PORTFOLIO 3 – NUMBER SYSTEMS

WHAT ARE NUMBER SYSTEMS?

According to multiple sources, A number system is a set of rules and symbols used to represent a number, or any system used for naming or representing numbers is called a number system also known as numeral system. Almost everyone is familiar with decimal number system using ten digits. However digital devices especially computers use binary number system instead of decimal, using two digits i.e. 0 and 1 based on the fundamental concept of the decimal number system. Various other number systems also used this fundamental concept of decimal number system i.e. quaternary, senary, octal, duodecimal, quadrodecimal, hexadecimal and vigesimal number system using four, six, eight, twelve, fourteen, sixteen, and twenty digits respectively. Number systems could also refer to the five basic number systems in mathematics: natural numbers, integers, rational numbers, real numbers, and complex numbers.

WHAT ARE THE TYPES OF NUMBER SYSTEMS?

1. Decimal (base-10): The most common number system, using digits 0-9. Each digit represents a power of 10 based on its position.

2. 2. Binary (base-2): A number system used in computing, consisting only of the digits 0 and 1. Each digit represents a power of 2.

3. 3. Octal (base-8): A system that uses digits 0-7, where each digit represents a power of 8. It is often used in computing for simplifying binary code.

4. 4. Hexadecimal (base-16): This system uses digits 0-9 and letters A-F (representing 10-15). Each digit represents a power of 16 and is widely used in programming for memory addressing and color coding.

Hajnal, P. (2024). Binary Numeration System with Alternating Signed Digits and Its Graph Theoretical Relationship. Algorithms, 17(2), 55.

WHAT ARE THE TYPES OF NUMBER SYSTEMS?

Binary (base-2):

The binary number system is a number system that uses only two digits, 0 and 1, to represent numbers. It is the number system used internally by modern electronic computers, as it is the simplest way to represent information using the two states of electric current (on and off).

Mishra, R. (2024). Navigating Number Systems for Computational Precision: An analytical exploration. Cognition, 6(1), 98–102.

WHAT ARE THE TYPES OF NUMBER SYSTEMS?

Octal (base-8):

The octal number system is a positional numeral system that uses the digits 0 to 7 to represent numbers, where each octal digit represents three binary digits (bits). The abstract states that the octal number system, in addition to the binary number system, is used for digital processing applications.

Natarajan, D. (2020). Number systems and binary codes. In Lecture notes in electrical engineering (pp. 95–119).

WHAT ARE THE TYPES OF NUMBER SYSTEMS?

Decimal (base-10):

The decimal number system is a positional number system that uses 10 digits (0-9) and has a base of 10. In the decimal system, the value of each digit depends on its position, with the rightmost digit representing ones, the next digit to the left representing tens, the next digit representing hundreds, and so on. Decimal fractions are represented by digits to the right of the decimal point, with each successive digit representing a power of 1/10.

Jha, A. C. (2020). Positional Number system. NUTA Journal, 7(1–2), 1–9.

WHAT ARE THE TYPES OF NUMBER SYSTEMS?

Hexadecimal (base-16):

The hexadecimal number system is a base 16 number system that uses 16 symbols or digits, including the numbers 0-9 and the letters A-F, to represent numbers. It is a common number system used in computer systems.

Kumar, J. (2019). A multiples method for number system conversions. International Journal of Scientific Research in Computer Sciences and Engineering, 7(4), 14–17.

WHAT ARE THE SIGNIFICANCES OF USING NUMBER SYSTEMS?

The key significance of using number systems like decimal, octal, hexadecimal, and binary in the context of this paper is that they enable the implementation of modular arithmetic and high-radix number systems, which can reduce computational complexity and the number of logic devices required for in-memory arithmetic operations.

Kim, W., Chattopadhyay, A., Siemon, A., Linn, E., Waser, R., & Rana, V. (2016). Multistate memristive tantalum oxide devices for ternary arithmetic. Scientific Reports, 6(1).

SIGNIFICANCES OF THE DECIMAL NUMBER SYSTEM

The significance of the decimal number system, according to Rotondaro et al. (2019), is that it influences the Gaussian representations of numerosities in the brain, which in turn affects how people mentally bisect numerical intervals. The decimal system's influence on numerosity representations leads to the "Number Interval Position Effect" (NIPE), where the position of the interval within a "ten" affects the bias in mentally bisecting it.

Rotondaro, F., Ponticorvo, M., Gigliotta, O., Pinto, M., Pellegrino, M., Gazzellini, S., Dolce, P., Miglino, O., & Doricchi, F. (2019). The Number Interval Position Effect (NIPE) in the mental bisection of numerical intervals might reflect the influence of the decimal-number system on the Gaussian representations of numerosities: A combined developmental and computational-modeling study. Cortex, 114, 164–175.

SIGNIFICANCES OF THE BINARY NUMBER SYSTEM

The binary number system is the fundamental representation used in computing, where natural numbers are expressed using only the digits 0 and 1. Its development and widespread use have been significant achievements, particularly with the rise of computers. Mathematically, the binary system is elegant because every natural number can be uniquely represented as a sum of distinct powers of two.

Hajnal, P. (2024b). Binary Numeration System with Alternating Signed Digits and Its Graph Theoretical Relationship. Algorithms, 17(2), 55.

SIGNIFICANCES OF THE OCTAL NUMBER SYSTEM

The octal number system, with a base of 8, has been proposed as a potential replacement for the decimal system due to its compatibility with computers and digital devices. Its advantages include simplified arithmetic operations and easier representation of large numbers compared to binary. The octal system is particularly useful in phage typing, allowing for manual coding and comparison of results without a computer for up to 21 phage.

Gabrielian, A. (1975). Formal systems of numerals. 1975 IEEE 3rd Symposium on Computer Arithmetic (ARITH), 76-81.

SIGNIFICANCES OF THE HEXADECIMAL NUMBER SYSTEM

The hexadecimal number system is important for digital processing applications, along with the binary and octal number systems. The abstract states that "In addition to binary number system, octal and hexadecimal number systems are also used for digital processing."

Natarajan, D. (2020b). Number systems and binary codes. In Lecture notes in electrical engineering (pp. 95–119).

ANALYSIS

Number systems are fundamental for representing, manipulating, and reasoning with numbers in mathematics and computing. The most commonly known system is the decimal system (base-10), which uses ten digits (0-9) to represent numbers. However, digital devices primarily use the binary system (base-2), which employs only two digits: 0 and 1. This binary system forms the basis for all modern computing as it mirrors the electrical states (on/off) of circuits. Other number systems, like octal (base-8) and hexadecimal (base-16), also play important roles in computing. Octal uses digits 0-7 and is often employed in digital systems to simplify binary representations. Hexadecimal, which uses digits 0-9 and letters A-F, is particularly useful for programmers because it allows for the compact representation of large binary numbers. Each hexadecimal digit represents four binary digits, making it easier to read and manage large quantities of data. The binary system's simplicity, representing numbers using just two states, makes it a natural fit for computers, which operate using electrical signals. Binary allows efficient encoding and processing of information. Octal and hexadecimal simplify binary numbers, making it easier for humans to read and perform operations. For instance, a single hexadecimal digit can represent four binary digits, reducing the length of binary numbers and simplifying code debugging. Decimal, while still the most intuitive system for humans, is less efficient in computing, which is why binary is more prominent. However, the decimal system remains crucial in areas like financial transactions and measurements, where we need to interact with numbers on a daily basis. The importance of number systems extends beyond simple binary or hexadecimal. Specialized systems, such as the Double-Base and Residue Number Systems, are used in advanced fields like digital signal processing and VLSI (Very-Large-Scale Integration) design. These systems can improve the speed and accuracy of complex calculations, making them critical in areas like cryptography, error detection, and high-performance computing. In addition to their practical applications, number systems also reflect cultural and historical approaches to mathematics. For example, ancient Babylonians used a base-60 system, which still influences how we measure time today (60 seconds per minute, 60 minutes per hour). The diversity of number systems illustrates how different civilizations adapted numerical frameworks to suit their unique needs. Mastering number systems is essential for anyone studying computer science, mathematics, or digital technologies. Understanding how to convert between systems, such as from binary to hexadecimal, is a key skill. Tools like tabulated representations help learners understand these concepts more intuitively, transitioning from basic arithmetic to advanced computational theory. In conclusion, number systems are foundational to both everyday life and the technical world, enabling everything from basic calculations to complex digital processing. Their study enhances both theoretical knowledge and practical digital skills, making them indispensable in modern education and technology development.

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THANK YOU!