

Number Systems

**In Partial Fulfillment of Portfolio No.3 for the Course CIS-1102
Introduction to Computing**

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What are number systems?

As per Wakerly (2002), Number systems are essentially a mathematical framework that aims to represent numbers based on its base value, wherein the position of each digit corresponds to its weight, and which each time the value moves left—its weight increases by its factor depending on its base.

In essence, number systems assist daily mathematical operations and calculations easier by providing a set of rules to follow when it comes to mathematical concepts. From counting numbers, to computation in banks (GeeksforGeeks, 2021).

Four common types of number systems

The **four** commonly used number systems include: Binary, Octal, Decimal, and Hexadecimal.

Binary

According to (Lande, 2014), the binary number system has two states, ‘on’ or ‘go’ which is represented by 1, and ‘off’ or ‘no-go’ represented as 0. Binary number systems are essential in the conditions of electric circuitry, wherein the combination of ones and zeros corresponds to different allocated translations based on the American Standard Code for Information Interchange (ASCII). Binary numbers are also given the base ‘2’ which denotes that it is in a binary number system. Furthermore, the binary number system was said to be discovered by Englishman Thomas Harriot and the Spaniard Juan Caramuel de Lobkowitz from 1606 to 1682 (Ares et al., 2017).

Octal

As per GeekforGeeks (2023), Octal Number systems include the digits zero to seven (0, 1, 2, 3, 4, 5, 6, 7), and is widely utilized for compact representation of binary numbers, where binary digits grouped to 3 bits is equal to an octal number. Octal numbers are denoted with base ‘8’.

Decimal

Decimal number system is the standard numbering system that is commonly used in daily calculations. Standard counting, calculating and arithmetic operations are done through the decimal number system. The decimal number system is denoted using the base ‘10’, that includes the numbers zero to nine (0, 1, 2, 3, 4, 5, 6, 7, 8, 9). Furthermore, the decimal number

system was introduced by Indian mathematicians, and further perfected by medieval Islamic mathematicians (*Numerical System | Mathematics*, n.d.).

Hexadecimal

A study by Grout (2008), defined a hexadecimal as a number to the base of 16, that is zero to fifteen (0, ..., 15), where the numbers 10 to 15 are replaced with the first 6 letters of the alphabet respectively (A is 10, B is 11, C is 12, D is 13, E is 14, and F is 15). Consequently this allows for the representation of numbers 1 to 9 and letters A to F, wherein the hexadecimal number system is commonly used in computer science related-fields.

What are the uses/significance of each number system?

Binary

The most simplest form of computer data are bits, short for binary digit, wherein a bit could either be a one (on) or zero (off). Binary is significant because it incorporates the usage of bits into bigger sizes of data which includes bytes, megabytes, gigabytes and so on, which one's computer translates and processes. Binary is useful in the field of programming for the reason of being the simplest form of data (on or off) (*Computer Science: Binary*, n.d.).

Octal

According to Plants and Berman (2017), the Octal number system is necessary in computer processes as it is a number system that has a base $2n$. This signifies its significance with the relationship of the binary number system where 3 bits is equal to an octal number, making the octal number system an efficient way in translating binary numbers for human readability.

Decimal

In a study by Rosales (2023), the base 10 number system (decimal number system) is the foundation of all mathematics, and encompasses basic arithmetic and mathematical operations. The decimal number system is the most widely used number system in daily calculations, and is also said to be the universal language for expressing numbers, equations, quantities, concepts, and measurements.

Hexadecimal

An article from Strickland and Jones (2022) exemplifies the fact that the hexadecimal number system has been utilized for decades, wherein the hexadecimal number has evolved throughout time to represent and express binary numbers grouped into 4 bits. This allows for the

hexadecimal number system to be used in fields such as color theory, machine code, and allocation of memory address.

Analysis

In my personal analysis and reflection, number systems play an important role in understanding mathematical problems and their relationships with other systems according to other mathematical or scientific fields. Each number system has its own strengths and weaknesses in how they are applied in real life situations, which is important to understand which number system should be used for a specific purpose. Take for example, the binary number system, using it in day to day life from counting numbers to taxes would be a hassle, unlike using the decimal system, but the decimal system would also be too complicated for a simple ‘on’ or ‘off’ electronic circuit, such as hardware. Furthermore, after understanding the processes of number systems in daily life, number systems play a crucial role in maintaining daily operations, from transportation, to taxes, and even to airline management. Subsequently, number systems allowed for the advancement of technology through the creation of circuitry and all the way to personal computers and internet access. With the creation of binary systems, software was created, altogether, with the hexadecimal number system, came software with the advancement of computing, simulations, entertainment, and accessibility to resources online. The decimal number system on the other hand are all the more useful in daily operations, an example would be counting a number, calculating differences, finding the sum of your allowance, calculating taxes, buying groceries, and more arithmetic operations done in daily life. Also, the decimal number system is the most used number system in daily arithmetic and advanced mathematical operations. Octal number systems on the other hand are also useful in making human-readable representations of binary numbers, they are also commonly used in the field of computing in computer science used in UNIX file permissions. In summary, humans have evolved number systems and created branches to perfectly fit each type of number system into its designated use. Number systems are essential due to the fact that it hastens efficiency for specific mathematical needs, such as binary number system for computers, decimal number system for normal arithmetic operations, octal number system for Operating Systems, and Hexadecimal number system for readability of longer binary numbers, and specifying colors in web pages. Overall modern day technology would be nothing without the assistance of the efficient number systems.

References

- Ares, J., Lara, J., Lizcano, D., & Martínez, M. A. (2017). Who discovered the binary system and arithmetic? Did Leibniz plagiarize Caramuel? *Science and Engineering Ethics*, 24(1), 173–188. <https://doi.org/10.1007/s11948-017-9890-6>
- Computer Science: Binary. (n.d.). GCFGlobal.org. <https://edu.gcfglobal.org/en/computer-science/binary/1/>
- GeeksforGeeks. (2021, September 27). *What is the importance of the number system?* GeeksforGeeks. <http://geeksforgeeks.org/mathematics/what-is-the-importance-of-the-number-system/>
- GeeksforGeeks. (2023, December 2). *Octal Number System.* GeeksforGeeks. <https://www.geeksforgeeks.org/mathematics/octal-number-system/>
- Grout, I. (2008). Introduction to Digital Logic Design. In *Elsevier eBooks* (pp. 217–331). <https://doi.org/10.1016/b978-0-7506-8397-5.00005-2>
- Lande, D. (2014). Development of the Binary Number System and the Foundations of Computer Science. *The Mathematics Enthusiast*, 11(3), 6. <https://scholarworks.umt.edu/tme/vol11/iss3/6/>
- Numerical system | mathematics. (n.d.). Encyclopedia Britannica. <https://www.britannica.com/science/numerical-system>
- Plantz, A. R., & Berman, M. (May, 2017). "Adoption of the Octal Number System," in *IEEE Transactions on Computers*, vol. C-20, no. 5, pp. 593-598, doi: 10.1109/T-C.1971.223307.
- Rosales, H. (2023). *Journal of Physical Mathematics Commentary Decimal Number: Unveiling the Power of Base-10 Representation.* <https://doi.org/10.37421/2090-0902.2023.14.429>
- Strickland, L., & Jones, O. D. (2022). F Things you (Probably) didn't know about hexadecimal. *The Mathematical Intelligencer*, 45(2), 126–130. <https://doi.org/10.1007/s00283-022-10206-w>
- Wakerly, J. (2002). Computer Organization and Programming. *Elsevier EBooks*, 42–33. <https://doi.org/10.1016/b978-075067291-7/50044-3>