CS 3333: Math Foundation of CS

Number Systems: examples of conversion

Other number systems to decimal system

- Theorem 1: Let b an integer greater than 1. Then if *n* is a positive integer, it can be expressed uniquely in the form
  - $n = a_k b^k + a_{k-1} b^{k-1} + \ \ldots + a_1 b + a_0,$

  where k is a nonnegative integer, a_0, a_1, …, a_k are nonnegative integers less than b, and $a_k \neq 0$.

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  where k is a nonnegative integer, $a_0, a_1, \ldots, a_k$ are nonnegative integers less than b, and $a_k \neq 0$.
- Examples of converting to decimal numbers:
- $(1\ 0101\ 1111)_2 = 1 \cdot 2^8 + 0 \cdot 2^7 + 1 \cdot 2^6 + 0 \cdot 2^5 + 1 \cdot 2^4 + 1 \cdot 2^3 + 1 \cdot 2^2 + 1 \cdot 2^1 + 1 \cdot 2^0 = 351$
- $(7016)_8 = 7 \cdot 8^3 + 0 \cdot 8^2 + 1 \cdot 8 + 6 = 3598$
- $(2AE0B)_{16} = 2 \cdot 16^4 + 10 \cdot 16^3 + 14 \cdot 16^2 + 0 \cdot 16 + 11 = 175627$

Decimal to other number systems

- Decimal -> Binary
- Decimal -> Octal
- Decimal -> Hexadecimal

Decimal to other number systems

- Decimal -> Binary
  - $(241)_{10} = (XXXXXXXXXXX)_2$

Decimal to other number systems

- Decimal -> Binary
  - $(241)_{10} = 2 \cdot 120 + 1$ (divided by 2)

    $120 = 2 \cdot 60 + 0$

    $60 = 2 \cdot 30 + 0$

    $30 = 2 \cdot 15 + 0$

    $15 = 2 \cdot 7 + 1$

    $7 = 2 \cdot 3 + 1$

    $3 = 2 \cdot 1 + 1$

    $1 = 2 \cdot 0 + 1$
  - $(241)_{10} = (1111\ 0001)_2$

Decimal to other number systems

- Decimal -> Binary
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Decimal to other number systems

- Decimal -> Octal
- $(12345)_{10} = (XXXX)_8$

$= 8 \cdot 1543 + 1$ (divided by 8)

$1543 = 8 \cdot 192 + 7$

$192 = 8 \cdot 24 + 0$

$24 = 8 \cdot 3 + 0$

$3 = 8 \cdot 0 + 3$

- $(12345)_{10} = (30071)_8$

Decimal to other number systems

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Decimal to other number systems

- Decimal -> Hexadecimal
- $(177130)_{10} = 16 \cdot 11070 + 10$ (divided by 16)

$$11070 = 16 \cdot 691 + 14$$

$$691 = 16 \cdot 43 + 3$$

$$43 = 16 \cdot 2 + 11$$

$$2 = 16 \cdot 0 + 2$$

- $(177130)_{10} = (2B3EA)_{16}$

Binary, Octal, and Hexadecimal

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