

31268 Web Systems



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Week 07: Computer Science 1

Part 4: Number Conversions

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Video

- <http://www.youtube.com/watch?v=fif6YVQakP4>

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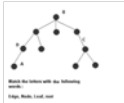
- And now for something different....
- The next 3 lectures cover computer science theory...

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Recap: Theory!!

- This is a foundation subject

→ You need to learn some computer science theory!!!



10101010 = 0xAA

- *file systems*
- *complexity theory*
- information representation – binary, hex
- Logic - Boolean algebra, binary arithmetic
- *computation theory, memory, coding*

not(A and B) = not(A) or not(B)

Week 1 - Administrative

Recall - The Decimal System



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- Uses ten symbols: **0,1,2,3,4,5,6,7,8,9**
- Each symbol represents a quantity:
0 represents the absence of things
1 represents a single thing
2 represents a pair of things ...
- The decimal system is positional:
we can represent quantities greater than 9 by stringing symbols together:

45 →
4*10¹ + 5*10⁰

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Recall - The Binary System



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- The binary system is positional like the decimal system
–but it only has two symbols: **0** and **1**
- 10 represents 1*2¹ + 0*2⁰
(in decimal this is 2)
- 1101 represents 1*2³ + 1*2² + 0*2¹ + 1*2⁰
(in decimal this is 13)

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Adding together binary numbers

101101

010101

111101

1000010

-- A

-- B

-- Carry

-- A + B

Binary-Decimal conversion

Binary 11100

$1 \cdot 2^4$

$+ 1 \cdot 2^3$

$+ 1 \cdot 2^2$

$+ 0 \cdot 2^1$

$+ 0 \cdot 2^0$

Binary-Decimal conversion

Binary 11100

$1 \cdot 2^4$

$+ 1 \cdot 2^3$

$+ 1 \cdot 2^2$

$+ 0 \cdot 2^1$

$+ 0 \cdot 2^0$

16

+

8

+

4

+

0

+

0

Binary-Decimal conversion

Binary 11100

$1 \cdot 2^4$

$+ 1 \cdot 2^3$

$+ 1 \cdot 2^2$

$+ 0 \cdot 2^1$

$+ 0 \cdot 2^0$

16

+

8

+

4

+

0

+

0

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- Very easy!

Decimal-Binary conversion

Repeat: remove largest powers of 2

Example: Convert decimal 123 to binary

2⁷ = 128

2⁶ = 64

Decimal

Binary

123 = 64 + 59

1000000 + binary(59)

Summing the binary numbers: 1111011

Decimal-Binary conversion

Repeat: remove largest powers of 2

Example: Convert decimal 123 to binary

2⁶ = 64

2⁵ = 32

Decimal

Binary

123 = 64 + 59

1000000 + binary(59)

59 = 32 + 27

0100000 + binary(27)

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Decimal-Binary conversion

Repeat: remove largest powers of 2
Example: Convert decimal 123 to binary

Decimal	Binary
123 = 64 + 59	1000000 + binary(59)
59 = 32 + 27	0100000 + binary(27)
27 = 16 + 11	0010000 + binary(11)
11 = 8 + 3	0001000 + binary(3)
3 = 2 + 1	0000010 + binary(1)
1 = 2^0	0000001

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Decimal-Binary conversion

Repeat: remove largest powers of 2
Example: Convert decimal 123 to binary

Decimal	Binary
123 = 64 + 59	1000000 + binary(59)
59 = 32 + 27	0100000 + binary(27)
27 = 16 + 11	0010000 + binary(11)
11 = 8 + 3	0001000 + binary(3)
3 = 2 + 1	0000010 + binary(1)
1 = 2^0	0000001

➔ **Summing the binary: 1111011**

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Recall Hexadecimal Numbers

- Numbers in base 16
- Sometimes referred to as "hex" numbers
- Each Hex digit is 4 binary places
- Eg: HTML: #FFFFFF == White
- #FF0000 == Red
- #RRGGBB

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Hexadecimal Digits

Decimal	Binary	Hexadecimal
0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
5	101	5
6	110	6
7	111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F
16	10000	10

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Note

- Alternative view:

Power of 16	Hex digit	Decimal
16 ⁴	10000	65536
16 ³	1000	4096
16 ²	100	256
16 ¹	10	16
16 ⁰	1	1

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Converting Hex to Decimal

- The conversion method is similar to that used to convert binary numbers to decimal
- We simply **multiply** each digit in our hex number by the appropriate power of **16**
- Let's convert hex number 7A25 to decimal....

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Converting Hex to Decimal - 2

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Power of 16: 3 2 1 0

7 A 2 5

5 × 16⁰ = 5 × 1 = 5

2 × 16¹ = 2 × 16 = 32

10 × 16² = 10 × 256 = 2560

7 × 16³ = 7 × 4096 = 28672

+

Sum (Decimal) = 31269

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Quiz

• www.menti.com 10 30 8

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Converting Decimal to Hexadecimal

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• Similar to converting decimal to binary

• Three methods

- repeated division by 16
- repeated subtraction by 16
- convert to binary; then group the digits into four digits; then convert group to hex

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Example

• Convert 300 to Hex by division:

Multiple of 16	Number	Divided/16	Integer Result	Remainder	Remainder (hex)
2	300	300/16 = 18.75	18	.75 * 16 = 12	C
1	18	18/16 = 1.125	1	.125 * 16 = 2	2
0	1	1/16 = 0.0625	0	.0625 * 16 = 1	1

Answer = 1 2 C

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NOTE

Easiest to convert if

(1) memorise the 1st 15 decimal/binary/hex table

Decimal	Binary	Hexadecimal
0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
5	101	5
6	110	6
7	111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Note

• (2) Also memorise 2x table

Decimal	2 power	Binary	Hex
1	2 ⁰	1	1
2	2 ¹	10	2
4	2 ²	100	4
8	3	1000	8
16	4	10000	10
32	5	100000	20
64	6	1000000	40
128	7	10000000	80
256	8	100000000	100
512	9	1000000000	200
1024	10	10000000000	400
2048	11	100000000000	800
4096	12	1000000000000	1000
8192	13	10000000000000	2000
16384	14	100000000000000	4000
32768	15	1000000000000000	8000
65536	16	10000000000000000	10000

Note

- (3) Braindump powers of 16

Power of 16	Hex digit	Decimal
16^4	10000	65536
16^3	1000	4096
16^2	100	256
16^1	10	16
16^0	1	1

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Example

- Convert 300 to Hex by subtraction

Multiple of 16	Number	Nearest power of 16
$16^2 = 256$	300 →	$= 256 \times 1 + 44$
$16^1 = 16$	44 ←	$= 16 \times 2 + 12$
$16^0 = 1$	12 ←	$= 1 \times 12 + 0$

300=256*1+44

44=16*2+12

Answer = 1 2 C

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Questions?

- ???
- You will convert number systems in the quiz and the final exam ...

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