CS155 – Z Sweedyk

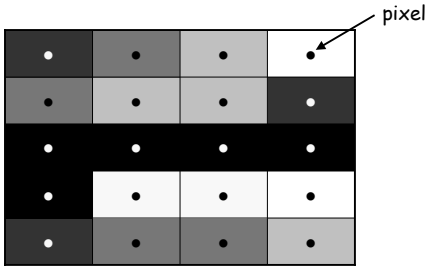
Digital Image

what is a digital image?

a digital image is a rectilinear array of samples of a continuous image

we call each sample a "pixel" (picture element)

digital image



digital image – sample values

.25	.5	.75	1
.50	.75	.75	.25
0	0	0	0
0	1	1	1
.25	.25	.5	.75

is it a digital image?

digital image fidelity

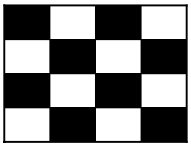
- spatial sampling
- color sampling

spatial sampling

how closely do our samples have to be to spaced in order to realistically represent our continuous image?

nyquist criteria

sample at more than twice the highest frequency to avoid aliasing



aliasing in images

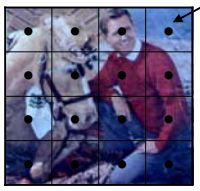
"jaggies"

if we can't avoid aliasing, can we do anything to fix it?

digital image fidelity

- spatial sampling
- color sampling

color quantization



bits per pixels

bits per pixel

1 bit per pixel

$2^1 = 2$ colors

8 bits per pixel

$2^8 = 256$ colors

24 bits per pixel

2^{24} colors

bits per pixel

3 bits per pixel

3 bits per pixel

bits per pixel per channel

1 channel,
1 bit per pixel per channel
$2^1 = 2$ grayscale colors

1 channel,
8 bits per pixel per channel
$2^8 = 256$ grayscale colors

3 channel,
8 bits per pixel per channel
2^{24} colors

3 channel color models

- RGB: red, green, blue
- HSV: hue, saturation, value

color values

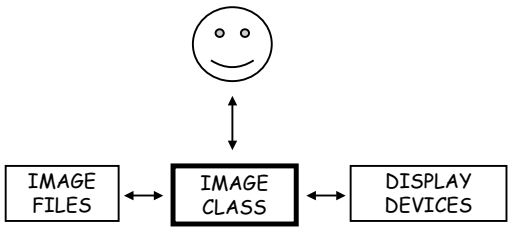
1. 0, 1, 2, ..., $2^n - 1$
2. 0, $1/(2^n-1)$, $2/(2^n-1)$, ... , 1

we use this convention

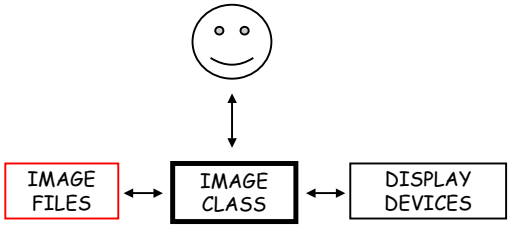
cs155 conventions

- Images are specified by:
  - Number of channels
  - Bits per pixel per channel
- Color values are in range [0,1].
- Three channel images are in RGB mode.

cs155 conventions



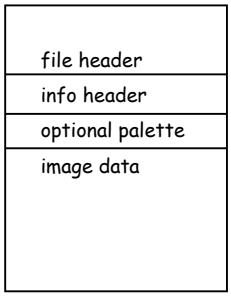
cs155 conventions



File Formats

- bmp ← we support
- pnm
- jpg
- etc.

bmp files



Exercise

1. Go to course web page. Download ipDemo.exe and Harry24.bmp from today's links.
2. Run the executable.
3. Right click within the image processing window and open Harry24.bmp.
4. The program will display the info header.

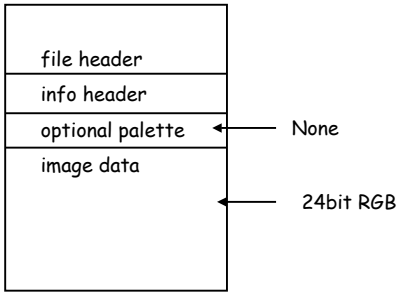
Harry24.bmp file header

- bfType: 4d42 Magic number
- bfSize: 51130 File size
- bfReserved1:0
- bfReserved2:0
- bfOffBits: 54 Offset to image data

Harry24.bmp info header

biSize: 40	Size of header (always 40 bytes)
biWidth: 150	Image width in pixels
biHeight: 113	Image height in pixels
biPlanes: 1	
biBitCount: 24	Bits per pixel
biCompression: 0	0= no compression
biSizeImage: 16950	Size of image in pixels
etc.	

Harry24.bmp



Harry24.bmp image data

row i	$R_{i,0}$	$G_{i,0}$	$B_{i,0}$	...	$R_{i,width-1}$	$G_{i,width-1}$	$B_{i,width-1}$	padding
row i+1	$R_{i+1,0}$	$G_{i+1,0}$	$B_{i+1,0}$	...	$R_{i+1,width-1}$	$G_{i+1,width-1}$	$B_{i+1,width-1}$	padding

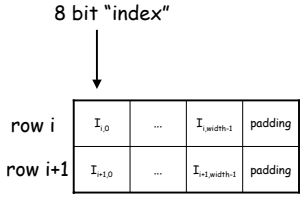
bmp colors

- 24 bit RGB is default
- you need to explain if you use less than 24 bits!

Exercise

2. Now right click within the image processing window and select process->gray. Save the file as Harry8.bmp.
3. Reload the new file and check how the file header and info header has changed.

Harry8.bmp image data



palette (color lookup table)

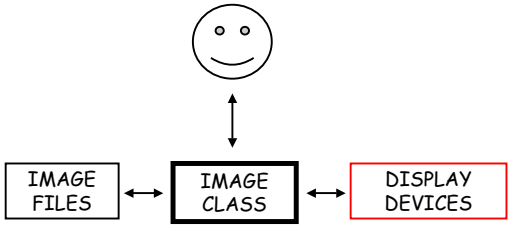
color	red	green	blue
0	R_0	G_0	B_0
1	R_1	G_1	B_1
⋮	⋮	⋮	⋮
255	R_{255}	G_{255}	B_{255}

24 bit color

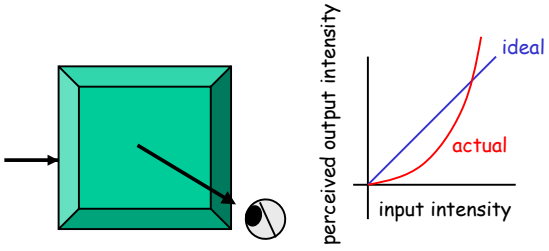
palette – one channel images

colors	red	green	blue
0	0	0	0
1	1	1	1
⋮	⋮	⋮	⋮
255	255	255	255

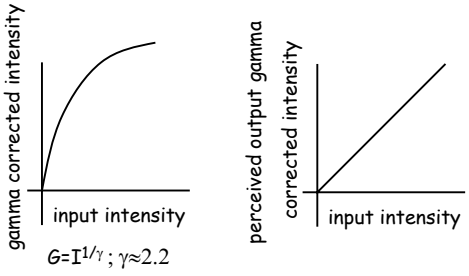
cs155 conventions



CRT displays are nonlinear



gamma correction



$G=I^{1/\gamma}$; $\gamma \approx 2.2$

next time: digital image processing

- avoid/correct errors
- restore
- enhance
- analyze
- create