Digital technology

Numbering systems

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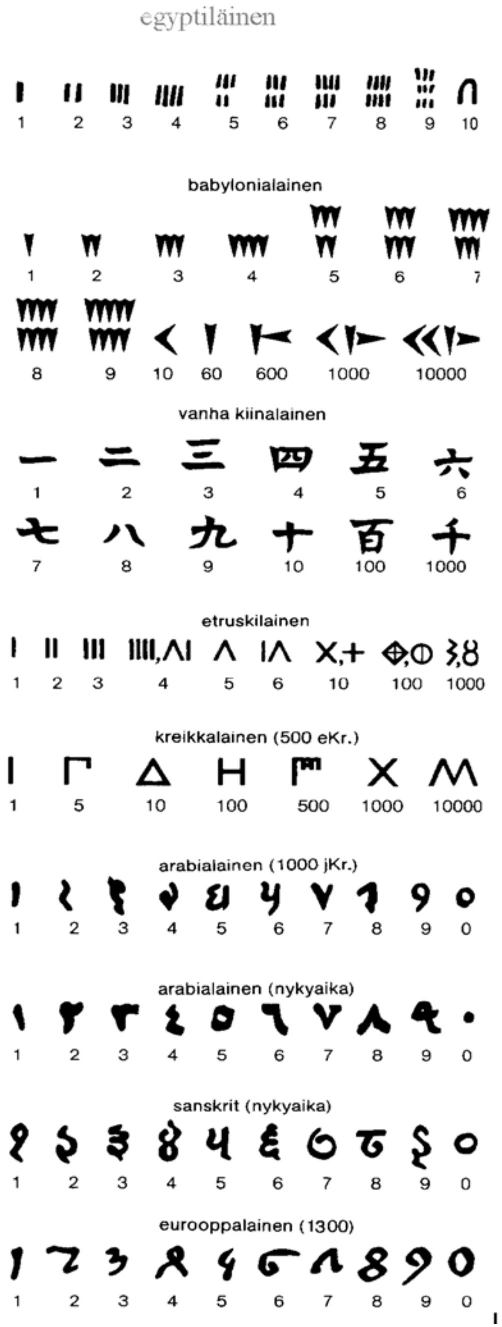
History

Several different numbering systems

- Arabic decimal system is a decimal system
  - Position of the number has significance
  - $2903 = 2*10^3+9*10^2+0*10^1+3*10^0$
  - What is the decimal position form of number 345_{10} ?
- Roman decimal system
- Babyloniam base60 (sexagesimal system)
  - Used in time units and angle rule
- Maya culture's base-20 (vigesimal) system
- In digital systems binary system (base-2) is used
- To simplify the presentation of numbers they are often converted into several different forms
  - Base-8 i.e., octal system
  - Base-16 i.e., hexadecimal system



 kymmenjärjestelmä = Decimal system

Numbering system conversions

Conversion from a system to decimal system

- Position-based numbering system conversions to decimal system

  $N=a_m*k^m+a_{(m-1)}*k^{(m-1)}+a_{(m-2)}*k^{(m-2)}+...$

  - N= conversion result
  - a_m=coefficient to be converted
  - k= convertable numbering system (in decimal system 10, octal system 8, etc.)
  - m="weight value" i.e., the number's position
- Notation

XD = decimal number = X_{10} 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

XO = octal number = X_8 0, 1, 2, 3, 4, 5, 6, 7

XH = hexadecimal number = X_{16} 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

XB = binary number = X_2 0, 1

E.g., 23DH tai $23D_{16}$

Numbering system conversions

Examples

- Decimal number notation with the common formula.

  $238_{\mathbf{10}}=2*\mathbf{10}^2+3*\mathbf{10}^1+8*\mathbf{10}^0$

- Octal number notation for conversion to decimal number.

  $257_{\mathbf{8}}=2*\mathbf{8}^2+5*\mathbf{8}^1+7*\mathbf{8}^0=2*64+5*8+7=175_{10}$

  $25{,}7_{\mathbf{8}}=2*\mathbf{8}^1+5*\mathbf{8}^0+7*\mathbf{8}^{-1}=2*8+5*1+7*0{,}125=21{,}875_{10}$

- Binary number conversion to decimal number

  $10110_2= 1*2^4 + 0*2^3 +1*2^2 +1*2^1 +0*2^0 = 1*16+0*8+1*4+1*2+0*1=22_{10}$

Exercises

1. Convert to decimal system

a) 238_{16}

b) $1AE_{16}$

c) 101_2

d) $1,11_2$

e) 1101010010100101_2

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