

Digital basics

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Morse code

Digital data

0

1

bit

Types of digital data

- Text
- Numbers
- Digital media
 - Pictures
 - Video
 - Sound

Text

How many bits are required for the alphabet?

A = 0

B = 1

Two bits?

A = 00

B = 01

C = 10

D = 11

Three bits?

A = 000

B = 001

C = 010

D = 011

E = 100

F = 101

G = 110

H = 111

Combinations

1 bit = 2 combinations

2 bits = 4 combinations

3 bits = 8 combinations

4 bits = 16 combinations

5 bits = 32 combinations

n bits = 2^n combinations

5 bits (32 combinations)?

A = 00000

B = 00001

C = 00010

D = 00011

etc.

11111 = switch

@ = 00000

\$ = 00001

? = 00010

! = 00011

etc.

11011 = switch back

6 bits (64 combinations)?

- Alphabet
- Special symbols
- Numerals
- Not lower case letters

7 bits (128 combinations)?

- Enough combinations...
- American Standard Code for Information Interchange (ASCII)

8 bits (256 combinations)

- 8 bits = 1 **byte**
- Extended ASCII
- Extended Binary Coded Decimal Interchange Code (EBCDIC) created by IBM
- What about other languages?
- More bits...

16 bits

$$2^{16}$$

65,536 combinations

Unicode

The alphabets of the world

Unicode, etc.

- Initial implementation included: ASCII, Arabic, Armenian, Bengali, Bopomofo, Cyrillic, Devanagari, Georgian, Greek and Coptic, Gujarati, Gurmukhi, Hangul, Hebrew, Hiragana, Kannada, Katakana, Lao, Latin, Malayalam, Oriya, Tamil, Telugu, Thai, and Tibetan.
- **UTF-8** is a variable-length standard

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- Numbers
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 - Pictures
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Numbers

0

1

2

3

4

5

6

7

8

9

10

100

1000

Two great inventions

- Place value
- Zero
- What would happen if we didn't have these?

$$\begin{array}{r} \text{MCXLIV} \\ \times \text{LXII} \\ \hline \text{???} \end{array}$$

Binary numbers

0 = 0000

1 = 0001

2 = 0010

3 = 0011

4 = 0100

5 = 0101

6 = 0110

7 = 0111

Binary numbers

$$8 = 1000$$

$$9 = 1001$$

$$10 = 1010$$

$$11 = 1011$$

$$12 = 1100$$

$$13 = 1101$$

$$14 = 1110$$

$$15 = 1111$$

Place values

[illegible]

Converting decimal to binary

Example: 95

128	64	32	16	8	4	2	1
-----	----	----	----	---	---	---	---

0 1 0 1 1 1 1 1

$$\begin{array}{r} 95 \\ -64 \\ \hline 31 \end{array}$$

$$\begin{array}{r} 31 \\ -16 \\ \hline 15 \end{array}$$

$$\begin{array}{r} 15 \\ -8 \\ \hline 7 \end{array}$$

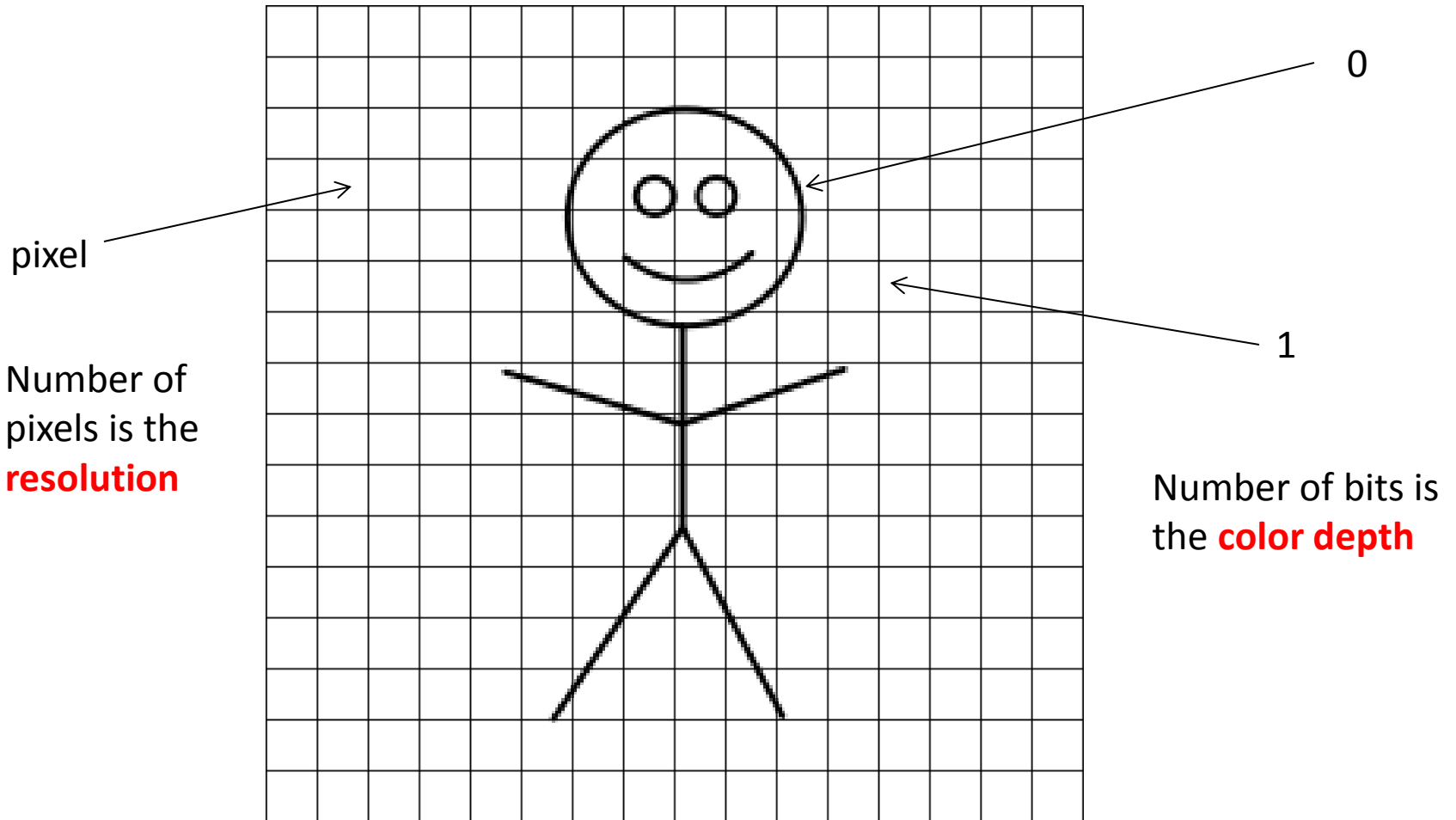
Binary addition

64	32	16	8	4	2	1	
0	0	0	1	0	0	1	9
0	0	0	1	0	1	0	+ 10
0	0	1	0	0	1	1	19

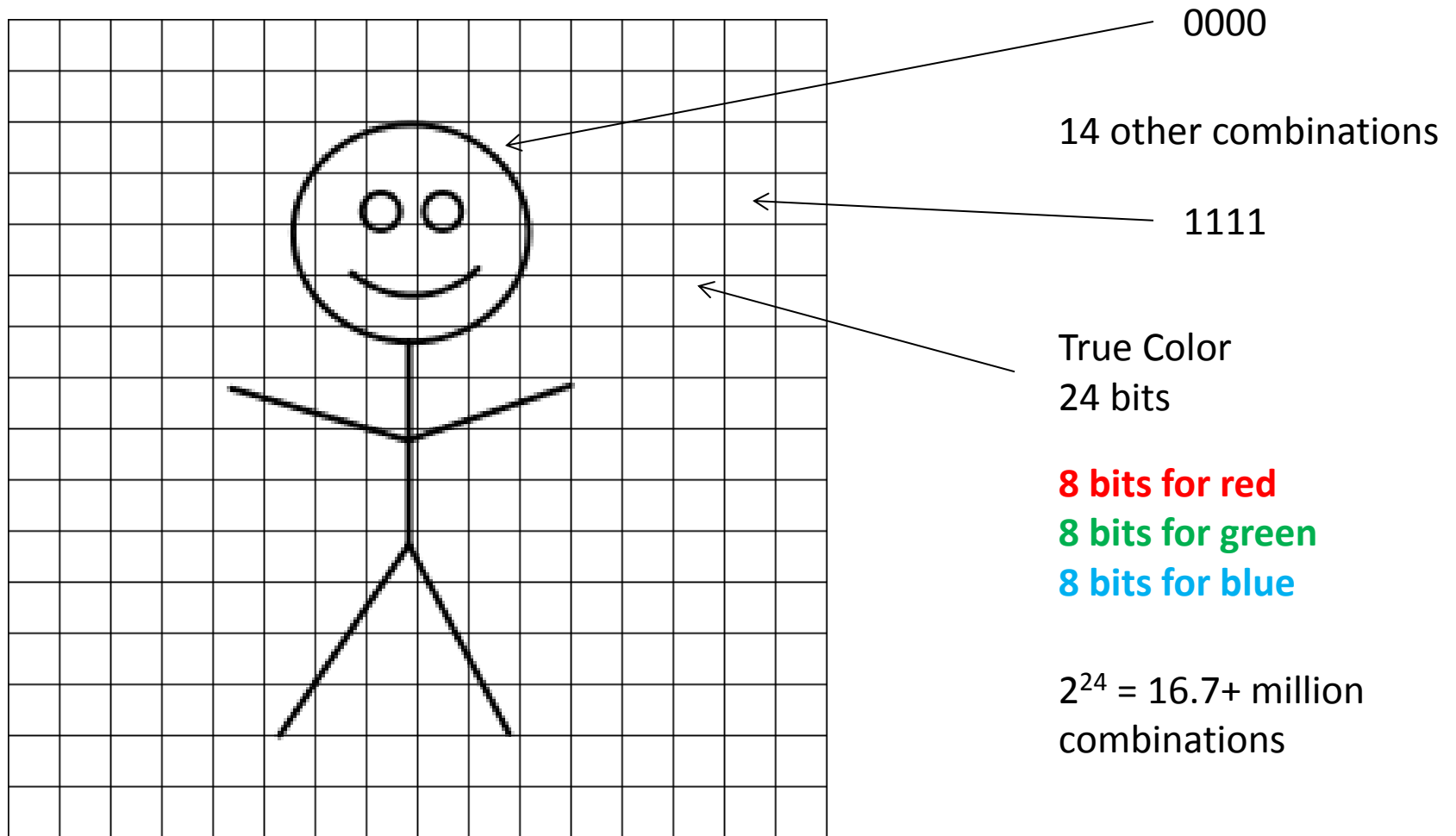
Types of digital data

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 - Pictures
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Pictures



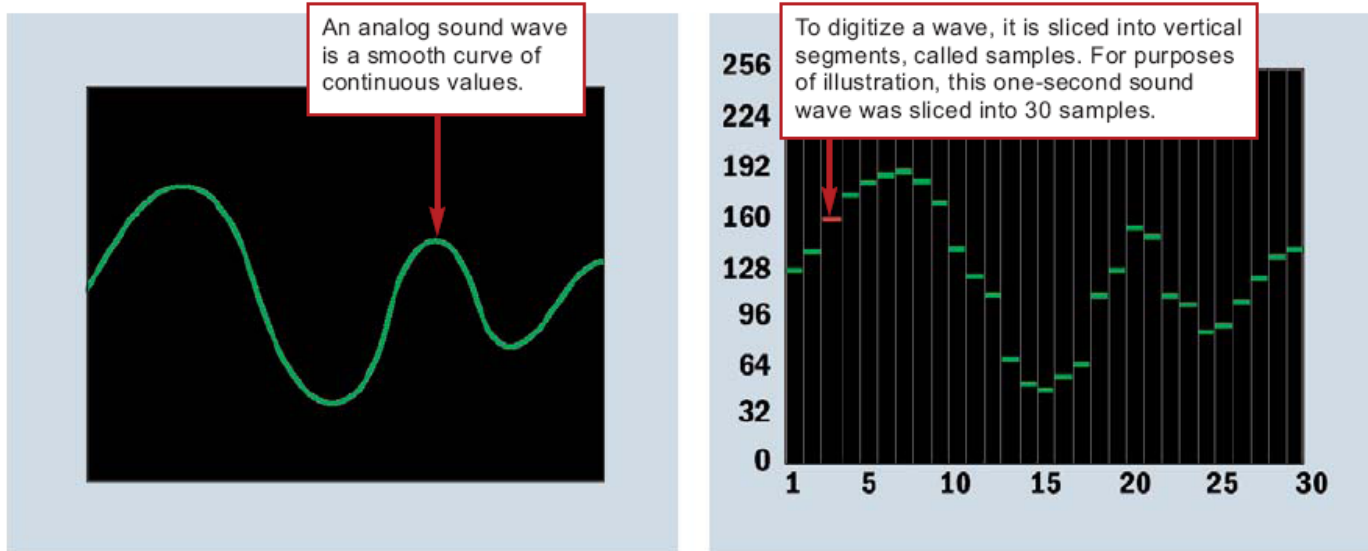
Color depth



Video

- Multiple pictures
- Each picture is a **frame**
- Frame rate determines video quality
- Typical rate is 30 frames per second

Sound



Sample	Sample Height (Decimal)	Sample Height (Binary)
1	130	10000010
2	140	1000110
3	160	10100000
4	175	10101111
5	185	10111001

The height of each sample is converted into a binary number and stored. The height of sample 3 is 160 (decimal), so it is stored as its binary equivalent—10100000.

Lots of data

- The need for **compression**

[illegible][illegible]

Types of digital data

- Text
- Numbers
- Digital media
- Software

Software

0001 = add

0010 = subtract

0100 = multiply

1000 = divide

1001 = square root

etc.

More binary stuff

Units of measure

- 8 bits = 1 **byte**
- KB = kilobyte = 1024 bytes (2^{10}) = **thousand**
- MB = megabyte = 1024^2 bytes (2^{20}) = **million**
- GB = gigabyte = 1024^3 bytes (2^{30}) = **billion**
- TB = terabyte = 1024^4 bytes (2^{40}) = **trillion**
- PB = petabyte = 1024^5 bytes (2^{50}) = **quadrillion**
- EB = exabyte = 1024^6 bytes (2^{60}) = **quintillion**
- ZB = zettabyte = 1024^7 bytes (2^{70}) = **sextillion**

Another counting system

0
1
2
3
4
5
6
7
8
9
A
B
C
D
E
F

Hexadecimal (**hex**) values

A = 10

B = 11

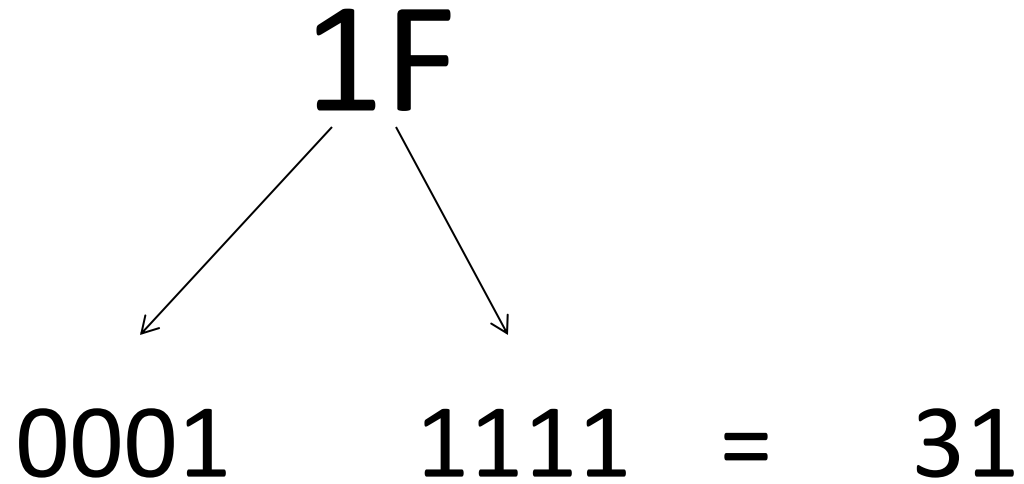
C = 12

D = 13

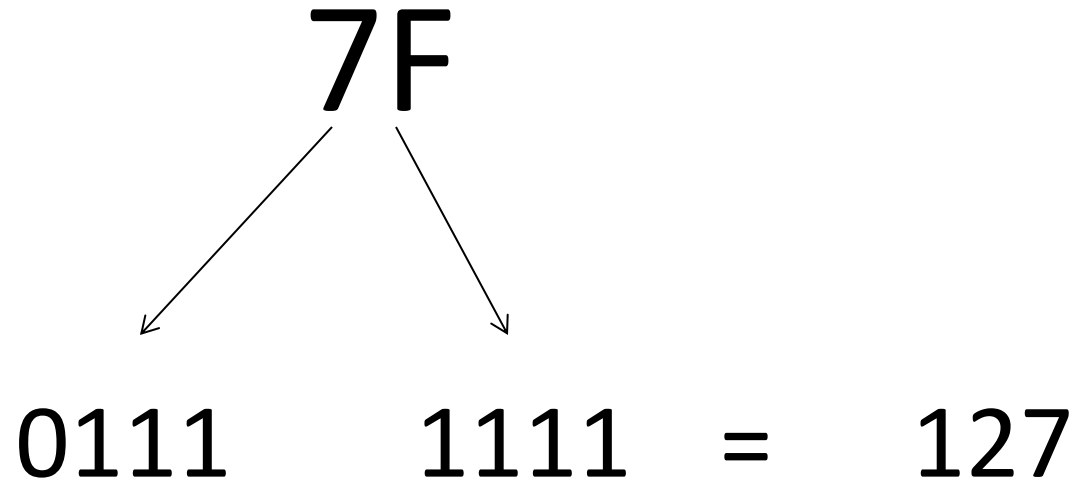
E = 14

F = 15

Examples

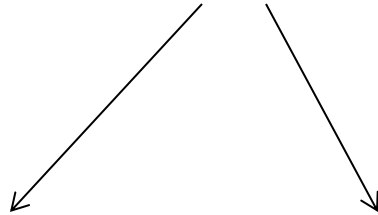


Another example



Example 3

FF



1111

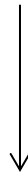
1111

=

255

Converting from decimal to hex

54 = 0011 0110



3



6

54_{decimal} = 36_{hex}

A real example

- Sample color = 7F36FF
- Red = 7F
- Green = 36
- Blue = FF

