Last time

- Administrivia
- CS in general
- CS 1800 in specific
- Magic trick

Today

- Binary representations
- Conversions
- Addition, subtraction, mult.
- Examples
- Magic trick

Next time

- Hexadecimal / Octal
- Negative numbers
  - two's complement

Announcement

- Office hours
- WHW1

Decimal

$$8792_{10} = 8\times10^3 + 7\times10^2 + 9\times10^1 + 2\times10^0$$

$$= (879)\cdot 10 + 2$$

$$= (87\times10 + 9)\cdot 10 + 2$$

$$= ((8\cdot 10 + 7)\cdot 10 + 9)\cdot 10 + 2$$

Binary

16 8 4 2 1

$$1\ 0\ 1\ 1\ 0_2 = 1\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 0\times2^0$$

$$16 + 4 + 2 = 22_{10} = ((( )\ldots + 1)\cdot 2 + 1)\cdot 2 + 0$$

Decimal → Binary

MSB → LSB

41_{10}

64	32	16	8	4	2	1
1	0	1	0	0	1	

$41 - 32 = 9$

$9 - 8 = 1$

27_{10}

32	16	8	4	2	1
1	1	0	1	1	

$27 - 16 = 11$

$11 - 8 = 3$

$3 - 2 = 1$

24_{10}

32	16	8	4	2	1
1	1	0	0	0	

$24 - 16 = 8$

$8 - 8 = 0$

LSB → MSB

	$41 \to 1$	LSB	(odd)
$(41-1) \div 2$	$20 \to 0$		
$(20-0) \div 2$	$10 \to 0$	$\Rightarrow$	101001_2
$(10-0) \div 2$	$5 \to 1$		
$(5-1) \div 2$	$2 \to 0$		
$(2-0) \div 2$	$1 \to 1$	MSB	

16 8 4 2 1

10100

$16 + 4 = 20$

$27 \to 1$		LSB	
$13 \to 1$			
$6 \to 0$	$\Rightarrow$	11011	
$3 \to 1$			
$1 \to 1$		MSB	

$24 \to 0$		LSB	
$12 \to 0$			
$6 \to 0$	$\Rightarrow$	11000	
$3 \to 1$			
$1 \to 1$		MSB	

Binary → Decimal

16 8 4 2 1

1 0 1 1 0$_2$

$16+4+2 = 22_{10}$

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64 32 16 8 4 2 1

1 1 0 1 0 0 1

$64+32+8+1 = 105$

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64 32 16 8 4 2 1

1 0 1 0 0 1 1

$64+16+2+1 = 83_{10}$

MSB	1	1
	0	1x2+0 = 2
	1	2x2+1 = 5
	1	5x2+1 = 11
LSB	0	11x2+0 = 22

MSB	1	1
	1	1x2+1 = 3
	0	3x2+0 = 6
	1	6x2+1 = 13
	0	13x2+0 = 26
	0	26x2+0 = 52
LSB	1	52x2+1 = 105

MSB	1	1
	0	2
	1	5
	0	10
	0	20
	1	41
LSB	1	83_{10}

Addition

$$\begin{array}{r} {}^{1}1\,{}^{1}0\,1\,1\,0_2 \\ +\;\;1\,0\,1\,0\,1_2 \\ \hline 1\,0\,1\,0\,1\,1 \end{array}$$

$$\begin{array}{r} 1\,{}^{0}\!\not{1}\,{}^{1}\!\not{0}\,{}^{0}\!\not{1}\,0_2 \\ -\;\;0\,0\,1\,1\,1_2 \\ \hline 1\,0\,0\,1\,1 \end{array}$$