

Numeral systems.
Transfer numeral from one
numeral system to another.
Arithmetic in the numeral
systems.

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Numeral system

□ (or system of numeration) is a writing system for expressing numbers; that is, a mathematical notation for representing numbers of a given set, using digits or other symbols in a consistent manner

The number the numeral represents is called its value.

- Ideally, a numeral system will:
- Represent a useful set of numbers (e.g. all integers, or rational numbers)
- Give every number represented a unique representation (or at least a standard representation)
- Reflect the algebraic and arithmetic structure of the numbers

Main numeral systems

- The most commonly used system of numerals is the Hindu–Arabic numeral system. Two Indian mathematicians are credited with developing it. Aryabhata of Kusumapura developed the place-value notation in the 5th century and a century later Brahmagupta introduced the symbol for zero.

Decimal Numbers

- Decimal numbers (base 10)
 - Represented using 10 numerals: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
- Each position represents a power of 10:
 - $401 = 4 \cdot 10^2 + 0 \cdot 10^1 + 1 \cdot 10^0 = 400 + 1$
 - $130 = 1 \cdot 10^2 + 3 \cdot 10^1 + 0 \cdot 10^0 = 100 + 30$
 - $9786 = 9 \cdot 10^3 + 7 \cdot 10^2 + 8 \cdot 10^1 + 6 \cdot 10^0 =$
 $= 9 \cdot 1000 + 7 \cdot 100 + 8 \cdot 10 + 6 \cdot 1$

Binary Numeral System

- Binary numbers are represented by sequence of bits (smallest unit of information – 0 or 1)
 - Bits are easy to represent in electronics
- 1 0 0 1 0 0 1 0
- 1 0 0 1 0 0 1 1
- 1 1 1 1 1 1 1 1
- 1 0 1 1 0 0 1 0

Binary Numbers

- Binary numbers (base 2)
 - Represented by 2 numerals: 0 and 1
- Each position represents a power of 2:
 - $101_b = 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 = 100_b + 1_b = 4 + 1 = 5$
 - $110_b = 1 \cdot 2^2 + 1 \cdot 2^1 + 0 \cdot 2^0 = 100_b + 10_b = 4 + 2 = 6$
 - $110101_b = 1 \cdot 2^5 + 1 \cdot 2^4 + 0 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 = 32 + 16 + 4 + 1 = 53$

How Computers Represent Text Data?

- A text encoding is a system that uses binary numbers (1 and 0) to represent characters
 - Letters, numerals, etc.
- In the ASCII encoding each character consists of 8 bits (one byte) of data
 - ASCII is used in nearly all personal computers
- In the Unicode(UTF-16) encoding each character consists of 16 bits (two bytes)
 - Can represent many alphabets

Number Systems

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graph TD; A[Number Systems] --> B[Decimal]; A --> C[Binary]; A --> D[Octal]; A --> E[Hexadecimal]; B --> B1["Counting using fingers<br/>Base 10 System (0-9)"]; C --> C1["For computers-since flip flops<br/>store either 0 or 1<br/>Base 2 (0,1)"]; D --> D1["To shorten long binary numbers<br/>Base 8 (0-7)"]; E --> E1["Since data is stored in bytes<br/>Base 16 (0-9, A-F)"];
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Decimal

Counting using fingers
Base 10 System (0-9)

Binary

For computers-since flip flops
store either 0 or 1
Base 2 (0,1)

Octal

To shorten long binary numbers
Base 8 (0-7)

Hexadecimal

Since data is stored in bytes
Base 16 (0-9, A-F)