

# Image and Video Analysis in R

Code workshop

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**Coding Outreach for Data Education  
(CODE)  
Workshop**



# Image and Video Analysis in R

Open Science Framework location:

<https://osf.io/k93zv/>

## Course outline

Part 1: Basics of images

Part 2: Working with images in R

Part3: Working with video in R



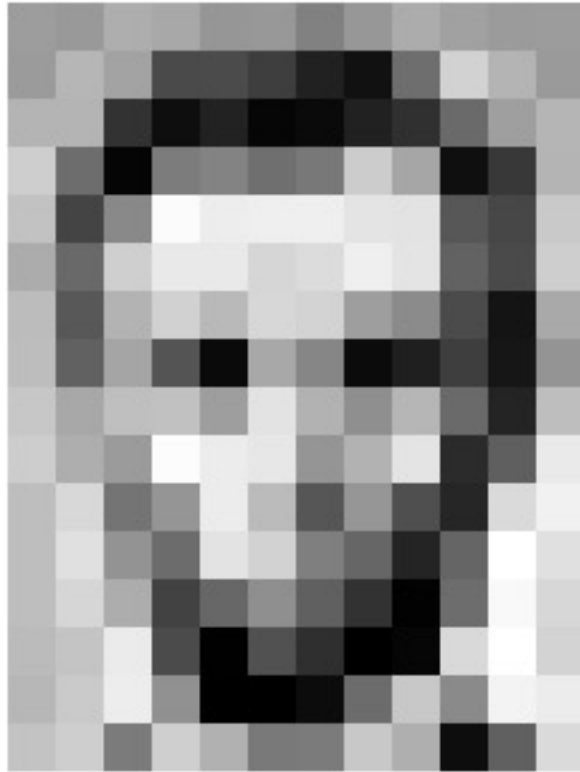
# Image and Video Analysis in R

## Participant Requirements

- A computer running the latest versions of R and R Studio with the following packages installed.
- Rvision (requires several steps to install)



# Intro to images

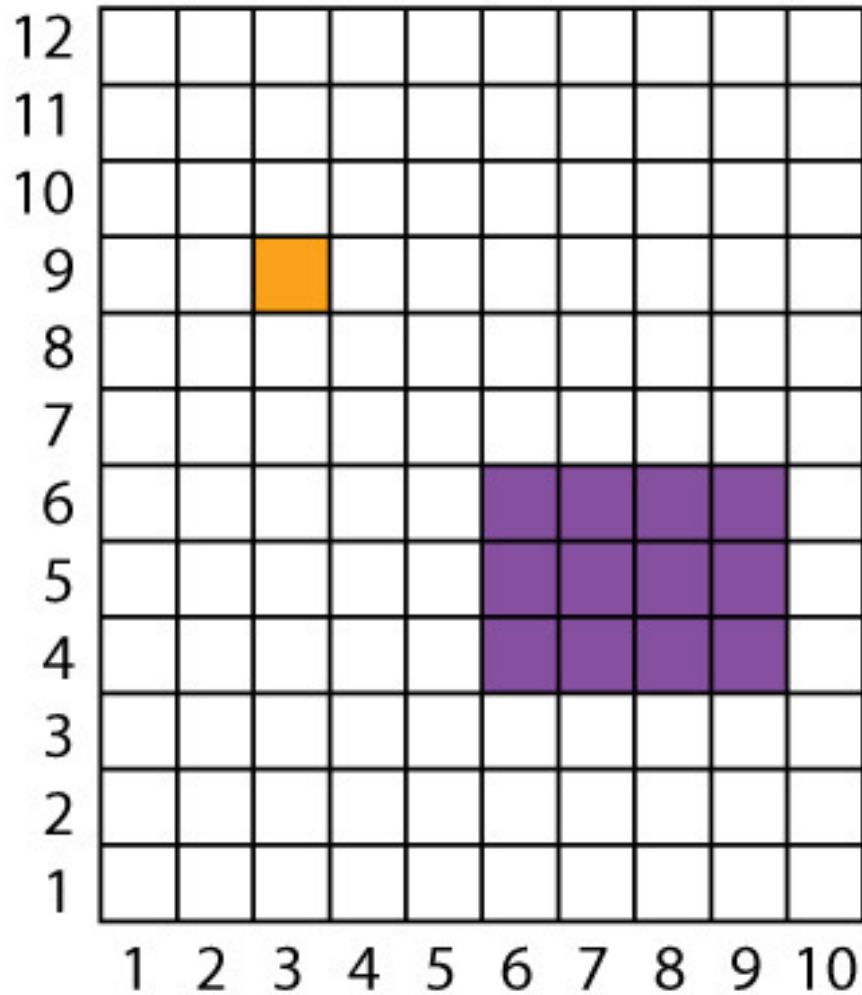


157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	85	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

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Digital images are a grid of numbers (usually bytes ranging from 0 to 255).  
In a grayscale image the numbers represent intensity of brightness (0 = black and 255 = white)

# Intro to images



in Rvision, pixels are numbered from bottom to top and from left to right, starting with 1. The y coordinate usually comes first

Orange pixel  
 $y=9, x=3; (9,3)$

Purple range  
 $y=4:6, x=6:9; (4:6, 6,9)$

# Intro to images

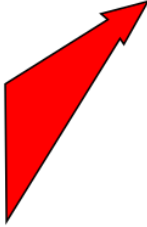
A color image has three layers that are combined (stacked) to generate virtually any color humans can discern

Often the layers represent Red, Green, and Blue, which gives us an RGB image.

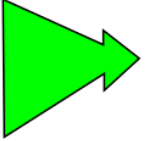
Black = R:0, G:0, B:0

White = R:255, G:255, B:255

#642b4e R: 100 G: 43 B: 78	#7b4360 R: 123 G: 67 B: 96	#936073 R: 147 G: 96 B: 115
#7a4360 R: 122 G: 67 B: 96	#a1727a R: 161 G: 114 B: 122	#c89c8f R: 200 G: 156 B: 143
#945f71 R: 148 G: 95 B: 113	#ca9b91 R: 202 G: 155 B: 145	#f6d0ac R: 246 G: 208 B: 172



100	123	147
122	161	200
148	202	246



43	67	96
67	114	156
95	155	208



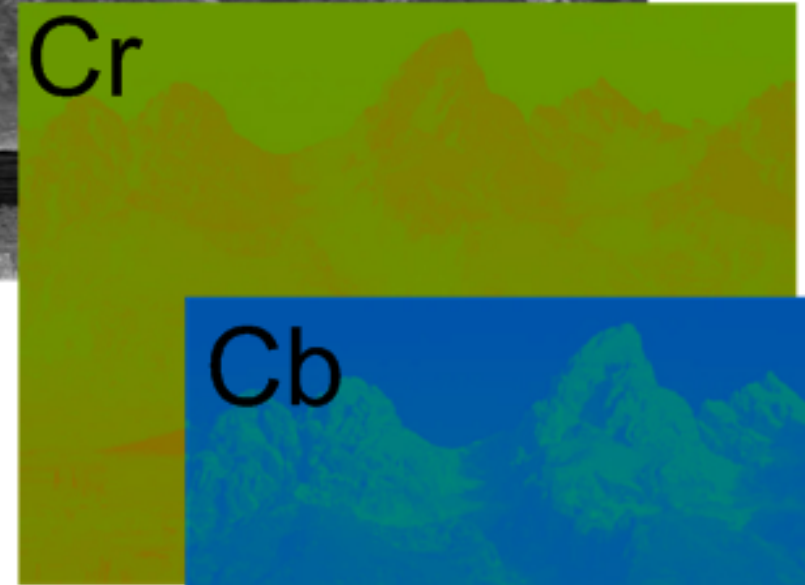
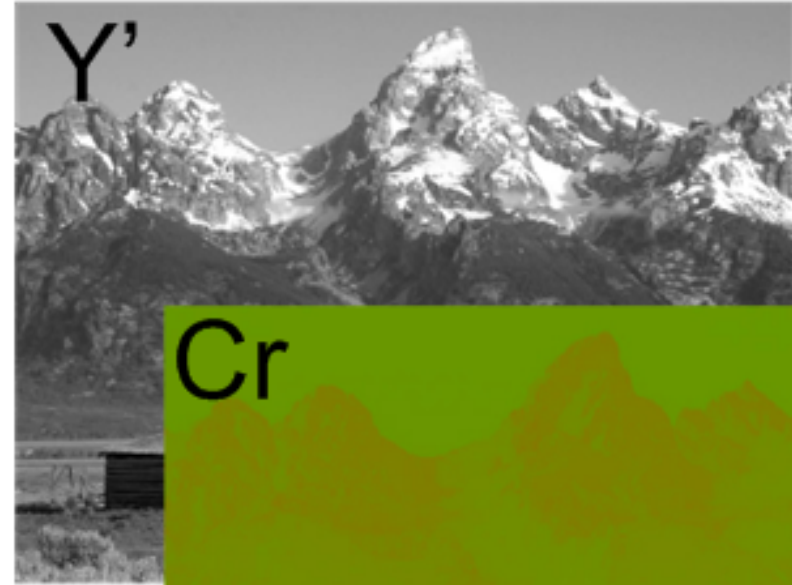
78	96	115
96	122	143
113	145	172



# Intro to images



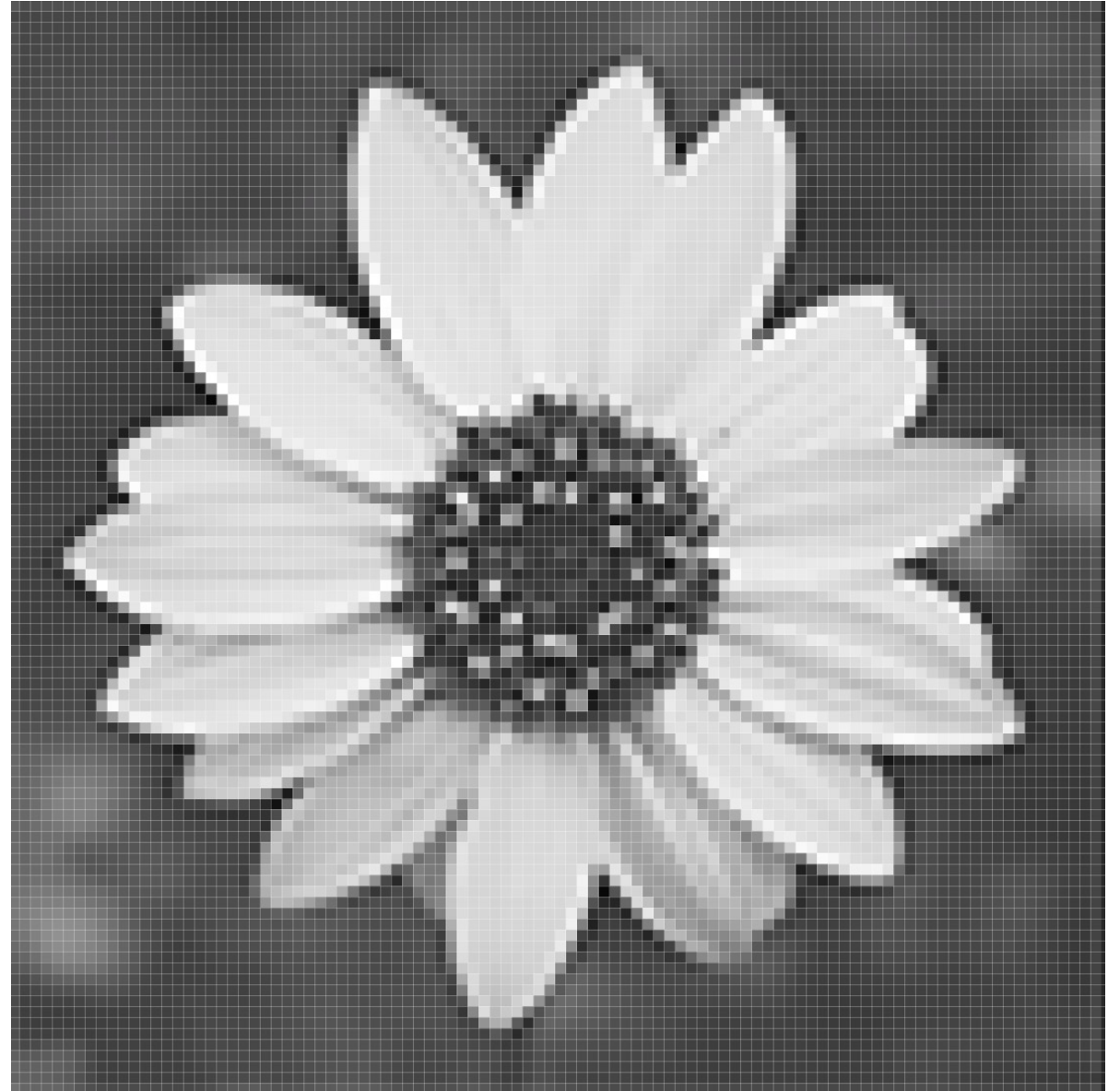
to  
 $Y'CrCb$   
→



Color Image layers can also be represented as brightness (grayscale), relative blueness, and relative redness (green is extrapolated). This method gives us a YCrCb image.

# Intro to images

- 100 x100 pixel grayscale image = 10,000 pixels.
- But when stored as a jpeg it only takes up about 5kB of memory or ~5000 bytes.
- How is this possible?





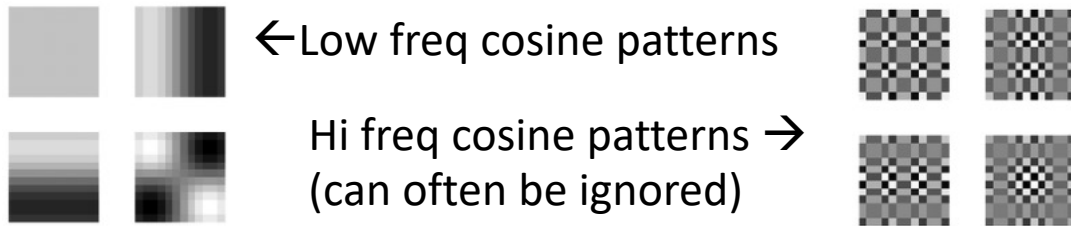
# Intro to images

## IMAGE COMPRESSION!!!

Jpegs are compressed in 3 ways:

**Chrominance Subsampling (color images only)** – converts to YCrCb and reduces resolution of color information.

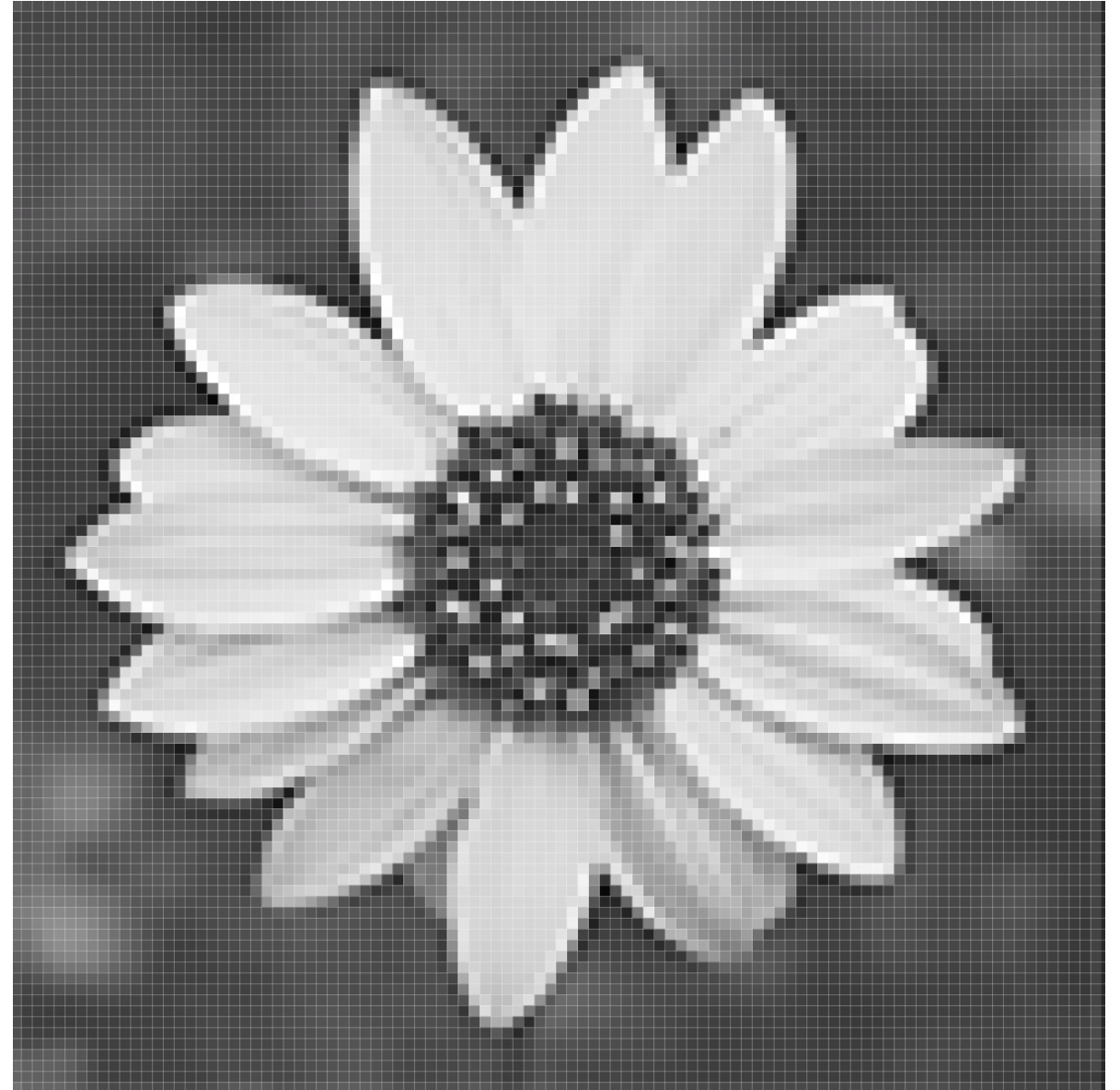
**Discrete Cosine Transformation** – Represents each 8x8 panel of pixels as cosine frequency coefficients that can represent any possible luminance or chromatic pattern.



**Delta Compression** – saves space by recoding repeated numbers and sequences  
(e.g. 4 4 4 5 5 5 5 3 3 3 3 3 3 -> 4 3 5 4 3 6)

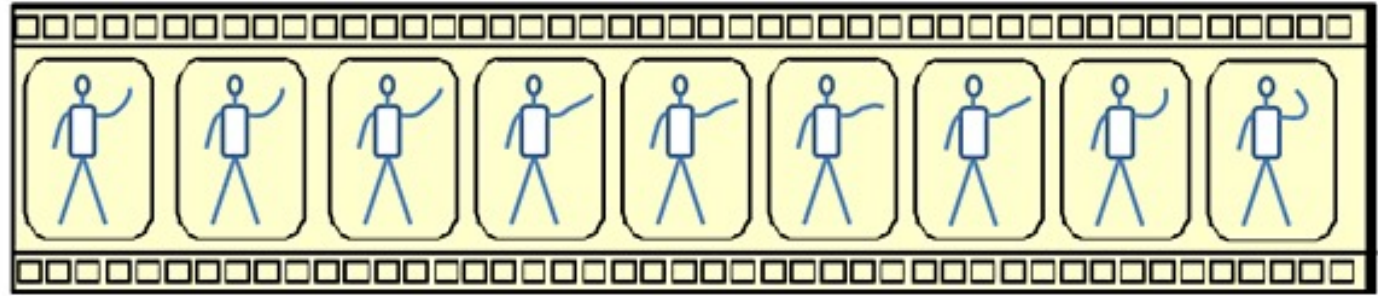
[Unraveling the JPEG](https://parametric.press/issue-01/unraveling-the-jpeg/)

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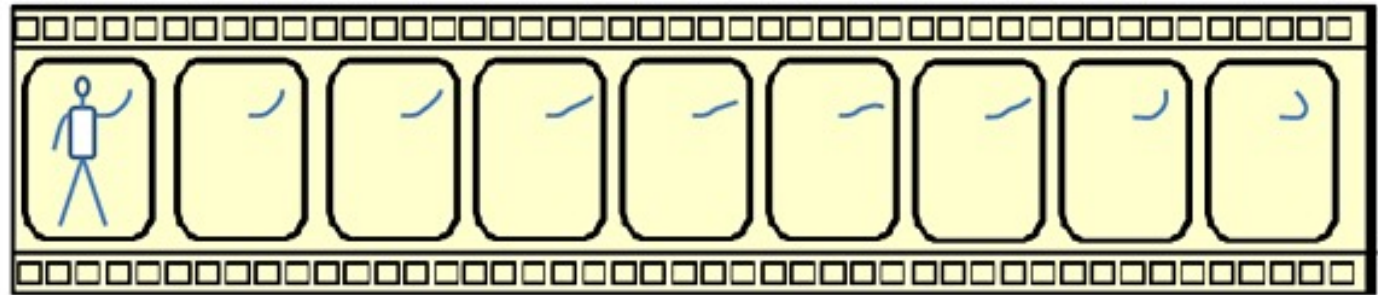


# Intro to Video

- Video is just a sequence of individual images (frames).
- Video frames can be compressed in the same way single images can be compressed.
- Video can also be compressed through time. In particular, If the background of an image is static, those pixels only need to be encoded once every few frames.
- Keyframes are reference frames where all pixels are updated.
- Codecs are the different compression and decompression schemes for video



**Intraframe compression**  
Every frame is encoded individually



**Interframe compression**  
Only the differences between frames are encoded  
for each group of frames