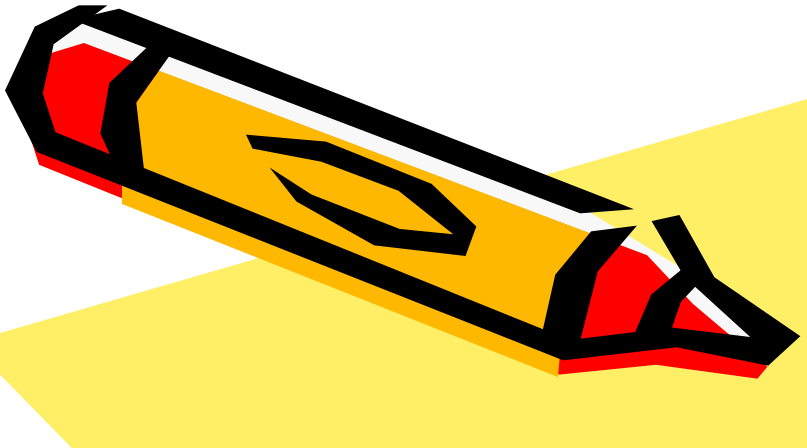
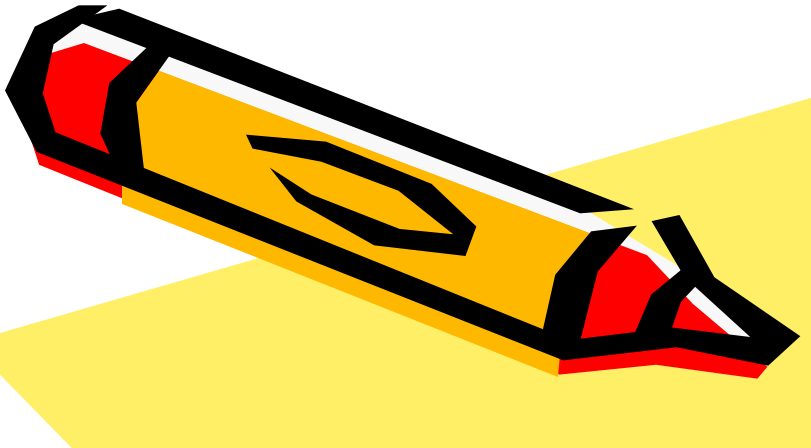


Logical Design

CS 221

Prof.Dr. Mohamed Osama Khozium

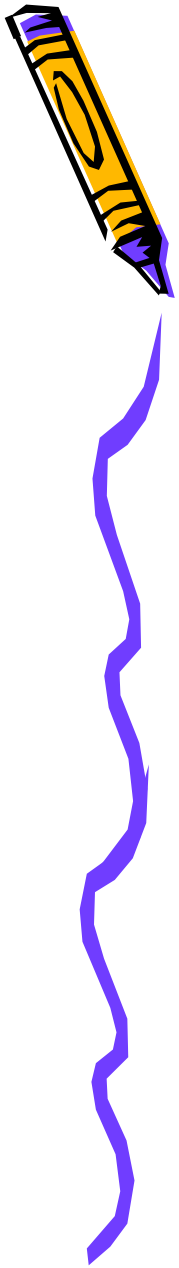


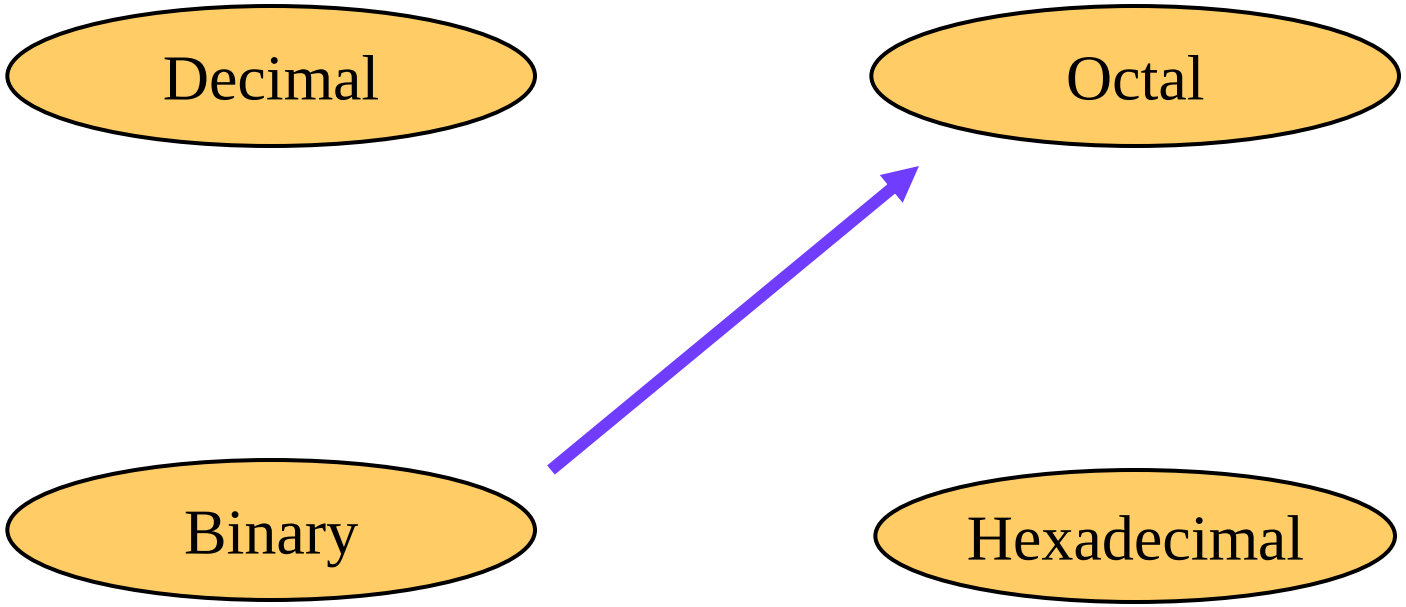
2. Number Systems

Location in course textbook

Chapt. 1

Binary to Octal



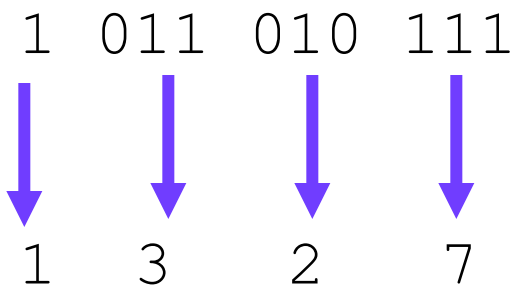


Binary to Octal

- Technique
  - Group bits in threes, starting on right
  - Convert to octal digits

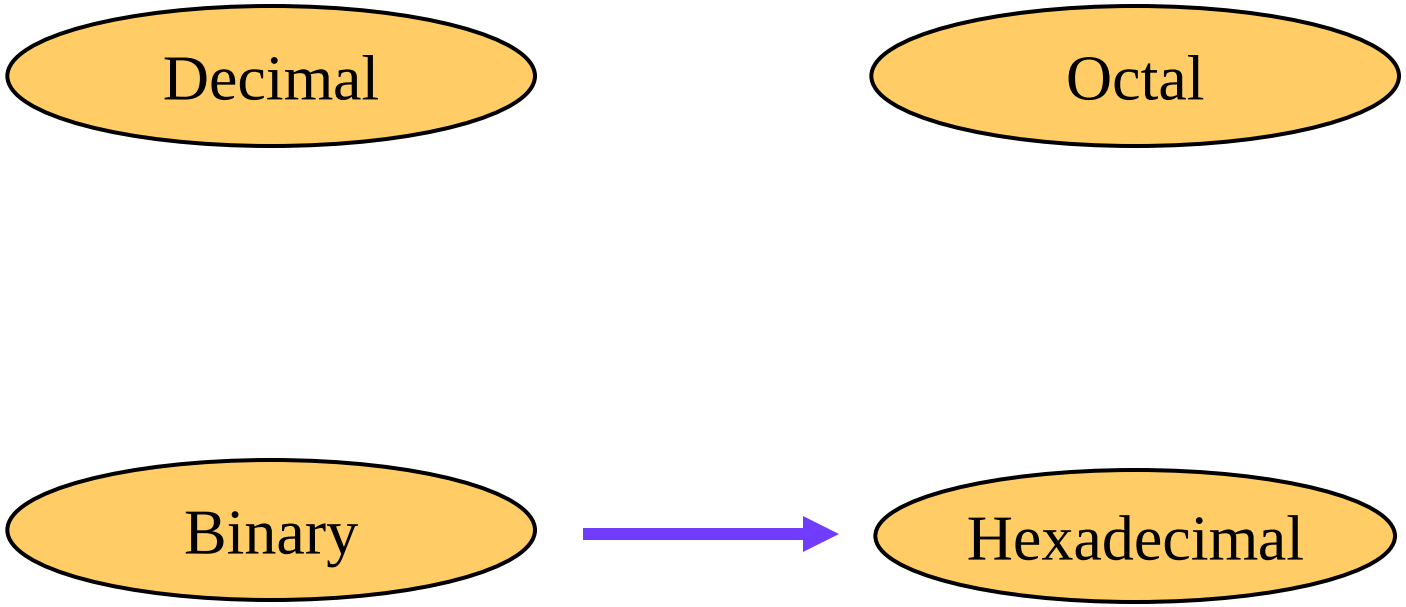
Example

$1011010111_2 = ?_8$



$1011010111_2 = 1327_8$

Binary to Hexadecimal

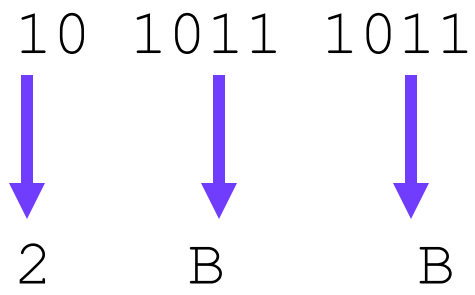


Binary to Hexadecimal

- Technique
  - Group bits in fours, starting on right
  - Convert to hexadecimal digits

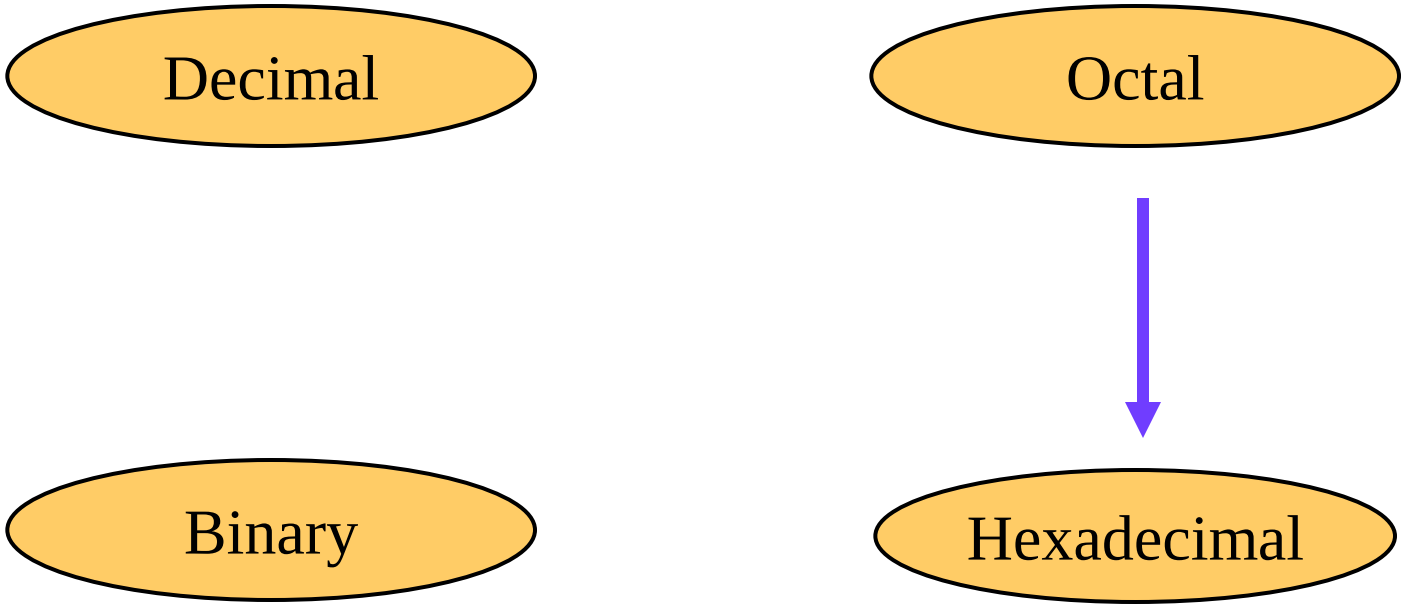
Example

$1010111011_2 = ?_{16}$



$1010111011_2 = 2BB_{16}$

Octal to Hexadecimal

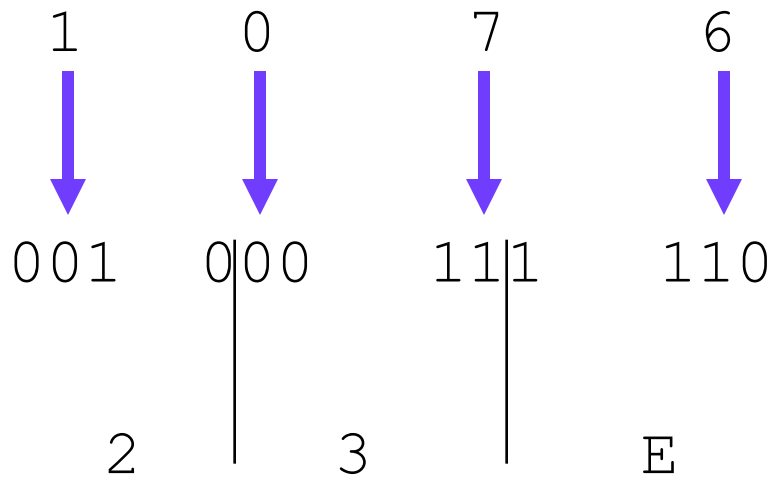


Octal to Hexadecimal

- Technique
  - Use binary as an intermediary

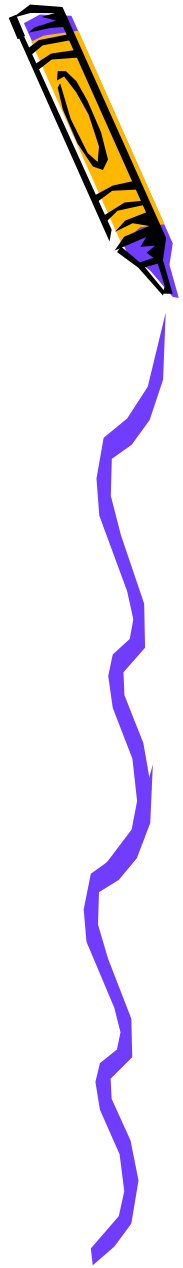
Example

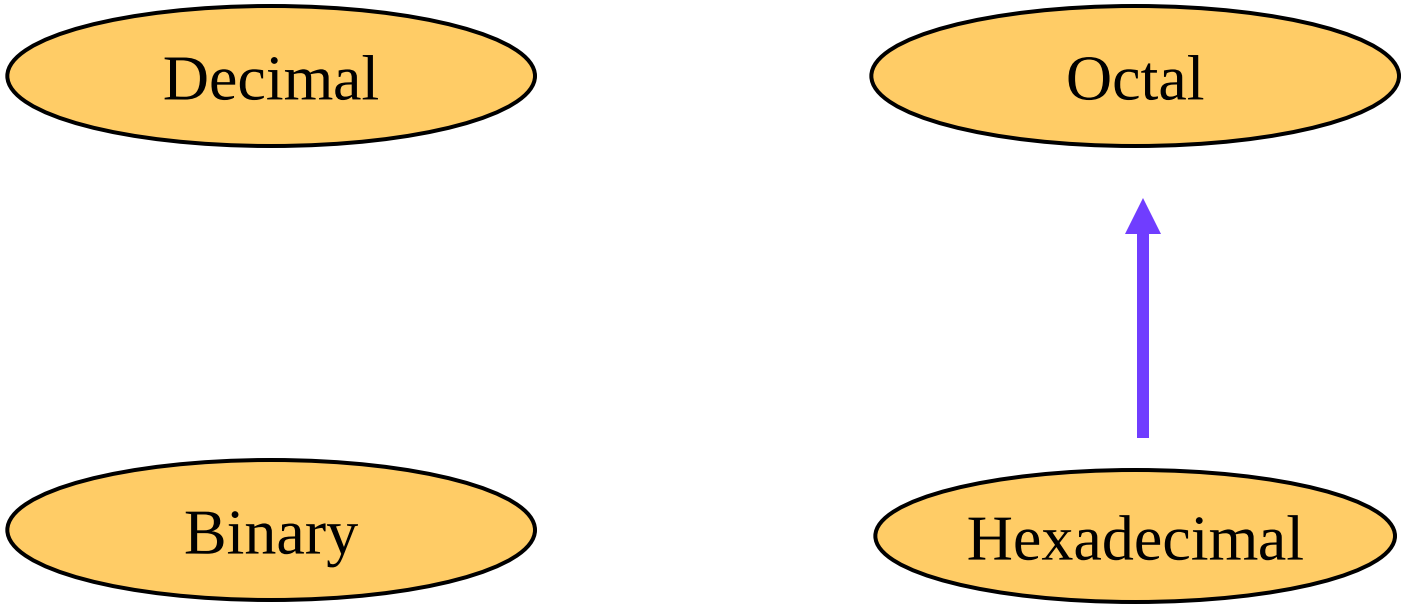
$1076_8 = ?_{16}$



$1076_8 = 23E_{16}$

Hexadecimal to Octal



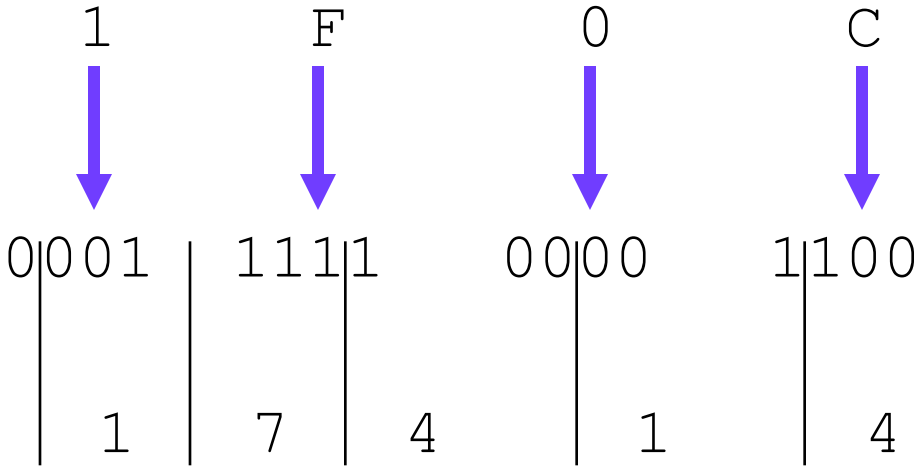


Hexadecimal to Octal

- Technique
  - Use binary as an intermediary

Example

$1F0C_{16} = ?_8$



$1F0C_{16} = 17414_8$

Exercise – Convert …

Decimal	Binary	Octal	Hexa-decimal
33			
	1110101		
		703	
			1AF

Don’t use a calculator!

Skip answer

Answer

Exercise – Convert …

Answer

Decimal	Binary	Octal	Hexa-decimal
33	100001	41	21
117	1110101	165	75
451	111000011	703	1C3
431	110101111	657	1AF

Common Powers (1 of 2)

- Base 10

Power	Preface	Symbol	Value
10^{-12}	pico	p	.000000000001
10^{-9}	nano	n	.000000001
10^{-6}	micro	μ	.000001
10^{-3}	milli	m	.001
10^{3}	kilo	k	1000
10^{6}	mega	M	1000000
10^{9}	giga	G	1000000000
10^{12}	tera	T	1000000000000

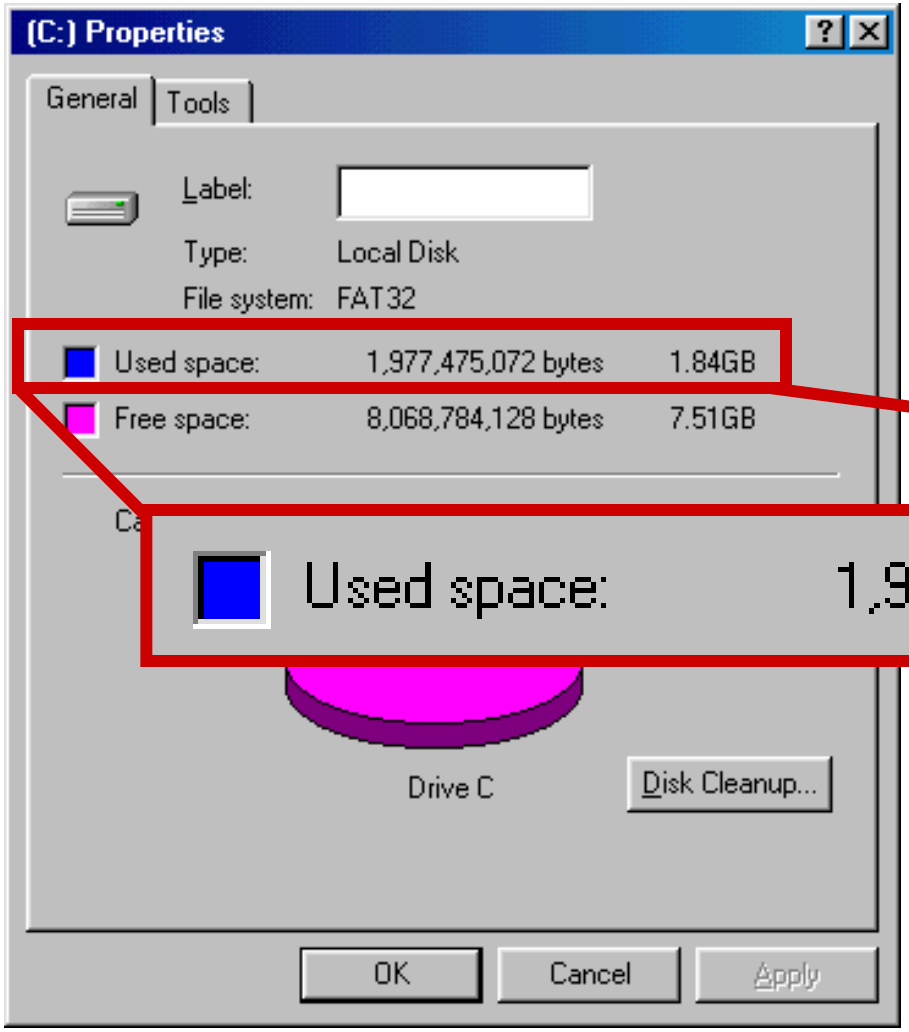
Common Powers (2 of 2)

- Base 2

Power	Preface	Symbol	Value
2^{10}	kilo	k	1024
2^{20}	mega	M	1048576
2^{30}	Giga	G	1073741824

- What is the value of "k", "M", and "G"?
- In computing, particularly w.r.t. memory, the base-2 interpretation generally applies

Example



In the lab…

1. Double click on My Computer
2. Right click on C:
3. Click on Properties

Used space: 1,977,475,072 bytes 1.84GB

/ 2^{30} =

Exercise – Free Space

- Determine the "free space" on all drives on a machine in the lab

Drive	Free space	
	Bytes	GB
A:		
C:		
D:		
E:		
etc.		

Review – multiplying powers

- For common bases, add powers

$$a^b \times a^c = a^{b+c}$$

$$2^6 \times 2^{10} = 2^{16} = 65,536$$

or…

$$2^6 \times 2^{10} = 64 \times 2^{10} = 64k$$

Binary Addition (1 of 2)

- Two 1-bit values

A	B	A + B
0	0	0
0	1	1
1	0	1
1	1	10

"two"

Binary Addition (2 of 2)

- Two *n*-bit values
  - Add individual bits
  - Propagate carries
  - E.g.,

```
  1     1          
  10101      21
+ 11001    + 25
------     ----
 101110      46
```

Multiplication (1 of 3)

- Decimal (just for fun)

$$
\begin{array}{r}
35 \\
\times\ 105 \\
\hline
175 \\
000\ \ \\
35\ \ \ \\
\hline
3675
\end{array}
$$

pp. 39

Multiplication (2 of 3)

- Binary, two 1-bit values

A	B	A × B
0	0	0
0	1	0
1	0	0
1	1	1

Multiplication (3 of 3)

- Binary, two *n*-bit values
  - As with decimal values
  - E.g.,

```
     1110
   x 1011
  ------
     1110
    1110
   0000
  1110
  ------
  10011010
```

Fractions

- Decimal to decimal (just for fun)

$$
\begin{aligned}
3.14 \Rightarrow \quad & 4 \times 10^{-2} = 0.04 \\
& 1 \times 10^{-1} = 0.1 \\
& 3 \times 10^{0} = 3 \\
\hline
& 3.14
\end{aligned}
$$

Fractions

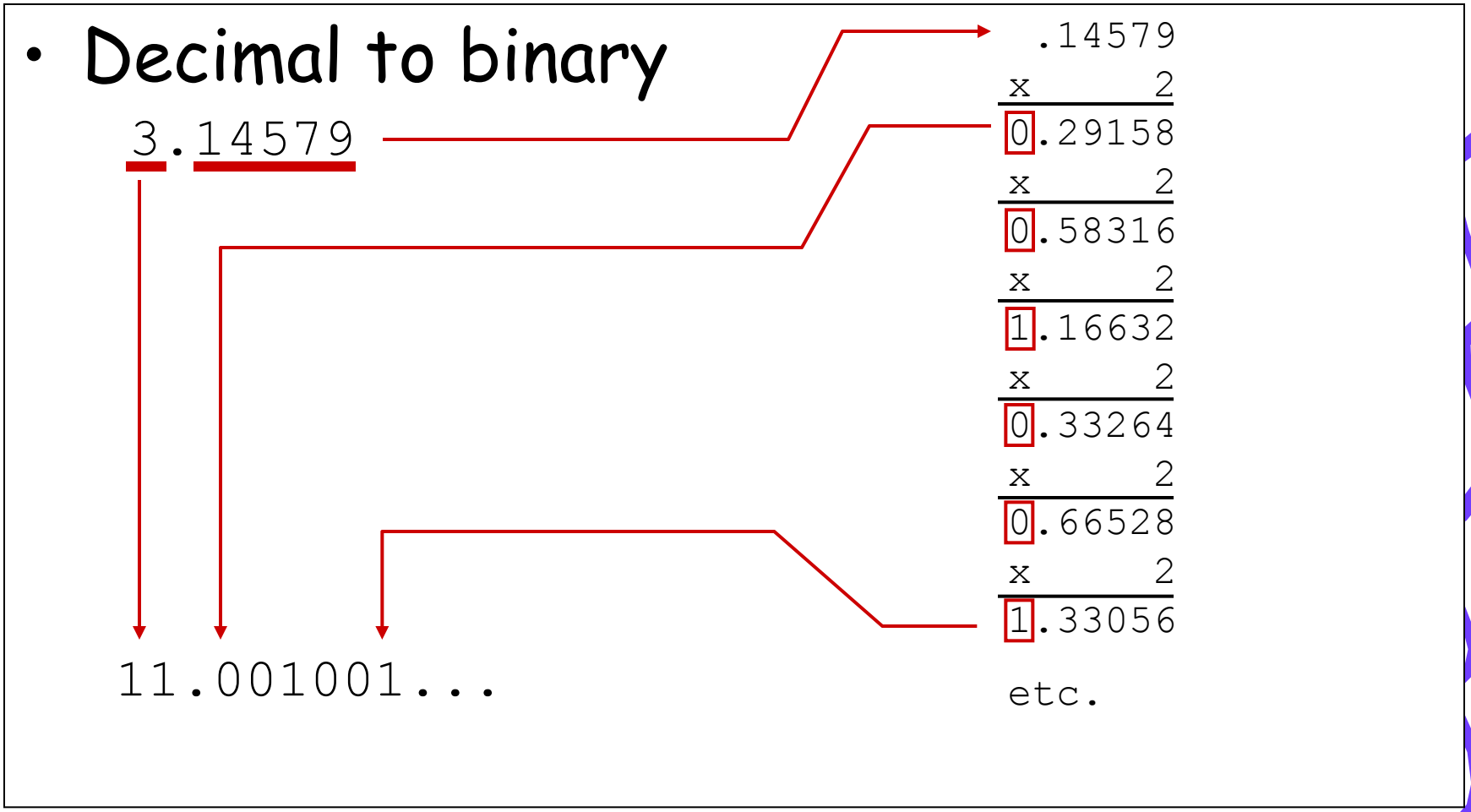
- Binary to decimal

$10.1011 \Rightarrow$

$$
\begin{aligned}
1 \times 2^{-4} &= 0.0625 \\
1 \times 2^{-3} &= 0.125 \\
0 \times 2^{-2} &= 0.0 \\
1 \times 2^{-1} &= 0.5 \\
0 \times 2^{0} &= 0.0 \\
1 \times 2^{1} &= 2.0 \\
&\hline \\
&= 2.6875
\end{aligned}
$$

Fractions

- Decimal to binary



Exercise – Convert …

Decimal	Binary	Octal	Hexa-decimal
29.8			
	101.1101		
		3.07	
			C.82

Don’t use a calculator!

Skip answer

Answer

Exercise – Convert …

Answer

Decimal	Binary	Octal	Hexa-decimal
29.8	11101.110011…	35.63…	1D.CC…
5.8125	101.1101	5.64	5.D
3.109375	11.000111	3.07	3.1C
12.5078125	1100.10000010	14.404	C.82

Thank you