IMAGES

E-lecture 4, CO3096/7096

Outline

- Various kinds of images and their representations.
- Image characteristics from a data compression viewpoint.

Example image

Images

- Images are two-dimensional arrays of *pixels* (picture elements).
- A pixel can be thought of as a tiny square that specifies the colour of the image at that point. Four types:
  - Monochrome/bi-level images
  - Grayscale images (black&white pictures)
  - Full-colour images
  - Indexed colour images

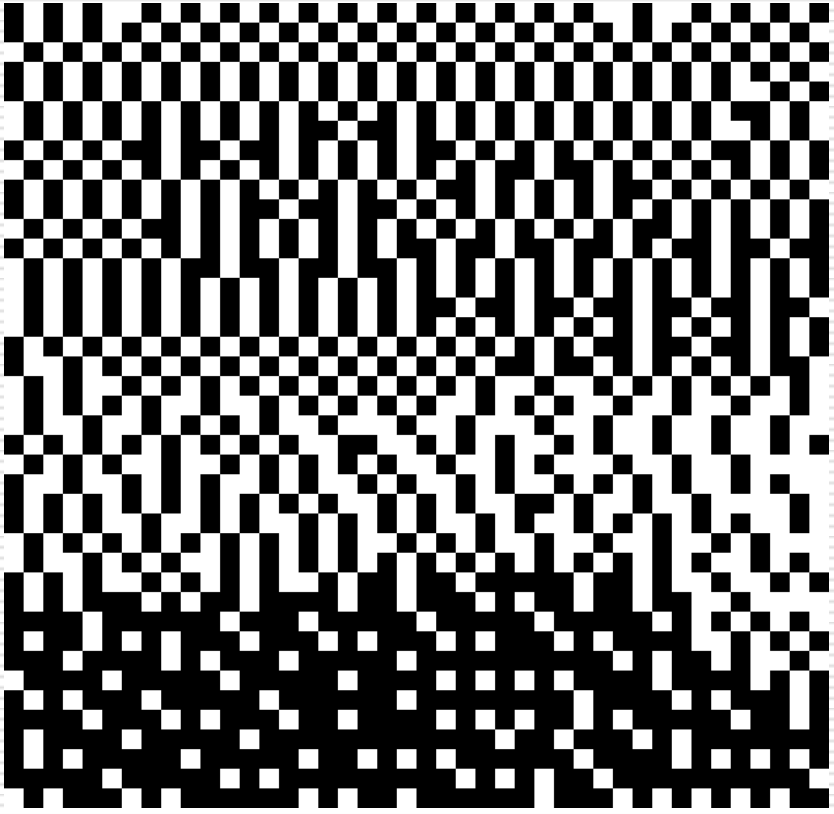
Bi-level images

- A pixel is 1 bit, coding for black (0) or white (1).
  - Fax images are bi-level images.
- Impression of shades of gray given by either
  - Halftoning (print technique)
  - Dithering (computer images).

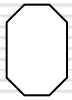
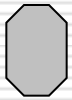
Bi-level images

Image characteristics

- Very unlike text data: no runs.
- Won’t cover bi-level image compression: similar to lossless JPEG.
- JBIG is the JPEG subgroup dealing with standards.



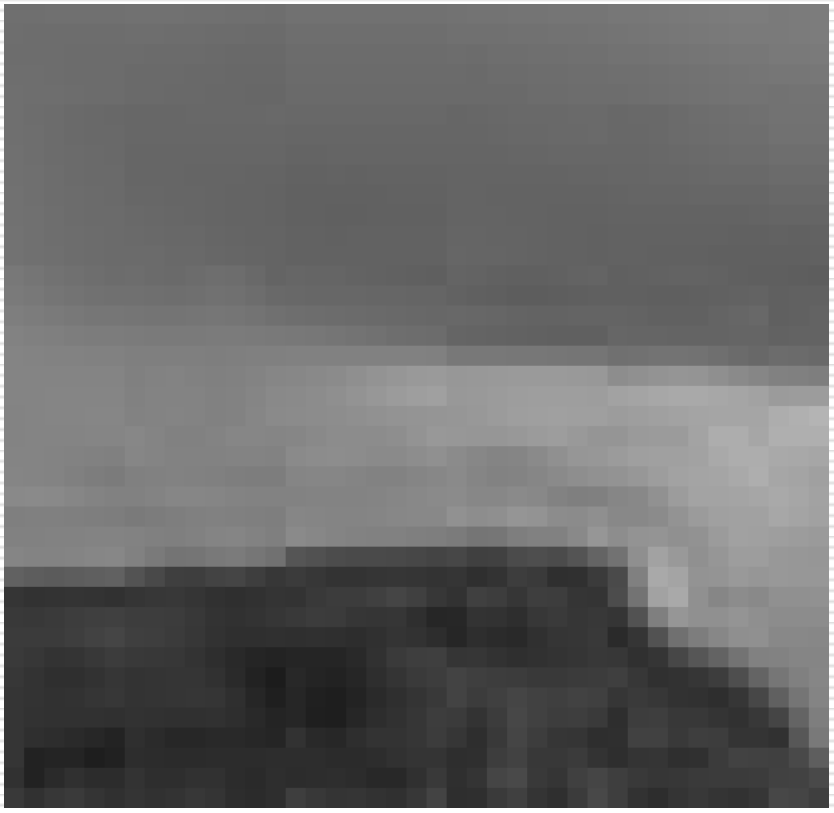
Grayscale images

- Pixels are 8-bit (unsigned) values.
  - i.e. integers from 0 to 255.
- By convention:
  - 0 codes for black 
  - 255 codes for white 
  - In between: shades of gray
    - 192 
    - 77 
- "Black and white" photos

Grayscale images

Image Characteristics

- Smooth variations of shades of gray
- Linear system model, except at boundaries.

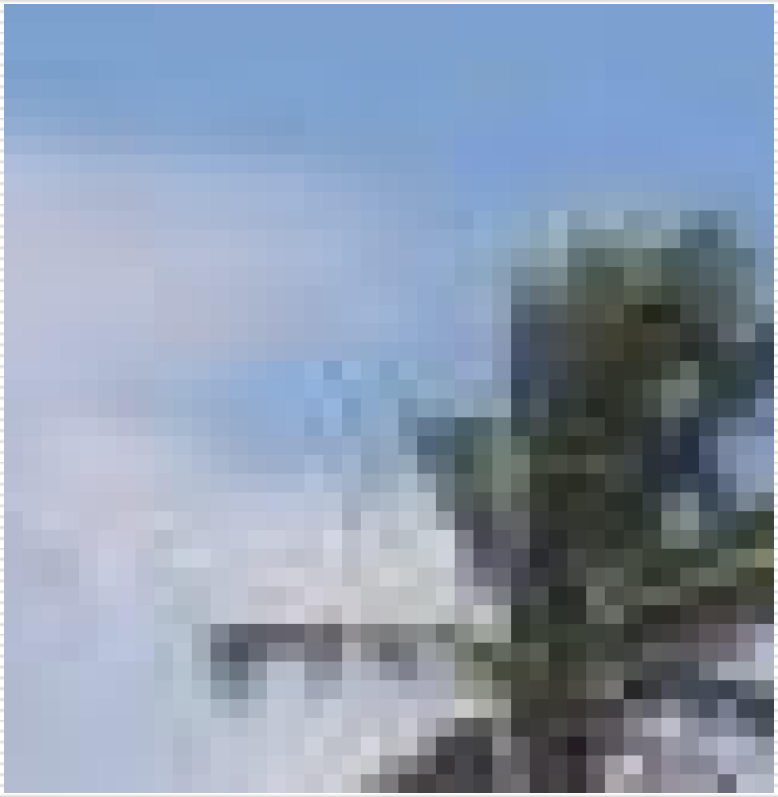


Full-colour images

- Pixels are 24 bits or 32 bits.
  - Three 8-bit values specifying colours in a “colour system”.
  - Possible 8-bit value giving “transparency” for overlaying images.
- Each pixel is one of $2^{24} = 16777216$ colours.
- Pixels unlikely to have exactly identical values.
  - Compressed format: .jpg files.

Example image

Image characteristics



- Again, relatively smooth variation, and adjacent pixels are similar, except at boundaries between objects.
- Linear system model for areas inside an object.

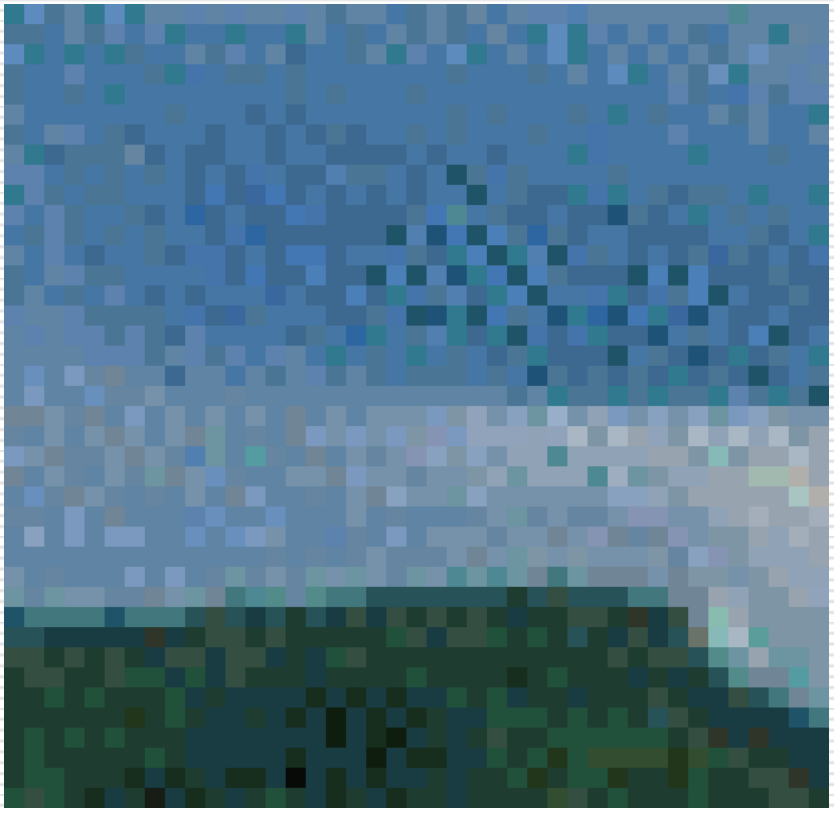
Indexed colour

- Each pixel has 8 bits, sometimes 16.
  - Along with the image is a "colour table", or array of colours, of size 2^8 (for 8-bit colour) or 2^{16} (for 16-bit colour).
- If a pixel's value is *i*, it's colour is given by *A*[*i*], where *A* is the colour table. The colour table contains 24-bit values.
- To convert a 24-bit colour image to an 8-bit indexed image, an appropriate colour table is chosen for the image, and each pixel in the original image is replaced by its nearest equivalent in the colour table.

Indexed colour

Image characteristics

- The image in full resolution is broadly similar.
- Zoomed in, it is quite different: pixels that appear the same are probably IDENTICAL.
- Runs of identical pixels; NOT linear system model.



Colour Systems

- Two main colour systems for image compression:
  - RGB
  - Composite systems (YIQ, YUV, YC_bC_r)

RGB

- Colour specified as a combination of Red, Green, Blue values (8-bit unsigned values => 24-bit colour)

R	G	B	
0	0	0	
77	77	77	
255	255	255	
255	0	0	

R	G	B	
128	0	0	
0	255	0	
255	255	0	
131	189	225	

RGB example

RGB

G

R

B

Composite Signals

- The three 8-bit components are called, variously:
  - *Y Cb Cr*
  - *Y I Q*
  - *Y U V*
- *Y* gives a "grayscale" version of the original image. (LUMINANCE/BRIGHTNESS)
- Other components give colour information in various ways (CHROMINANCE/COLOUR)
- Originally used to run colour and B/W TVs simultaneously.
- Standard for video/TV but adopted in JPEG, JPEG2000.

RGB to YIQ

- RGB --> YIQ

$$Y = 0.299R + 0.587G + 0.114B$$

$$I = 0.596R - 0.274G - 0.322B$$

$$Q = 0.211R - 0.523G + 0.312B$$

$$R = G = B = x \Rightarrow Y = x, I = 0, Q = 0$$

YIQ example

RGB

Y

I

Q

Conclusion

- Understanding of the basic kinds of images and their characteristics (for compression purposes).
- Quick overview of main systems for specifying colours in full-colour images.