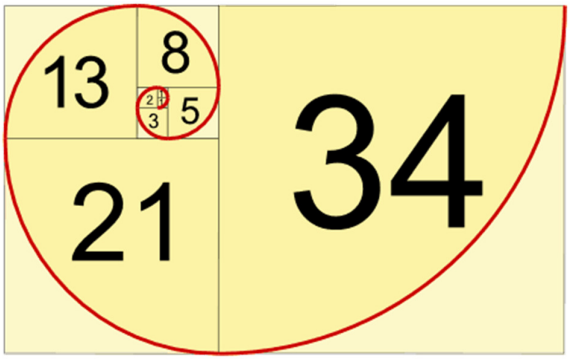
Are numbers real?

As project managers we use numbers every day of the week but how real are they?

Arabic Numerals

Our modern numbers are descended from the Hindu-Arabic numeral system developed by ancient Indian mathematicians, in the 5th century. These Indian numerals are traditionally thought to have first been adopted by the Muslim Persian and Arab mathematicians in India, and then passed on to the Arabs further West, with the current form of the numerals developing in North Africa. Europeans came to know of them thanks to the work of an Italian mathematician, Leonardo Pisano Bigollo (c.1170 – c.1250), better known as Fibonacci. He was born around 1170 to Guglielmo Bonacci, a wealthy Italian merchant, and notary by profession. Guglielmo directed a trading post in Bugia, a port east of Algiers in the Almohad dynasty's sultanate in North Africa (now Béjaïa, Algeria). As a young boy, Fibonacci travelled with him to help in the business. It was in Bugia he learned Hindu-Arabic decimal system and came to appreciate the benefits he later described in his book ***Liber Abaci*** (1202).



Another of Fibonacci's developments was the Fibonacci sequence which has many applications. The sequence is created by adding the previous 2 numbers 1, 2, 3, 5, 8, etc.

When Fibonacci published the ***Liber Abaci***, it was well received throughout educated Europe and eventually had a profound impact on European thought. In the book, Fibonacci advocated numeration with the digits 0–9 and place value, and showed the practical importance of the new numeral system by applying it to commercial bookkeeping[1] and other applications. However, as with anything new there was resistance to change despite the systems advantages for accounting.

Initially, the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9 and 0 and the concept of place value (where an 8 could represent 8, 80 or 8000 depending on its position) caused some scepticism among Europeans. The Church declared Arabic numbers ungodly and some cities banned them. For example, Florence in 1299 banned the use of Arabic numbers in contracts and official documents, it was argued that Arabic numbers are easier to falsify than Roman numbers, and were difficult to decipher in accounting books. Zero in particular, created discord. This number, which has no value, but can represent multiples of ten, worried the Italians. Negative numbers also inspired mistrust.

On the other hand, the arithmetic superiority of the Arab system is immediately evident to traders and even the most sceptical must, at some point, have admitted that the new system offered an unparalleled facility of calculation. By the 15th century Arabic numerals had gradually extended to the rest of Europe via trade routes.

Arabic numbers in which a sequence of digits such as '975' is read as a single number is easy to use and widespread but it was not the first or last system of numbers.

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[1] If you have ever wondered why accountants have such as strong position in the project management world, double-entry bookkeeping developed in medieval Europe based on the work of Fibonacci. Modern project management developed in the 1960s.

Roman Numerals

The numbering system used in most of Europe before the decimal system was Roman. The Roman system uses letters to describe values (I, V, X, L, C, D, M), and is a much more complicated system (as anyone knows who has ever tried to figure out a date written in Roman numerals).

Mathematical calculations quickly became close to impossible. For example, the sum of 2688 + 2786 = 5474 was written as MMDCLXXXVIII + MMDCCLXXXVI = MMMMMCDLXXIV, but getting to the answer was far from simple.

To overcome the difficulty of performing calculations using the Roman system, they used a type of abacus, with pebbles as counters and mathematical operations using the abacus were performed by people called '*calculators'*. They were so named because they used *calcule* (Latin for pebbles) to add, subtract, multiply and divide. After completing the calculations, the result was written (or more accurately described) using the letters to describe the value. The image below is a Roman Hand Abacus:

Other Systems

Not too much physical evidence survives, but judging from references, and contemporary devices found in Greece, the standard Roman abacus may have been borrowed from either Greece or Babylon[2]. These earlier Mediterranean civilisations had their numbering systems[3] and the modern world has others. Most

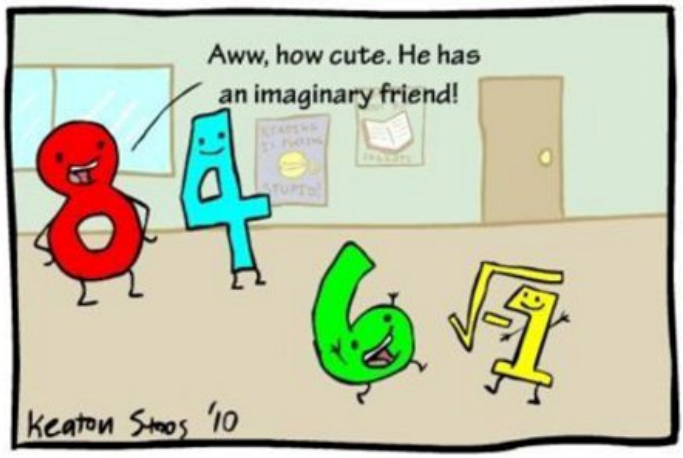
[2] For more on how the Roman abacus worked see: https://en.wikipedia.org/wiki/Roman_abacus

[3] For example, the Sumerians used a number system based on 60, for more on this see: https://mosaicprojects.com.au/PDF_Papers/P185-The_origin_of_calendars.pdf

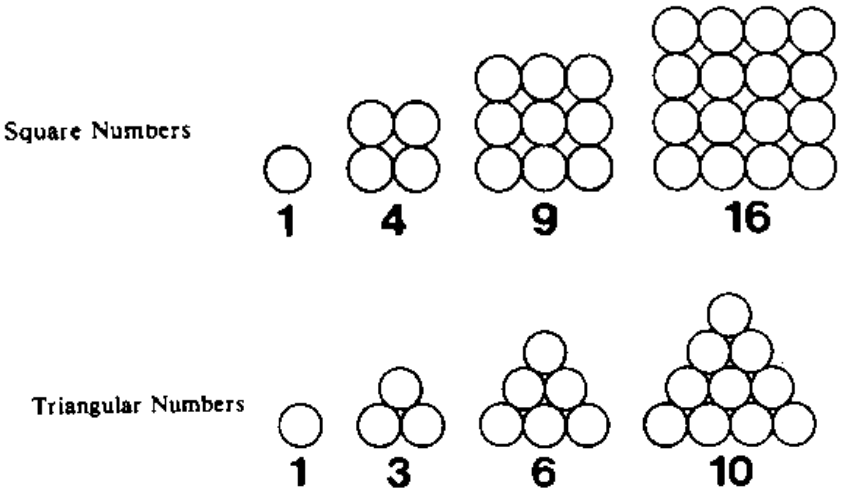
computers rely on binary mathematics. Duodecimals were used in the UK prior to metrication (using a base of 12 to deal with measurements in feet and inches) etc. Which raises the question how real are numbers?

Problems with Numbers

Some numbers are 'irrational' such as the 'square root of 2' and π (Pi) - there is no complete answer. Others are imaginary such as the square root of minus 1.



In Ancient Greece, the sect of the *Pythagoreans* was devoted to the power of numbers. Pythagoras studied the concept of square and triangular numbers and identified the irrational characteristics of the 'square root of 2' but leading a sect based on the perfection of numbers and geometry to describe the world, it is rather challenged if you cannot define the length of the diagonal of a square…… he kept the inconvenience of irrational numbers secret.



To solve the conundrum of irrational numbers, the *Pythagoreans* called such lengths *alogon* - the word has two meanings, *not a ratio* and *not to be spoken*. Breaking the secret could be fatal. According to legend, when one of his followers, Hippasus broke the oath of silence he was assassinated which is certainly taking an interest in numbers to an extreme!

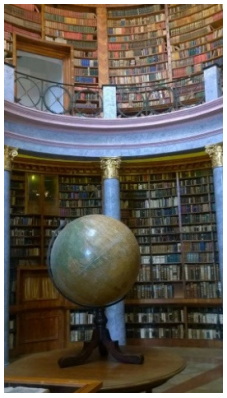
And then there are strange sequences that build fascinating patterns:

1 x 8 + 1 = 9
12 x 8 + 2 = 98
123 x 8 + 3 = 987
1234 x 8 + 4 = 9876
12345 x 8 + 5 = 98765
123456 x 8 + 6 = 987654
1234567 x 8 + 7 = 9876543
12345678 x 8 + 8 = 98765432
123456789 x 8 + 9 = 987654321

1 x 9 + 2 = 11
12 x 9 + 3 = 111
123 x 9 + 4 = 1111
1234 x 9 + 5 = 11111
12345 x 9 + 6 = 111111
123456 x 9 + 7 = 1111111
1234567 x 9 + 8 = 11111111
12345678 x 9 + 9 = 111111111
123456789 x 9 +10= 1111111111

Give our reliance on mathematics for virtually everything how 'real' is a system that cannot define the ratio between the diameter and circumference of a circle[4] but can generate fascinating sequences like those above?

There's no answer to this question other than to suggest there are 10 types of people in the world – those who understand binary mathematics and those that don't.



[4] **π** (pi) is the ratio between the diameter and circumference of a circle, it is approximately equal to 3.14159. However, the precise value has recently (14th March 2019) been calculated to 31,415,926,535,897 digits behind the decimal point without getting a finite answer! However, $\pi \times 10^{13}$ is probably near enough for most people: https://en.wikipedia.org/wiki/Chronology_of_computation_of_%CF%80