Raster Images

- 2-dimensional representation: grid
- smallest element: pixel

- each pixel has a color value
- color depth: number of bits per color

- file size: width x height x depth

Indexed Color

- assign a number to each color
- 1 bit per pixel: 2 colors
- black & white:
  - 0 → black
  - 1 → white

Color Palettes

- 1 byte per pixel: 256 colors
- custom palette:
  - 0 → black
  - 1 → red
  - …
  - 120 → blue
  - 121 → purple
  - …
  - 255 → white

Direct Encoding

- 1 byte per pixel: 256 colors
- monochrome: shades of one color

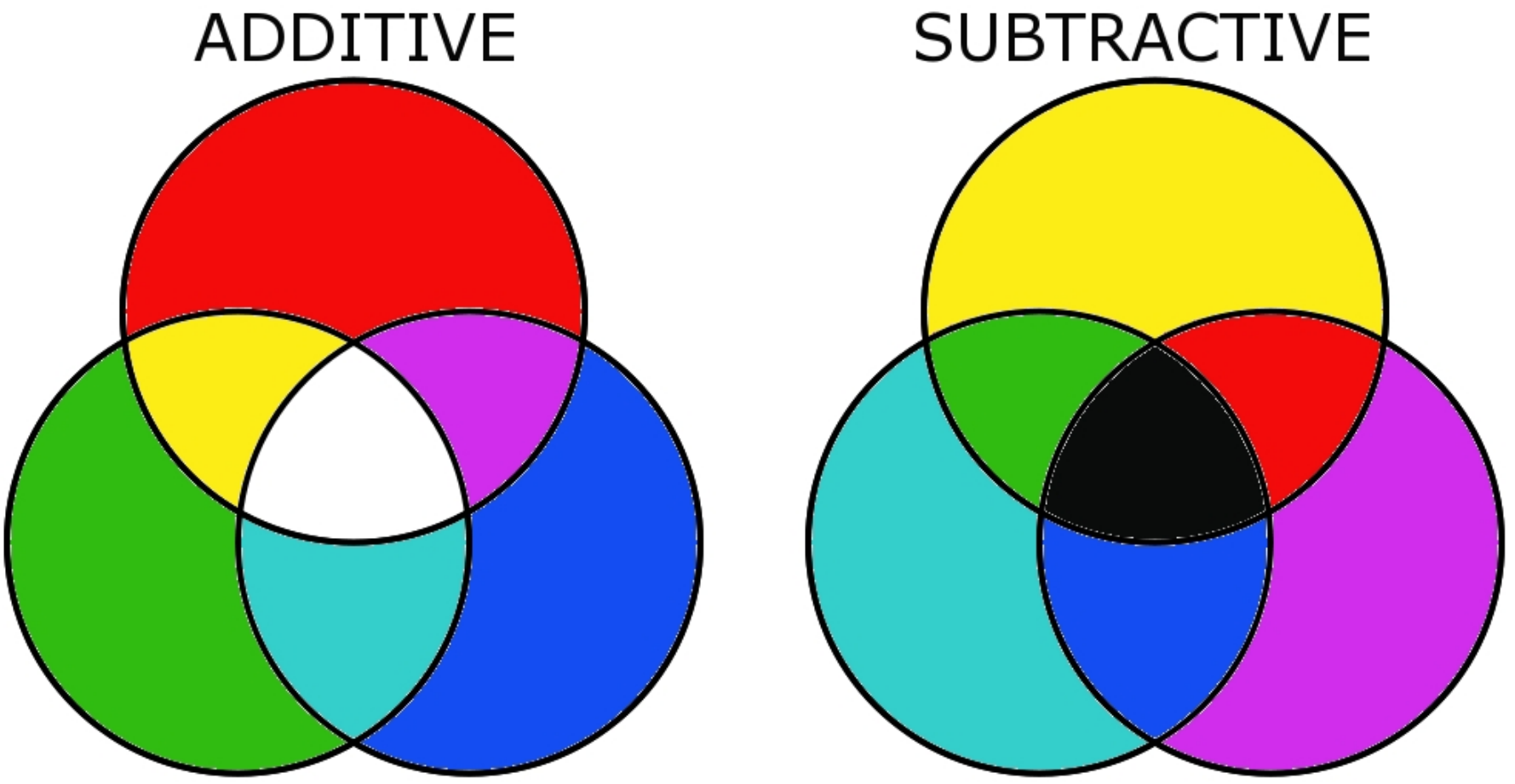
- grayscale:
  - 0 → black
  - 255 → white
  - anything in between → shade of gray

RGB

- mixture of 3 components: RGB
- Red, Green, Blue

- 1 byte per component: $3 \times 8 = 24$ bits
- 16.7 million colors

Additive vs Subtractive Color



Additive Color

- additive color scheme
- based on transmitted light

- how monitors and projectors work

RGB Examples

- hex representation: `RRGGBB`

RGB	hex	color
`(  0,   0,   0)`	`000000`	black
`(255, 255, 255)`	`FFFFFF`	white
`(255,   0,   0)`	`FF0000`	red
`(  0,  64,   0)`	`004000`	dark green
`(255, 255,   0)`	`FFFF00`	yellow

CMYK

- CMYK: Cyan, Magenta, Yellow, Key Black

- subtractive color scheme
- based on reflected light

- how printers work

Resolution

- what is the size of a pixel?
- resolution: number of pixels per unit length

- ppi: pixels per inch
- also called dpi: dots per inch

- monitors have fixed resolution (~70ppi)
- resolution is important when printing (≥300ppi)

Resolution and Size

- same width and height:

- higher resolution → smaller pixels
- lower resolution → larger pixels

Raster Formats

- BMP: header + color values
- grayscale / RGB

- GIF: indexed
- 256 colors

Compressed Formats

- use compression to get smaller file size
- e.g. run-length encoding (RLE)

- lossless: possible to get back to original data
- lossy: not possible to get back to original data

- PNG: versatile, compressed, lossless
- JPG: photolike compression, lossy

Common Raster Operations

- scale
- resize
- flip
- rotate
- crop
- filters: blur/sharpen, edge detect, lens flare, …

Advanced Raster Operations

- brushes (opacity, size, shape)
- color picking (background & foreground)
- selection (square, all, fuzzy, freehand, grow, shrink)
- layers, transparency

Raster vs Vector

	raster	vector
primitive element	pixel	path, shape
good for	photorealism	drawings
bad for	scaling	detail
typical format	BMP, PNG, JPG	SVG, PDF
example software	GIMP, Photoshop	Inkscape, CorelDraw

Raster vs. Vector

https://openclipart.org/detail/219677/world-flags-globe

Vector Image Primitives

- shapes (“objects”)
- paths

Advanced Vector Operations

- stroke & fill
- transform
- align & distribute
- path set operations
- text on path
- converting: vector ↔ raster