painting and drawing programs

(continued)

colour intensities in binary

- in the computer memory, colours are represented in *binary notation* (0's and 1's)
- 8 *bits* (= 0/1 variables) are needed to represent 256 possibilities

more on binary notation

- 1 bit can represent 2 possibilities: 0 or 1
- 2 bits can represent 4 possibilities: 00, 01, 10, 11
- How many possibilities can be represented with 3 bits ? (Can you list them?)
- How many possibilities can be represented with 8 bits?

specifying colour intensities

- you can specify a colour precisely, using three numbers between 0 and 255
  - e.g.: 0, 5, 255
  - human friendly
- or, you can use three 8-bit binary numbers
  - e.g.: 00000000, 00000101, 11111111
  - computer friendly
- or, you can use *hexadecimal notation*
  - a compromise between human and computer
  - see pages 105-106 of the text

hexadecimal notation

- decimal notation uses 10 digits
- binary notation uses 2 digits (0 and 1)
- hexadecimal notation uses 16 digits:
  - '0' through '9' (10 of the digits)
  - 'A' through 'F' (6 more "digits" representing 10 through 15)

table of first 16 numbers

… fill in missing spaces!

Note: leftmost 0's optional

decimal	binary	hexadecimal
00	0000	00
01	0001	01
02	0010	02
03	0011	03
04	0100	04
05		05
06	0110	06
07		07
08		08
09	1001	09
10	1010	0A
11	1011	
12		0C
13	1101	0D
14	1110	
15		0F

from binary to decimal

- see page 292 of the text
- example:

1 1 0 0 1

1s place multiply by 1:	1
2s place multiply by 2:	0
4s place multiply by 4:	0
8s place multiply by 8:	8
16s place multiply by 16:	16
Total (add them up):	25

from hexadecimal to binary and back

- **easy:** replace each hexadecimal "digit" with the corresponding four binary digits
- examples:

hexadecimal	binary
AC	10101100
	01101001
11	
	11100001
FF	11111111

why hexadecimal

- less cumbersome than binary for humans
  - e.g., easier to specify an HTML colour
- easy to convert from hexadecimal to binary (computer representation) and back

exercises

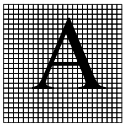
- Can you convert the binary number 10010110 to decimal? To hexadecimal?
- Try other 8-bit binary numbers.
- Use binary to decimal converters on the web to check your answer
  - e.g.:http://www.aquariussoft.com/ce-binary-converter
- (With a bit of effort, you could probably write your own converter in javascript…)

concepts: representing images digitally

- "Text and music have had abstract symbolic notational systems for thousands of years; the visual arts have just achieved such a system for the first time" - *Anne Morgan Spalter*
- How might you write down an accurate representation of an image, from which someone else could recreate the image?

bit-mapped image representation

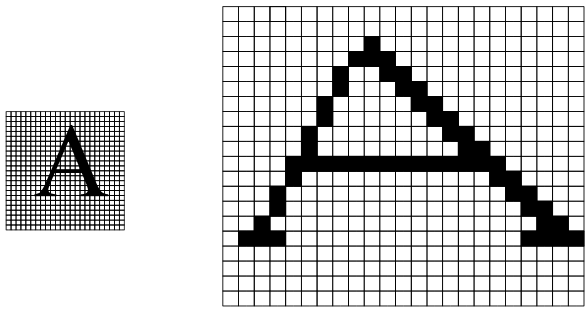
- also called raster image representation
- image is partitioned into tiny squares



- a sample of the colour in each square is obtained
- the colour of the square is set to that of the sample (represented as RBG colour intensities)
- a ***pixel*** (**pic**ture **el**ement) is the colour of the point sample

bit-mapped images, continued

- resolution-dependent: scaling up diminishes quality



applying the concepts: how filters work

- filters *globally transform* an image, by changing color intensity values of pixels

filters for blurring

- to blur an image, the colour value of each pixel is averaged with the values of its neighbours
- to avoid unexpected colours at interfaces between objects, UP darkens blurred areas
- the custom filter can also be used to control the averaging weights when blurring

concepts: compressing bit-mapped images

- bit-mapped image files can be big
- but, bit-mapped image can often be compressed without significant loss in quality
- What might be reasonable approaches to image compression?

some compression approaches

1. areas with similar hue can be modified to have the same hue (*lossy* compression)
2. "runs" of identical intensities are identified as such, rather than repeating the intensities
3. recurrent patterns in the sequence data is replaced by short "codes", and a dictionary of codes is maintained

image file types

- GIF (graphic image format) files use
  - 8 bits per pixel to represent colour intensities
  - compression approach 3
- JPEG (joint photographic experts group) files use
  - 24 bits per pixel to represent colour intensities
  - compression approaches 1 and 2 (lossy)
  - user can choose size/quality trade-off