Pixel Representation

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Outline

- Representing pixels in PixelMath and other Imaging Systems

- Binary Numbers

- Converting to/from decimal

- Bits and Bytes and how binary numbers represent information

- Direct RGB color representation

- Indexed color representation

Binary Numbers and Pixels

The binary number system (or base 2) uses one binary digit ("bit") for each power of 2 in some range of powers, say 2^0 to 2^7.

Decimal	Binary
0	0
1	1
2	10
3	11

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Binary Numbers (continued)

Decimal	Binary
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Pixel Values in Binary

Decimal	Binary
0	00000000
1	00000001
100	01100100
127	01111111
128	10000000
254	11111110
255	11111111

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Bits are ordered from right to left by increasing "significance".

The rightmost bit of a number is its least significant bit

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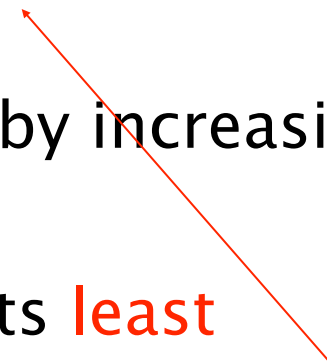
$11_2 = 3_{10}$

$101_2 \;\; = ?$

$1000_2 \;\; = ?$

$11000_2 \;\; = ?$

$1000001_2 \;\; = ?$

Bits and Bytes

A bit is one binary digit. (Either 0 or 1).
It can represent a choice between two possibilities.
on vs off,   even or odd,   heads or tails,
male or female,   older than 21 vs younger,
presence of something vs its absence.

A byte consists of 8 bits, and so it can represent 8 such choices.
E.g., 10011101   ↔   HTTHHHTH

Describing the bits of a binary number

Since each bit of a binary number represents a power of two, we can number the bits using the exponents of those powers.

Consider the binary number 10110_2.

Binary number:	1	0	1	1	0
Powers of 2:	2^4	2^3	2^2	2^1	2^0
position number:	4	3	2	1	0
place value:	16	8	4	2	1
Contribution:	16	0	4	2	0

Total: 22

Color Pixels with Direct RGB representation

Each pixel is represented by 3 values:
Red: a number between 0 and 255, inclusive
Green: "   "   "   "
Blue: "   "   "   "

It takes one byte to represent each value.
Thus each pixel is represented by 3 bytes or ___ bits.

This means there are 2^{24} possible colors for a pixel in the 24-bit color system. This is 16,777,216 colors!

An Alternative:

Each pixel is represented by only one byte, but this is not an RGB value but a "color index". It is a number that tells what row to look at in a table of colors. If there are not very many table entries, this method can be efficient.

Pixel value: 2
Table:
index	R,G,B	description
0:	0, 0, 0	(black)
1:	255,0,0	(red)
2:	127,0,255	(purple)
3:	255,255,255	(white)

GIF (graphics interchange format) uses this method and limits the table size to 256, so that each index can be represented by one byte.

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