MULTIMEDIA AND CODING

WHAT MEDIA TYPES WE KNOW?

TEXTS
IMAGES
SOUNDS
MUSIC
VIDEO
INTERACTIVE CONTENT
Games
Virtual reality

EXAMPLES OF MULTIMEDIA

MOVIE
audio + video

COMPUTER GAME
audio + video + interactive

WWW
text + images + audio
+ video + interactive

HYPERMEDIA

REPRESENTING MULTIMEDIA

INDIVIDUAL MEDIA REPRESENTATION

Images, videos, sound, interaction, script...
Graphical information, audio information, etc.

e.g. JPEG

BINDING MEDIA INTO MULTIMEDIA

Standards and formats for multimedia systems
Principles of media combination

e.g. Flash

GRAPHICAL INFORMATION

MODELS, MATERIALS, GEOMETRY, ANIMATION

Usually parametric, continuous

...We've been there

IMAGES

Can be discrete (rasterized) or continuous (vector)

VIDEOS

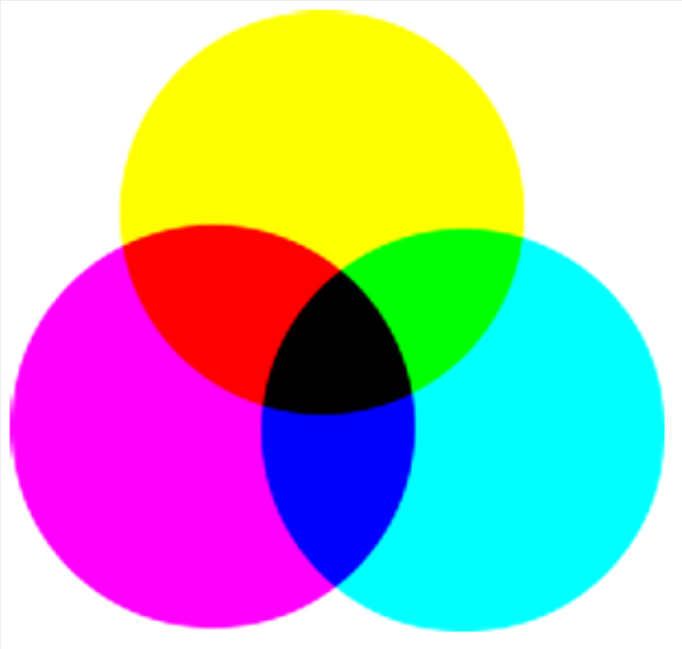
Discrete, rasterized

COLOR SPACES
COLOR MODELS

COLOR MODELS

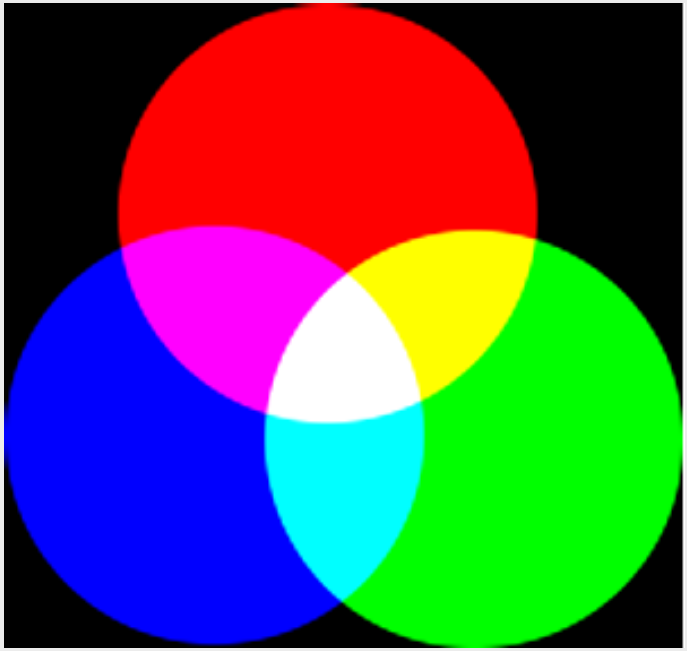
COMBINING THE PRIMARIES

Subtractive



Pigments

Additive



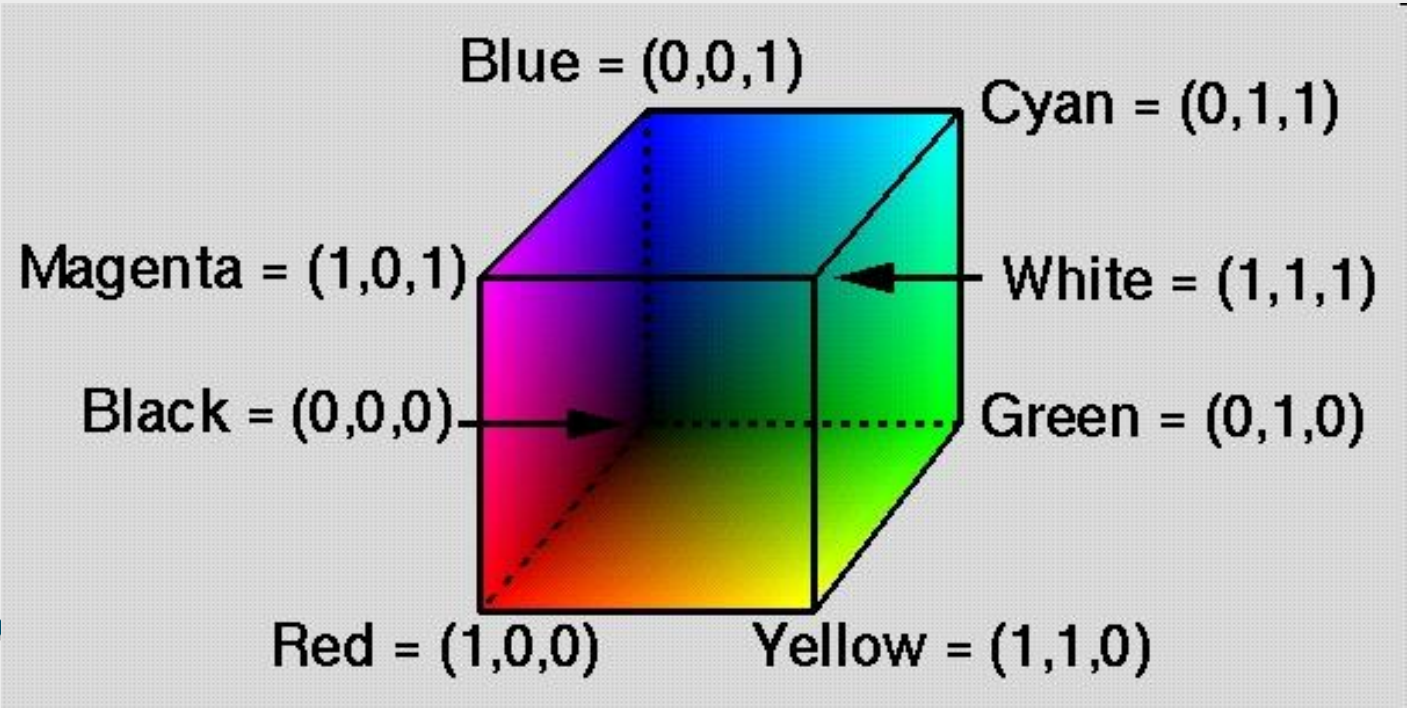
Lights

COLOR SPACES – TECHNICAL

CMY(K) - SUBTRACTIVE MODEL
- PRINTERS

RGB - ADDITIVE MODEL
- MONITORS, PROJECTORS

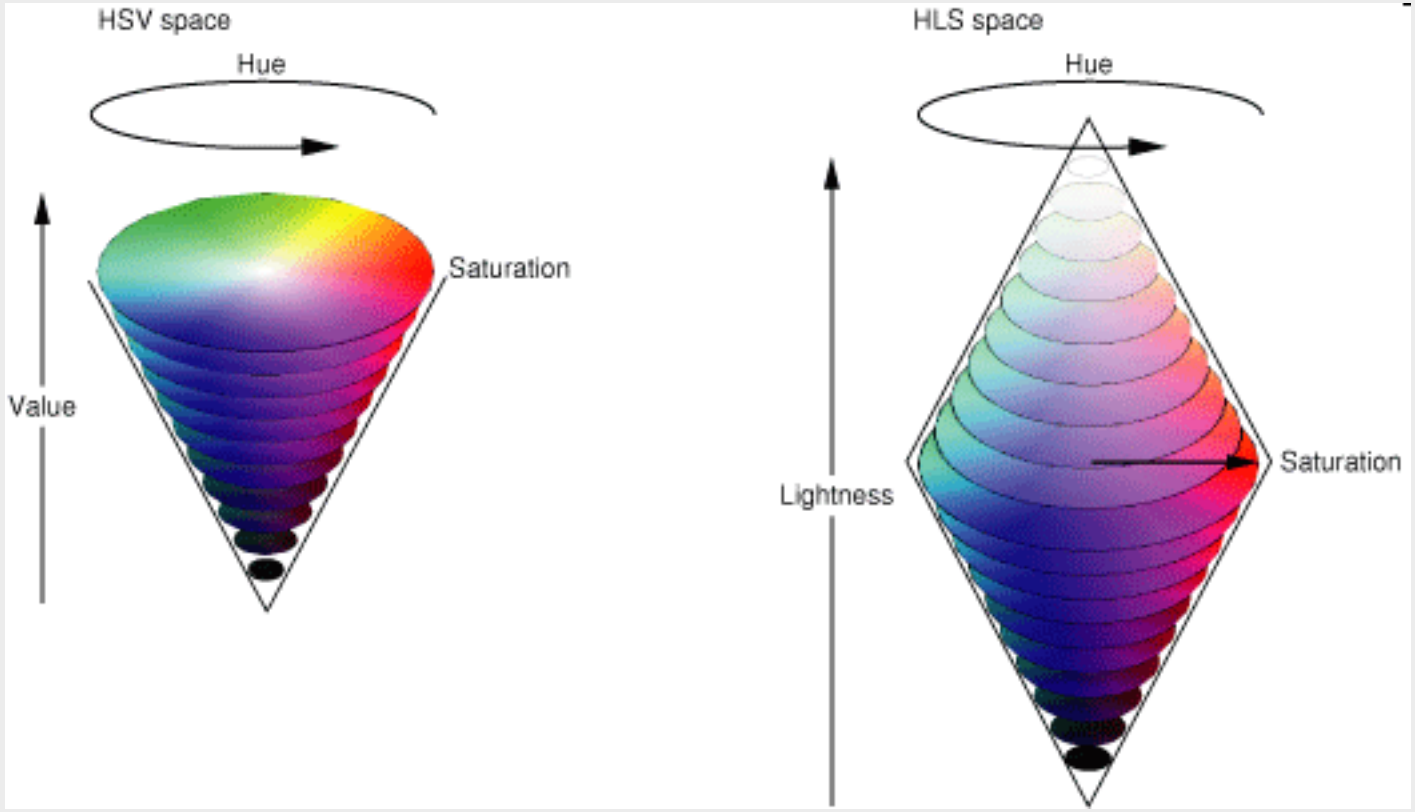
YCBCR - TELEVISION



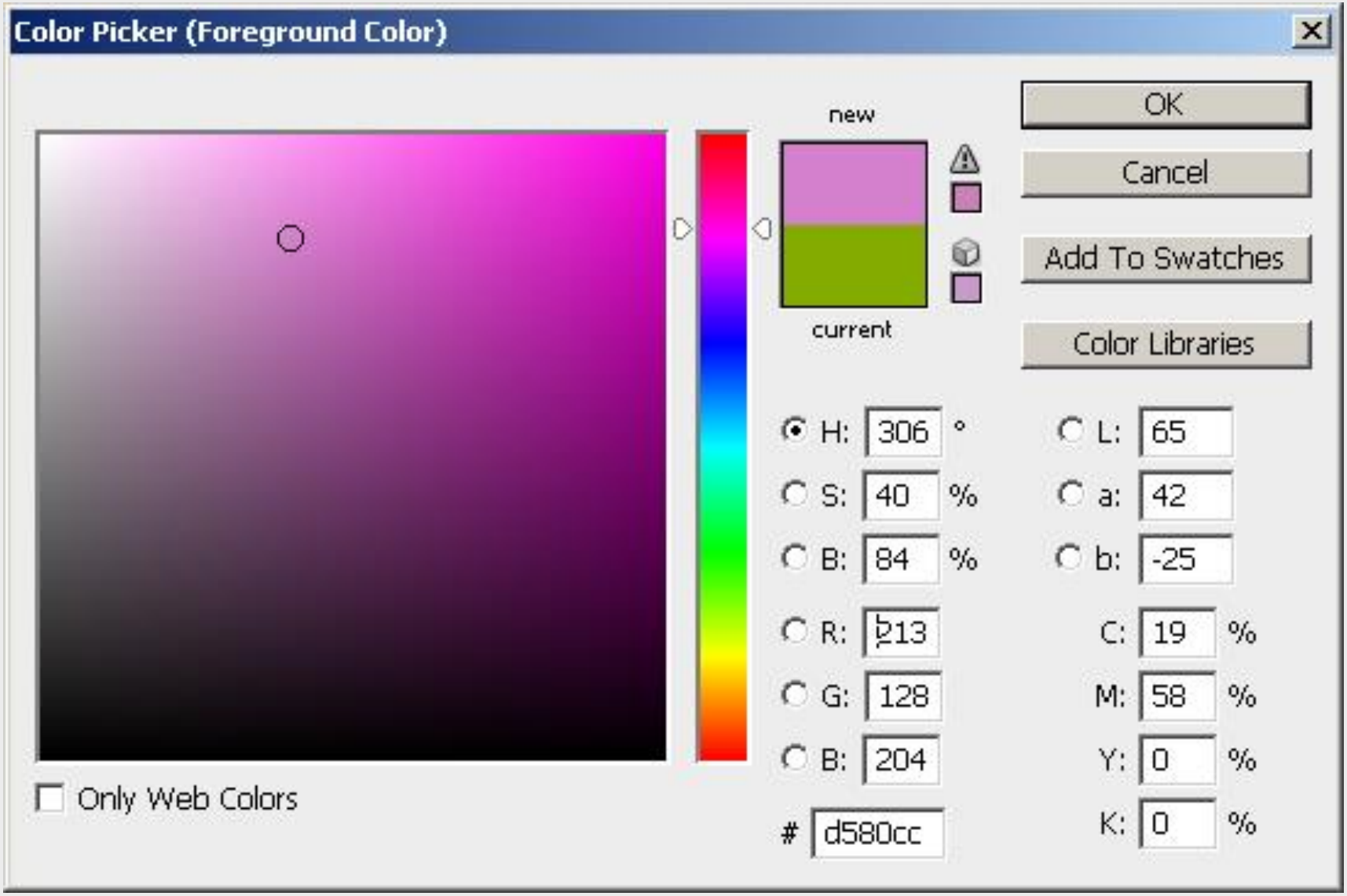
COLOR SPACES – INTUITIVE

HSB, HSL, HSV

Separate hue, saturation, brightness



HSB COLOR PICKER



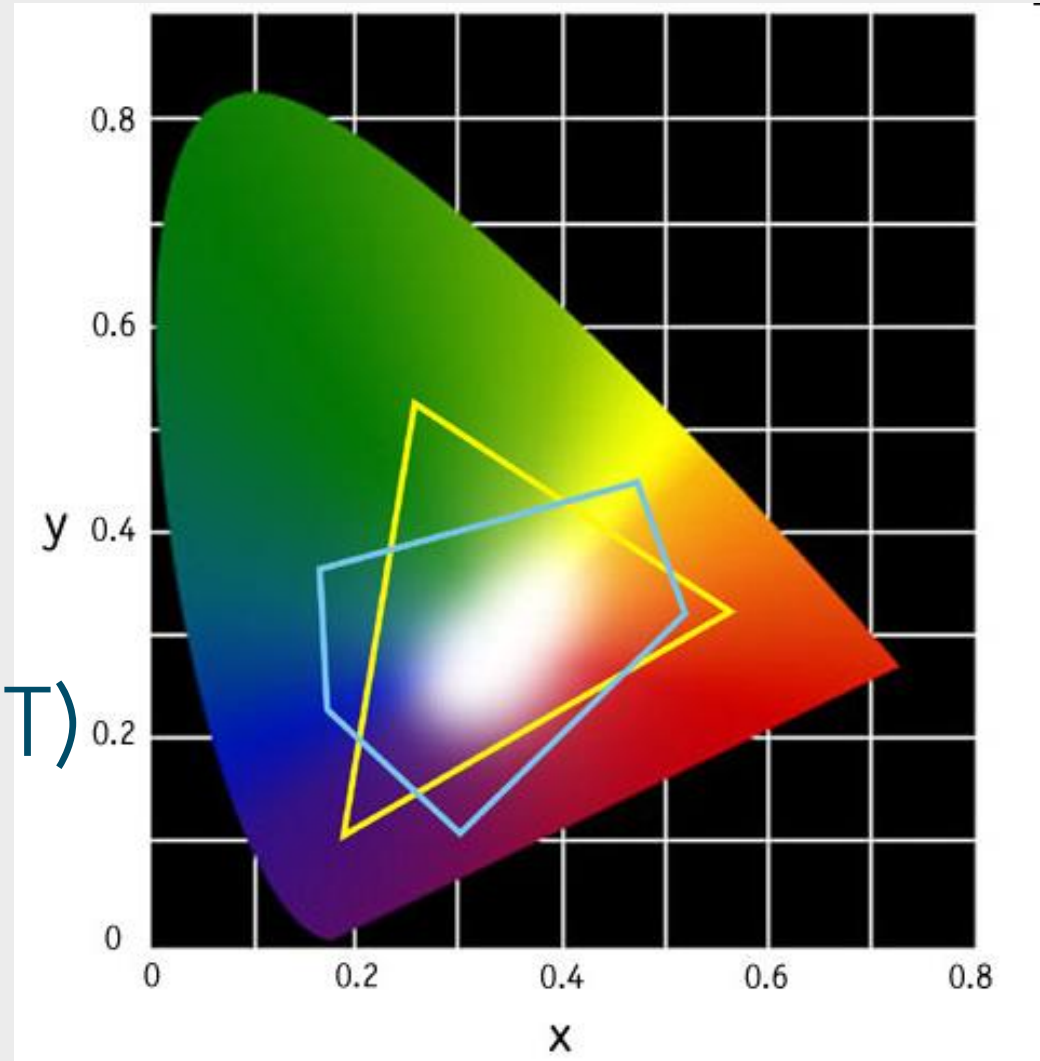
CIE COLOR SPACE AND DEVICE GAMUT

EACH DEVICE HAS ITS OWN PRIMARY COLORS

Triangle vertices

ALL COLORS OF THE DEVICE ARE INSIDE THE TRIANGLE (GAMUT)

DIFFERENT DEVICES = DIFFERENT GAMUTS



COLOR REPRESENTATION

24BIT RGB

i.e. 24 bit colors, each pixel = 8 + 8 + 8 bits =
0..255 red, 0..255 green, 0..255 blue

32BIT RGBA, CMYK

COLOR DEPTH - NUMBER OF BITS

Maximum number of different colors

Special: 30bit, 36bit
Better color resolution - medical imaging, scanning...

RASTER IMAGES

IMAGE FORMATS

YOU TELL ME ☺

JPEG, PNG, GIF, BMP, TIFF, PSD, AI, EPS, WMF, CDR, PS, PDF, TGA, SVG, ...

SOME OF THEM ARE RASTER
SOME OF THEM ARE VECTOR

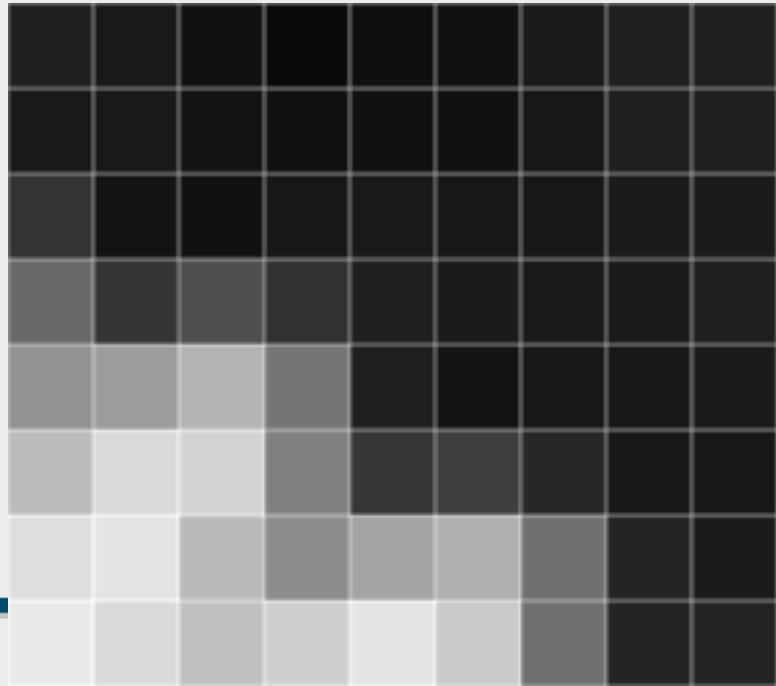
SOME CAN DO BOTH

BITMAPS = DISCRETE REPRESENTATION

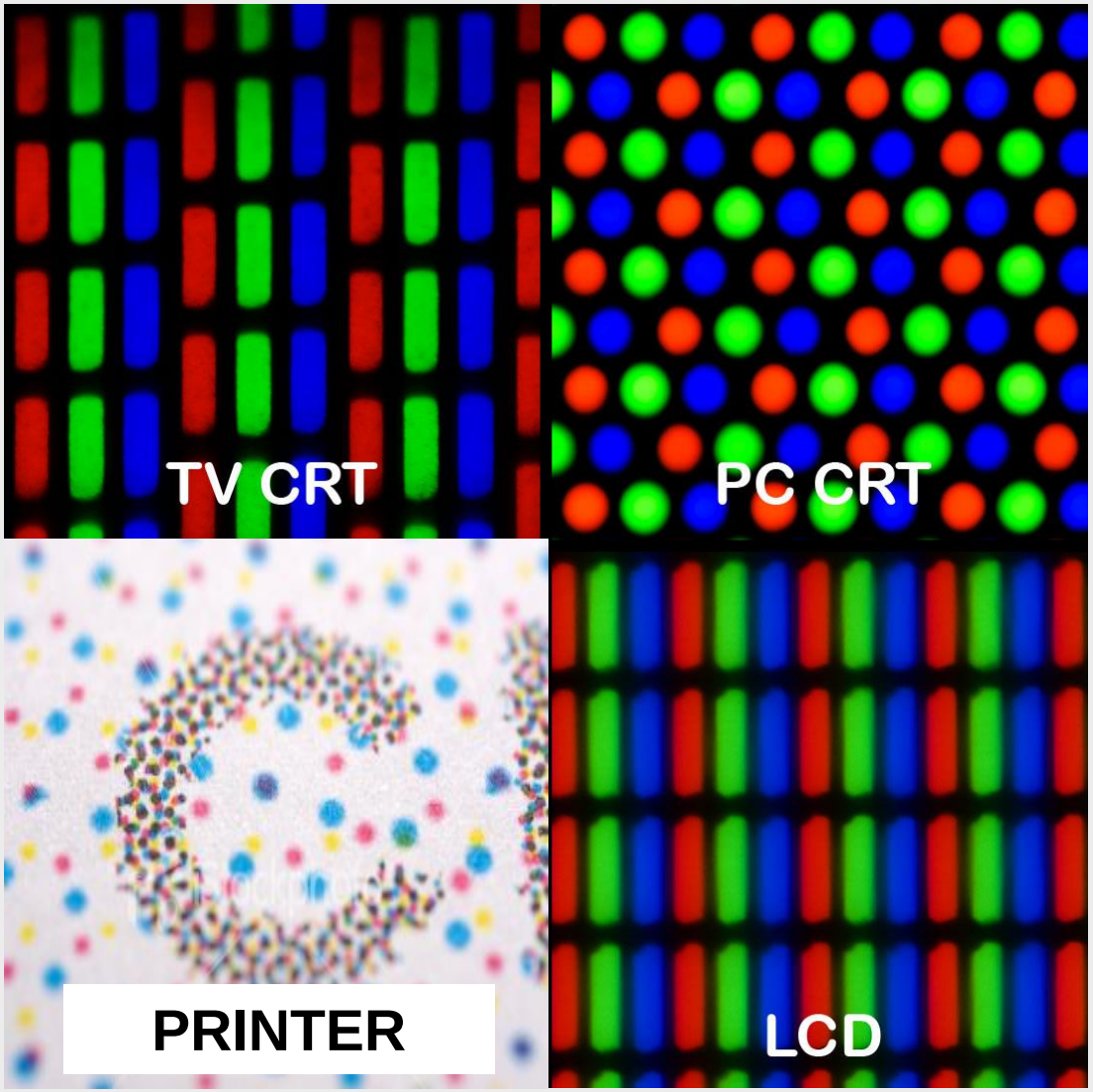
PIXEL = PICTURE ELEMENT

IMAGE RESOLUTION =
DIGITAL SIZE : PHYSICAL SIZE

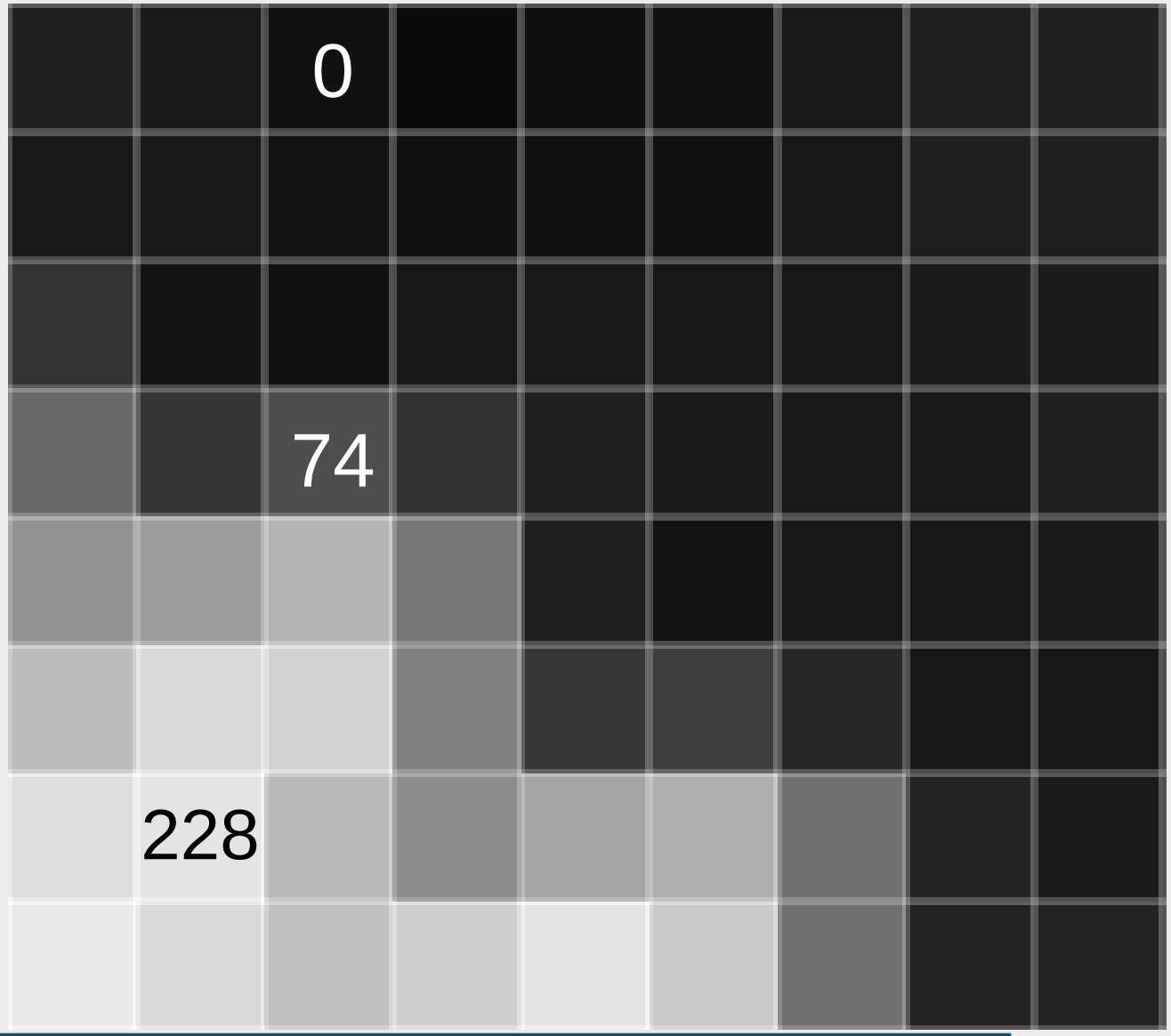
DPI, PPI
(dots per inch, points per inch)
72 - 130 dpi (monitors)
150 - 600 dpi (print)
600 - 1200 dpi (scanners)



DEVICES CLOSE-UP



PIXEL VALUES (IN GRAY SCALE)



2D RASTER IMAGES

WIDTH, HEIGHT

BITMAP

CODING

COLOR ORDER (RGB, BGR)

COMPRESSION

WHAT IS CODING?

REPRESENTING INFORMATION IN A CERTAIN WAY

Encoding, decoding, transcoding

E.G. DATE (YEAR, MONTH, DAY) = DD.MM.YYYY

GRAPHICAL INFORMATION

2D/3D geometry
Colors
Motion

EXAMPLES OF CODED INFO

JPEG
PDF
DVD
FLASH

STANDARDS
ANSI
ISO

IMAGE COMPRESSION

RLE (RUN-LENGTH ENCODING)

AAAAAAABBBBCCCCCC = 7A4B6C (35%) ☺
ABCBABCBABCB = 1A1B1C....1C1B (200%) ☹

DICTIONARY

ABCBABCB**ABCB** = 3#Q; #Q = ABCB (25%)

LZW (GIF), HUFFMAN CODE, DEFLATE (PNG)

LOSSLESS COMPRESSION

LOSSY IMAGE COMPRESSION: DCT IN JPEG

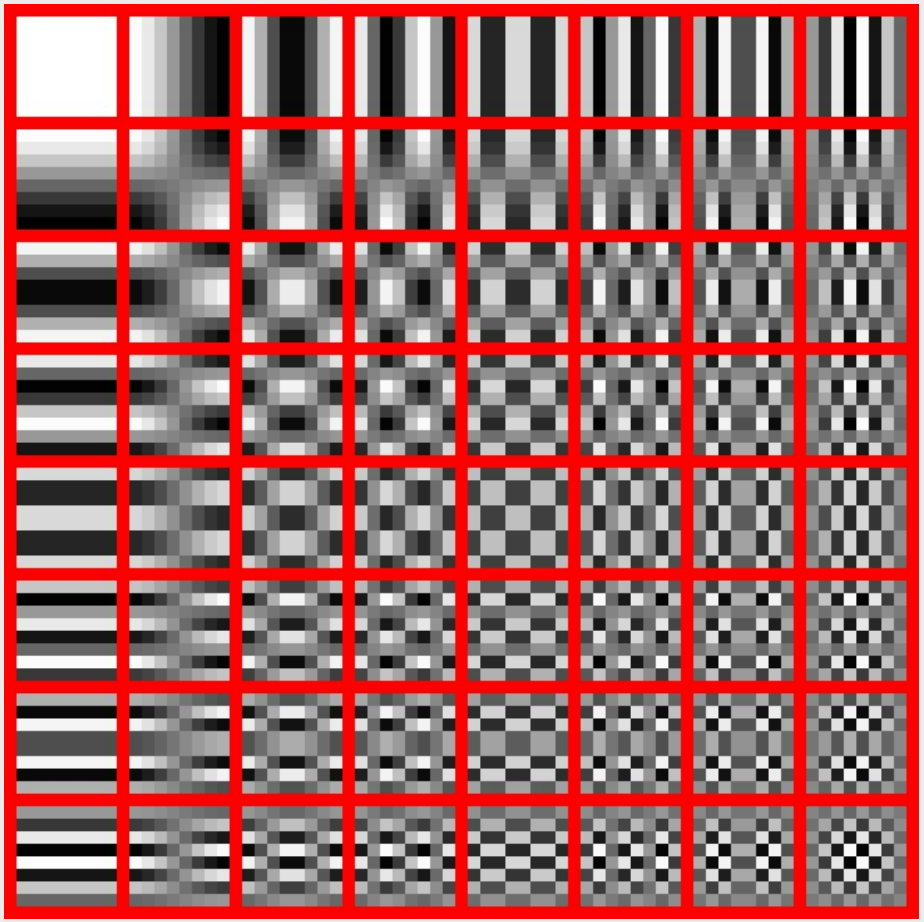
Every 8x8pixel block is decomposed to a combination basic blocks.

Some blocks are discarded = Less data

PICTURE QUALITY

Variable

More discarded block = less data = lower quality



JPEG LOSSY COMPRESSION

CONTROL HOW MANY BASIS FUNCTIONS WILL CONTRIBUTE TO THE FINAL RESULT

Quality

Artifacts

a. Original image

b. With 10:1 compression

c. With 45:1 compression

FIGURE 27-15
Example of JPEG distortion. Figure (a) shows the original image, while (b) and (c) shows restored images using compression ratios of 10:1 and 45:1, respectively. The high compression ratio used in (c) results in each 8×8 pixel group being represented by less than 12 bits.

LOSSLESS VS. LOSSY

LOSSLESS

Decompress = reconstruct
Worse compression ratio
Safe

LOSSY

Decompress = approximate
Better compression ratio
Destructive
Artifacts

IMAGE FORMATS USAGE

GIF

8bit + animation + 1 bit transparency

PNG

lossless, uniform areas, up to 64bit, no animation,
8bit transparency, no CMYK

JPEG

lossy, photographic areas, also CMYK, no transparency

PDF

universal

VECTOR IMAGES

BITMAP VS. VECTOR GRAPHICS

BITMAPS

Ugly scaling
Perfect for realistic pictures

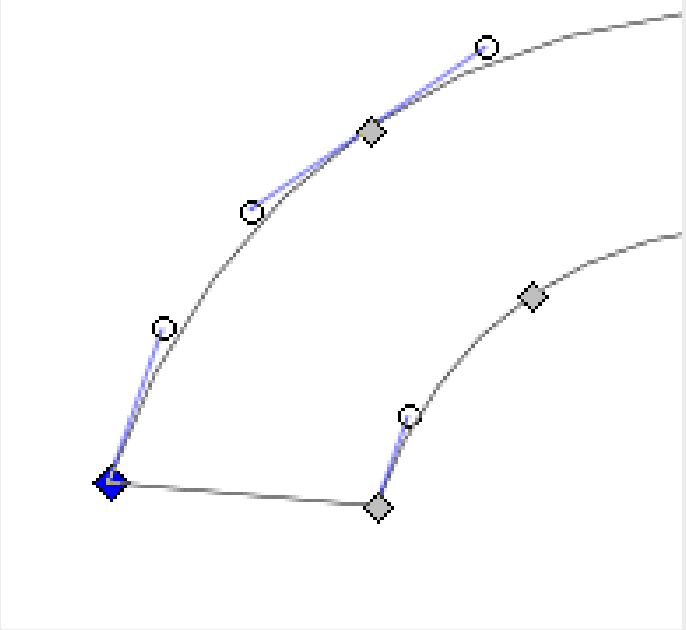
SHAPES

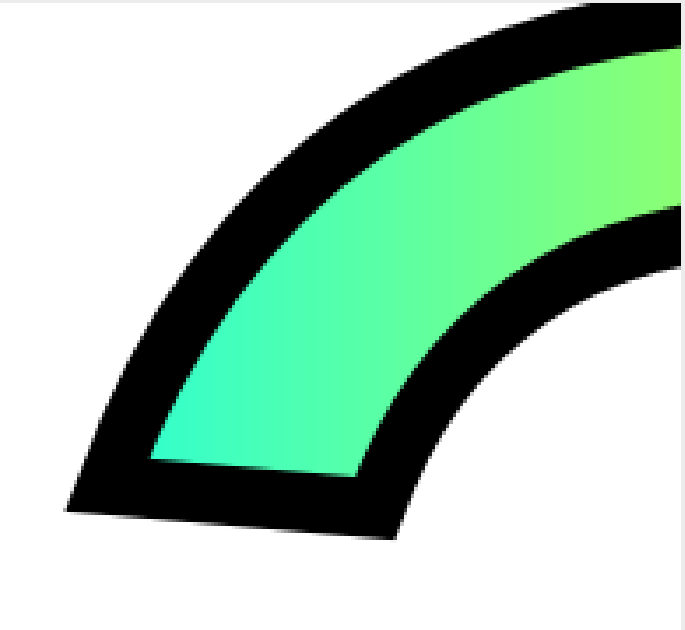
Perfect scaling
Perfect for symbols, logos
Bad with realistic pictures
Parametric = editable
Small size for simple objects

VECTOR GRAPHICS

PARAMETRIC OR POLYGONAL REPRESENTATION IN 2D

SVG, EPS, PS, AI, CDR, PDF, WMF, EMF





SCALABLE VECTOR GRAPHICS (SVG)

2D GRAPHICS + ANIMATIONS IN XML

DEVELOPED BY W3C

OPEN, FREE

NICE FOR DYNAMIC VISUALIZATIONS

HTTP://WWW.W3.ORG/GRAPHICS/SVG/

RUNS IN WEB BROWSERS

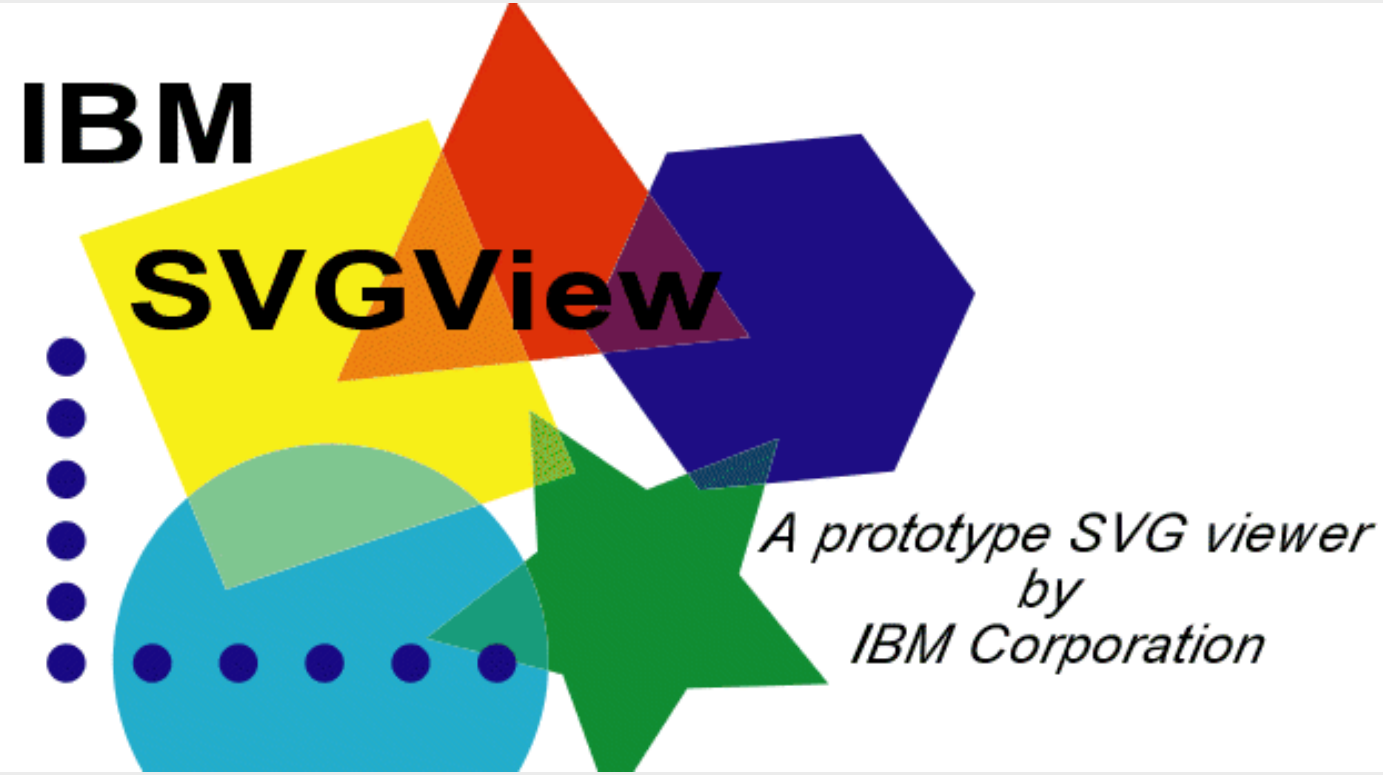
BASIC OBJECTS

SHAPES

Curves, lines, geom. objects

IMAGES

TEXT



SHAPES AND TEXTS

SHAPES

Fill
Stroke
Markers

TEXT

Glyphs (font)
Unicode text

EXAMPLE ELEMENTS - POLYGON

```
<POLYGON
      FILL="LIME"
      STROKE="BLUE"
      STROKE-WIDTH="10"
      POINTS="  850,75
                958,137.5
                958,262.5
                850,325
                742,262.6 742,137.5"
/>
```

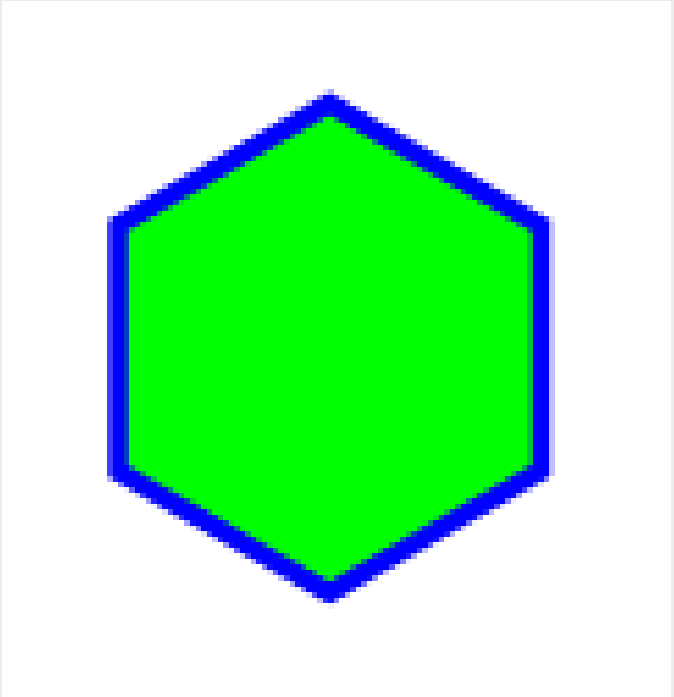


IMAGE FORMATS USAGE

SVG
In-browser, universal, free, standardized, HTML5

EPS
Compatibility issues,

AI, CDR
Proprietary

PDF
universal

DIGITAL VIDEOS

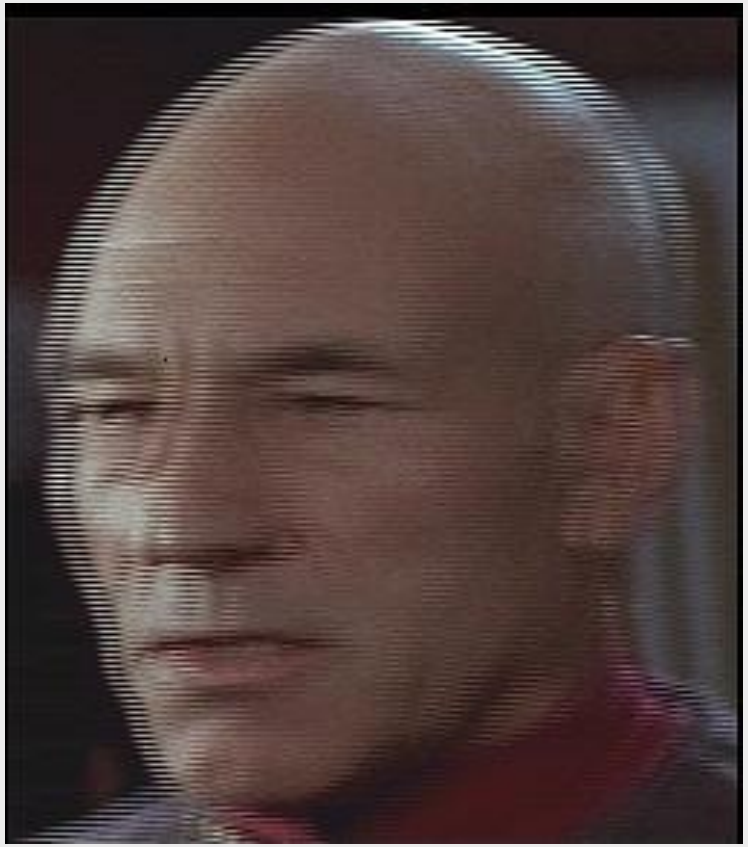
MOVING PICTURES

FRAMERATE

INTERLACED OR PROGRESSIVE

INHERITANCE FROM ANALOG ERA
NTSC, PAL, interlacing

YUV, YCBCR COLOR SPACES



STANDARDS IN DIGITAL AGE

NTSC (USA, EAST ASIA, 30FPS)
PAL (EUROPE, AFRICA, 25FPS)
remnants of the analog era

HDTV (1280X720, 1920X1080)
24fps, 25fps, 30fps...

4K2K (3840 X 2160)
digital (3D) cinema

8K2K (7680X4320P)

YCBCR, YUV & COMPANY

SEPARATION OF LUMA & CHROMA

LUMINANCE =

Y= 0.2126 R +
0.7152 G +
0.0722 B

CB = LUMINANCE - B

CR = LUMINANCE - R

JPEGS

MOVIE FORMATS

YOU TELL ME ☺

AVI, MPEG, MOV, MPEG2, MPEG4, X264, XVID, DIVX;-), H.263, AVC,FLV, 3GP, TS, DV ...

CONTAINER VS. CODEC

FILE FORMAT VS. VIDEO FORMAT

STREAMING - YES / NO

BANDWIDTH

MOVIE COMPRESSION

INTRA-FRAME COMPRESSION

Every frame can be compressed just like any other image

INTER-FRAME COMPRESSION

Keyframes + delta frames
I, P, B
Object tracking
Motion estimation

MPEG AND ITS OFFSPRINGS

INTER-FRAME COMPRESSION

VIDEO CONTAINERS PROPERTIES

STREAMING
(e.g. AVI = no, MP4 = yes)

SUPPORT FOR LOSSLESS CODECS
(e.g. AVI = yes, MP4 = little)

NUMBER OF TRACKS
(1 video + 1 audio, 1 video + multi audio, + subtitles)

COMPATIBILITY
(e.g. MOV vs. Windows, AVI vs. OSx)

SUMMARY

IMAGES

Vector graphics, raster graphics
Color models, color spaces
Compression (lossless, lossy)
Formats

VIDEOS

Containers and codecs
Video compression
Formats