PRORTFOLIO #3
A Comprehensive Study

DATE
09/07/2024

NUMBER SYSTEMS

BS INFORMATION TECHNOLOGY
CIS 1102

PRESENTED BY
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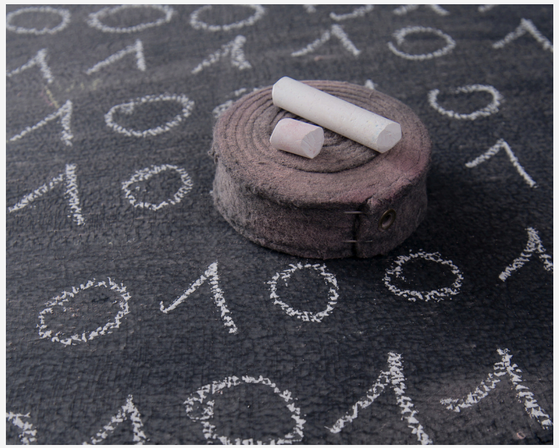


What do we know?

Not all numbers were created equal (Wanhammar, 1999).

What's the His-tea-ory?

Gottfried Wilhelm Leibniz (1646–1716) is the self-proclaimed inventor of the binary system. Really though, we owe the groundwork of today's computing not to Leibniz but to the Englishman Thomas Harriot and the Spaniard Juan Caramuel de Lobkowitz (1606–1682), whom Leibniz plagiarized (Ares, et al., 2018).

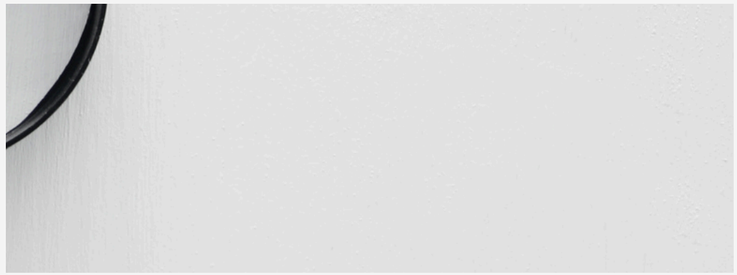
THE NUMBER SYSTEMS

What are Number Systems?

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 (Latif, et al. 2013). It has a certain set of numbers in a consistent manner, using strings of some given digits in relation to a base (Rossi & Thuswaldner, 2022).

What are Number Systems in Computer?

Number system in computer is the most commonly used number system is the binary system, also known as the base-2 number system. The binary system uses only two digits, 0 and 1, to represent all numbers and data (Prepbytes, 2023).

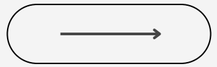


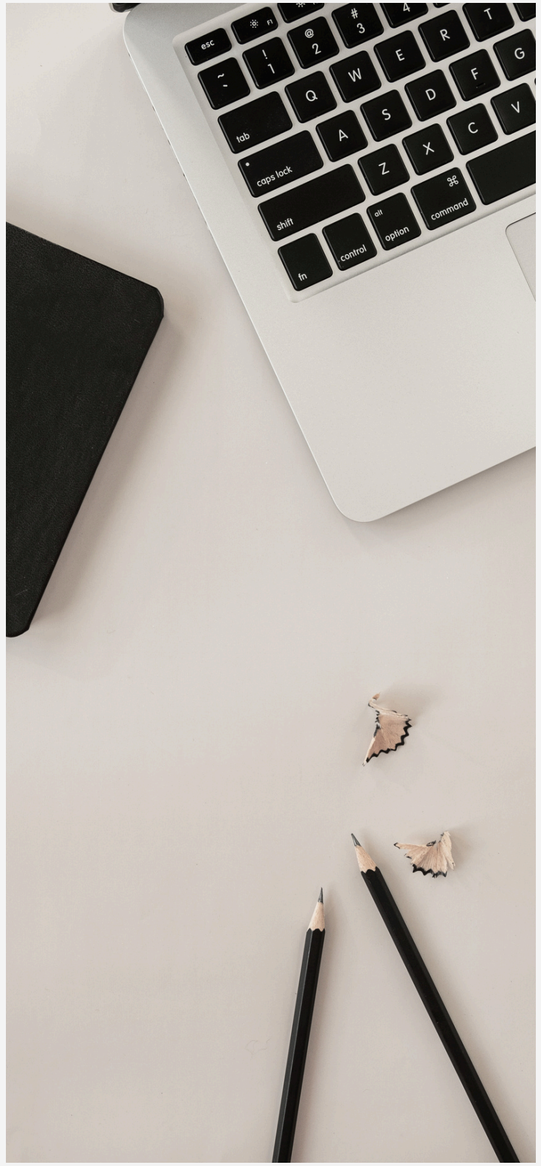
WHAT IS THE IMPORTANCE OF THE NUMBER SYSTEM?

Number system plays a crucial role in our day-to-day lives.

- It helps us keep count of things around us.
- Enables unique/accurate representation of several types of numbers.
- Used for computation in the banking sector.
- Helps us in encrypting data, avoiding hacking and misuse of data.
- Allows easy conversion of numbers for technical purposes.
- It should be noted that every fiber of data gets stored in the computer as a number.

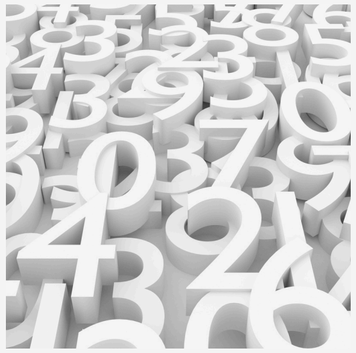
STUID (2023). Importance of Number System





Types of Number Systems

The four types of Number Systems



- Binary Number System
- Octal Number System
- Decimal Number System
- Hexadecimal Number System

Overview

01 **Binary** is a numerical system that uses only two digits, 0 and 1, to represent values. You'll sometimes see this referred to as a base-2 system (Thomas, 2023).

02 **Octal** is a number system with its base as 'eight' is known as an Octal number system and uses numbers from 0 to 7 i.e., 0, 1, 2, 3, 4, 5, 6, and 7 (Sharma, 2024).

03 **Decimal** comprises ten digits from 0 to 9 that are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. The base of the decimal number system is 10 (Wadhwa, 2023).

04 **IHexadecimal** has the base as 16, containing 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F. with 10 as A (Sharma, 2024).

What is the Binary Number System?

A binary number is a positional numeral system with two as the base. The binary number system consists of two different numerals, namely zero and one. It is mostly used in electronic and computer-based devices, networking and digital signal processing (Rouse, 2017).

UNDERSTANDING THE BINARY NUMBER SYSTEM

Base:

2

Digits used:

0 and 1

Representation:

Each position represents a power of 2.

Application:

Finding its use in multiple places. Here are some applications of Binary code:

- Machine language
- ASCII code
- UTF-8
- internet Protocols
- Circuitry
- Visual Data

Ranjan, R. (2020). History, advantages, and applications of binary language and how binary translators translate it?

Binary Arithmetic

The following table is essential to binary arithmetic:

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 0 CARRIES 1

BRIEF HISTORY ON BINARY

2400 BCE
Ancient Egypt

- The Horus-Eye fractions were used to represent fractional quantities, based on binary principles (Datta, 2020).

19th Century
China

- The I Ching, one of China's oldest texts, used trigrams and hexagrams representing the duality of yin and yang. These are early versions of binary notation (Datta, 2020).

2nd Century
India

- The scholar Pingala developed a binary system using patterns of long and short syllables in his work on prosody (Datta, 2020).

1600s
Europe

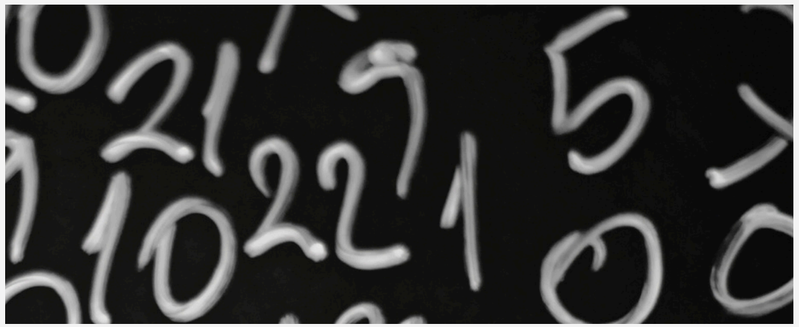
- English mathematicians like Thomas Harriot and Francis Bacon explored binary systems, with Bacon converting letters into binary sequences (Datta, 2020).

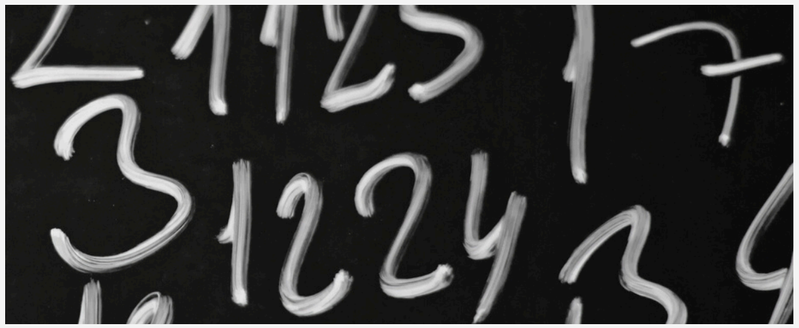
1703
Europe

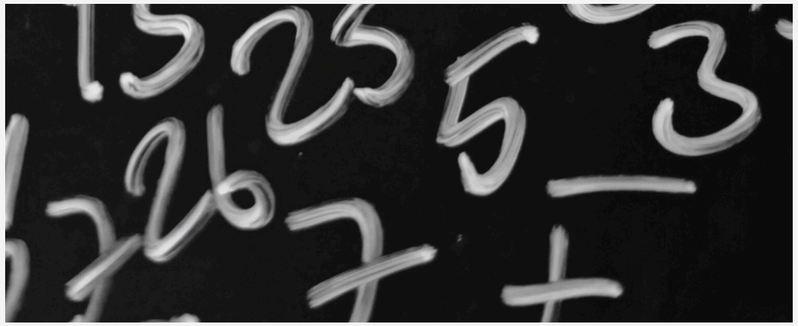
- Gottfried Wilhelm Leibniz published "Explanation of Binary Arithmetic," formulating the binary system as we know it today, inspired by the I Ching's hexagrams (Datta, 2020).

What is the Octal Number System?

The octal numbering system uses the Base-8 system and, as such, an octal number is represented by a subscript “8”. Further, it is noticeable that each digit of an octal number has a value between 0 and 7 (Shahid, n.d.).







UNDERSTANDING THE OCTAL NUMBER SYSTEM

Base:

8

Digits used:

0, 1, 2, 3, 4, 5, 6, 7

Representation:

Each position represents a power of 8.

Application:

It is often utilized in computing as a shorthand for binary numbers.

Octal Arithmetic

In performing octal arithmetic and master arithmetic operations for octal numbers, we should be familiar with the multiples of 8.

	1	2	3	4	5	6	7	8
8	8	16	24	32	40	48	56	64

WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF OCTAL NUMBER SYSTEM?

ADVANTAGES:

- It is of one third length of the binary.
- Easy conversion process from binary to octal and vice-versa.
- Easier to handle input and output in the octal form.

DISADVANTAGES:

- Computer does not understand **octal number system** so there must be a requirement of additional circuitry known as octal to binary converters before it is applied to a digital system or a computer.

What is the Decimal Number System?

The decimal number system is the most common number system in use today. It is a base 10 number system, which means that it uses 10 different symbols to represent numbers. The symbols are 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

UNDERSTANDING THE DECIMAL NUMBER SYSTEM

Base:

10

Digits used:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Representation:

Each position represents a power of 10.

Application:

The most common system used in daily life for calculations and measurements.

BRIEF HISTORY ON DECIMAL

3500 - 2500 BC

the earliest usage of a close relative of the decimal system by the Iranian Elamites (Gill, 2024).

2900 BC

Egyptians start counting in powers of 10 (Gill, 2024).

2600 BC

Indus Valley civilization begins the usage of decimal points with reference to measuring weight (Gill, 2024).

1400 BC

Chinese manuscripts shed light on the existence of a possible decimal system when making calendars (Gill, 2024).

1200 BC

Indian Yajur Veda makes ground breaking news by establishing the power of 10 up to 1055 (Gill, 2024).

400 BC

a concrete binary system is built with conversions to and from the decimal system (Gill, 2024).

250 BC

Archimedes takes the power of 10 to 10 (Gill, 2024).

100 - 200 CE

decimal logarithms come into existence (Gill, 2024).

What is the Hexadecimal Number System?

The hexadecimal number system, also called base-16 or sometimes just hex, is a number system that uses 16 unique symbols to represent a particular value. Those symbols are 0-9 and A-F (Fisher, 2023).

UNDERSTANDING THE HEXADECIMAL NUMBER SYSTEM

Base:

16

Digits used:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

Representation:

Each position represents a power of 16.

Application:

Frequently used in programming, especially for memory addresses and color codes in web design.

Hexadecimal Arithmetic

Hexadecimal Numbers have a base of 16 digits ranging from 0 to F (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and A, B, C, D, E, F). A, B, C, D, E, F are equivalent single digits of 10, 11, 12, 13, 14, 15 respectively. Generally, it is expressed by subscript 16 or Hexa

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
16	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256

BRIEF HISTORY ON HEXADECIMAL

17th Century (Late 1600s):

Gottfried Wilhelm Leibniz experiments with base-16 (sedecimal) notation and creates new symbols and names for numbers. This is one of the first known documented uses of base-16 (Strickland, et al. 2023).

1845

Thomas Wright Hill proposes a base-16 system called "sexdecimal" at a British scientific conference, introducing a unique notation system (Strickland, et al. 2023).

1859

John William Nystrom develops a detailed base-16 system called tonal, suggesting new names for numbers and units of time, mass, and more (Strickland, et al. 2023).

1950

The term "hexadecimal" is used in relation to the Standards Eastern Automatic Computer (SEAC) developed by the National Bureau of Standards (Strickland, et al. 2023).

1954

The Oxford English Dictionary first records the term "hexadecimal" in a newsletter, marking its formal recognition in computing (Strickland, et al. 2023).

1968

Bruce Alan Martin criticizes the choice of A-F as hexadecimal symbols, proposing new ones that were never adopted (Strickland, et al. 2023).

What's the Significance of each Number Systems?

The Significance and Usage of Binary Number System

Its Significance:

The binary number system is important because this is the number system mostly used by microcontrollers, as well as computers. The smallest element in the binary number system is a bit. The term binary provides a hint to the values contained in a bit. Binary means two, as in 0 or 1, On–Off, Yes–No, True–False, etc.; one gets the idea. In computer lingo, a bit can have one of two values, 0 or 1. If dealing in a logic mode, the values are true and false where True = 1 and False = 0 (Iovine, 2024).

Its usage:

The binary system is essential for digital electronics and modern computing, as electronic devices can be in two states, on or off. This can easily be represented by the digits 0 and 1 (Luis Llamas, 2024).

Most electronic circuits used in computer systems are based on binary logic, meaning that calculations and operations are performed using only two possible values (Luis Llamas, 2024).

The Significance and Usage of Octal Number System

Its Significance:

The octal number system uses fewer digits (3-bits) as compared to the hexadecimal numbers (4-bits), which is one of its major advantages. That further leads to fewer computations and a lesser possibility of occurrence of error.

Because of fewer digits, it is also easy to convert octal numbers to any other number system and vice-versa.

One of the limitations of the octal number system is that computers do not understand the octal numbers in a direct way and hence it has to be converted into binary numbers first (Sharma, 2024).

Its usage:

The octal number system is widely used in the world of computer applications and also in the aviation sector to use the number in the form of a code.

Based on octal number system applications, several computing systems have been developed. All the modern generation computing systems use 16-bit, 32-bit, or 64-bit words which are further divided into 8-bit words. Similarly, for various programming languages, octal numbers are used for the purpose of coding or to store data in the encrypted language, which can only be understood by the computing machine (Sharma, 2024).

The Significance and Usage of Decimal Number System

Its Significance:

In computing, the decimal system holds a significant place, particularly for tasks involving user input/output operations, data analysis, programming arithmetic and much more. The vast majority of our interactions with computers involve decimal numbers as it is most natural and familiar to us.

Although machines operate using binary, human-interface devices primarily use the decimal system. It forms the backbone of numeric data in user-centric applications. When processing numeric data, computers convert decimal values into binary and perform computations. The resulting binary data is then transformed back into decimal form for user-friendly output.

Its usage:

Many programming languages use the decimal system to represent numbers, although other number systems (such as binary and hexadecimal) are also used in some contexts.

Decimal numbers are used in communication systems, such as telephone numbers, ZIP codes, and IP addresses.

The Significance and Usage of Hexadecimal Number System

Its Significance:

- Hexadecimal numbers are often used as a beneficial method of data representation in computer science
- It takes fewer digits to represent a given value in hexadecimal than in binary
- One hexadecimal digit can represent four bits of binary data
- It is beneficial to use hexadecimal over binary because:
  - The more bits there are in a binary number, the harder it is to read
  - Numbers with more bits are more prone to errors when being copied

Peters, B. (n.d.) Hexadecimal (CIEIGCSE Computer Science)

Its usage:

- Using hexadecimal allows computer scientists to represent large amounts of binary data in a more manageable and readable format
- There are many uses of hexadecimal in computers:
  - Memory addresses and other hardware related values
  - Representation of colour values
  - Error messages
  - Memory dump
  - Debugging
  - IP addresses
  - ASCII / Unicode
  - Assembly language
  - URLs

Peters, B. (n.d.) Hexadecimal (CIEIGCSE Computer Science)

AN ANALYSIS TO COMPUTING

Number systems are a fundamental part of computing, mathematics, and everyday life. A number system is essentially a way to represent numbers using a specific set of symbols or digits. In computing, number systems are especially crucial because computers process data in binary (0s and 1s). There are four main types of number systems: Binary, Octal, Decimal, and Hexadecimal. These systems vary in base values, making them useful for different functions in both computation and human interaction.

First, the **Binary number system**, with a base of 2, is the most significant in computing because computers operate using binary. All data stored and processed by computers is represented using combinations of 0s and 1s. This system's significance lies in its simplicity for representing two states, such as "on" and "off," which aligns with how circuits work in digital electronics. The binary system enables the functioning of machine code, which is the lowest-level programming language that directly interacts with hardware.

AN ANALYSIS TO COMPUTING (cont'd)

Next is the **Octal number system**, which has a base of 8 and uses digits from 0 to 7. While not as widely used as binary, it was historically more common in early computing systems for reducing long binary strings. The octal system condenses binary numbers into a simpler form, where three binary digits correspond to one octal digit. Despite this, octal isn't frequently used today except for specific purposes like memory addressing in older systems. Its significance lies in making binary more human-readable and manageable during certain programming tasks.

The **Decimal number system**, which uses a base of 10, is the most familiar number system to humans. It's used in everyday life for counting, measuring, and performing calculations. Though computers don't process data in decimal, they convert binary to decimal for user-facing operations. This system's significance is primarily in human-computer interaction since most interfaces display data in a way that's intuitive for users. While machines do the heavy lifting in binary, the decimal system ensures that humans can easily understand and interact with numbers in tasks like programming, arithmetic, and data entry.

AN ANALYSIS TO COMPUTING (cont'd)

Lastly, the **Hexadecimal number system** (base-16) is vital for representing large amounts of binary data in a compact format. Hexadecimal digits range from 0 to 9 and A to F, where A equals 10 and F equals 15. This system is especially useful in programming, where it is often employed in color codes, memory addresses, and debugging. One hexadecimal digit represents four binary digits, making it easier to handle large binary numbers without losing accuracy. Hexadecimal is efficient for programming because it allows for more straightforward reading and representation of complex data compared to binary.

In conclusion, number systems, from binary to hexadecimal, each play essential roles in computing and our daily lives. Binary is the foundation of all digital operations, while octal, decimal, and hexadecimal provide simplified ways to represent, interpret, and manage data. Whether simplifying computations, making numbers more readable, or enhancing data storage, these systems ensure the smooth running of both everyday tasks and complex computing processes.

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