02-on-images

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1 We need to talk about images

1.1 Images are numbers organized in a grid

• Image is composed of pixels:

1.2 Number representations

- 1 bit: 0 or 1 (False or True) aka boolean
- 8 bit integer
- signed: -128 to 127 aka int8
- unsigned: 0 to 255 aka uint8
- 16 bit inger
- signed: -32768 to 32767 aka int16
- unsigned: 0 to 65535 aka uint16

1.3 Coordinate system

1.3.1 Image = Table

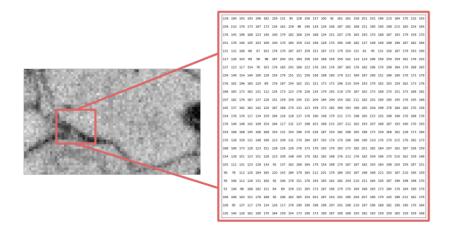
- numbers are organized in a grid
- like a table an image has rows and columns
- row and column indices start at 0
- origin is in the **top-left** corner

(puppy photo by Joe Caione on Unsplash)

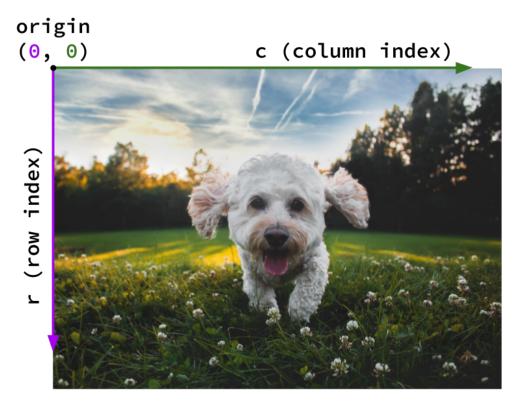
1.3.2 What about x and y (and z)?

- using x and y to specify positions is very common, too (e.g. have a look at fiji).
- We'll use r and c throughout this course
- r corresponds to 'y"
- c corresponds to x

BEWARE: coordinates in x-y form are usually given in (x, y) order. In r-c coordinates, we use the (r, c) order.



Images and Numbers



coordinates

1.4 Image Channels

- more than just a single value per pixel
- -> multiple images stacked on top of each other
- e.g. from multiple flurophores
- also from different modalities after alignment
- can be presented/viewed as different colors

1.4.1 RGB as a special case

- additive color model where colors are composed of primary colors red, green and blue
- each primary color stored in a separate channel, so 3 values per pixels are stored
- each value can be in the range of [0..255]
- software for viewing recognizes this and interprets the triplets to generate a color mixture

1.4.2 Exercise: Thinking about RGB colors

Suppose that we represent colors as triples (r, g, b), where each of r, g, and b is an integer in [0, 255]. What colors are represented by each of these triples?

- 1. (255, 0, 0)
- 2. (0, 255, 0)
- 3. (0, 0, 255)
- 4. (255, 255, 255)
- 5. (0, 0, 0)
- 6. (128, 128, 128)

1.5 Compression

1.5.1 Lossless Compression

- Algorithm that reorganizes the data in a more efficient way when saving
- When loading the image, the reverse of the algorithm has to be applied
- Reversing the compression process results in a file that is *identical* to the original

1.5.2 Lossy Compression

- Algorithm that throws away some detail of the data when saving
- Level of detail that is discared can be adjusted
- Original image can never be reconstructed again

1.6 Image formats

1.6.1 Components of an image file

- image data (numbers)
- uncompressed/compressed
- dimensions
- data-type (optional)

- meta-data (optional)
- pixel size (physical)
- channel names
- calibration
- software-specific values
- ...

1.7 Image formats summary

	Format	Compression	n Metadata <i>A</i>	Advantages	Disadvantages	
TIFF	None, lossy, or lossless	Yes	High quality or smaller file size		ot universally viewa ooo many flavors	able
PNG	lossless	yes	Universally viewhigh quality	wable, La	arge file sizes for nat	tural images
JPEG	Lossy	Yes	Universally viewsmaller file size		etail may be lost	

- TIFF: Tagged Image File Format
- PNG: Portable Network Graphics
- JPEG: Joint Photographic Experts Group