Seneca

Introduction to Number Systems

Agenda

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

Decimal Number System

- Also known as “Base 10”
- There are 10 symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
- Used universally in mathematics

Binary Number System

- Also known as “Base 2”
- There are 2 symbols: 0 and 1
  - 0 represents “off”
  - 1 represents “on”
- This number system is used in computer instructions

- Video: Basics of Binary

Octal Number System

- Also known as “Base 8” or “Oct”
- There are 8 symbols: 0, 1, 2, 3, 4, 5, 6, 7
- Represented by grouping 3 binary digits together
  - Example: $010_2 = 2_8$
- This number system is used in computer instructions such as in Linux permissions (i.e. Read, Write, Execute)

- Video: Understanding the octal numbering system

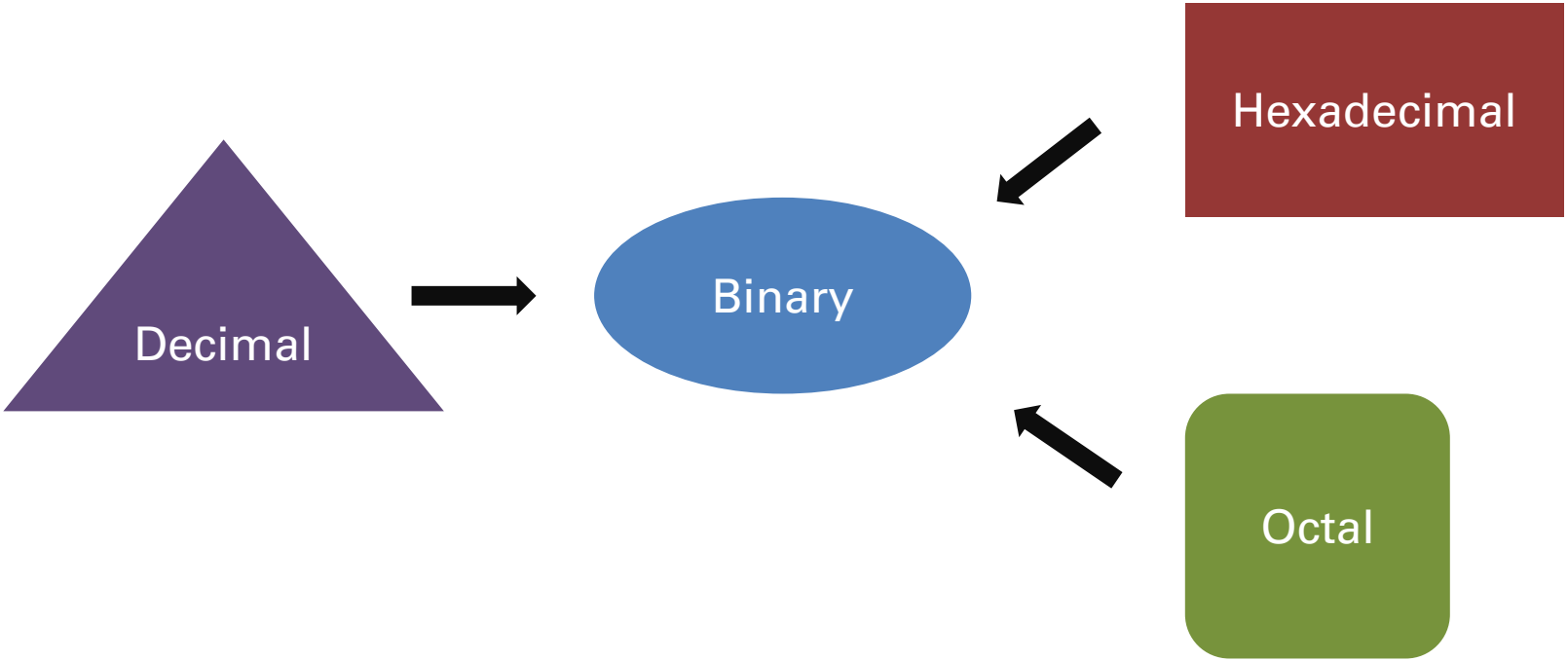
Hexadecimal Number System

- Also known as "Base 16" or "Hex"
- There are 16 symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- Represented by grouping 4 binary digits together
  - Example: $1110_2 = E_{16}$
- This number system is used to express large binary numbers

- Video: Understanding hexadecimal numbers

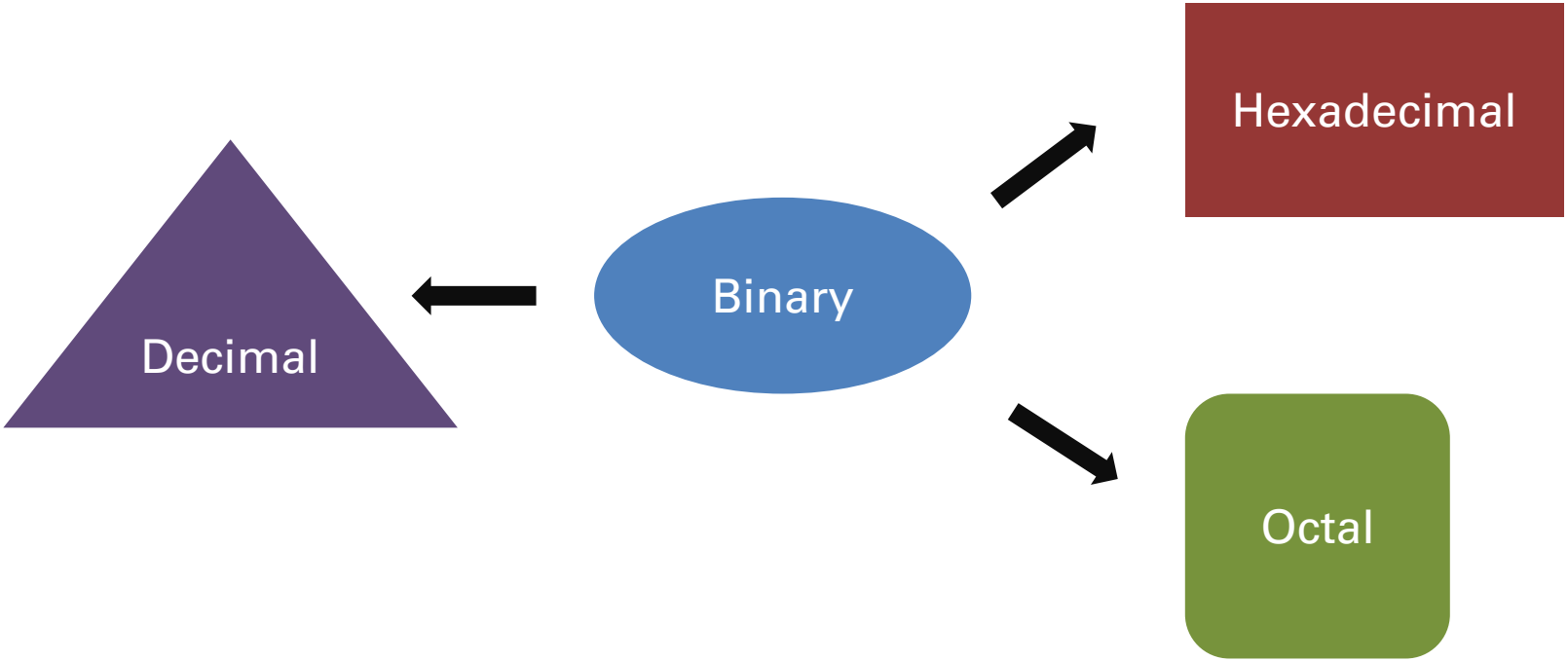
Conversions: Strategy

- Convert all number systems to Binary



Conversions: Strategy

- Then convert Binary to other number systems



Conversions: Decimal to Binary

- Video: Decimal to Binary conversion

Conversions: Decimal to Binary Examples

- In groups, convert the following Decimal numbers to Binary:
  1) 192
  2) 168
  3) 255
  4) 248
  5) 200
  6) 127
  7) 1024

Conversions: Octal to Binary

- Each octal digit represents 3 binary digits
  - $0_8 = 000_2$
  - $1_8 = 001_2$
  - $2_8 = 010_2$
  - $3_8 = 011_2$
  - $4_8 = 100_2$
  - $5_8 = 101_2$
  - $6_8 = 110_2$
  - $7_8 = 111_2$

- Example: **72_8** = **111 010_2**

Conversions: Octal to Binary Examples

- In groups, convert the following Octal numbers to Binary:
  1) 763
  2) 553
  3) 442
  4) 176
  5) 853
  6) 221
  7) 774

Conversions: Hexadecimal to Binary

- Each Hexadecimal digit represents 4 binary digits
  - $0_{16} = 0000_2$
  - $1_{16} = 0001_2$
  - …
  - $9_{16} = 1001_2$
  - $A_{16} = 1010_2$
  - $B_{16} = 1011_2$
  - $C_{16} = 1100_2$
  - $D_{16} = 1101_2$
  - $E_{16} = 1110_2$
  - $F_{16} = 1111_2$

- Example: **8F**$_{16}$ = **1000 1111**$_2$

Conversions: Hexadecimal to Binary Examples

- In groups, convert the following Hexadecimal numbers to Binary:
  1) ABC
  2) 184
  3) E09
  4) D15
  5) 2F7
  6) 89A
  7) DEF

Conversions: Binary to Decimal

- Use positional notation to convert
- Example: **10101**$_2$
- **1** x 2^4 = 16
- **0** x 2^3 = 0
- **1** x 2^2 = 4
- **0** x 2^1 = 0
- **1** x 2^0 = 1
- Total = 21_{10}

Conversions: Binary to Decimal Examples

- In groups, convert the following Binary numbers to Decimal:
  1) 11111111
  2) 11001101
  3) 11100011
  4) 10011011
  5) 11110000
  6) 10001111
  7) 10101010

Conversions: Binary to Octal

- Group the binary bits into groups of 3
- Example: **110111_2**
- **$110_2 = 6_8$**
- **$111_2 = 7_8$**
- Result = **67_8**

Conversions: Binary to Octal Examples

- In groups, convert the following Binary numbers to Octal:
  1) 11111111
  2) 11001101
  3) 11100011
  4) 10011011
  5) 11110000
  6) 10001111
  7) 10101010

Conversions: Binary to Hexadecimal

- Group the binary bits into groups of 4
- Example: **10011111_2**
- **$1001_2 = 9_{16}$**
- **$1111_2 = F_{16}$**
- Result = **$9F_{16}$**

Conversions: Binary to Hexadecimal Examples

- In groups, convert the following Binary numbers to Hexadecimal:
  1) 11111111
  2) 11001101
  3) 11100011
  4) 10011011
  5) 11110000
  6) 10001111
  7) 10101010

Conversions: Examples

- Convert to Octal: AE_{16}
- Convert to Binary: 176_{8}
- Convert to Hexadecimal: 752_{8}
- Convert to Decimal: 11011001_{2}

Questions