred Pursuit. Within academic mathematics, a quasi-sacred reverence for number has persisted. The idea that mathematics reveals eternal truths parallels religious sentiments. Mathematicians like G.H. Hardy exemplified this attitude.

> “A mathematician, like a painter or a poet, is a maker of patterns... the mathematician’s patterns, like the painter’s or the poet’s, must be beautiful” (Hardy, 1940, p. 84).

This aesthetic, almost sacred, conception of mathematics as an art form governed the development of number theory in the 19th and 20th centuries, particularly in the work of Gauss, Riemann, and later Ramanujan, whose insights have been described as “mathematical revelations.” Ramanujan himself said:

> “An equation for me has no meaning, unless it expresses a thought of God” (Kanigel, 1991, p. 92).

Such views reflect a spiritualized engagement with number theory, one in which beauty, mystery, and truth converge — not unlike sacred practice. In this case it would seem to be a convergence of the two types of sacrality, both inner and outer. The inner sacrality being mathematics pursued for its own sake, service to Mathematics itself, which is elevated to a god-like status. Outer sacrality is the traditional view of, and dutiful service to, the religious, mystical and holy aspects of the gods, and the whole of the universe as a divine creation.

Thirdly, there is Profane and Applied Number. In contrast to the inner and outer sacred traditions, the profane use of number flourished in modernity through economics, engineering, military science, and computing. The rise of probability theory, statistics, and numerical analysis catered to practical ends: managing populations, markets, and machines. As Hacking (1990) observes:

> “The emergence of probability transformed the ways we govern society — replacing divine providence with quantifiable risk” (Hacking, 1990, p. 12).

The late 20th century to the present has seen the explosive growth in the applications of number in digital computing and cryptography, with prime numbers at the heart of encryption systems like RSA. These uses of number are guided not by aesthetics or spiritual belief but by utility, efficiency, and control — marking the triumph of the profane over the sacred philosophies of mathematics, as evidenced in the world.

Despite their distinctions, these strands often intersect. For instance, Ramanujan's number-theoretic discoveries, later applied to string theory and black hole physics, originated from intuition grounded in religious dreams and temple mathematics. Likewise, ideas from mystical geometry influenced early computing pioneers like Leibniz, who also pursued theological symbolism in binary numbers.

Thus, the modern story of number is not a linear march from mysticism to pragmatism, but a branching evolution of symbolic, intellectual, and practical uses. Sacred and profane continue to coexist — whether in the symmetry of quantum equations, the elegance of number fields, or the mystical awe that many mathematicians still feel before the infinity of primes.

Indeed it can be argued that the mystical awe and reverence that mathematicians feel and experience in the presence of and in the making of mathematics is a sacred inner revelation of the transcendent being, Mathematics. The experience of the power of this superhuman entity, a harsh master that requires total submission before its ultimate discipline, Such devotion may necessary for the progress and development of mathematics.

Lakatos (1976) illustrates this perspective of mathematics

> Mathematics, this product of human activity, 'alienates itself' from the human activity which has been producing it. It becomes a living, growing organism, that acquires a certain autonomy from the activity which has produced it; it develops its own autonomous laws of growth, its own dialectic. The genuine creative mathematician is just a personification, an incarnation of these laws which can only realise themselves in human action. Their incarnation, however, is rarely perfect. The activity of human mathematicians, as it appears in history, is only a fumbling realisation of the wonderful dialectic of mathematical ideas. But any mathematician, if he has talent, spark, genius, communicates with, feels the sweep of, and obeys this dialectic of ideas. (Lakatos 1976, p. 155).

Like the Law, Money, Literature or indeed Religion, Mathematics is a human product that takes on a life of its own. It becomes larger than any of its adherents, practitioners, servants or creators. For the inner sacredness of mathematics that I am describing, the adherents' view has moved from God is mathematics (i.e. God is expressed and sought through mathematics), to Mathematics is god. This is the replacement of the outer sacredness of mathematics, mathematics in the service and worship of something larger, to the domination of the inner sacredness of mathematics as something larger itself, bigger than its social practice. This is the current 'religion' of many active pure mathematicians. It explains some of the key questions in the philosophy of mathematics. These concern the universality, absoluteness and timeless certainty of mathematical knowledge, as well as the rock-hard solidity of the objects of mathematics in some Platonic domain. Whether or not these are scientific claims made for the epistemology and ontology of mathematics, undeniably these are also firmly held beliefs and values about the entity Mathematics and its heart Number Theory. As an object of veneration and 'worship' this has all the universal attributes of the gods and is subscribed to irrationally, that is, without reasoned justification, and is possessed of eternal properties and values.

The Profane Face of Mathematics

I began writing this chapter with the belief that the sacred and profane faces of mathematics could be traced back, if not to its inception in the hazy, almost unknowable, prehistoric times, then at least back through the written historical record. However, as reported in this chapter my study of history shows this is not the case. All mathematical and number practices were sacred until the times of the Ancient Greeks, when there was a split and profane (commercial) mathematics was important for trade, taxes and so on. This continued through the Roman empire.

> "The Roman abacus and counting boards were tools of commerce. Roman businessmen calculated profits, interest, and debts with a facility that reflected an economy built on numeric fluency, not theory." (Neal 2002, p. 88)

While sacred or symbolic uses of number existed, they were far less emphasized in Roman culture than in Greek, Egyptian, Indian, or later Christian thought. Roman religion was ritualistic and legalistic, but not deeply numerological.

> "Unlike the Greeks or Pythagoreans, the Romans were not inclined to see numbers as sacred. Their interest lay in practicality; where symbolic numbers occur, they are usually rhetorical or traditional rather than metaphysical." (Clarke 2003, p. 143)

In the dark ages and medieval times sacred mathematics prevailed in both Islamic and Christian medieval societies when linked to religious architecture, astronomy, or theology. Profane mathematics emerged primarily in Islamic contexts for taxation, inheritance, and trade and in European contexts, especially in Italian mercantile cities, for bookkeeping, currency conversion, and profit calculation.

Thus mathematical and number practices in the Muslim/Moorish empires and medieval Europe included both sacred and profane dimensions, though the balance between them varied by context. In Islamic societies, mathematics was often deeply integrated with religious and philosophical thought, while in medieval Europe, sacred uses coexisted with the growth of commercial and utilitarian (profane) applications, especially from the 12th century onwards.

In the Islamic Golden Age, mathematics had sacred associations, particularly in relation to astronomy (for prayer times and qibla direction), geometry (for mosque design), and numerology (e.g. the symbolic interpretation of numbers in the Qur'an).

> "For the Muslim mathematician, mathematics was not a purely rational enterprise; it had religious significance, since it was part of understanding the divine order of the cosmos." (Berggren 1986, p. 14)

Alongside sacred uses, Islamic societies also developed utilitarian mathematics, especially in trade, inheritance law, and taxation.

> "Islamic arithmetic developed to serve practical needs—division of inheritances, calculation of zakat (alms tax), and commercial transactions—all of which demanded a profane, that is, worldly application of number." (Hogendijk & Sabra 2003, p. 109)

In medieval Christian Europe, mathematics had sacred associations especially through Platonic and Augustinian traditions. Numbers and geometry were seen as reflections of divine harmony, used in cathedral design, theological numerology, and calendar calculations, such as computing the date of the Easter festival.

Profane or utilitarian mathematics developed especially in the Italian city-states, where the rise of merchant capitalism in the 13th–14th centuries created a demand for arithmetic and bookkeeping skills. This was most evident in the abbaco schools.

> "From the 13th century, Italian merchants developed a form of practical arithmetic—known as abbaco mathematics—explicitly designed for commercial calculation, distinct from the sacred or scholastic arithmetic of the universities." (Swetz 1987, p. 41)

This distinction illustrates how both sacred and utilitarian number practices coexisted, shaped by cultural, religious, and economic contexts.

Profane, that is, commercial and utilitarian mathematics has come to dominate the modern world through its integration into nearly all aspects of governance, trade, surveillance, computation, and everyday life. This dominance is rooted in the expansion of measurement, categorization, datafication, and control mechanisms that serve commerce, taxation, governance, and performative optimization in modern economies. The widespread adoption and employment of profane mathematics marks a shift from to instrumental reason and managerial rationality. This is evidenced in a number of ways.

First, profane mathematics is an instrument of modern power and governance. Porter explains how profane mathematics underpins modern bureaucratic rationality, especially through standardized measurement and audit systems. Quantification is linked to trust, legitimacy, and control.

> "Quantification is not merely a technique but a form of power… numbers create systems of control, classification, and comparison that shape modern bureaucracies, from taxation and education to criminal justice and welfare." (Porter 1995, p. 45)

Second, there is the newly imposed data gathering and digital surveillance. How data is gathered, categorized, and analyzed mathematically is central to new modes of capitalist extraction, shaping behaviour and enabling constant surveillance.

> "In the datafied world, almost every human action becomes a number... Algorithms sort, rank, and direct our behavior, reinforcing a regime where numerical performance defines success, value, and visibility." (Couldry & Mejias 2019, p. 3)

Third, there are powerful new applications in trade and commerce. Mathematics governs pricing, marketing, consumer profiling, and global logistics—embedding profane calculation at every level of modern trade.

> "Contemporary commerce is inseparable from profane mathematics: pricing algorithms, logistics optimization, and digital finance depend on advanced computation and vast data flows. Trade is now ruled by invisible numbers." (Kitchin 2014, p. 102)

Fourth, in modern society quantification enables control, governmentality, especially by employing performance metrics. The rise of statistics allows states to manage populations like resources, emphasizing utility, risk, and output over symbolic or sacred meaning.

> "Governments now rely on statistical data not only to measure populations, but to manage and optimize them. Education, health, and security are governed through metrics, rankings, and performance indicators." (Desrosières 2002, p. 16)

Fifth, there is the emergence of performative control via Apps and algorithms throughout government, society, business operations and civil society. There is a shift to algorithmic governmentality, where behaviour is directed by models and predictions derived from mathematical pattern recognition.

> "Mathematics is no longer just descriptive, it is performative. Algorithms tell us what to do—when to walk, how to drive, who to date, what to buy—creating a world where mathematical models prescribe reality." (Mackenzie 2017, p. 17)

Profane mathematics now governs trade, taxation, administration, and human interaction in modern digital society. Through data, algorithms, and surveillance infrastructures, mathematics has become: the basis for performative governance (metrics, targets, scores), a tool of economic optimization, a mechanism for population management and a means of behavioural control and prediction. This widespread reliance on mathematics signals not only the dominance of the profane over the sacred but the embedding of the logic of mathematics into the very infrastructure of modern life.

Through the immense power of its profane uses mathematics has come to be seen as god. But this is not the benevolent god nor even the aloof god of past religions. It is a resurrection of the ancient devilish gods Mammon and Moloch, that demanded the sacrifices of humans and controlled not only material resources, but human bodies and souls.

Mammon is the god of wealth, and in modern form, this becomes the logic of market capitalism, driven by mathematical abstraction: currency, pricing, interest, and performance indicators. Mathematics is the language of modern Mammon, replacing the visible idols of gold with digital accounts, App interfaces, and predictive metrics. It demands loyalty through productivity and quantifiable success, often at the cost of care, solidarity, or justice. "Mammonism today is not worship of coins, but of data. The spreadsheet becomes a sacred text. Metrics replace morality." (Han 2017, p. 36).

> "Mammon has become algorithmic. The financial markets, ruled by numerical codes and high-frequency trading, no longer resemble a human economy. They are governed by the purest profane mathematics—detached from ethics, history, or place." (Davis 2018, p. 88)

If Mammon governs through profit, Moloch governs through sacrifice—and in modern systems, this sacrifice is often enacted via measurable suffering: productivity stress, gig economy precarity, climate degradation, and burnout, all driven by optimization.

> "Moloch is the god of optimization without limit. He asks us to sacrifice leisure, health, even family life to maximize output, efficiency, and growth—measured in data and governed by algorithms." (Yudkowsky (2007, p. 3)

In modern surveillance capitalism, human bodies and behaviours are measured and modified by technologies that promise efficiency but extract control.

> "Quantification has become sacrificial: it removes complexity and replaces it with performance. Humans are now assets to be optimized—lives quantified and evaluated by digital systems, often in real time." (Eubanks 2018, p. 15)

The outcome is that profane mathematics has turned into the ritual of the machine. Together, Mammon and Moloch merge in the computational logic that governs the modern world: a regime of total measurement, performance metrics, credit scoring, biometric tracking, and algorithmic management. The sacred has not disappeared, it has been displaced into the profane, where mathematics now serves as ritual and doctrine, commanding loyalty not through mystery, but through measurement.

> "Moloch and Mammon are no longer gods with temples—they are the implicit gods of code, finance, and infrastructure. They are worshipped through daily rituals of optimization, calculation, and sacrifice." (Zuboff 2019, p. 319)

The once sacred kingdom of number, with its original outer sacred religious nature and its inner mathematical sacred quest, is now overtaken by the worship of profane number and mathematics. In modern society these have become the new sacred, worshipping data and the reborn ancient gods Moloch and Mammon. This means that the once sacred kingdom of number, despite its original outer sacred religious and inner mathematical sacredness has witness the transformation of profane number from its derogated profane place as something dirty, to be avoided by the holy, to the new sacred. The rise of data as an object of belief and authority—what Harari (2016) calls Dataism—marks the emergence of a new sacred order in modern society.

> "Humans were once deemed the source of all meaning; now information and its processing are the ultimate source. The new system worships neither gods nor man—it worships data." (Harari 2016, p. 427)

This is new. The new sacred order is grounded in: worship of data flows and information processing, rituals of connectivity, tracking, and optimization, priestly institutions in tech companies and algorithmic systems, sacrifices of privacy, autonomy, and individuality.

This new sacred overlays seamlessly with the rise of profane mathematics and algorithmic control, where measurement and calculation have become both normative and transcendent.

So we now have three strands of sacred mathematics,

1. The outer and original religious sacred mathematics of the priests and religions.
2. The inner sacred mathematics of the mathematicians that grew out of the inward practices of the scribes and philosopher-mathematicians.
3. The profane number and mathematics that controls our functioning, lives and society - newly elevated to the sacred domain. Perhaps this should be termed devilish rather than sacred mathematics.

The first was for the cohesion and good of society through the priests and religion. The second was for the good of number, mathematics and the mathematicians. But the third is for the benefit of Moloch, Mammon and corporate capitalism, with no regards to human flourishing or human or social goods or anything beyond the increase of wealth and power of the privileged few.

> "The applications of mathematics in society can be deleterious to our humanity unless very carefully monitored and checked." (Ernest, 2018, p. 187)

As ethics is subtracted the risks multiply. As worship is added the opportunities for critical democratic control converge on zero. As number is unleashed through Dataism the concentrated power of the elite grows exponentially. Can the clarion call for ethical control, Hippocratic Oaths for mathematicians and the rehumanising of high priests of Dataism be heard? Among the clamour of all the 'wicked' problems facing humanity (Rittel & Webber 1973). including genocide, war, climate catastrophe, degradation of the Earth, mass migrations and so on its is not likely. But number and mathematics in the hands of empathy and justice oriented people could be the way out of this mess (Skovsmose 2024).

Conclusion

Officially, from the scientific perspective, it has taken two and a half millennia to cleanse mathematics from what it sees as the taint of the religious, mystics and philosophers, but it is time to recognise the dark shadow that follows mathematics wherever it travels. Mathematics itself, ventriloquated through mathematicians, has demanded the right to define its own meaning inwardly. But the penumbra of human practices, institutions, and outsider meanings, intentions and values that carry it forward also need to be observed. It is only the hegemony of ideas of purity and other-worldliness that lead to the self-imposed silencing of outsiders. Once the ideologies of purism and Platonism are seen through, mathematics is revealed as the supreme tool, that which controls modern trade, commerce, governance, technology, and the digital and information revolution. It is also what gives us atomic and cyber-weapons and the electronic battlefield. Because of the penetration of profane mathematics as the new sacred order, the ruling by numbers, we need an ethics of mathematics and a Hippocratic oath for mathematicians. Through the unblemished purity of mathematics, mathematics as a supreme entity lives on in the minds of mathematicians. But this inner sacredness does not recognise or check its profane uses. Disconnected from its uses, mathematicians have not noticed that the profane cousins of their love object, pure mathematics, have grown up into the new gods of Moloch, Mammon and Dataism that now control the world. To conclude in terms of the three mathematical concepts that opened this chapter, we might now say that the power of zero and one, together, is now infinite.

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