



ML Session - 2

Jaswanth Reddy K

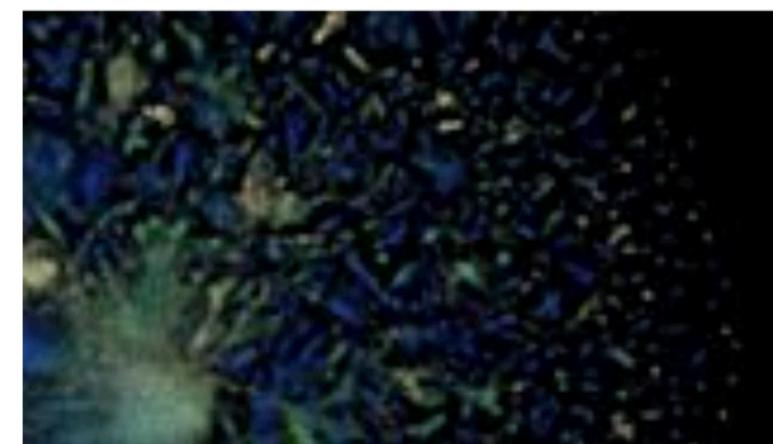
Coordinated by Dr. G Mamatha, SDIC

Assignment 1 : Survey

- OpenAI
- Tesla
- Meta - Facebook
- Deepmind
- SpaceX
- Netflix
- Amazon Cloud Services, Google Cloud Platform, Microsoft Azure
- Disney AI/ML Research
- Alexa

Recent ML Advancements

- Machine Learning and Artificial Intelligence are daily headlines.



Perceptron: AI that sees with sound, learns to walk and predicts seismic physics

Research in the field of machine learning and AI, now a key technology in practically every industry...



Perceptron: AI saving whales, steadyng gaits and banishing traffic

Research in the field of machine learning and AI, now a key technology in practically every industry...



Will Robots Save The Future Of Work?

Alastair Bathgate is CEO of robotic process



Salesforce researchers are working on an AI economist for more equitable tax policy

tax policy is surely a complex beast, and depending on your political leanings, you probably have...

By Ron Miller | April 29, 2020



Microsoft and Nvidia team up to build new Azure-hosted AI supercomputer

Roughly two years ago, Microsoft announced a partnership with OpenAI, the AI lab with which it has a...

By Kyle Wiggers | November 16, 2022

Recent ML Advancements :

Text generation

⚡ Text Generation demo
using [gpt2](#)

Text Generation

My name is Lewis and I am|

Compute ⌘+Enter

Computation time on cpu: 0.099 s

⟨/⟩ JSON Output

Examples ▾

Maximize

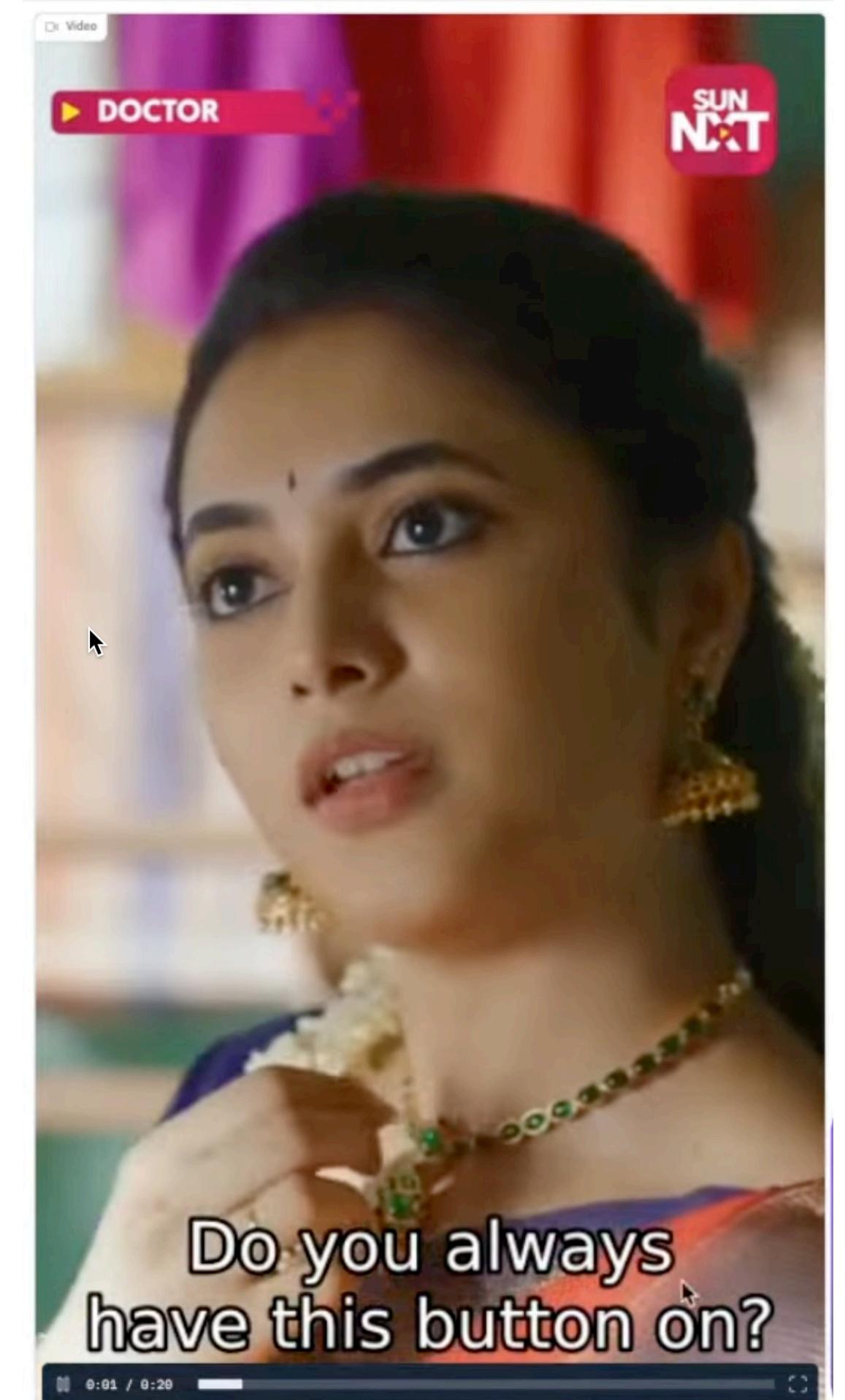
0.3

Image generation



Prompt : [John Snow sitting on the iron throne](#)

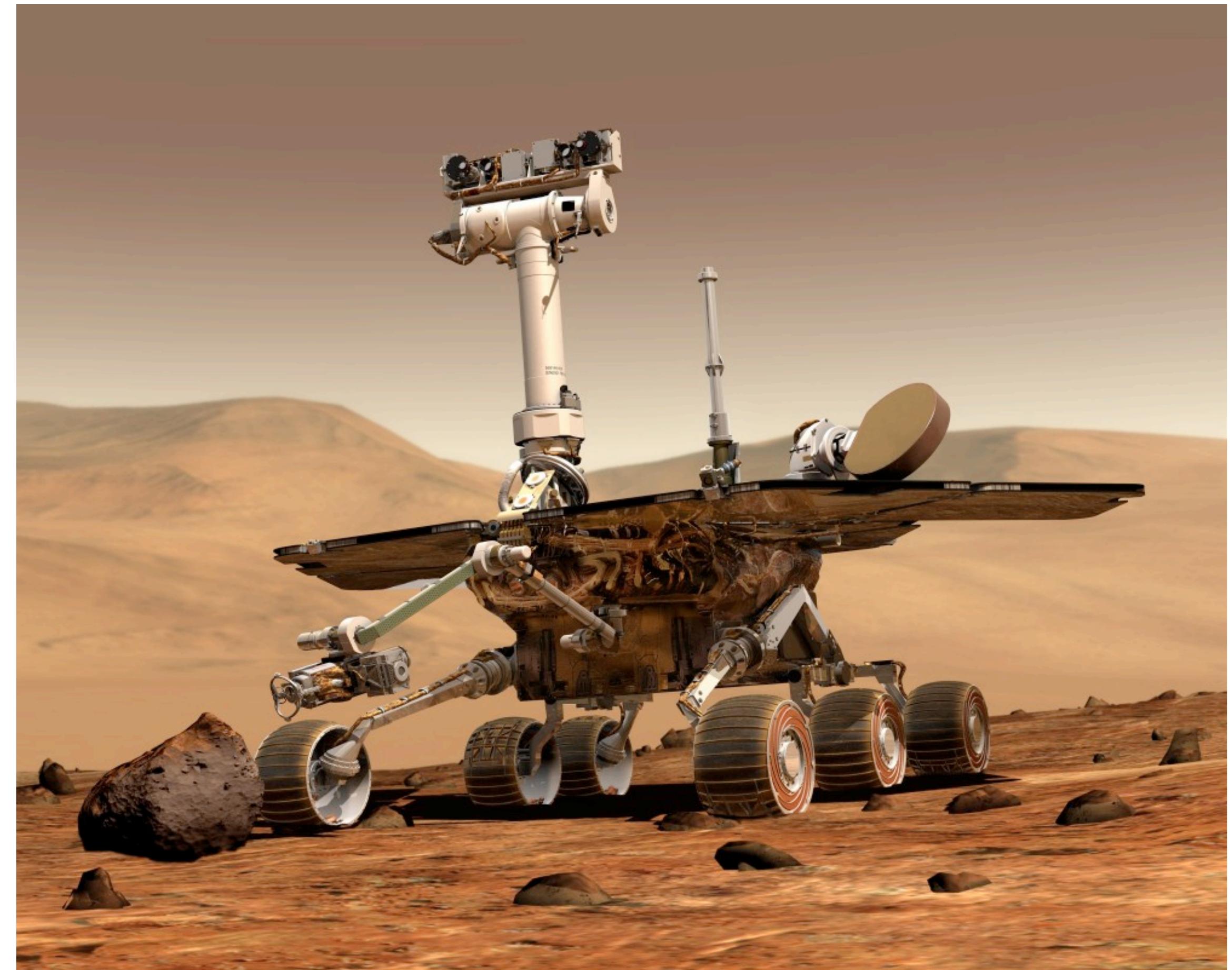
Audio Transcripts



Source : <https://github.com/amrrs/subtitle-embedded-video-generator>

Why are these important to you?

- All these advancements affect the market
- They affect the jobs available
- This is very similar to industrial revolution
- The academic curriculum is getting outdated
- And, most importantly
- To maintain your curiosity
- And use it in a beneficial direction



Practical

- Scripting language
- Object Oriented Programming
- Python
- Machine Learning libraries
- Deep Learning libraries
- Jupyter Notebooks for EDA
- Kaggle competitions
- Research projects

Theory

- Maths
 - Linear Algebra
 - Optimization Theory
- Probability
- Random Variables
- Moments
- Signal Processing
- Machine Learning Algorithms
- Research papers

Signals and Systems

- Signal is a disturbance in a medium (looks like “wave” definition).
- Ex : Images, Audio, Text, Video, Taste, smell
- Systems process signals, and produce new signals.



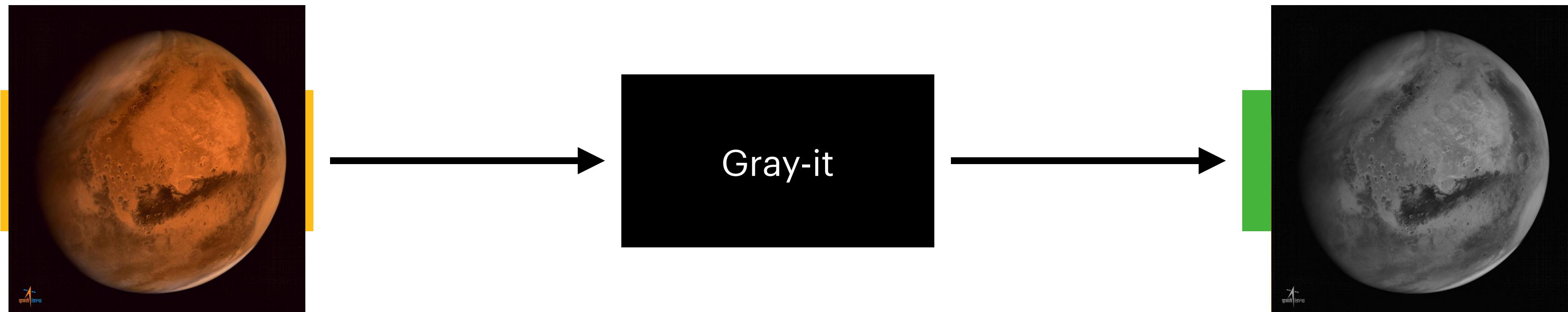
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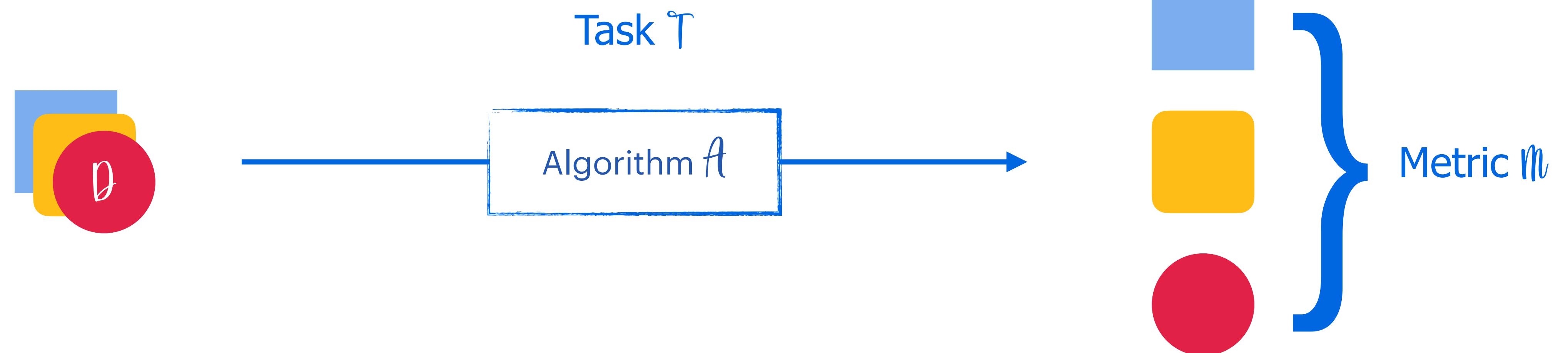
Signals and Systems

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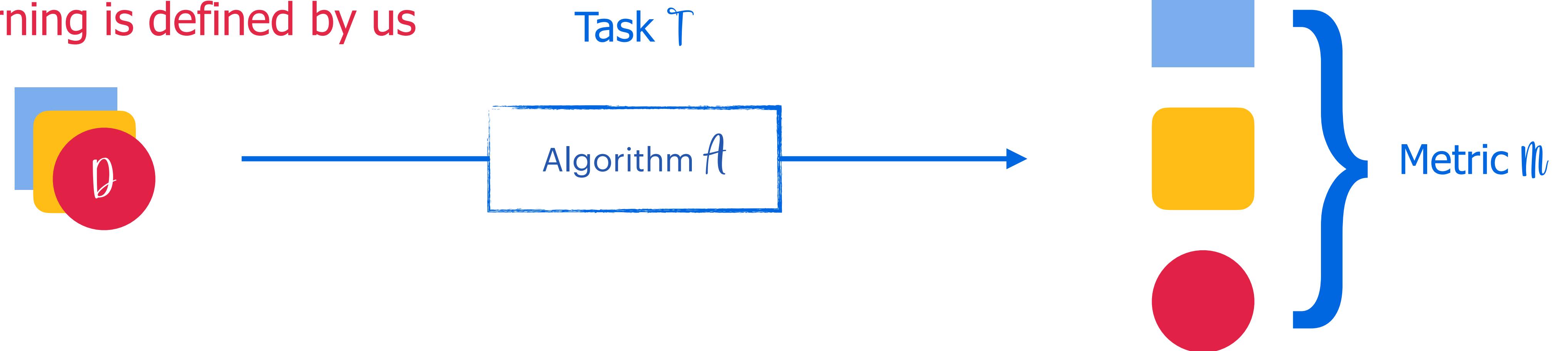
Signal Processing

- Data D
- Task T
- Metric M
- Algorithm \mathcal{A}
- Specified by us



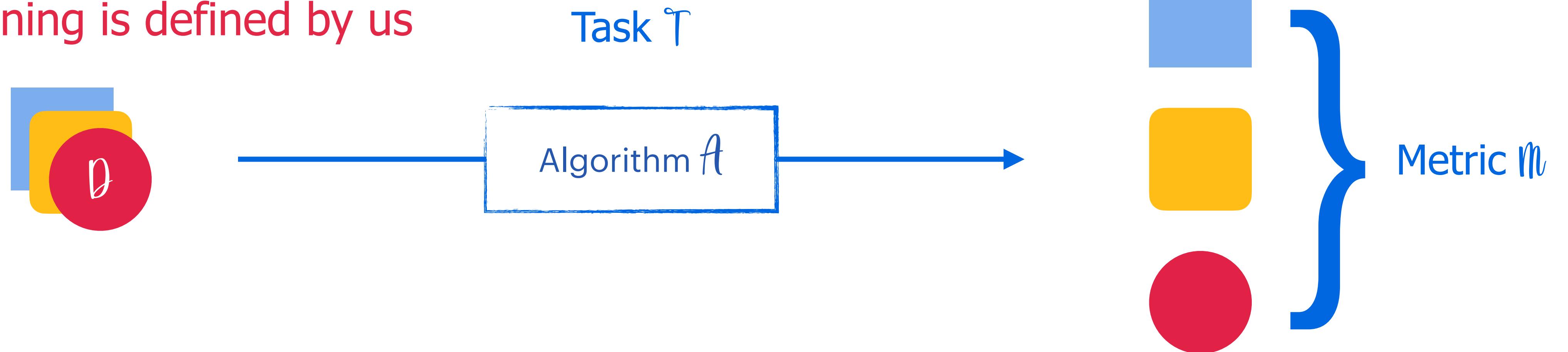
Signal Processing

- Data D
- Task T
- Metric M
- Algorithm f
 - Learnt by Machine
 - The learning is defined by us



Machine Learning

- Data D
- Task T
- Metric M
- Algorithm \hat{A}
 - Learnt by Machine
 - The learning is defined by us

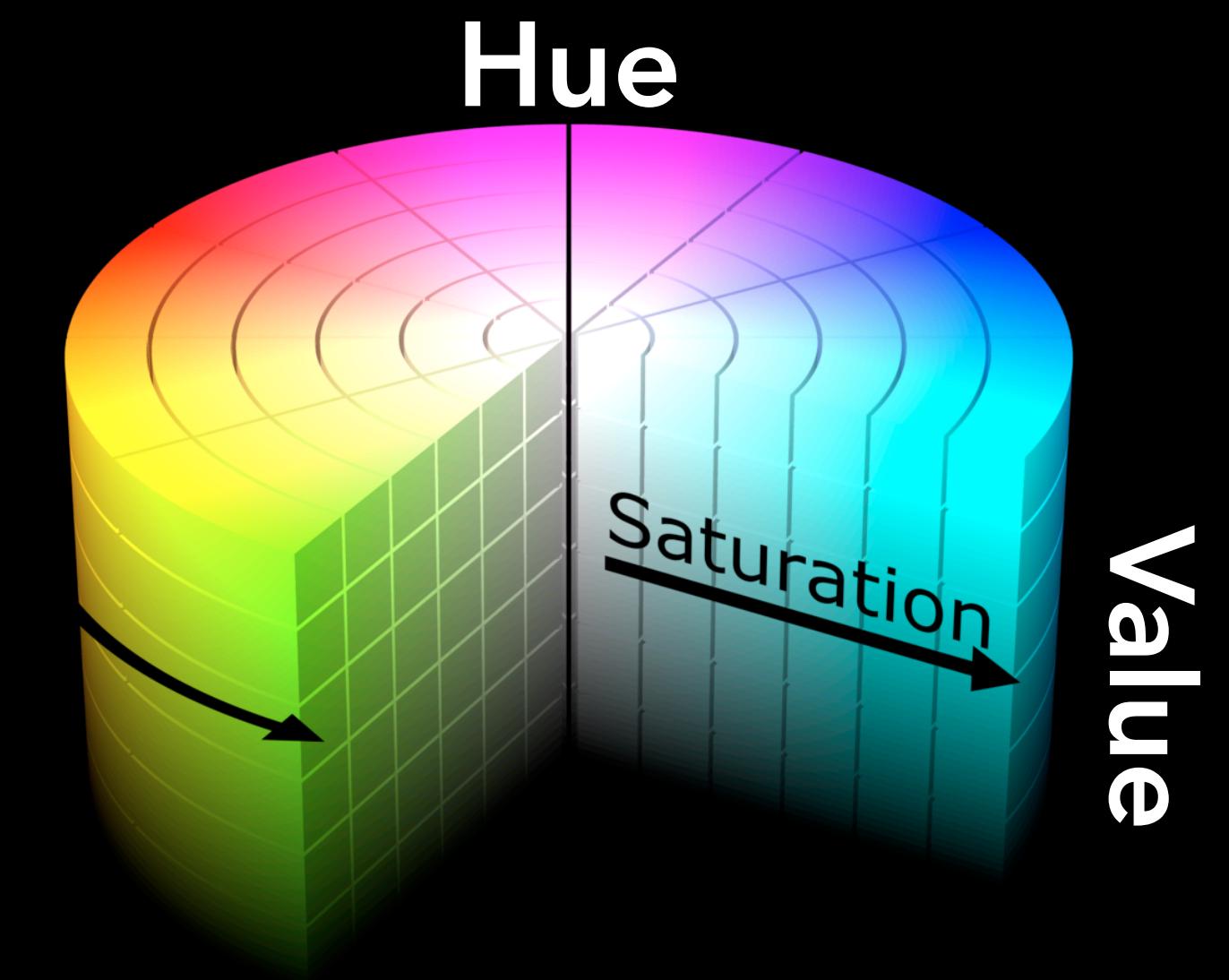
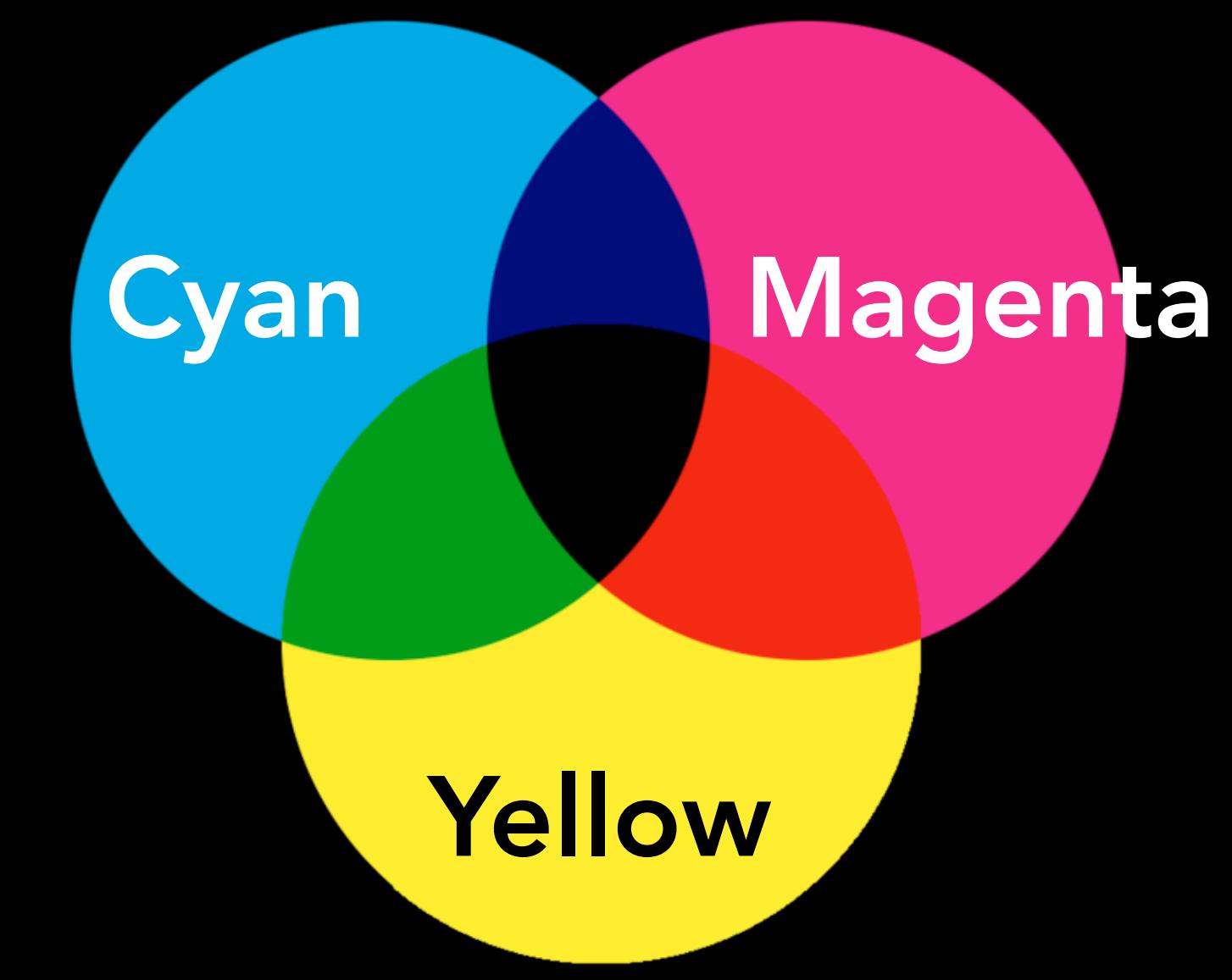
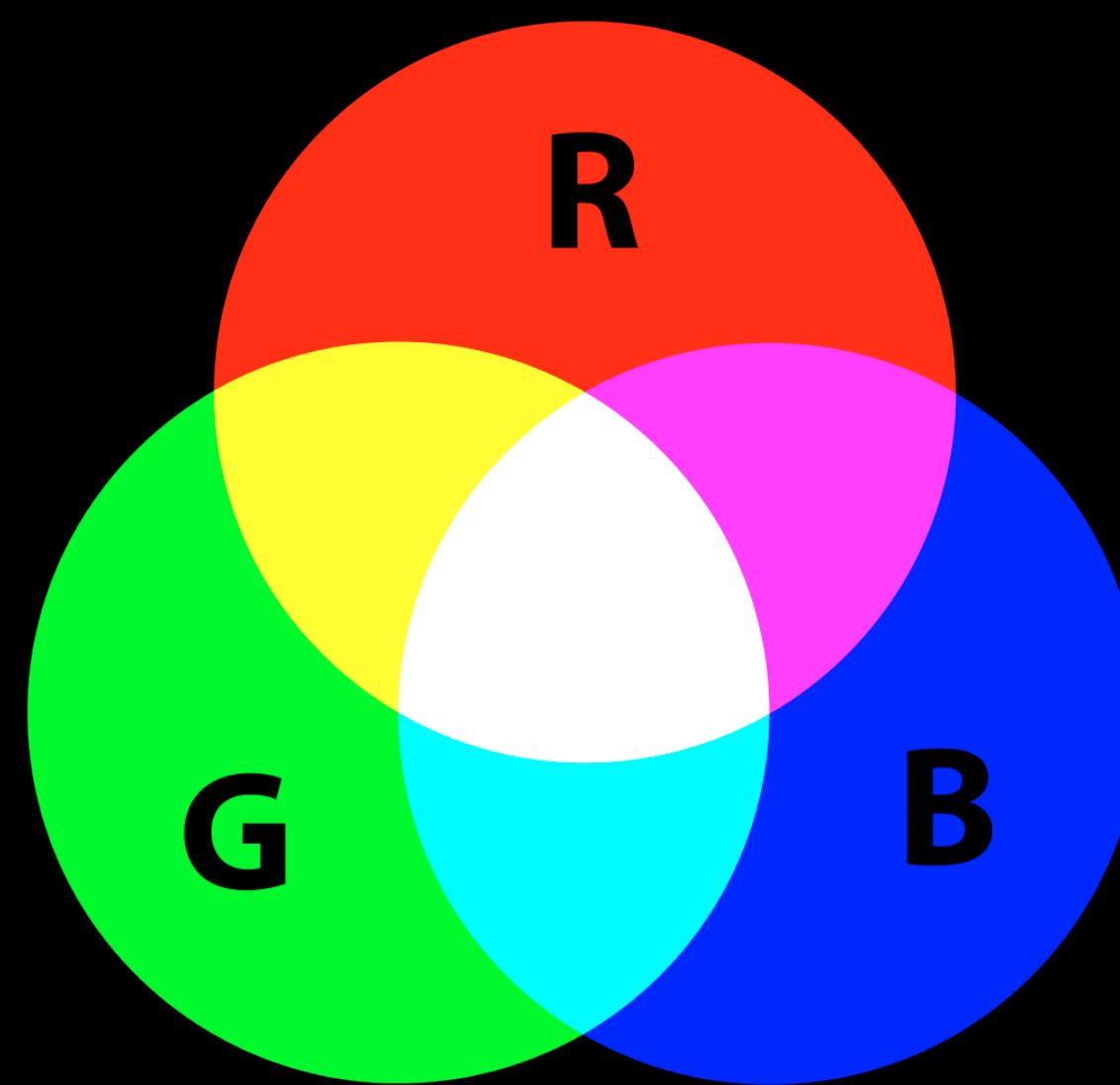


One Image System : Histogram

- Histogram gives us information about an image.
- It counts the occurrence of values.
- To understand it properly, we need to first define few things :
 - Image
 - Intensity values
 - occurrence
- Image :
 - Digital Image

Histogram : Digital Image

- Digital Formats
- File Formats : JPEG, PNG, TIFF, PDF, EPS
- Color spaces : RGB, CMYK, HSV

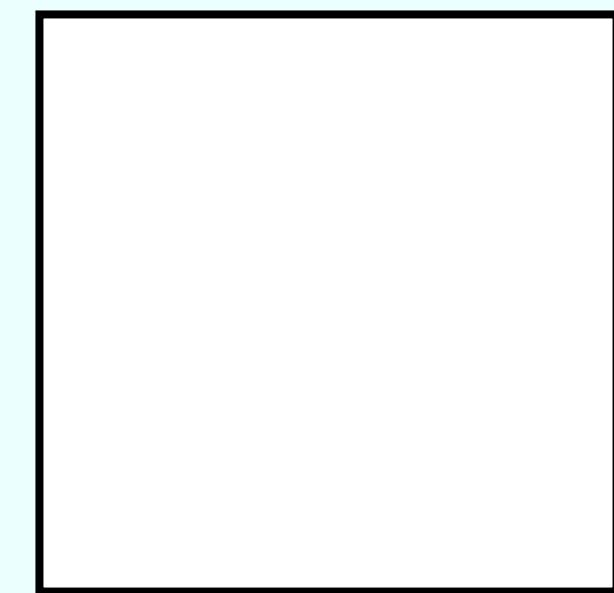


Digital conversion - Images

- Resolution is the scale we are working/measuring at.
- Similarly, for images.
- To what precision do we want to capture the colour information.
- That is called “bit-depth”.
- Number of bits we use to represent each pixel.

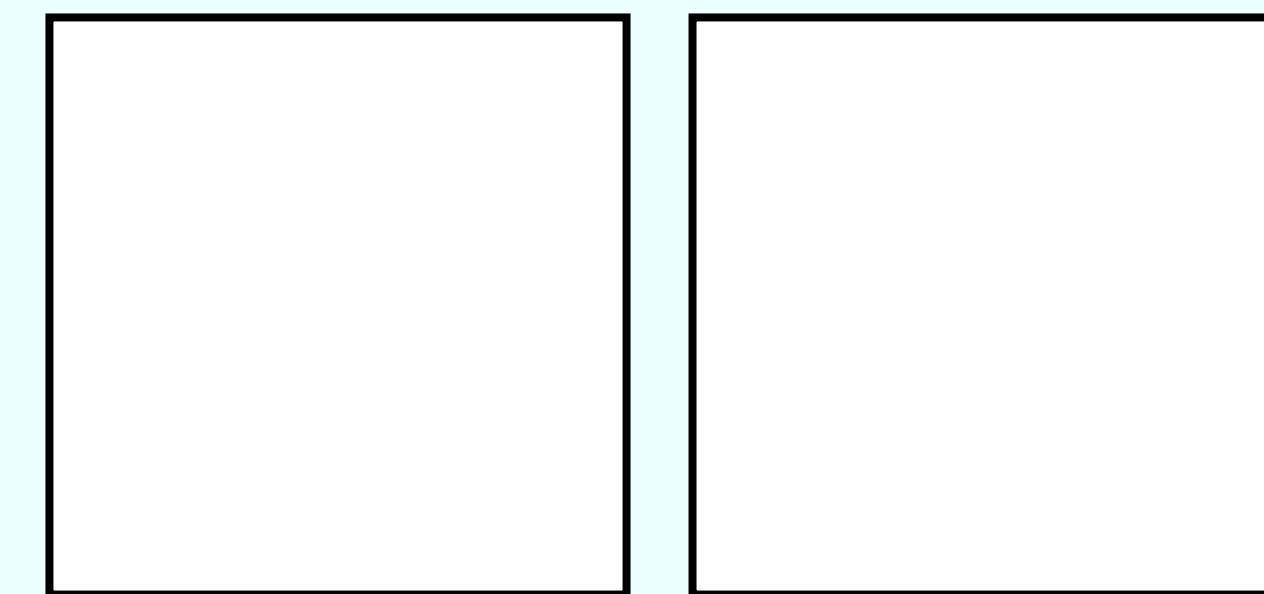
- Therefore while storing/capturing image, we need to think about :
 - The file format : JPG, PNG, TIFF
 - The color space : RGB, CMYK, HSV
 - The bit-depth : 8-bit, 10-bit, 12-bit, 14-bit

Resolution & Bit-depth



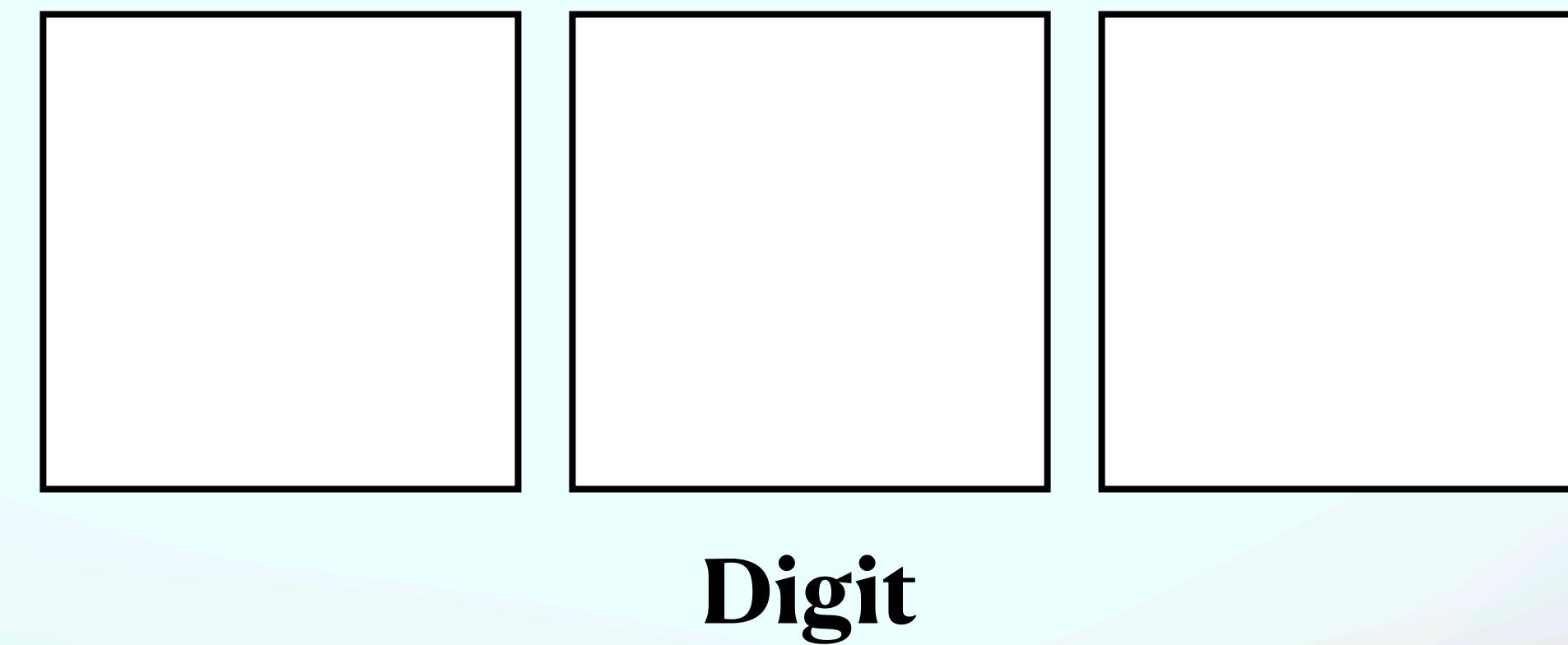
Digit

Resolution & Bit-depth



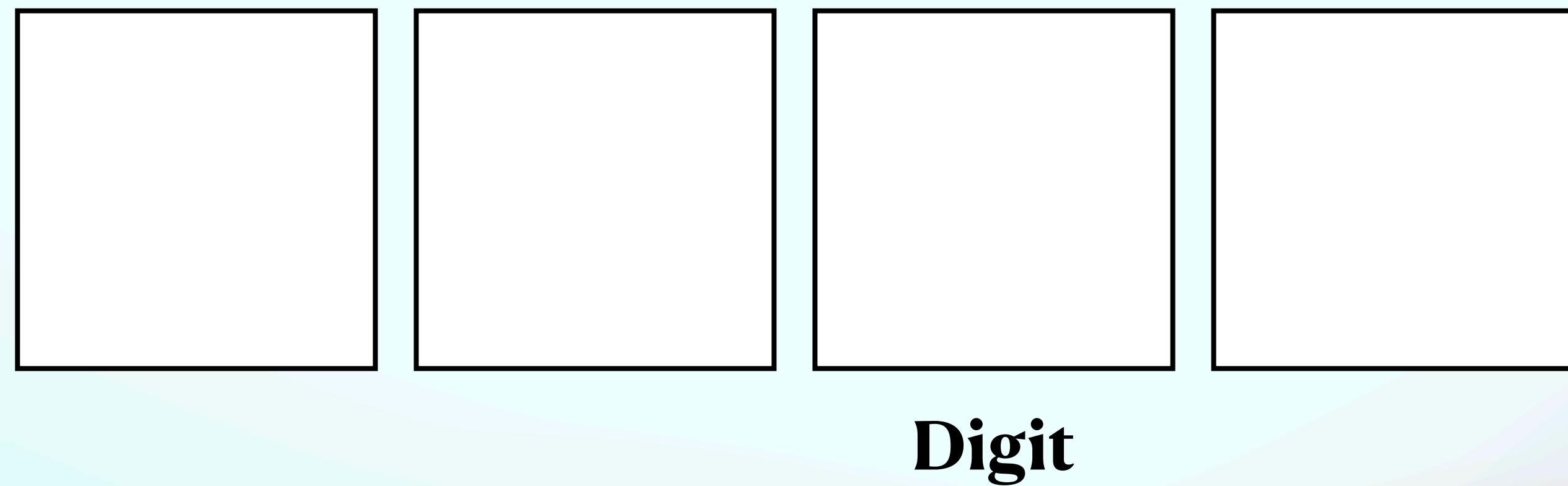
Digit

Resolution & Bit-depth



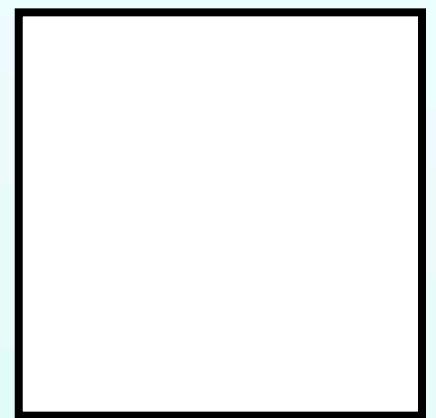
Digit

Resolution & Bit-depth



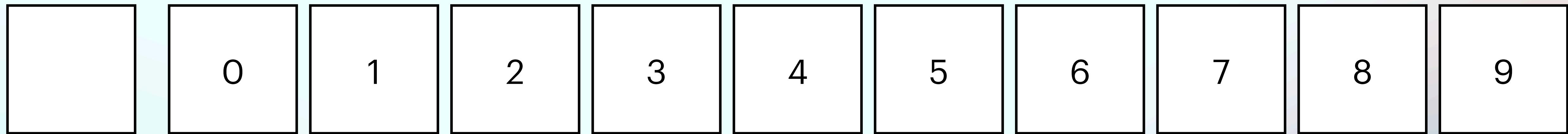
Digit

Resolution & Bit-depth



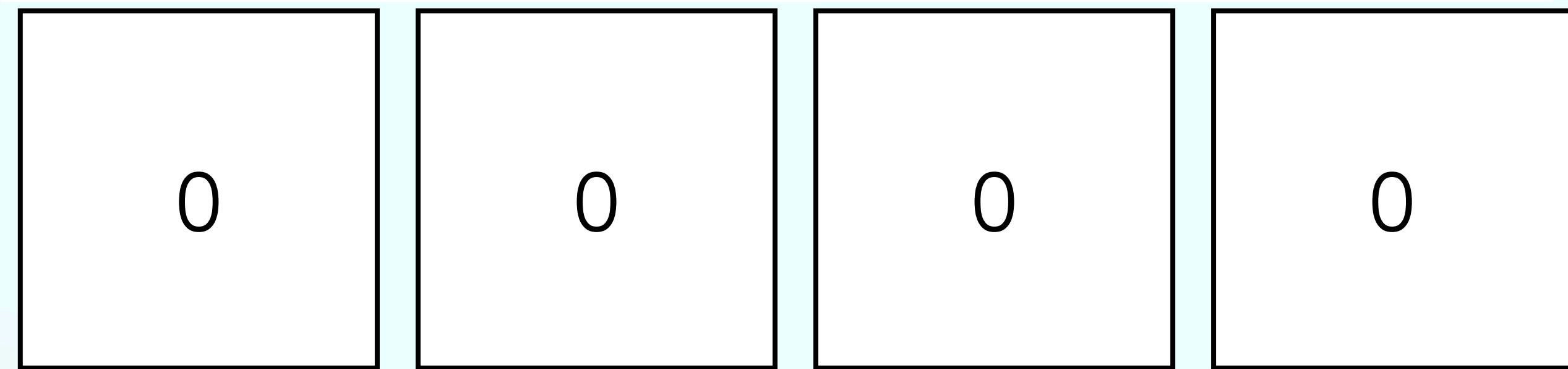
Digit

Resolution & Bit-depth



Resolution & Bit-depth

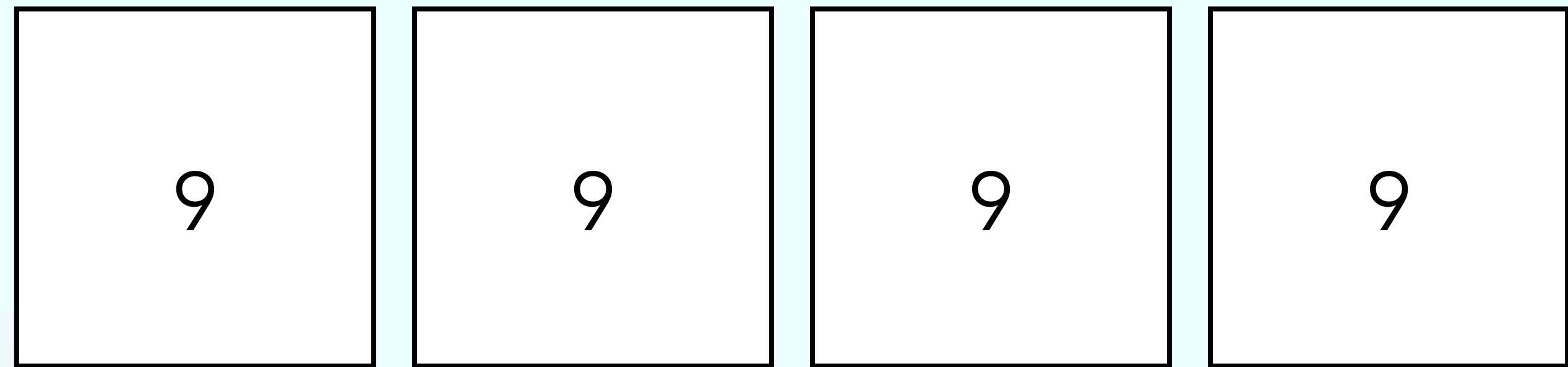
4 - Digit Number



Ranges from 0000 to 9999
that is
10000 values

Resolution & Bit-depth

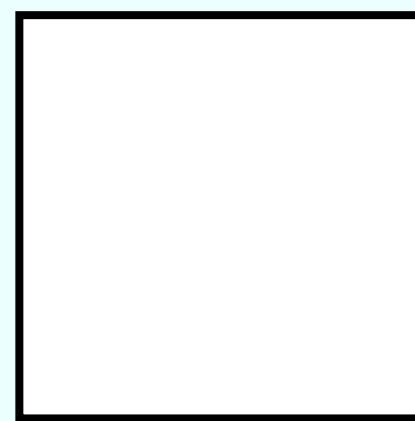
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Ranges from 0000 to 9999
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10000 values

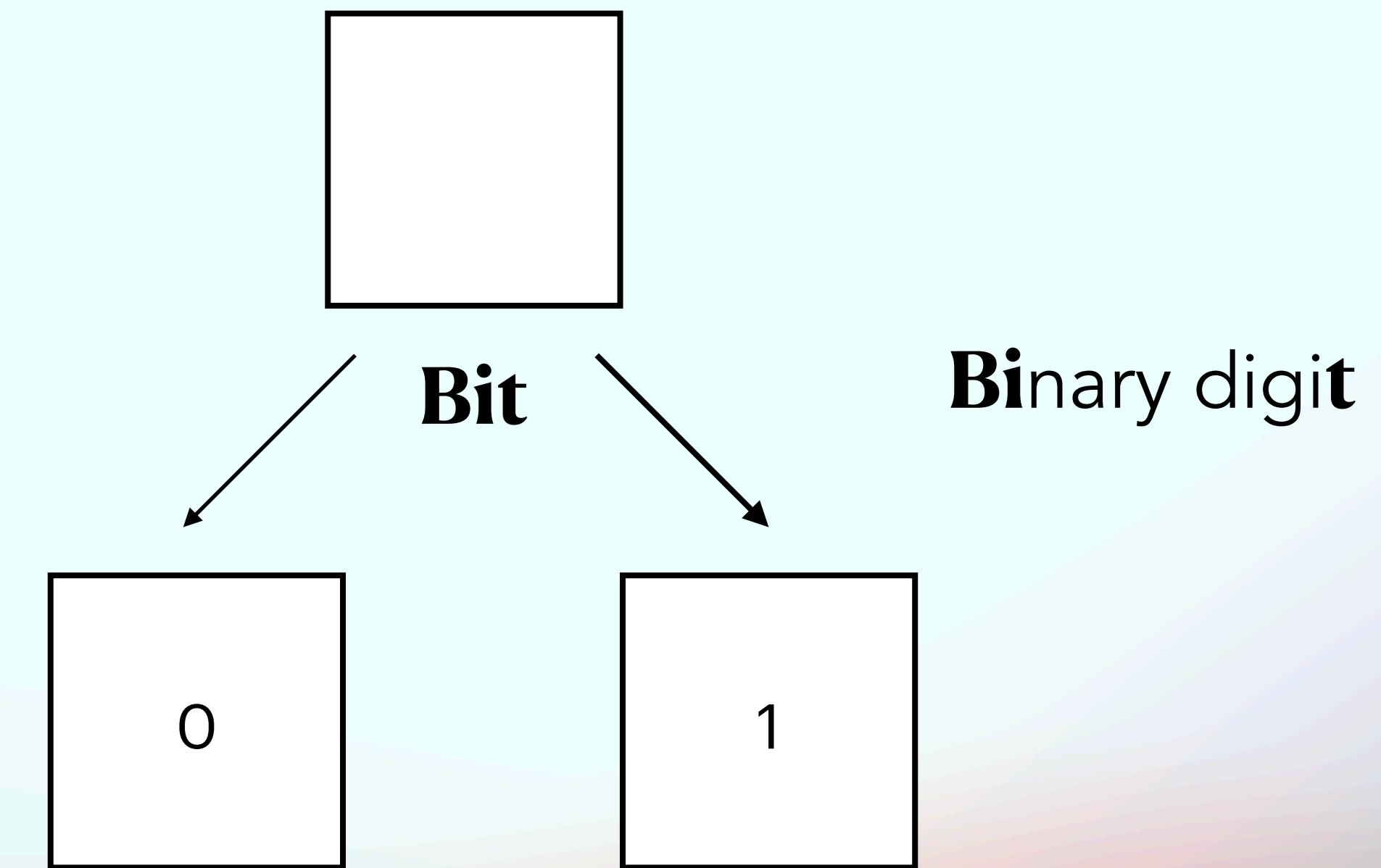
Resolution & Bit-depth

Binary digit



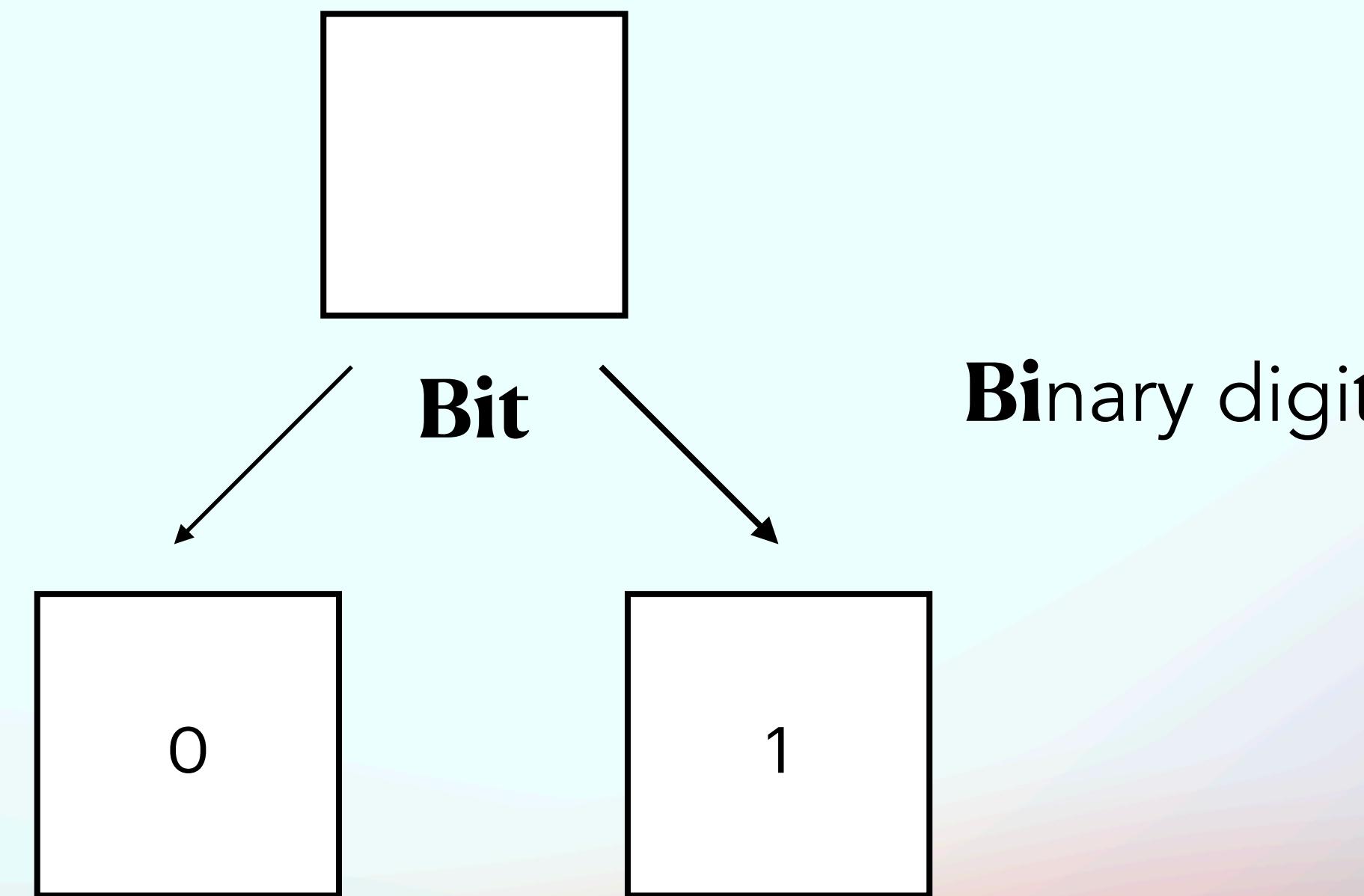
Bit

Resolution & Bit-depth



Resolution & Bit-depth

- Examples :
 - Light - ON/OFF
 - Yes/No
 - True/False
 - Exists/Not



2¹

Resolution & Bit-depth

$$4 = 2^2$$

- Examples :

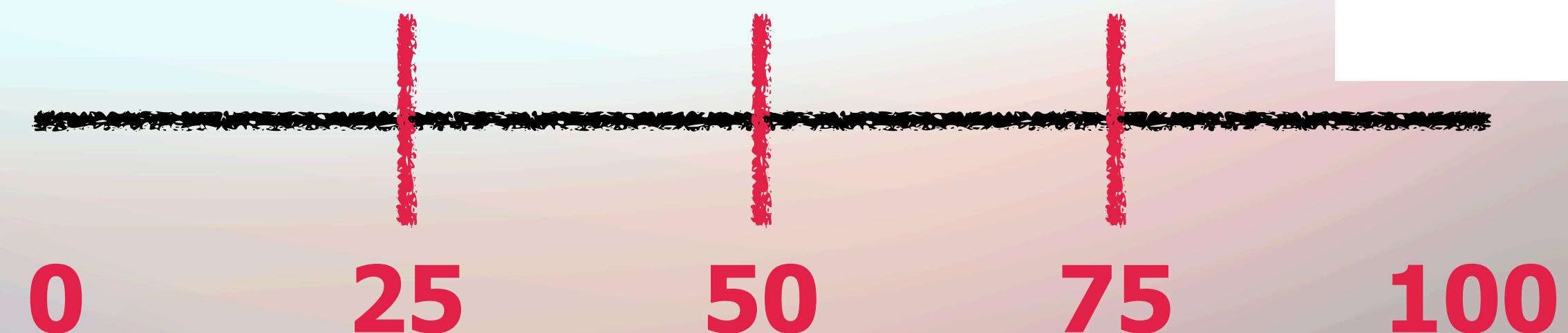
- Season - Winter, Spring, Summer, Rainy
- Part of day - Morning, noon, evening, night
- 0, 25, 50, 75

2 bit number

0

0

Ranges from 0 to 3



Resolution & Bit-depth

$$4 = 2^2$$

- Examples :

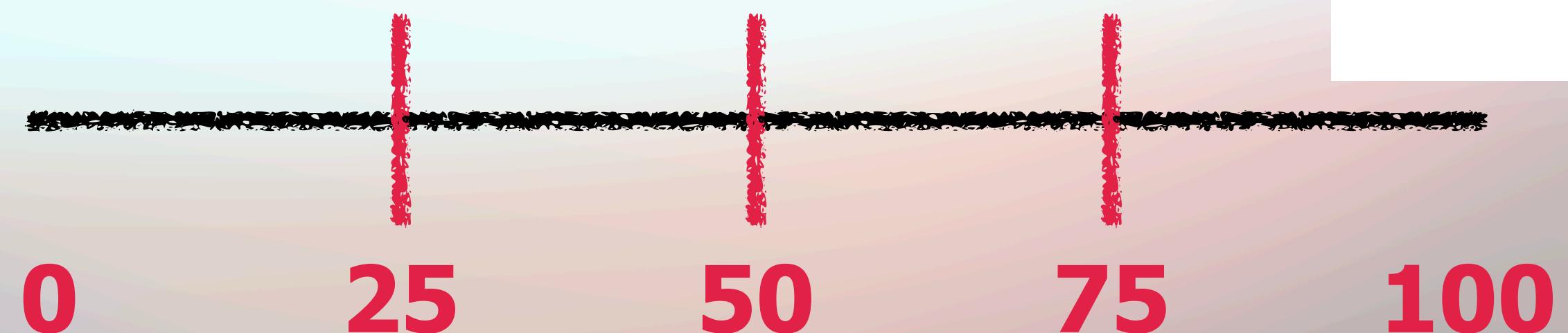
- Season - Winter, Spring, Summer, Rainy
- Part of day - Morning, noon, evening, night
- 0, 25, 50, 75

2 bit number

1

1

Ranges from 0 to 3



Resolution & Bit-depth

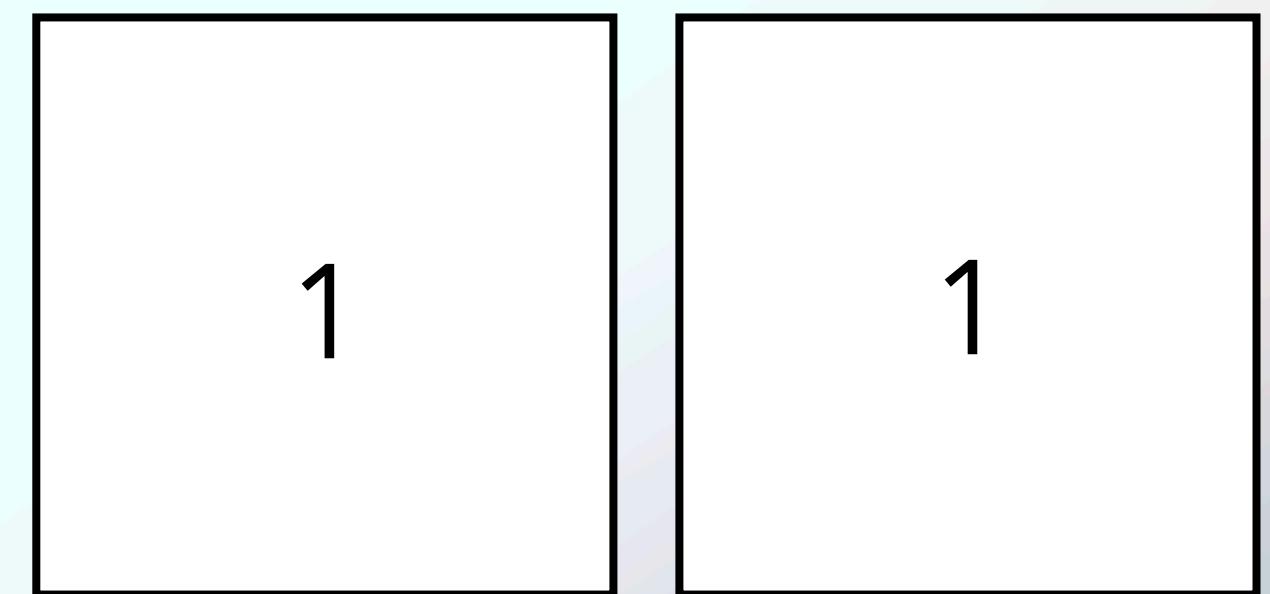
$$4 = 2^2$$

- Examples :

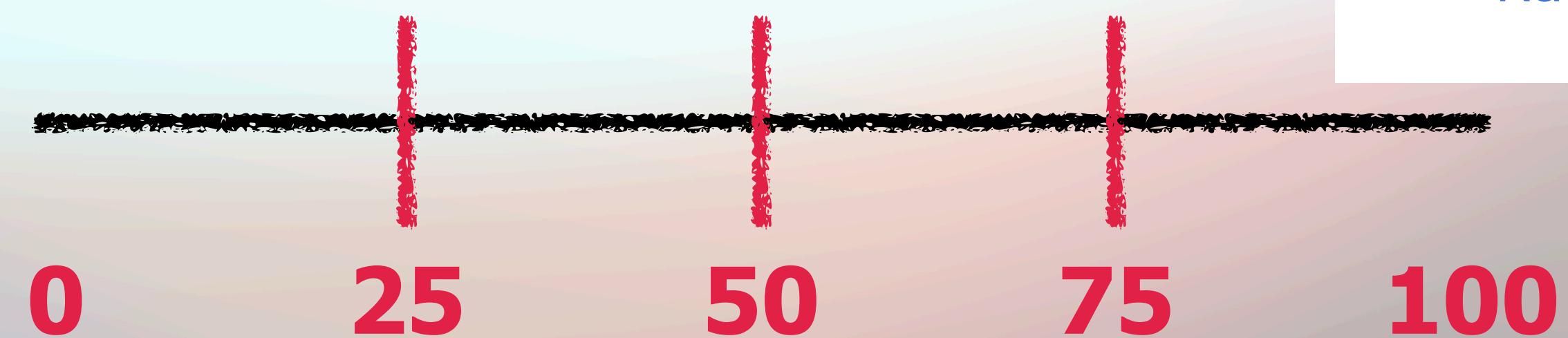
- Season - Winter, Spring, Summer, Rainy
- Part of day - Morning, noon, evening, night
- 0, 25, 50, 75

0 0 - 0+
 0 1 - 25+
 1 0 - 50+
 1 1 - 75+

2 bit number



Ranges from 0 to 3



Resolution & Bit-depth

$$4 = 2^2$$

- Examples :
 - Season - Winter, Spring, Summer, Rainy
 - Part of day - Morning, noon, evening, night
 - 0, 25, 50, 75

0	0
0	1
1	0
1	1

Resolution & Bit-depth

$$4 = 2^2$$

- Examples :

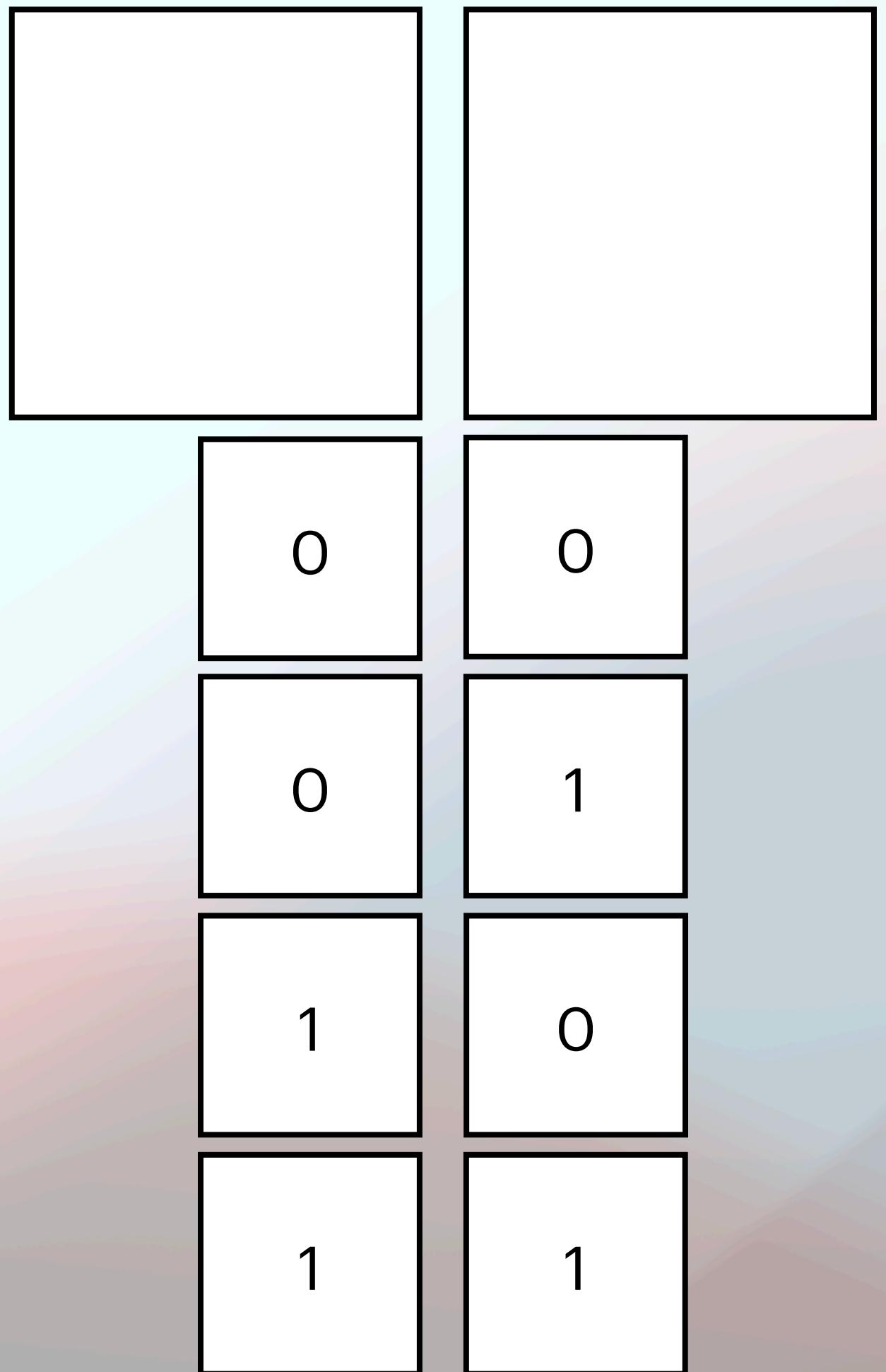
- Season - Winter, Spring, Summer, Rainy
- Part of day - Morning, noon, evening, night
- 0, 25, 50, 75

0 0 - 0

0 1 - 1

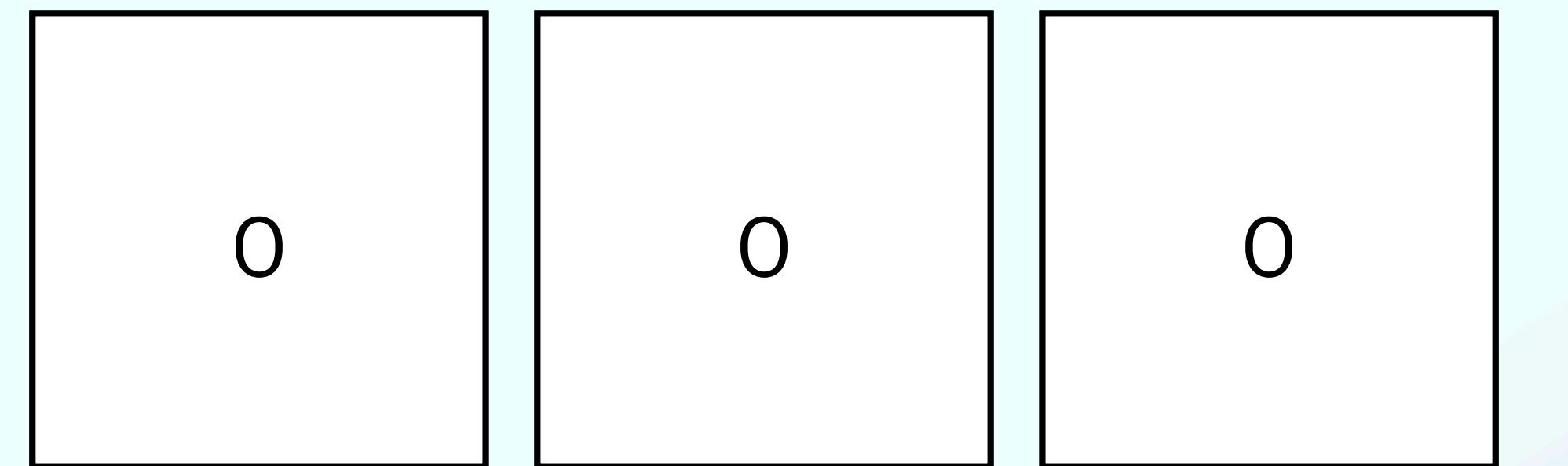
1 0 - 2

1 1 - 3



Resolution & Bit-depth

$$8 = 2^3$$



- 0

Resolution & Bit-depth

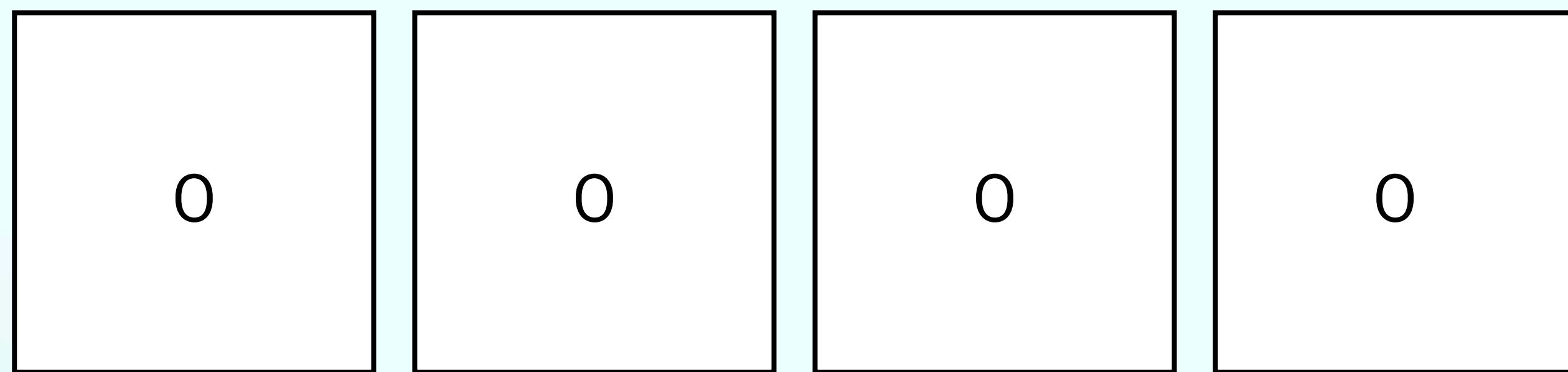
0	0	0	- 0	
0	0	1	- 1	
0	1	0	- 2	
S	1	1	- 3	
1	0	0	- 4	
1	0	1	- 5	
1	1	0	- 6	
1	1	1	- 7	

$$8 = 2^3$$

$$- \quad 0 \\ - \quad 7$$

Resolution & Bit-depth

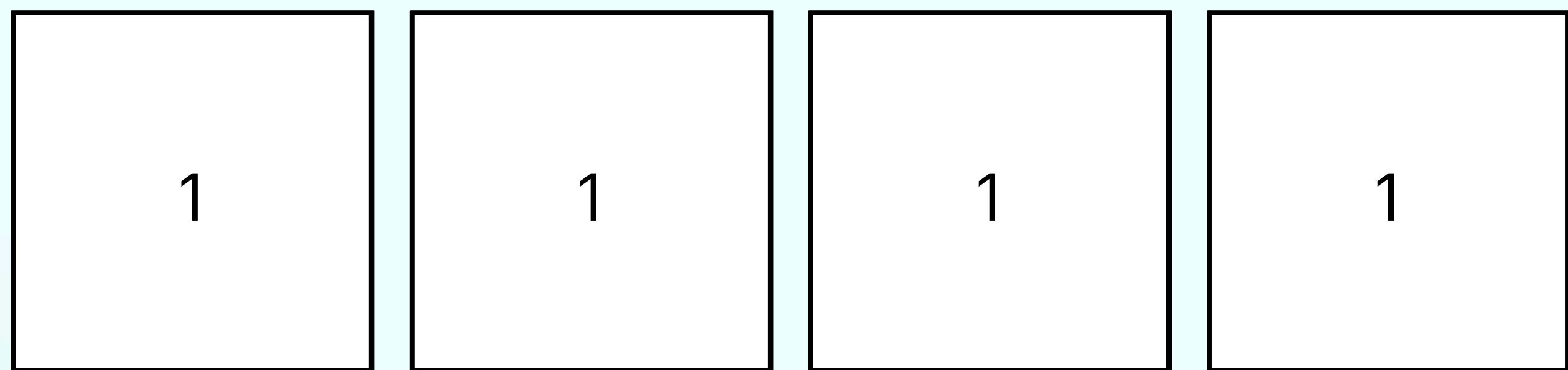
16 = 2⁴



0

Resolution & Bit-depth

16 = 2⁴



15

Resolution & Bit-depth

$$32 = 2^5$$

0

0

0

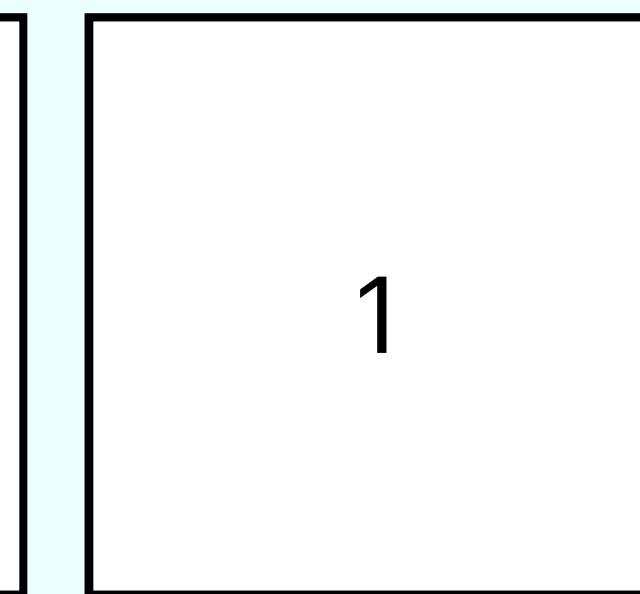
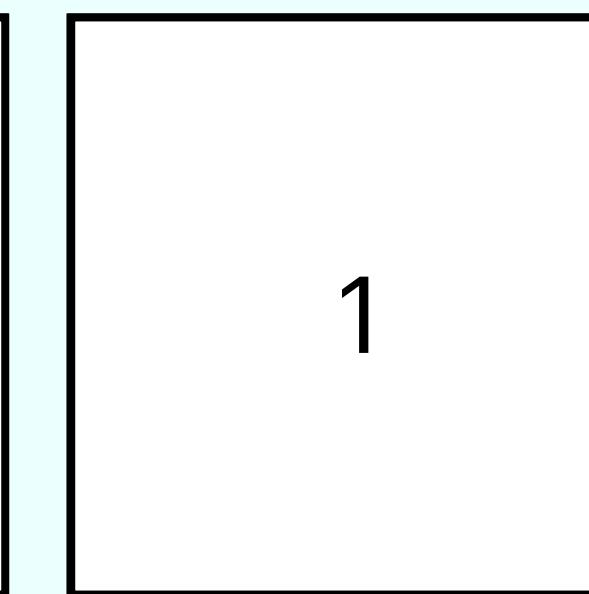
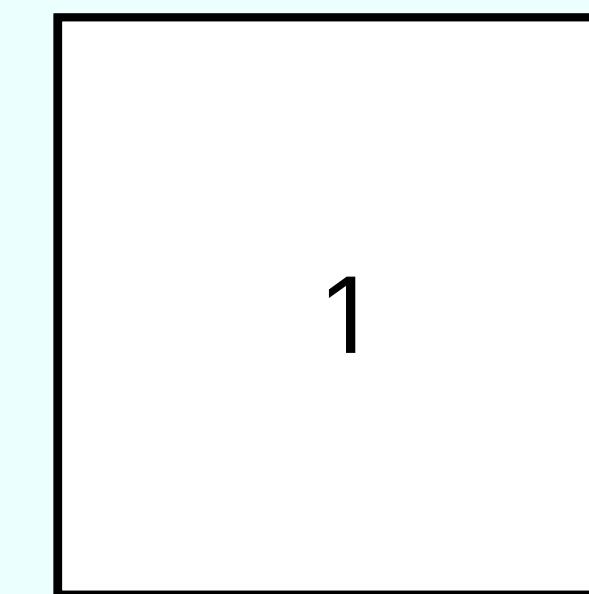
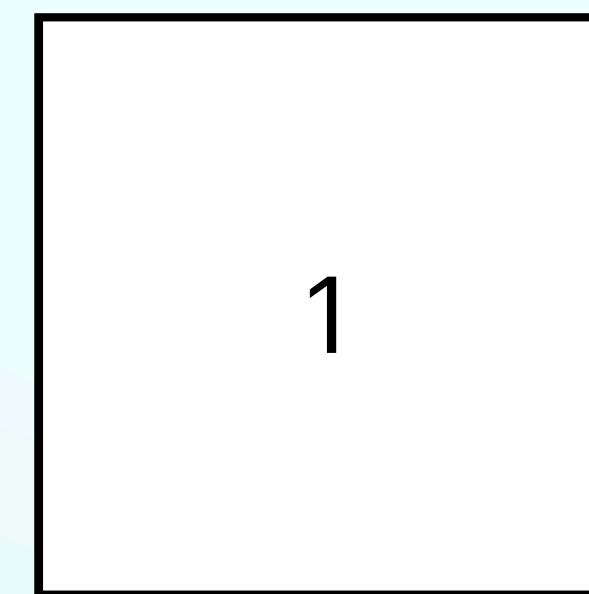
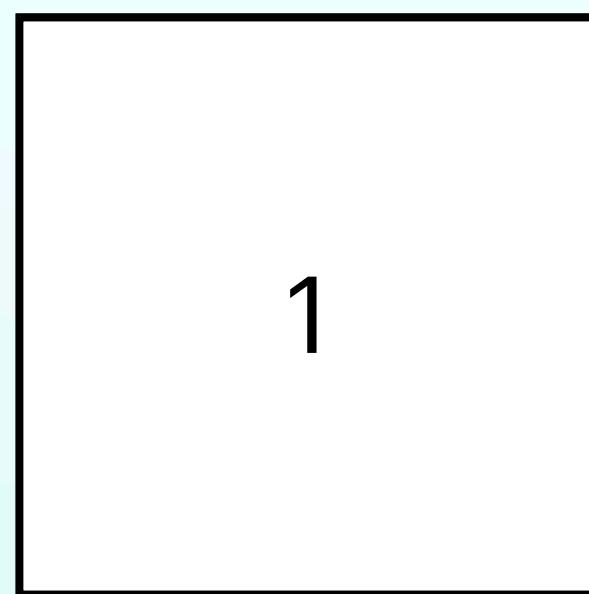
0

0

0

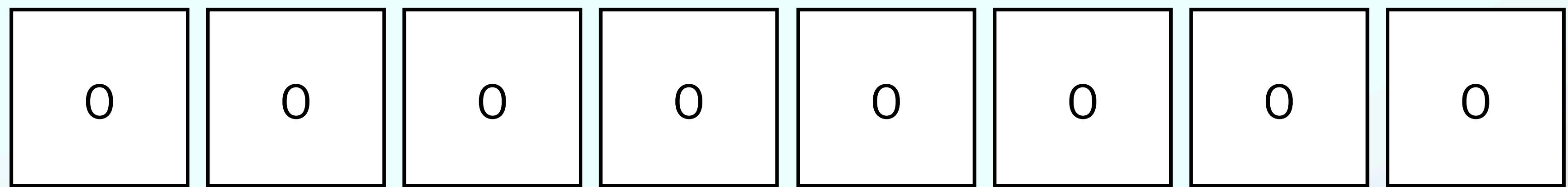
Resolution & Bit-depth

$$32 = 2^5$$

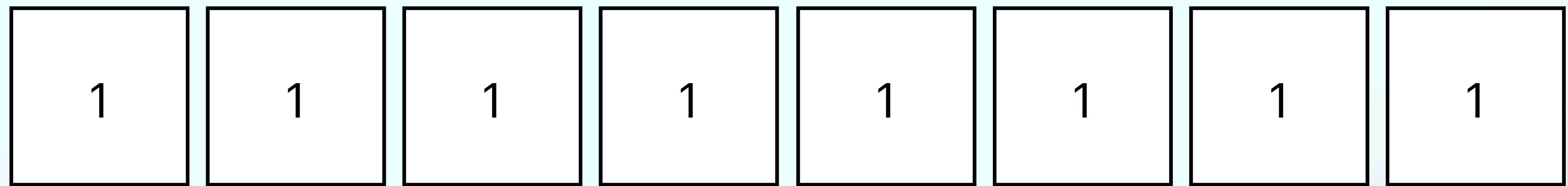


31

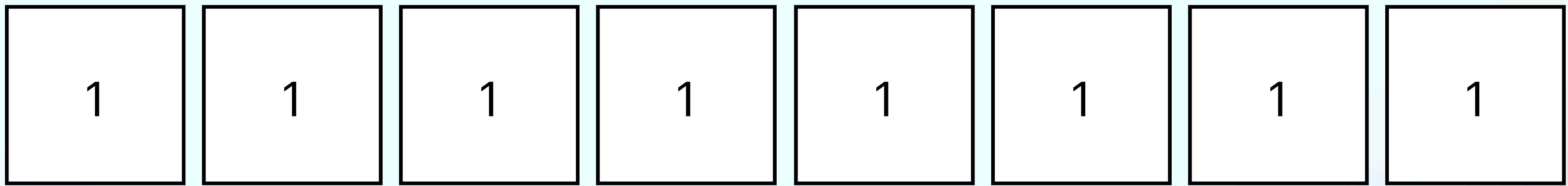
Resolution & Bit-depth



Resolution & Bit-depth

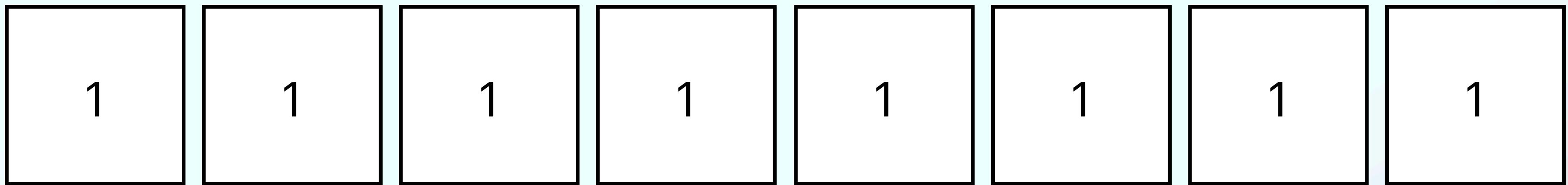


Resolution & Bit-depth



$$256 = 2^8$$

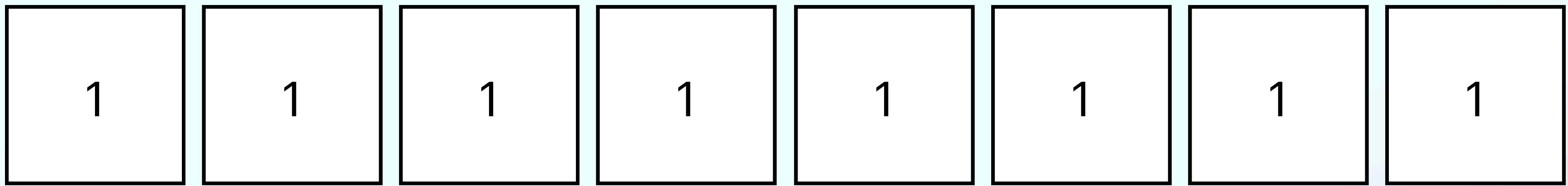
Resolution & Bit-depth



255

$$256 = 2^8$$

Resolution & Bit-depth



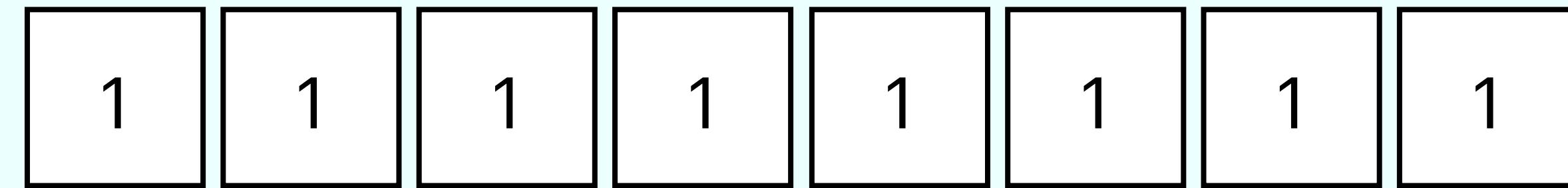
255

0

$$256 = 2^8$$

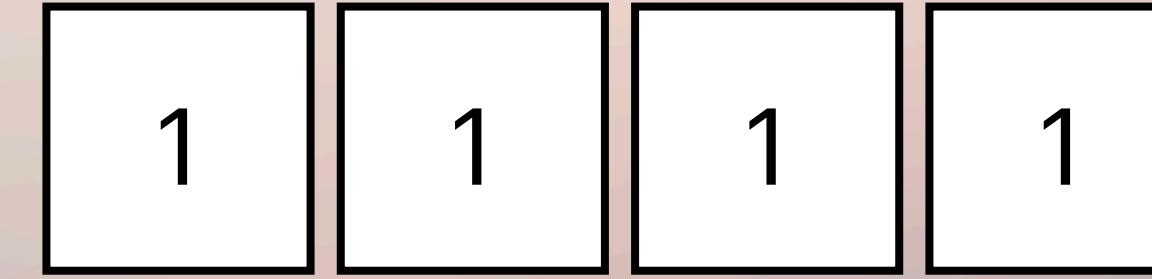
Resolution & Bit-depth

Byte



256 = 2^8

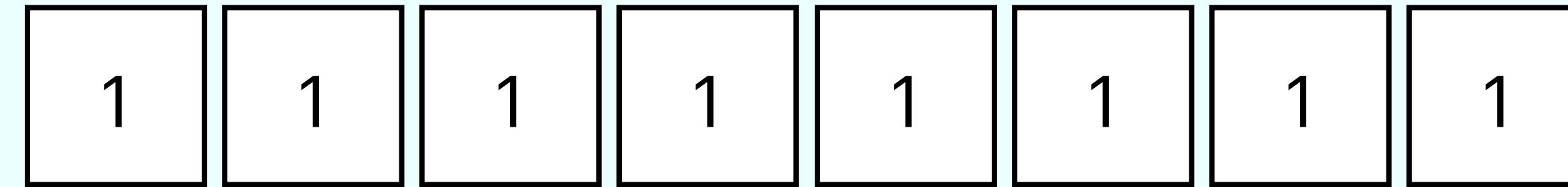
Nibble



16 = 2^4

Resolution & Bit-depth

Byte

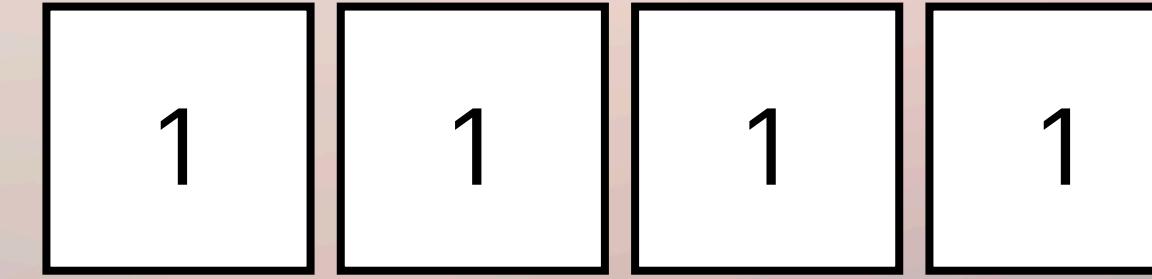


$$256 = 2^8$$

0 0 - 0+
0 1 - 25+
1 0 - 50+
1 1 - 75+

2 Bits

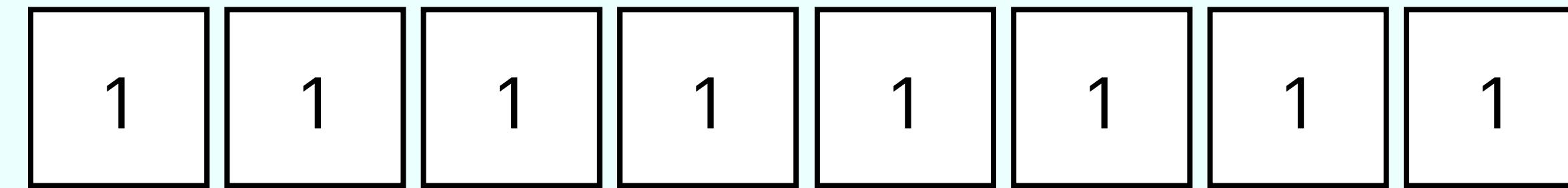
Nibble



$$16 = 2^4$$

Resolution & Bit-depth

Byte



$$256 = 2^8$$

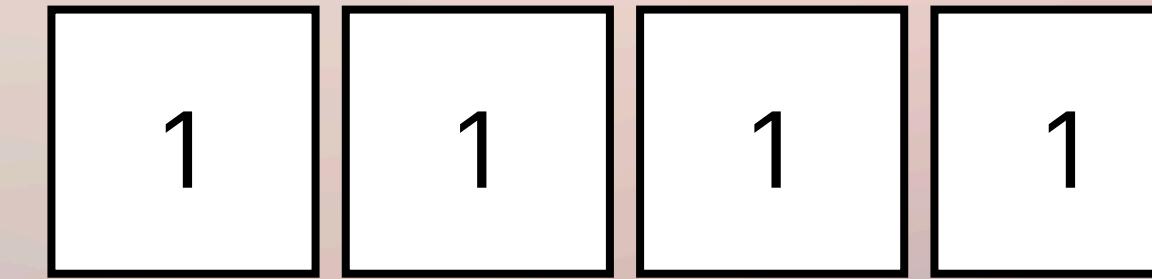
0 0 - 0+
0 1 - 25+
1 0 - 50+
1 1 - 75+

2 Bits

0000 - 0+
0001 - 6.25+
0010 - 12.50+
..
..
1111 - 93.75+

4 Bits

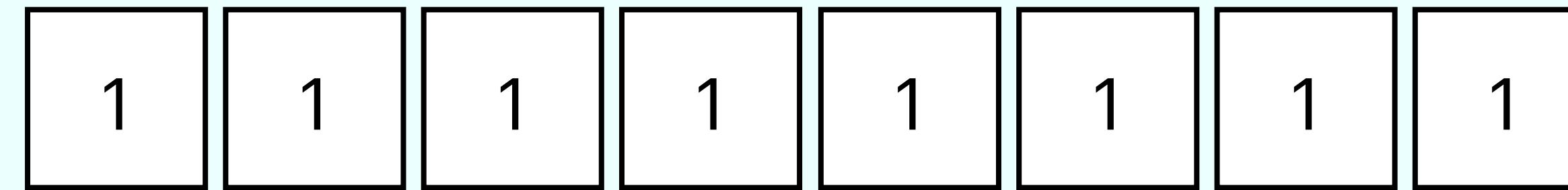
Nibble



$$16 = 2^4$$

Resolution & Bit-depth

Byte



$$256 = 2^8$$

0 0 - 0+
0 1 - 25+
1 0 - 50+
1 1 - 75+

2 Bits

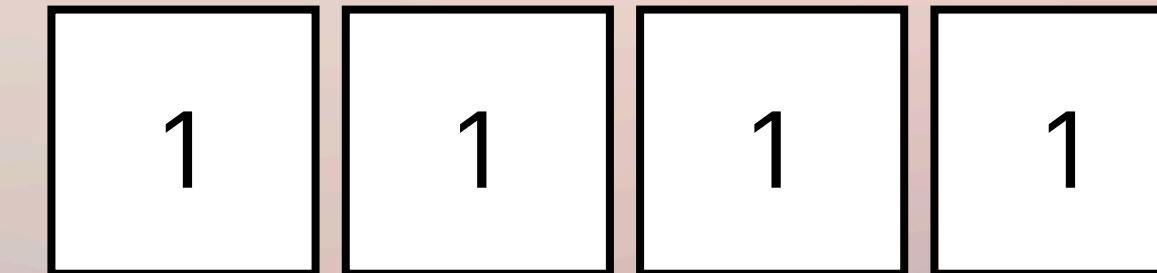
0000 - 0+
0001 - 6.25+
0010 - 12.50+
..
..
1111 - 93.75+

4 Bits

00000000 - 0+
00000001 - 0.39+
00000010 - 0.78+
..
..
11111111 - 99.61+

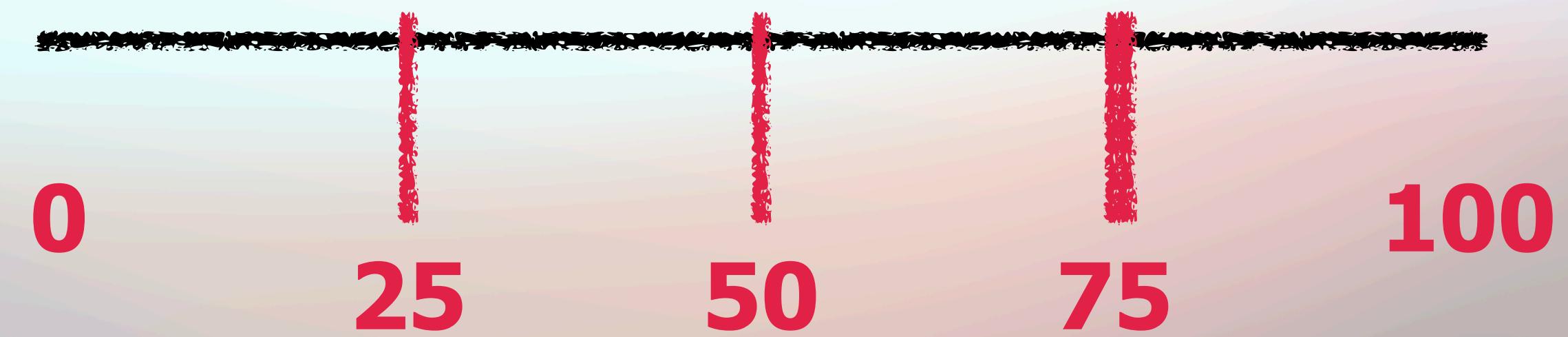
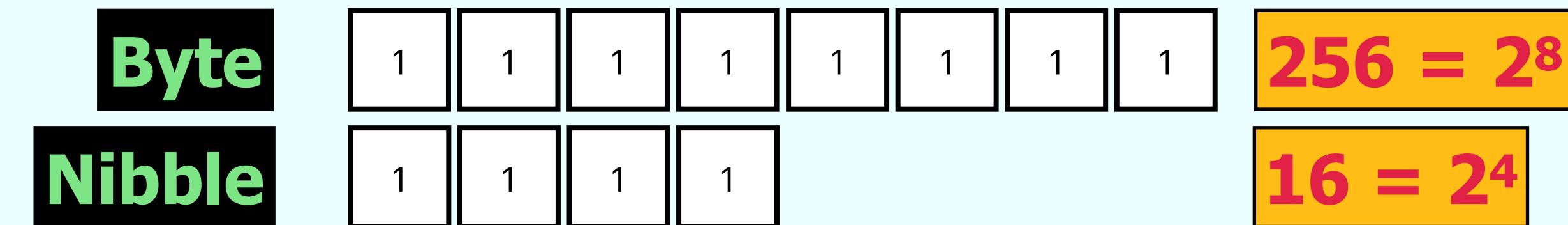
8 Bits

Nibble

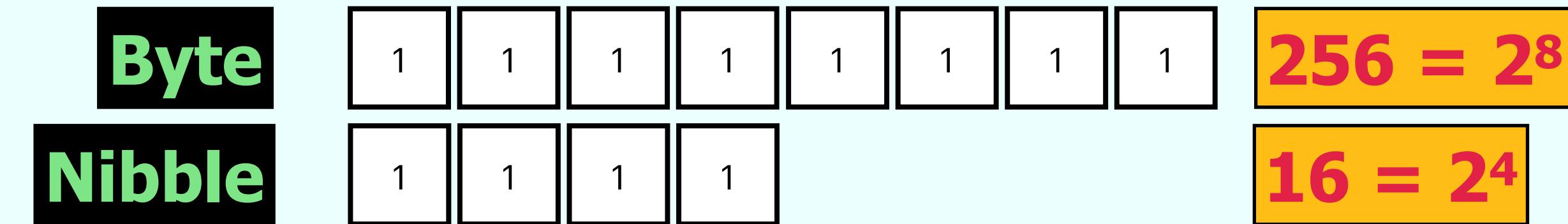


$$16 = 2^4$$

Resolution & Bit-depth

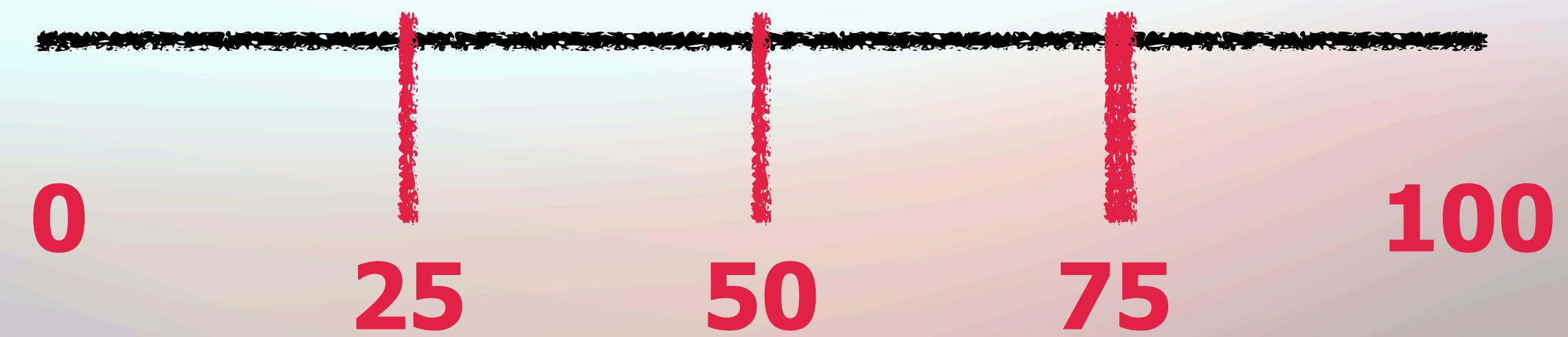


Resolution & Bit-depth

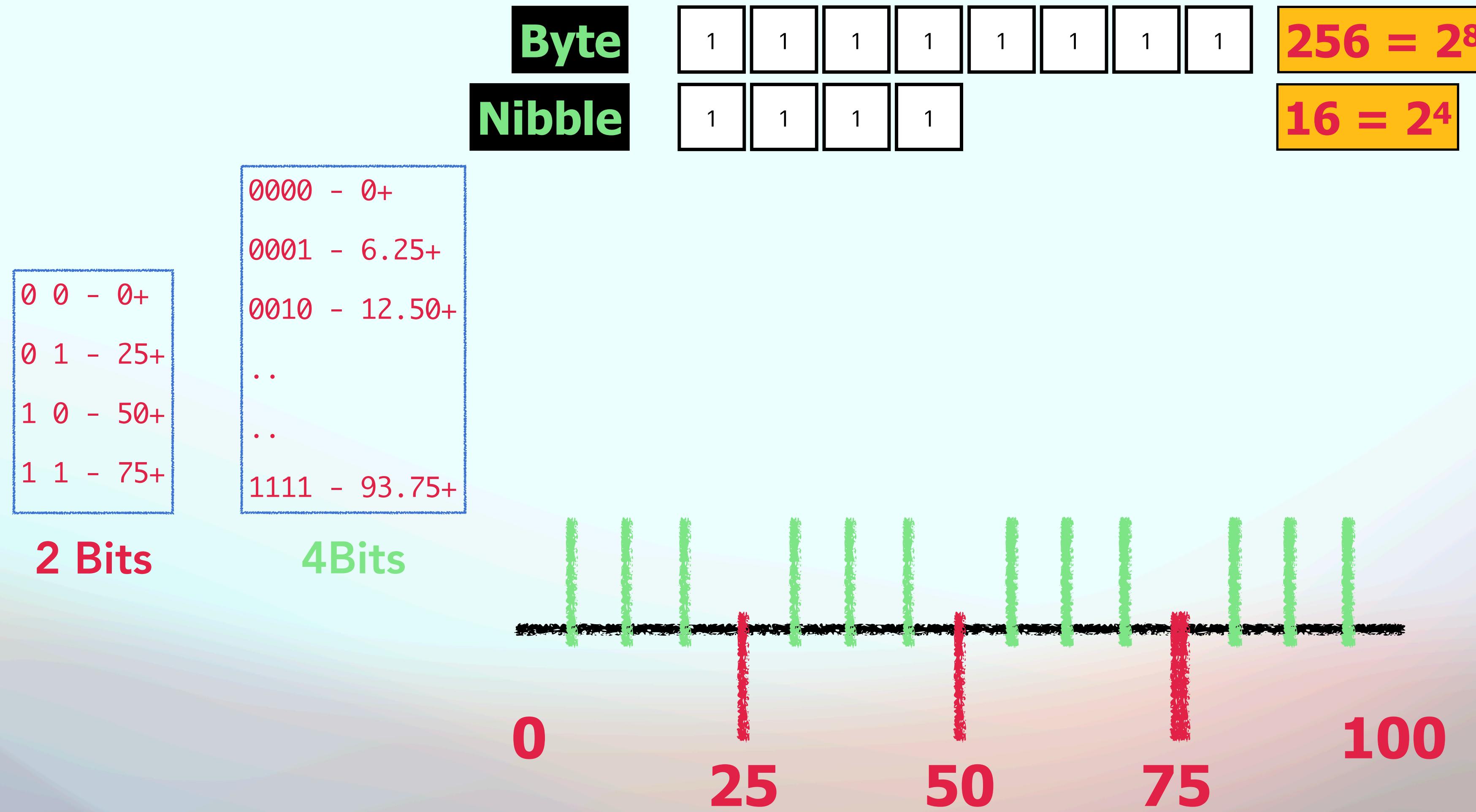


0 0 - 0+
0 1 - 25+
1 0 - 50+
1 1 - 75+

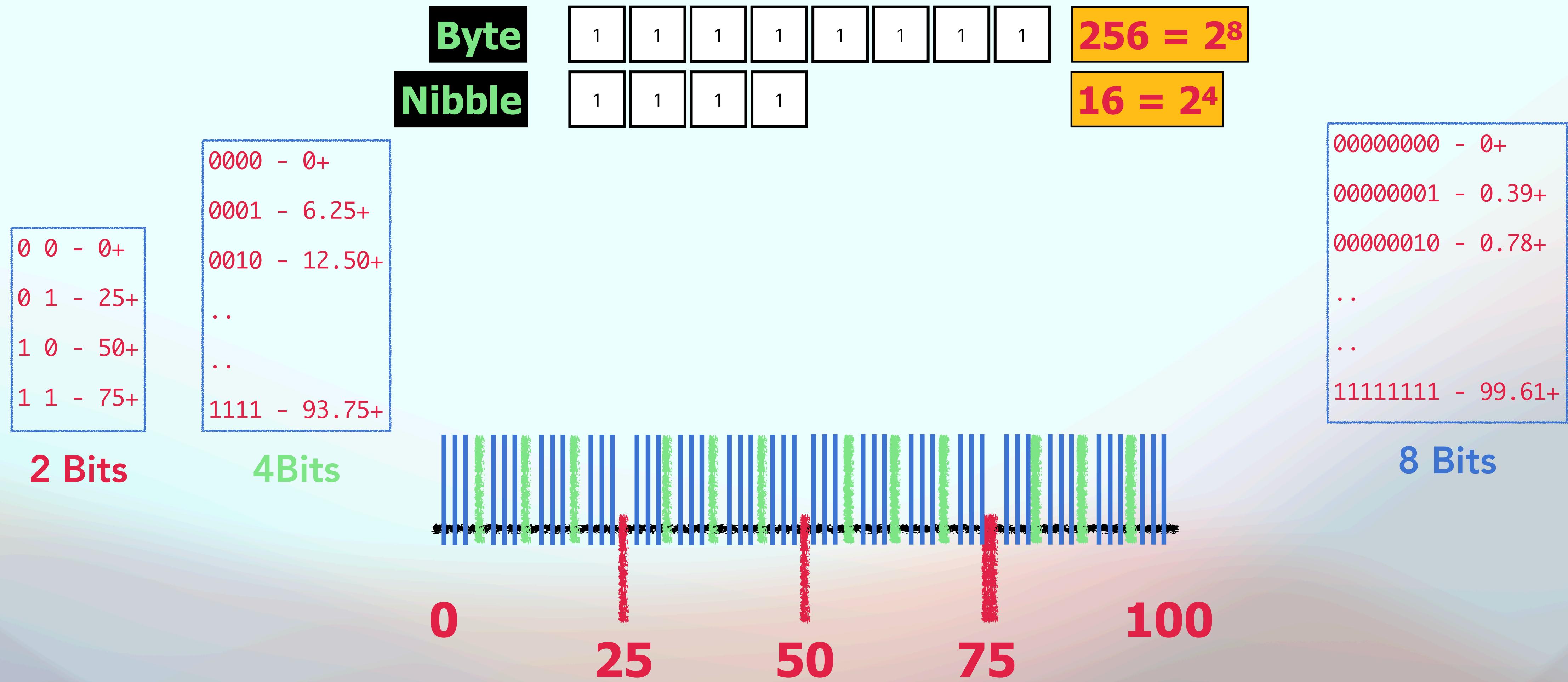
2 Bits



Resolution & Bit-depth

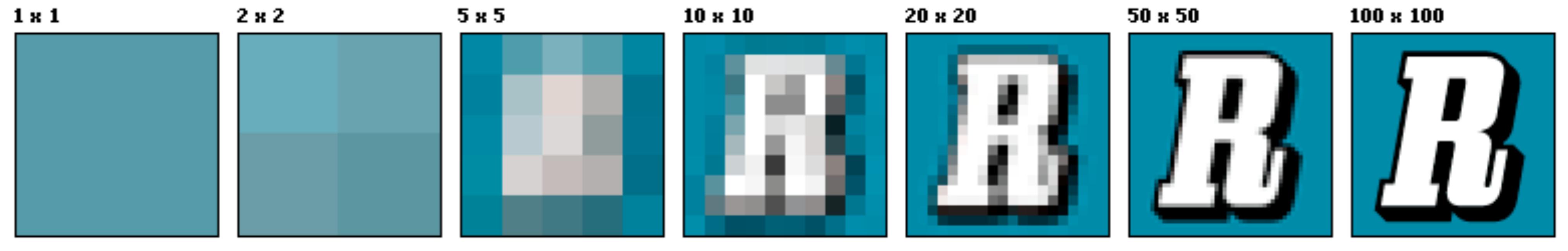


Resolution & Bit-depth



Resolution & Bit-depth

Number of pixels



Histogram : Images and Matrices

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- What is an image?
 - Visual representation of anything

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 - Three 2D matrices - Red, Green, Blue

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Histogram : Images and Matrices

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 - Three 2D matrices - Red, Green, Blue
 - Each image can be represented as 3D matrix.



Histogram : Images and Matrices

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 - Visual representation of anything
- If RGB, each image is a 3D matrix.
 - Three 2D matrices - Red, Green, Blue
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255	255	255	255	255	251	248	247	251	252	254
255	255	255	255	253	250	248	248	252	254	255
253	253	247	250	253	254	252	249	247	246	247
255	255	245	247	250	251	250	248	247	247	250
255	255	242	244	250	251	250	248	247	247	251
253	253	245	244	249	246	249	246	247	250	251
250	250	249	246	249	246	245	245	244	244	245
241	241	244	240	244	240	240	234	234	234	234
241	241	240	234	240	234	234	227	227	227	227
242	242	227	229	227	228	227	93	87	86	89
							105	100	96	99
							108	108	120	120
							126	126	131	131
							134	134	141	141
							140	140	144	144
							149	149	153	153
							151	151	155	155
							157	157	158	158
							138	138	140	140
							141	141	149	149
							147	147	153	153
							151	151	155	155
							155	155	158	158
							124	124	125	125
							128	128	129	129
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							131	131	133	133
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							155	155	158	158
							124	124	125	125
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							166	166	172	172
							168	168	174	174
							170	170	176	176
							172	172	178	178
							174	174	180	180
							176	176	182	182
							178	178	184	184
							180	180	186	186
							182	182	188	188
							184	184	190	190
							186	186	192	192
							188	188	194	194
							190	190	196	196
							192	192	198	198
							194	194	200	200
							196	196	202	202
							198	198	204	204
							200	200	206	206
							202	202	208	208
							204	204	210	210
							206	206	212	212
							208	208	214	214
							210	210	216	216
							212	212	218	218
							214	214	220	220
							216	216	222	222
							218	218	224	224
							220	220	226	226
							222	222	228	228
							224	224	230	230
							226	226	232	232
							228	228	234	234
							230	230	236	236
							232	232	238	238
							234	234	240	240
							236	236	242	242
							238	238	244	244
							240	240	246	246
							242	242	248	248
							244	244	246	246
							246	246	248	248
							248	248	250	250
							250	250	252	252
							252	252	254	254
							254	254	256	256
							256	256	258	258
							258	258	260	260
							260	260	262	262
							262	262	264	264
							264	264	266	266
							266	266	268	268
							268	268	270	270
							270	270	272	

Histogram : Images and Matrices

- What is an image?
 - Visual representation of anything
- If RGB, each image is a 3D matrix.
 - Three 2D matrices - Red, Green, Blue
 - Each image can be represented as 3D matrix.



Height ↓

255	255	255	255	255	251	248	247	251	252	254
255	255	255	255	253	250	248	248	252	254	255
253	255	247	250	253	254	252	249	247	246	247
255	255	245	247	250	251	250	248	247	247	250
255	255	242	244	250	251	250	248	247	247	251
253	255	245	244	249	246	248	247	247	250	251
250	253	249	246	249	246	248	247	247	250	251
241	241	250	245	244	240	242	241	241	241	242
241	241	244	240	240	234	242	234	234	234	234
242	242	227	229	227	228	227	227	227	227	227

Histogram : Images and Matrices

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Histogram : Images and Matrices

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Width →

	255	255	255	255	255	251	248	247	251	252	254
	255	255	255	255	253	250	248	248	252	254	255
	253	253	247	250	253	254	252	249	247	246	247
	255	255	245	247	250	251	250	248	247	247	249
	255	255	242	244	250	251	250	248	247	247	251
	255	255	245	244	249	246	133	135	138	137	137
	255	255	245	244	249	246	130	132	134	134	135
	253	253	249	246	249	246	135	135	138	140	141
	250	250	250	245	250	245	124	125	128	129	131
	241	241	244	240	244	240	124	123	122	123	126
	241	241	240	234	240	234	122	119	118	118	121
	242	242	227	229	227	229	117	112	109	109	117
			227	228	227	228	105	100	96	99	108
			227	227	227	227	76	77	79	86	95
							69	70	73	80	88
							66	66	69	74	81

Height ↓

Channels ↓

Histogram : Images and Matrices

- What is an image?
 - Visual representation of anything
- If RGB, each image is a 3D matrix.
 - Three 2D matrices - Red, Green, Blue
 - Each image can be represented as 3D matrix.
 - $[H, W, C]$ - Ex : $(1920, 1080, 3)$



Width →

										Width		
										Height ↓		
										Channels ↓		
255	255	255	255	255	251	248	247	251	252	254		
255	255	255	255	253	250	248	248	252	254	255		
253	247	250	253	254	252	249	247	246	247	248	249	
255	245	247	250	251	250	248	247	247	250	251		
255	242	244	133	135	138	137	137	136	138	140	147	151
255	245	244	130	132	134	134	135	135	138	141	149	153
255	249	246	124	125	128	129	131	133	136	141	151	155
253	249	246	124	123	122	123	126	130	134	139	149	153
250	250	245	124	123	122	123	126	130	134	139	145	158
241	244	240	122	119	118	118	121	127	130	135	145	149
241	240	234	117	112	109	109	117	124	129	133	140	144
242	227	229	105	100	96	99	108	120	126	131	134	141
	227	228	93	87	86	89	101	114	123	129	129	135
	227	227	76	77	79	86	95	104	112	117	124	129
			69	70	73	80	88	95	103	108	117	121
			66	66	69	74	81	89	95	100	110	113
												117

Histogram : Images and Matrices

- What is an image?
 - Visual representation of anything
- If RGB, each image is a 3D matrix.
 - Three 2D matrices - Red, Green, Blue
 - Each image can be represented as 3D matrix.
 - $[H, W, C]$ - Ex : $(1920, 1080, 3)$
- Image processing \approx Matrix Transformations



Width →

255	255	255	255	255	251	248	247	251	252	254
255	255	255	255	253	250	248	248	252	254	255
253	255	247	250	253	254	252	249	247	246	247
255	255	245	247	250	251	250	248	247	247	249
255	255	245	244	133	135	138	137	137	136	138
253	255	245	244	130	132	134	134	135	135	138
250	253	249	246	124	125	128	129	131	133	136
241	250	249	246	124	123	122	123	126	130	134
241	241	244	240	122	119	118	118	121	127	130
242	241	240	234	117	112	109	109	117	124	129
242	242	227	229	105	100	96	99	108	120	126
242	242	227	228	93	87	86	89	101	114	123
242	242	227	227	76	77	79	86	95	104	112
69	70	73	80	88	95	103	108	117	121	126
66	66	69	74	81	89	95	100	110	113	117

Height ↓

Channels ↓

Histogram : Images and Matrices

- What is an image?
 - Visual representation of anything
- If RGB, each image is a 3D matrix.
 - Three 2D matrices - Red, Green, Blue
 - Each image can be represented as 3D matrix.
 - $[H, W, C]$ - Ex : $(1920, 1080, 3)$
- Image processing \approx Matrix Transformations

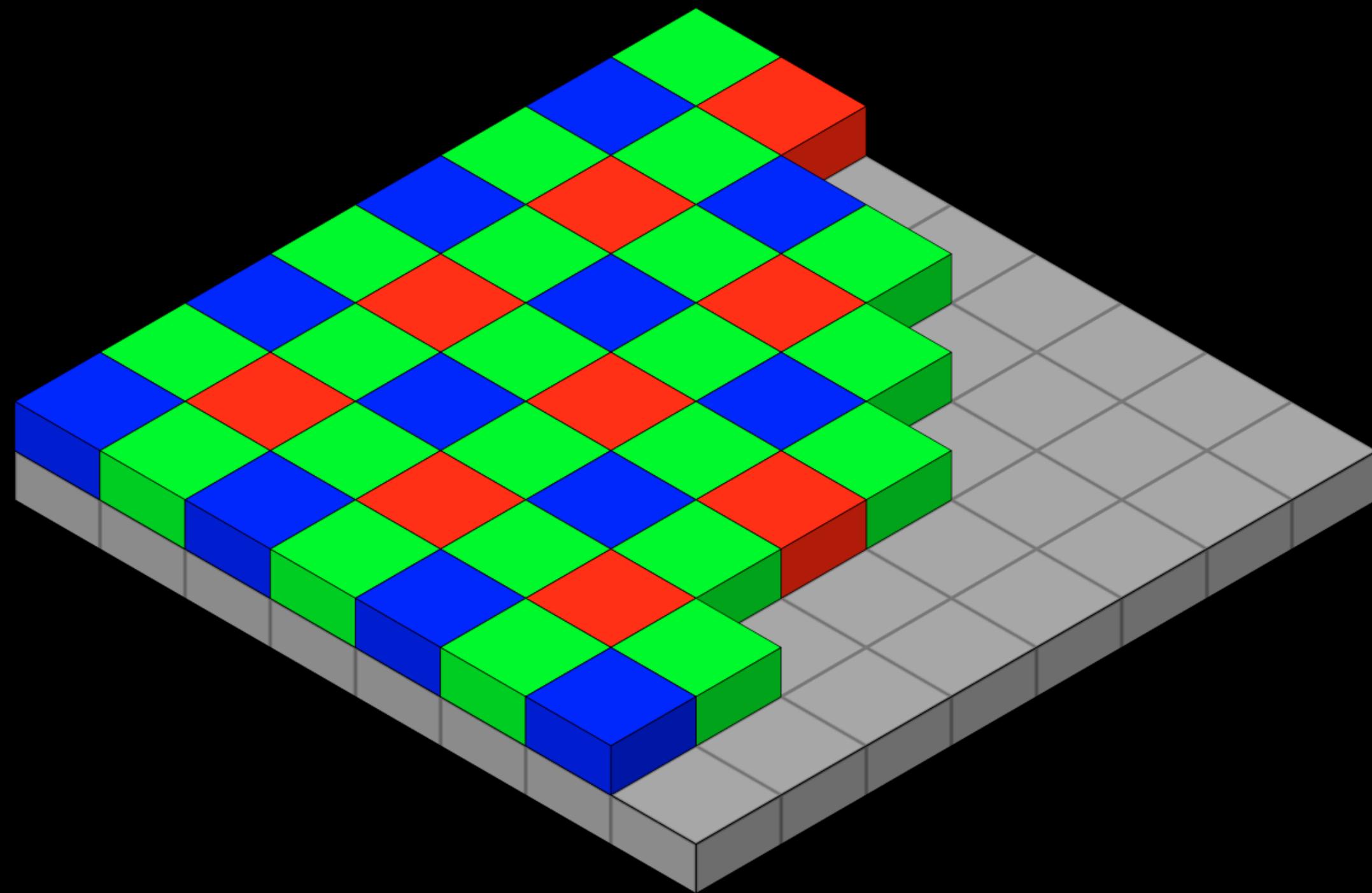
Therefore, to process any image/signal, we need :

- Matrix operations - Theory
- Computer programming - Practical

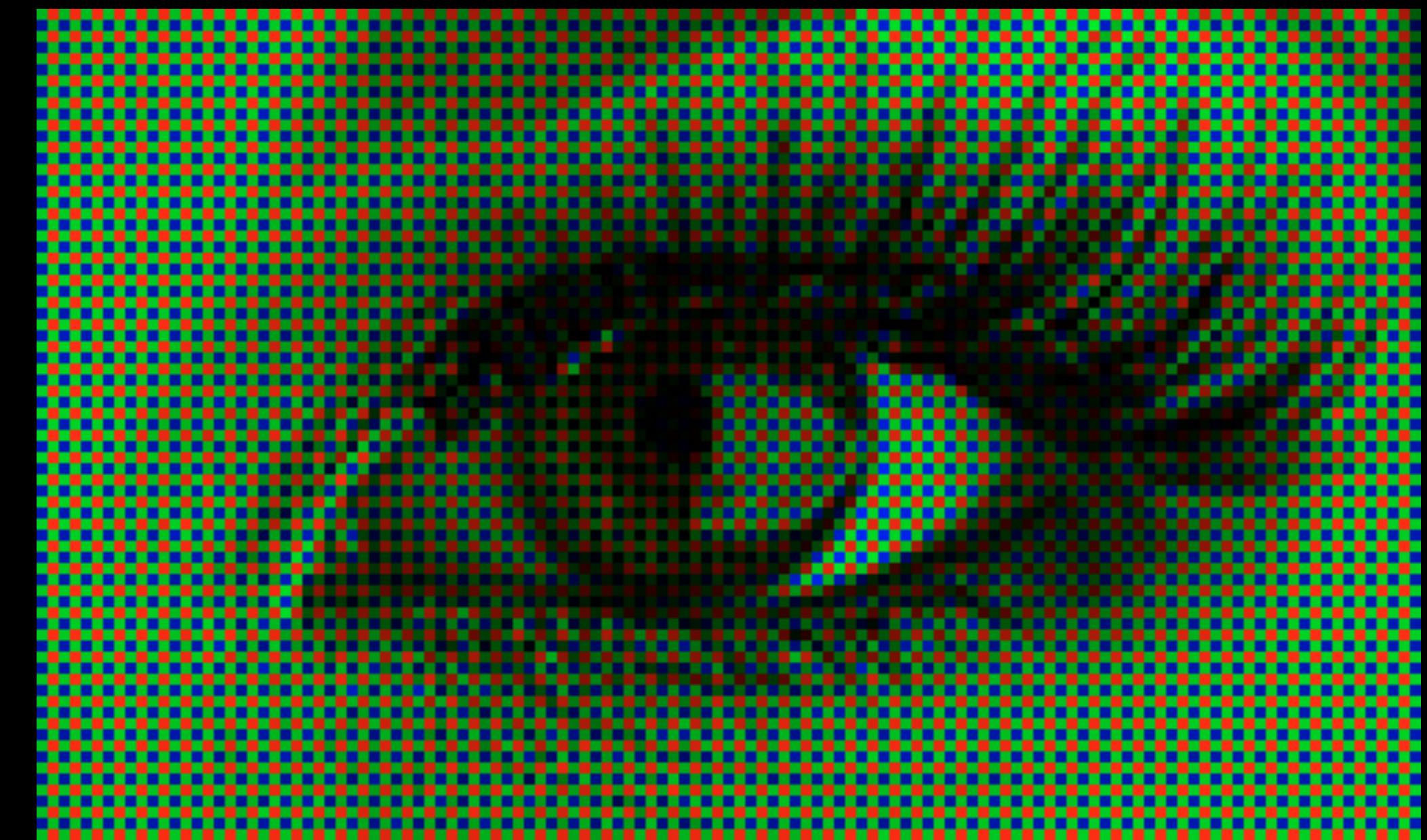


Width												
Height	255	255	255	255	255	251	248	247	251	252	254	
	255	255	255	255	253	250	248	248	252	254	255	
	253	253	247	250	253	254	252	249	247	246	247	248
	255	255	247	247	250	251	250	248	247	247	250	251
	255	255	245	247	250	251	250	248	247	247	250	251
	253	253	245	247	249	251	250	248	247	247	250	251
	255	255	242	244	245	246	133	135	138	137	137	136
	255	255	245	244	249	246	130	132	134	134	135	135
	253	253	249	246	249	246	124	125	128	129	131	133
	250	250	250	245	250	245	124	123	122	123	126	130
	241	241	244	240	244	240	122	119	118	118	121	127
	241	241	240	234	240	234	117	112	109	109	117	124
	242	242	227	229	227	228	105	100	96	99	108	120
	227	227	227	228	227	228	93	87	86	89	101	114
	227	227	227	227	227	228	76	77	79	86	95	104
	69	70	73	80	88	95	112	117	124	129	135	140
	66	66	69	74	81	89	95	103	108	117	121	126
	66	66	69	74	81	89	95	100	110	113	117	

Histogram : Digital Image Sensor

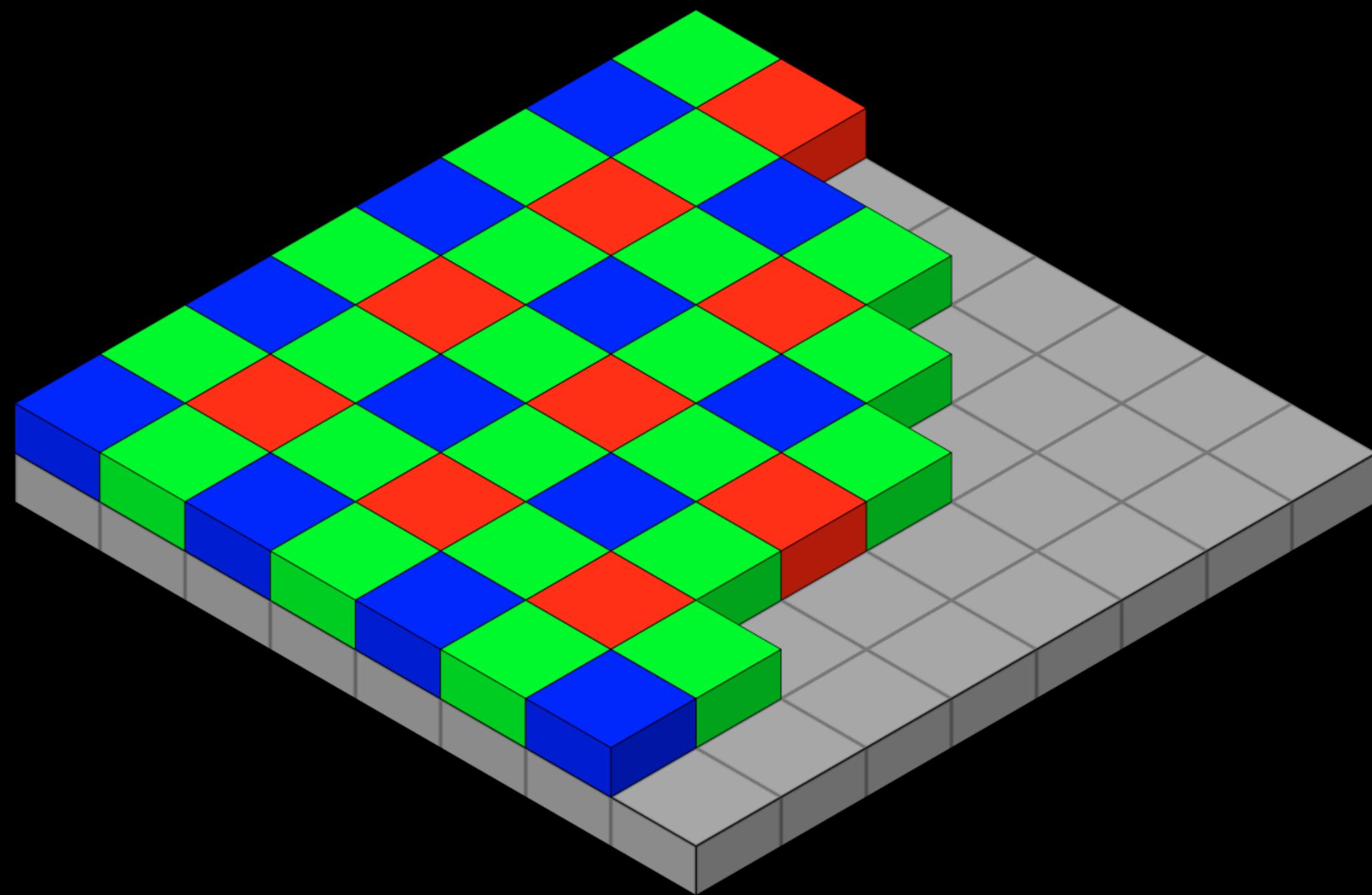


Bayer Sensor

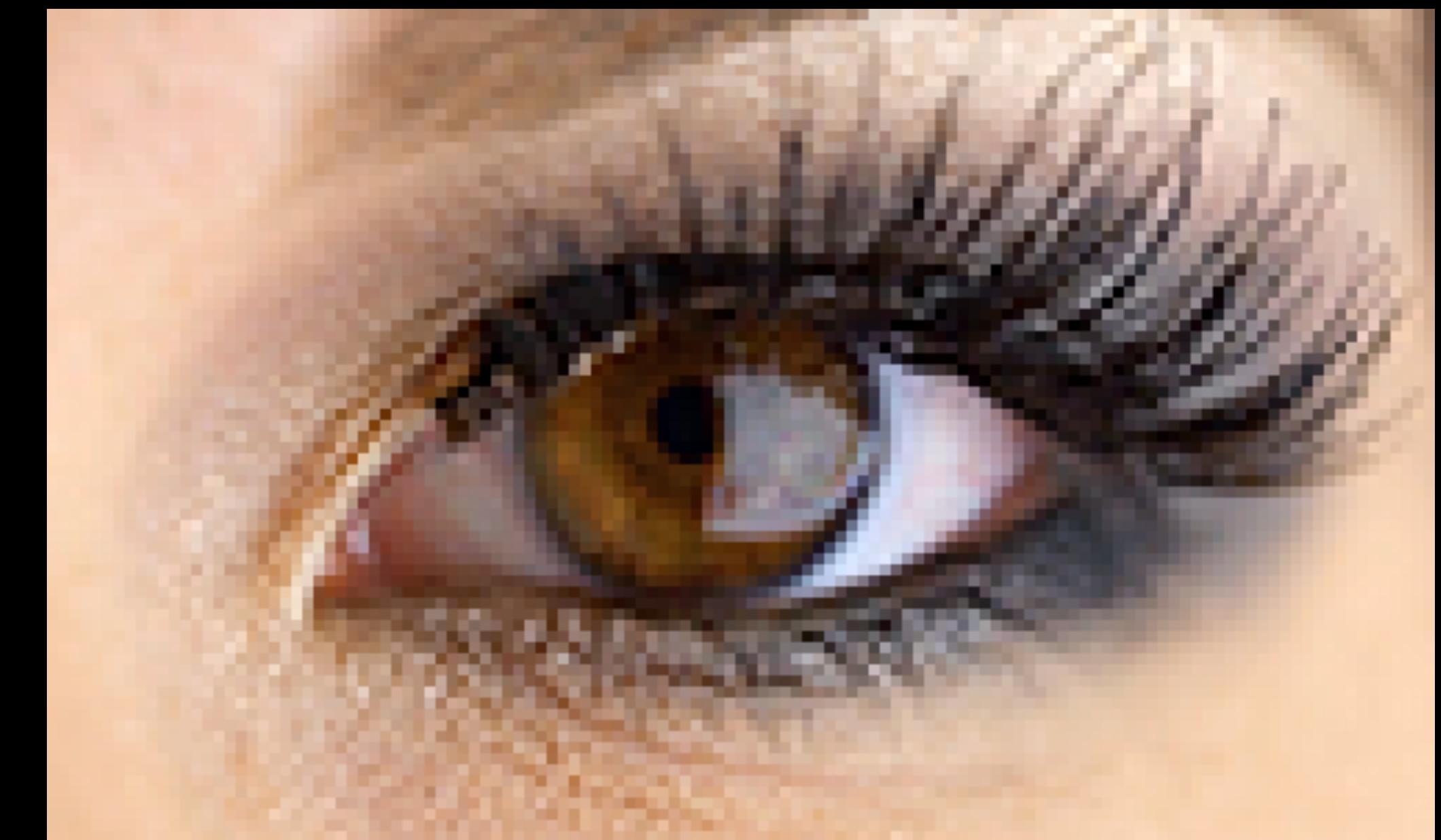


Source : <https://www.red.com/red-101/bayer-sensor-strategy>

Histogram : Digital Image Sensor



Bayer Sensor



Source : <https://www.red.com/red-101/bayer-sensor-strategy>

Histogram : Grayscale Images

- Image with single Channel



=



3 channels

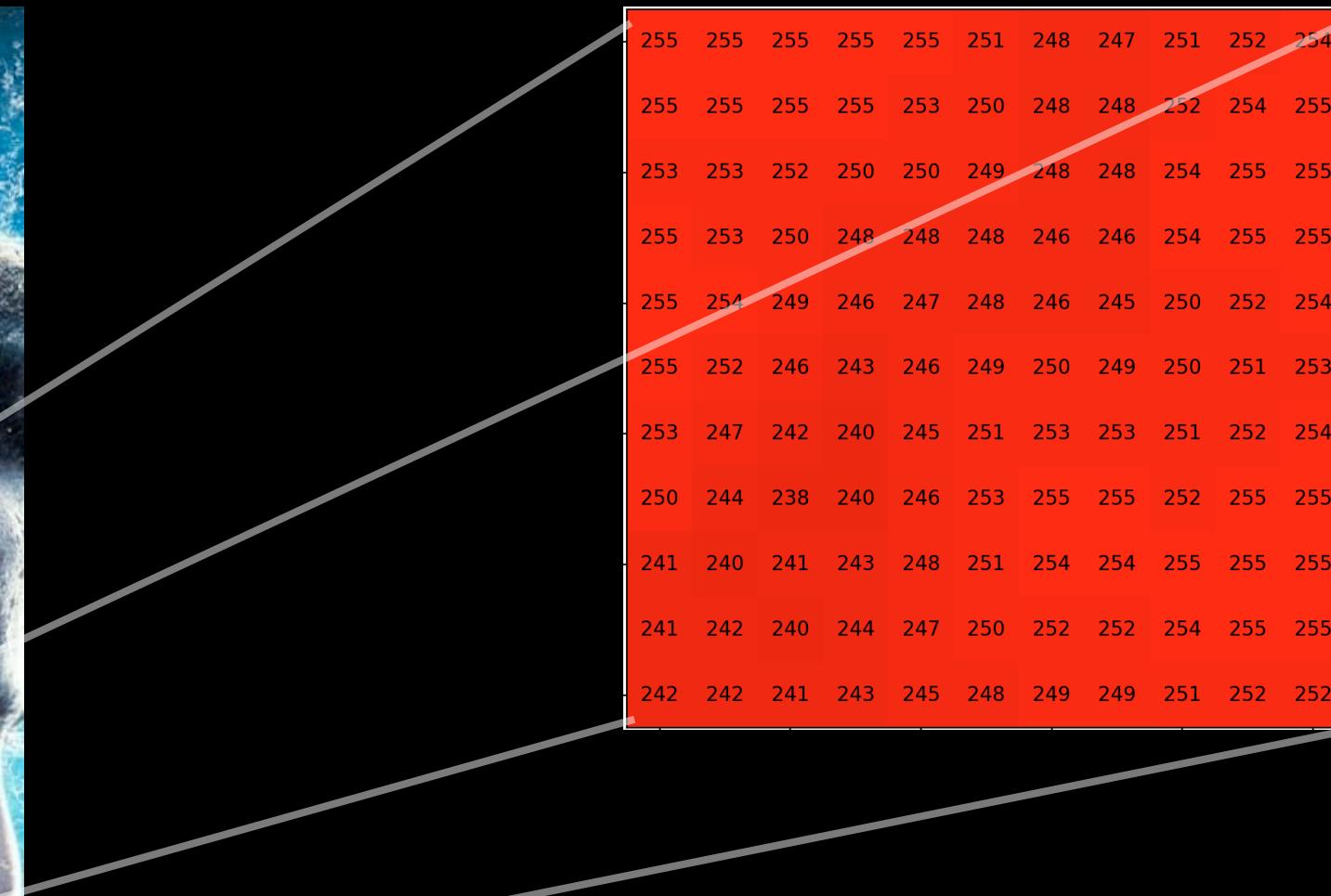
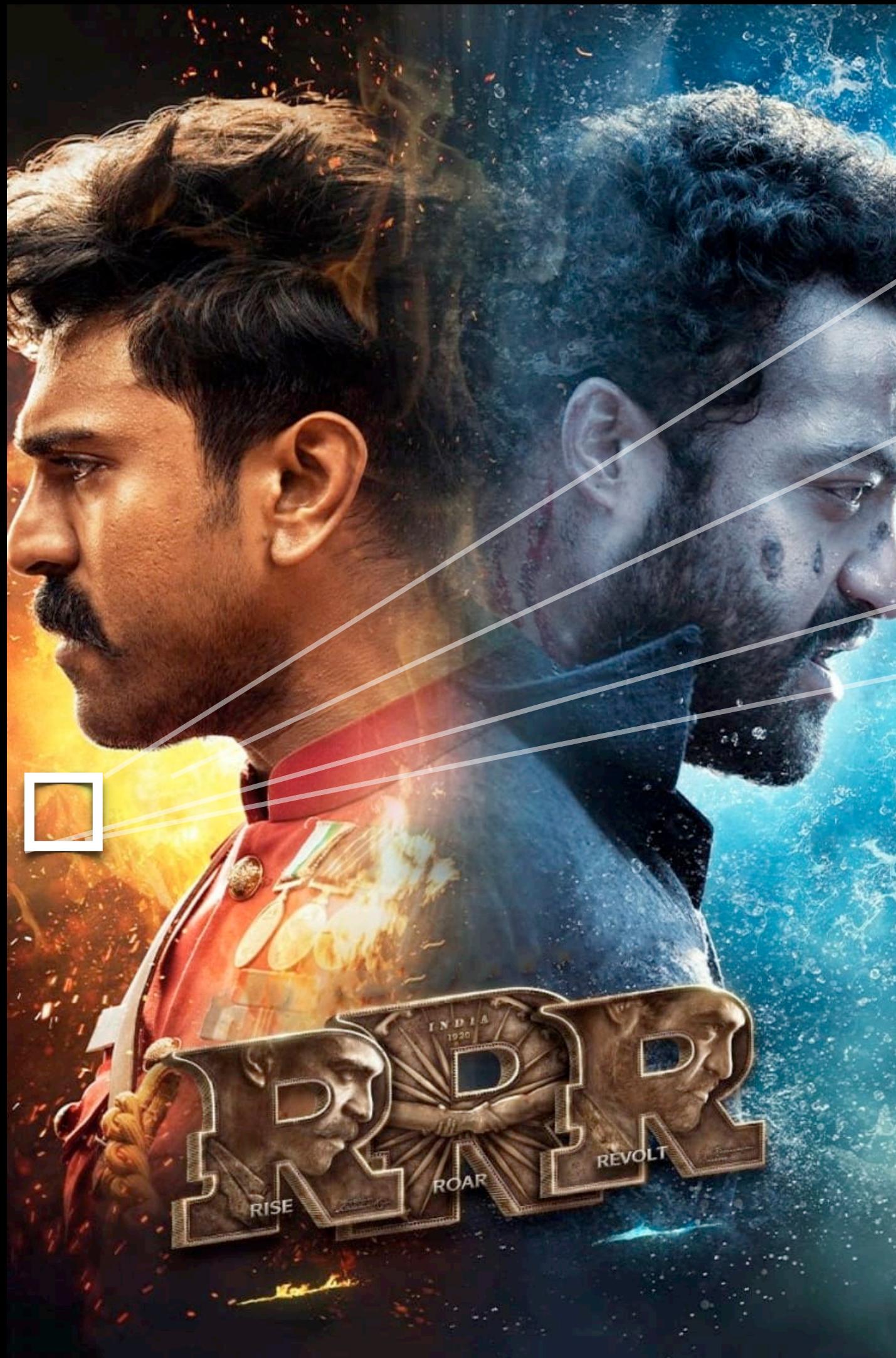
31

[892, 1338, 3]



1 channel = mean of 3 channels

Histogram : Digital Image

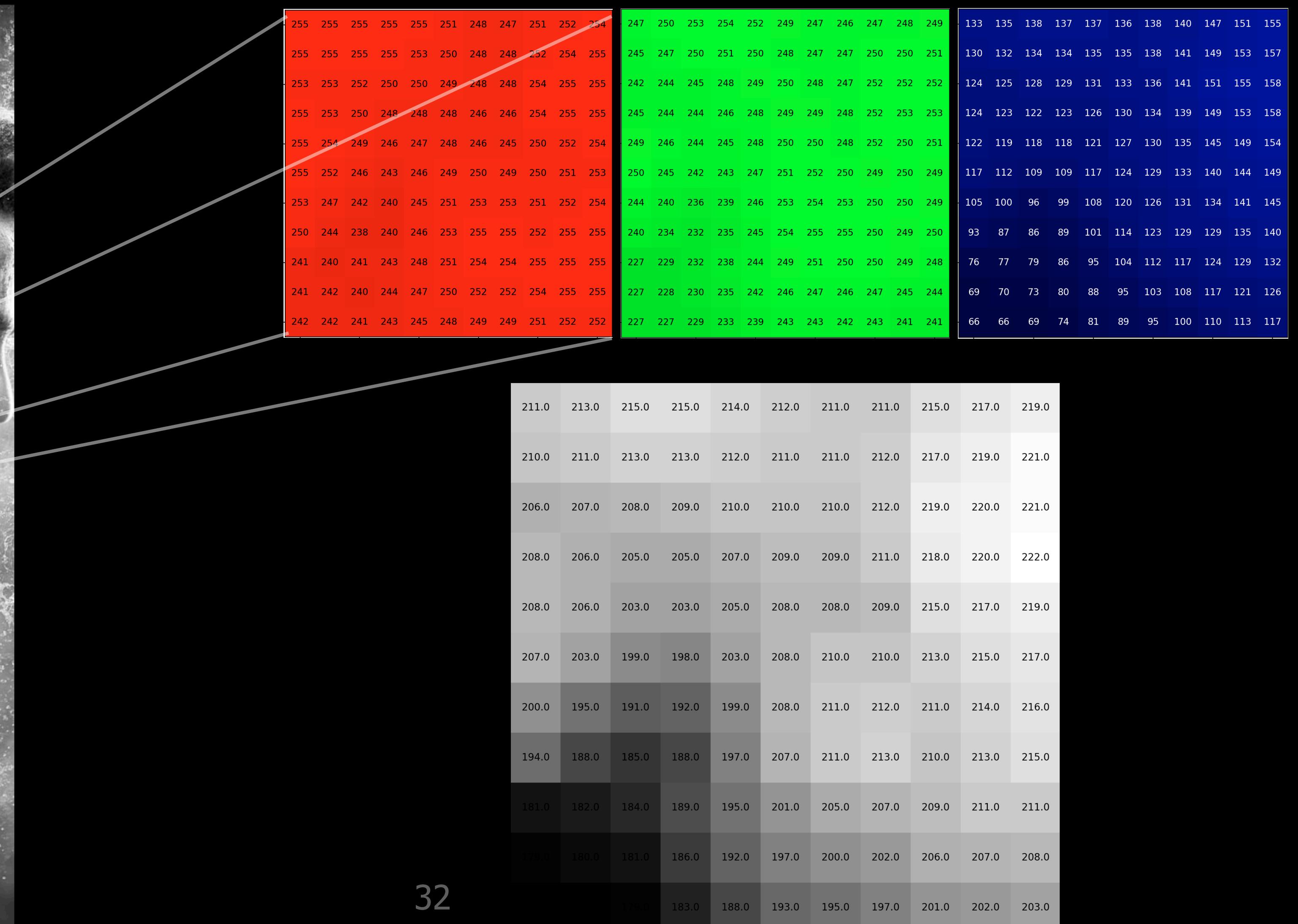


255	255	255	255	255	255	251	248	247	251	252	254
255	255	255	255	253	250	248	248	252	254	255	255
253	253	252	250	250	249	248	248	248	254	255	255
255	253	250	248	248	248	246	246	254	255	255	255
255	254	249	246	247	248	246	245	250	252	254	254
255	252	246	243	246	249	250	249	250	251	253	253
253	247	242	240	245	251	253	253	251	252	254	254
250	244	238	240	246	253	255	255	252	255	255	255
241	240	241	243	248	251	254	254	255	255	255	255
241	242	240	244	247	250	252	252	254	255	255	255

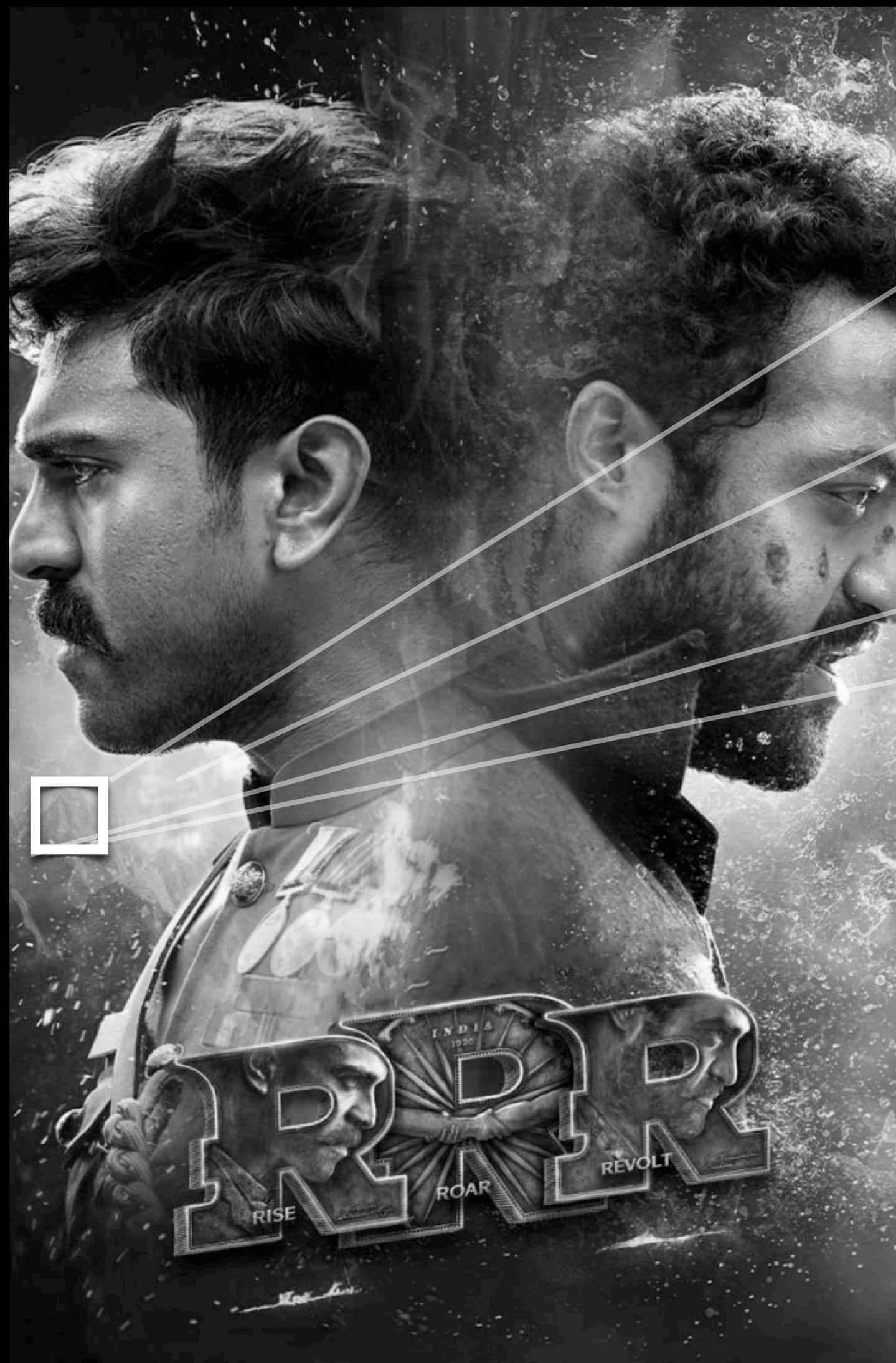
247	250	253	254	252	249	247	246	247	248	249
245	247	250	251	250	248	247	247	250	250	251
242	244	245	248	249	250	248	247	252	252	252
245	244	244	246	248	249	249	248	252	253	253
249	246	244	245	248	250	250	248	252	250	251
250	245	242	243	247	251	252	250	249	250	249
244	240	236	239	246	253	254	253	250	250	249
240	234	232	235	245	254	255	255	250	249	250
227	229	232	238	244	249	251	250	250	249	248
227	228	230	235	242	246	247	246	247	245	244
227	227	229	233	239	243	243	242	243	241	241

133	135	138	137	137	136	138	140	147	151	155
130	132	134	134	135	135	138	141	149	153	157
124	125	128	129	131	133	136	141	151	155	158
124	123	122	123	126	130	134	139	149	153	158
122	119	118	118	121	127	130	135	145	149	154
117	112	109	109	117	124	129	133	140	144	149
105	100	96	99	108	120	126	131	134	141	145
93	87	86	89	101	114	123	129	129	135	140
76	77	79	86	95	104	112	117	124	129	132
69	70	73	80	88	95	103	108	117	121	126
66	66	69	74	81	89	95	100	110	113	117

Histogram : Digital Image



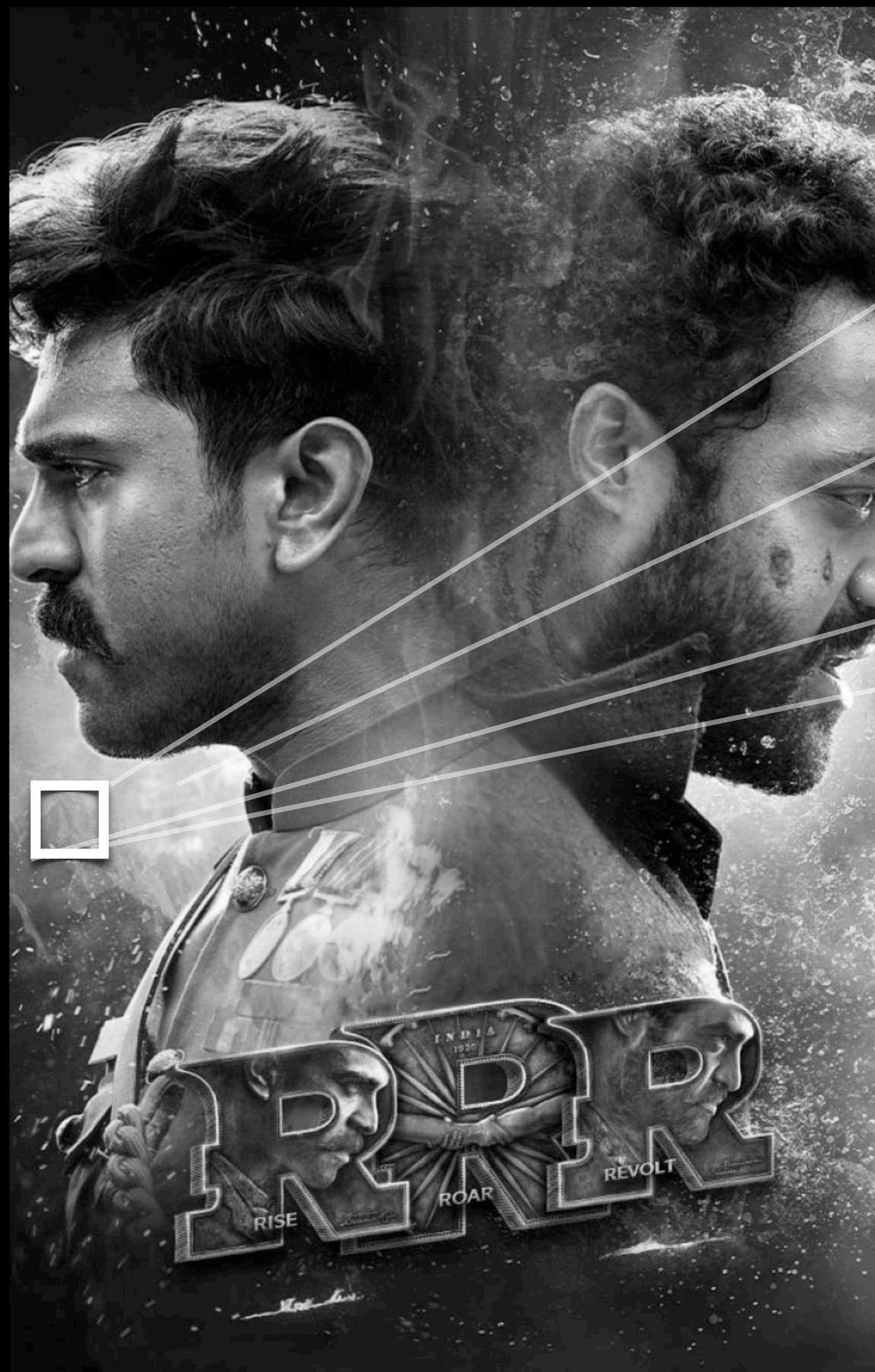
Histogram : Digital Image



255	255	255	255	255	255	251	248	247	251	252	254
255	255	255	255	253	250	248	248	252	254	255	255
253	253	252	250	250	249	248	248	254	255	255	255
255	253	250	248	248	248	246	246	254	255	255	255
255	254	249	246	247	248	246	245	250	252	254	254
255	252	246	243	246	249	250	249	250	251	253	253
253	247	242	240	245	251	253	253	251	252	254	254
250	244	238	240	246	253	255	255	252	255	255	255
241	240	241	243	248	251	254	254	255	255	255	255
241	242	240	244	247	250	252	252	254	255	255	255
242	242	241	243	245	248	249	249	251	252	252	252

211.0	213.0	215.0	215.0	214.0	212.0	211.0	211.0	215.0	217.0	219.0
210.0	211.0	213.0	213.0	212.0	211.0	211.0	212.0	217.0	219.0	221.0
206.0	207.0	208.0	209.0	210.0	210.0	210.0	212.0	219.0	220.0	221.0
208.0	206.0	205.0	205.0	207.0	209.0	209.0	211.0	218.0	220.0	222.0
208.0	206.0	203.0	203.0	205.0	208.0	208.0	209.0	215.0	217.0	219.0
207.0	203.0	199.0	198.0	203.0	208.0	210.0	210.0	213.0	215.0	217.0
200.0	195.0	191.0	192.0	199.0	208.0	211.0	212.0	211.0	214.0	216.0
194.0	188.0	185.0	188.0	197.0	207.0	211.0	213.0	210.0	213.0	215.0
181.0	182.0	184.0	189.0	195.0	201.0	205.0	207.0	209.0	211.0	211.0
179.0	180.0	181.0	186.0	192.0	197.0	200.0	202.0	206.0	207.0	208.0

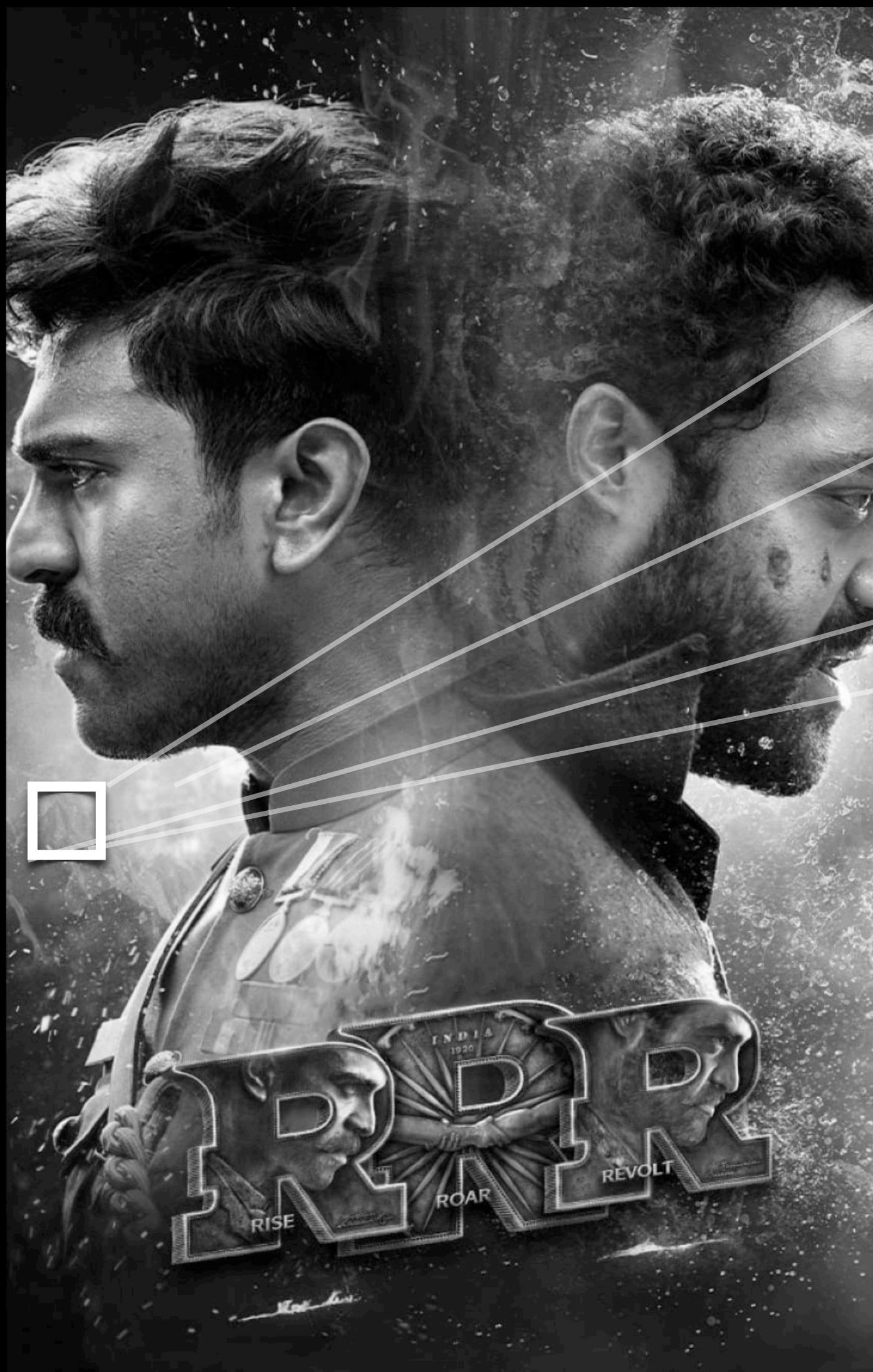
Histogram : Digital Image



255	255	255	255	255	255	251	248	247	251	252	254
255	255	255	255	253	250	248	248	252	254	255	255
253	253	252	250	250	249	248	248	254	255	255	255
255	253	250	248	248	248	246	246	254	255	255	255
255	254	249	246	247	248	246	245	250	252	254	254
255	252	246	243	246	249	250	249	250	251	253	253
253	247	242	240	245	251	253	253	251	252	254	254
250	244	238	240	246	253	255	255	252	255	255	255
241	240	241	243	248	251	254	254	255	255	255	255
241	242	240	244	247	250	252	252	254	255	255	255
242	242	241	243	245	248	249	249	251	252	252	252

211.0	213.0	215.0	215.0	214.0	212.0	211.0	211.0	215.0	217.0	219.0
210.0	211.0	213.0	213.0	212.0	211.0	211.0	212.0	217.0	219.0	221.0
206.0	207.0	208.0	209.0	210.0	210.0	210.0	212.0	219.0	220.0	221.0
208.0	206.0	205.0	205.0	207.0	209.0	209.0	211.0	218.0	220.0	222.0
208.0	206.0	203.0	203.0	205.0	208.0	208.0	209.0	215.0	217.0	219.0
207.0	203.0	199.0	198.0	203.0	208.0	210.0	210.0	213.0	215.0	217.0
200.0	195.0	191.0	192.0	199.0	208.0	211.0	212.0	211.0	214.0	216.0
194.0	188.0	185.0	188.0	197.0	207.0	211.0	213.0	210.0	213.0	215.0
181.0	182.0	184.0	189.0	195.0	201.0	205.0	207.0	209.0	211.0	211.0
179.0	180.0	181.0	186.0	192.0	197.0	200.0	202.0	206.0	207.0	208.0

Histogram : Digital Image



255	255	255	255	255	255	251	248	247	251	252	254
255	255	255	255	253	250	248	248	252	254	255	255
253	253	252	250	250	249	248	248	254	255	255	255
255	253	250	248	248	248	246	246	254	255	255	255
255	254	249	246	247	248	246	245	250	252	254	254
255	252	246	243	246	249	250	249	250	251	253	253
253	247	242	240	245	251	253	253	251	252	254	254
250	244	238	240	246	253	255	255	252	255	255	255
241	240	241	243	248	251	254	254	255	255	255	255
241	242	240	244	247	250	252	252	254	255	255	255
242	242	241	243	245	248	249	249	251	252	252	252

247	250	253	254	252	249	247	246	247	248	249
245	247	250	251	250	248	247	247	250	250	251
242	244	245	248	249	250	248	247	252	252	252
245	244	244	246	248	249	249	248	252	253	253
249	246	244	245	248	250	250	248	252	250	251
250	245	242	243	247	251	251	252	250	249	249
244	240	236	239	246	253	254	253	250	250	249
240	234	232	235	245	254	255	255	250	249	250
227	229	232	238	244	249	251	250	250	249	248
227	228	230	235	242	246	247	246	247	245	244
227	227	229	233	239	243	243	242	243	241	241

133	135	138	137	137	136	138	140	147	151	155
130	132	134	134	135	135	138	141	149	153	157
124	125	128	129	131	133	136	141	151	155	158
124	123	122	123	126	130	134	139	149	153	158
122	119	118	118	121	127	130	135	145	149	154
117	112	109	109	117	124	129	133	140	144	149
105	100	96	99	108	120	126	131	134	141	145
93	87	86	89	101	114	123	129	129	135	140
76	77	79	86	95	104	112	117	124	129	132
69	70	73	80	88	95	103	108	117	121	126
66	66	69	74	81	89	95	100	110	113	117

211.0	213.0	215.0	215.0	214.0	212.0	211.0	211.0	215.0	217.0	219.0
210.0	211.0	213.0	213.0	212.0	211.0	211.0	212.0	217.0	219.0	221.0
206.0	207.0	208.0	209.0	210.0	210.0	210.0	212.0	219.0	220.0	221.0
208.0	206.0	205.0	205.0	207.0	209.0	209.0	211.0	218.0	220.0	222.0
208.0	206.0	203.0	203.0	205.0	208.0	208.0	209.0	215.0	217.0	219.0
207.0	203.0	199.0	198.0	203.0	208.0	210.0	210.0	213.0	215.0	217.0
200.0	195.0	191.0	192.0	199.0	208.0	211.0	212.0	211.0	214.0	216.0
194.0	188.0	185.0	188.0	197.0	207.0	211.0	213.0	210.0	213.0	215.0
181.0	182.0	184.0	189.0	195.0	201.0	205.0	207.0	209.0	211.0	211.0
179.0	180.0	181.0	186.0	192.0	197.0	200.0	202.0	206.0	207.0	208.0

Histogram : Grayscale Images

3 4 2 1 9 5 6 2 1 8
 8 9 1 2 5 0 0 6 6 4
 6 7 0 1 6 3 6 3 7 0
 3 7 7 9 4 6 6 1 8 2
 2 9 3 4 3 9 8 7 2 5
 1 5 9 8 3 6 5 7 2 3
 9 3 1 9 1 5 8 0 8 4
 5 6 2 6 8 5 8 8 9 9
 3 7 7 0 9 4 8 5 4 3
 7 9 6 4 7 0 6 9 2 3

MNIST Data



0	2	15	0	0	11	10	0	0	0	0	9	9	0	0	0
0	0	0	4	60	157	236	255	255	177	95	61	32	0	0	29
0	10	16	119	238	255	244	245	243	250	249	255	222	103	10	0
0	14	170	255	255	244	254	255	253	245	255	249	253	251	124	1
2	98	255	228	255	251	254	211	141	116	122	215	251	238	255	49
13	217	243	255	155	33	226	52	2	0	10	13	232	255	255	36
16	229	252	254	49	12	0	0	7	7	0	70	237	252	235	62
6	141	245	255	212	25	11	9	3	0	115	236	243	255	137	0
0	87	252	250	248	215	60	0	1	121	252	255	248	144	6	0
0	13	113	255	255	245	255	182	181	248	252	242	208	36	0	19
1	0	5	117	251	255	241	255	247	255	241	162	17	0	7	0
0	0	0	4	58	251	255	246	254	253	255	120	11	0	1	0
0	0	4	97	255	255	255	248	252	255	244	255	182	10	0	4
0	22	206	252	246	251	241	100	24	113	255	245	255	194	9	0
0	111	255	242	255	158	24	0	0	6	39	255	232	230	56	0
0	218	251	250	137	7	11	0	0	0	2	62	255	250	125	3
0	173	255	255	101	9	20	0	13	3	13	182	251	245	61	0
0	107	251	241	255	230	98	55	19	118	217	248	253	255	52	4
0	18	146	250	255	247	255	255	249	255	240	255	129	0	5	0
0	0	23	113	215	255	250	248	255	255	248	248	118	14	12	0
0	0	6	1	0	52	153	233	255	252	147	37	0	0	4	1
0	0	5	5	0	0	0	0	0	14	1	0	6	6	0	0

0	2	15	0	0	11	10	0	0	0	0	9	9	0	0	0
0	0	0	4	60	157	236	255	255	177	95	61	32	0	0	29
0	10	16	119	238	255	244	245	243	250	249	255	222	103	10	0
0	14	170	255	255	244	254	255	253	245	255	249	253	251	124	1
2	98	255	228	255	251	254	211	141	116	122	215	251	238	255	49
13	217	243	255	155	33	226	52	2	0	10	13	232	255	255	36
16	229	252	254	49	12	0	0	7	7	0	70	237	252	235	62
6	141	245	255	212	25	11	9	3	0	115	236	243	255	137	0
0	87	252	250	248	215	60	0	1	121	252	255	248	144	6	0
0	13	113	255	255	245	255	182	181	248	252	242	208	36	0	19
1	0	5	117	251	255	241	255	247	255	241	162	17	0	7	0
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0	173	255	255	101	9	20	0	13	3	13	182	251	245	61	0
0	107	251	241	255	230	98	55	19	118	217	248	253	255	52	4
0	18	146	250	255	247	255	255	249	255	240	255	129	0	5	0
0	0	23	113	215	255	250	248	255	255	248	248	118	14	12	0
0	0	6	1	0	52	153	233	255	252	147	37	0	0	4	1
0	0	5	5	0	0	0	0	0	14	1	0	6	6	0	0

Source : <https://github.com/NehaCkumari/MNIST-Handwritten-Digit-Recognition-using-CNN>

Histogram : Grayscale Images

- Image with single Channel

3 4 2 1 9 5 6 2 1 8
 8 9 1 2 5 0 0 6 6 4
 6 7 0 1 6 3 6 3 7 0
 3 7 7 9 4 6 6 1 8 2
 2 9 3 4 3 9 8 7 2 5
 1 5 9 8 3 6 5 7 2 3
 9 3 1 9 1 5 8 0 8 4
 5 6 2 6 8 5 8 8 9 9
 3 7 7 0 9 4 8 5 4 3
 7 9 6 4 7 0 6 9 2 3

MNIST Data



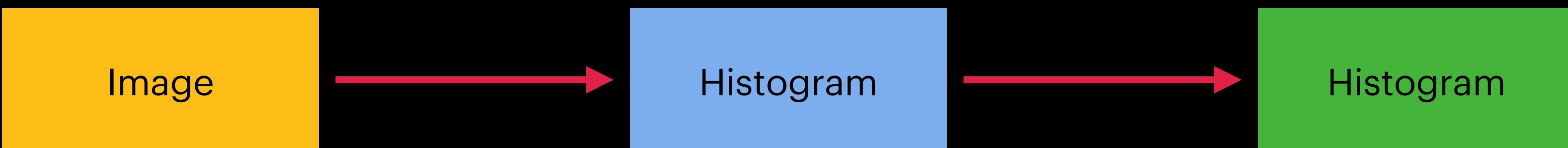
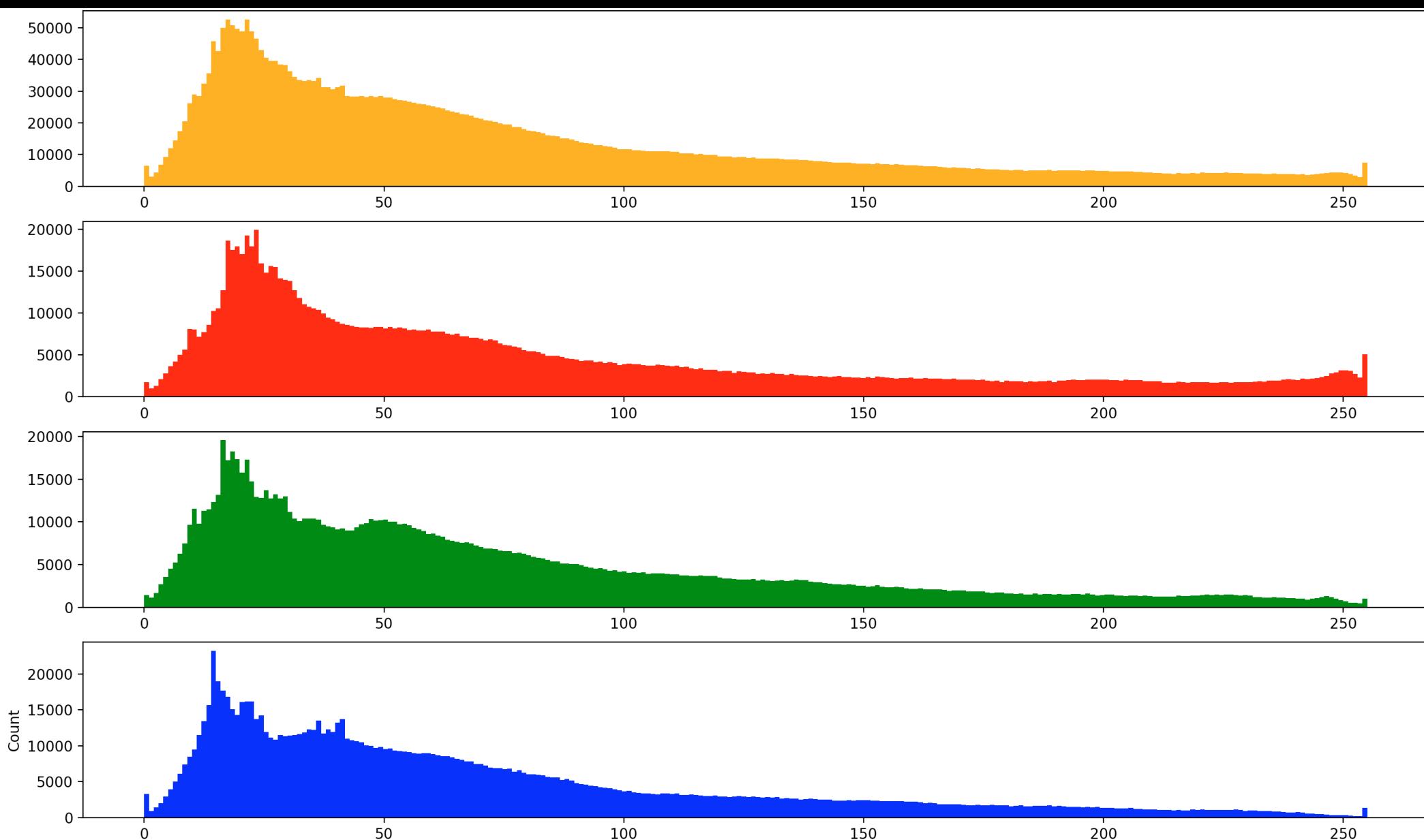
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0	0	0	4	60	157	236	255	255	177	95	61	32	0	0	29
0	10	16	119	238	255	244	245	243	250	249	255	222	103	10	0
0	14	170	255	255	244	254	255	253	245	255	249	253	251	124	1
2	98	255	228	255	251	254	211	141	116	122	215	251	238	255	49
13	217	243	255	155	33	226	52	2	0	10	13	232	255	255	36
16	229	252	254	49	12	0	0	7	7	0	70	237	252	235	62
6	141	245	255	212	25	11	9	3	0	115	236	243	255	137	0
0	87	252	250	248	215	60	0	1	121	252	255	248	144	6	0
0	13	113	255	255	245	255	182	181	248	252	242	208	36	0	19
1	0	5	117	251	255	241	255	247	255	241	162	17	0	7	0
0	0	0	4	58	251	255	246	254	253	255	120	11	0	1	0
0	0	4	97	255	255	248	252	255	244	255	182	10	0	4	0
0	22	206	252	246	251	241	100	24	113	255	245	255	194	9	0
0	111	255	242	255	158	24	0	0	6	39	255	232	230	56	0
0	218	251	250	137	7	11	0	0	0	2	62	255	250	125	3
0	173	255	255	101	9	20	0	13	3	13	182	251	245	61	0
0	107	251	241	255	230	98	55	19	118	217	248	253	255	52	4
0	18	146	250	255	247	255	255	249	255	240	255	129	0	5	0
0	0	23	113	215	255	250	248	255	255	248	248	118	14	12	0
0	0	6	1	0	52	153	233	255	252	147	37	0	0	4	1
0	0	5	5	0	0	0	0	0	14	1	0	6	6	0	0

0	2	15	0	0	11	10	0	0	0	0	9	9	0	0	0
0	0	0	4	60	157	236	255	255	177	95	61	32	0	0	29
0	10	16	119	238	255	244	245	243	250	249	255	222	103	10	0
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2	98	255	228	255	251	254	211	141	116	122	215	251	238	255	49
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6	141	245	255	212	25	11	9	3	0	115	236	243	255	137	0
0	87	252	250	248	215	60	0	1	121	252	255	248	144	6	0
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0	0	4	97	255	255	248	252	255	244	255	182	10	0	4	0
0	22	206	252	246	251	241	100	24	113	255	245	255	194	9	0
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0	173	255	255	101	9	20	0	13	3	13	182	251	245	61	0
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0	0	23	113	215	255	250	248	255	255	248	248	118	14	12	0
0	0	6	1	0	52	153	233	255	252	147	37	0	0	4	1
0	0	5	5	0	0	0	0	0	14	1	0	6	6	0	0

Source : <https://github.com/NehaCkumari/MNIST-Handwritten-Digit-Recognition-using-CNN>

Histogram : Let's Define Goals

- Always reiterate inputs
- And where we need to reach from here



How to approach any problem ?

1. Note down given information
2. Note down what we desire to find
3. Go on with the approach
4. Verify your result with the desired result

STAR : Situation, Task, Action, Result

Q: Find roots of $x^2 + 5x + 6 = 0$

A:

- 1 **Given :** $x^2 + 5x + 6 = 0$
 $a = 1, b = 5, c = 6$
- 2 **x = ?**
- 3
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-5 \pm \sqrt{5^2 - 4(1)(6)}}{2(1)}$$

$$= \frac{-5 \pm 1}{2}$$

$$= -3, -2$$
 $\therefore x = -2, -3$
- 4 **Verify :** $(x+2)(x+3) = \underline{\underline{x^2 + 5x + 6}}$

How to approach our problem ?

1. Given Image.
2. Required output : Histogram
3. Go on with the coding and matrix manipulations
4. Verify your result with the desired result

STAR : Situation, Task, Action, Result

Computer Programming :

- Why do we need language?
 - To communicate with ourselves
 - Life evolution

Natural Language :

- Why do we need language?
 - To communicate with ourselves
 - Life evolution

Natural Language :

- Earth before larynx?
- Before reptiles
- Frogs were first to develop larynx
- Why?
- Or What advantage?
- Dinosaurs in Jurassic Park



Natural Language :

- Why do we need language?
 - To communicate with ourselves
 - Helped animals to survive and mate.
- Humans were first to map words with abstract ideas.
- Humans were first to map words with visual symbols
- Later, humans framed rules for communication
- And, called it language
- Grammar
- Language is symbols (with rules) for real world.



<https://socratic.org/questions/what-is-an-abstract-idea>



Computer Programming :

Computer Programming :

- Computer Languages

Computer Programming :

- Computer Languages
- To tinker with the computers

Computer Programming :

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Computer Programming :

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 - Output from microprocessor will also be in 0 & 1 (010010100..)

Computer Programming :

- Computer Languages
- To tinker with the computers
- To make computers do what we want
- A set of instructions in the particular language : **Code , program**
- Any computer code cycle :
 - Human writes the code using keyboard
 - The code will be converted to 0 & 1 (010010100..) - using interpreter or compiler
 - The 0 & 1 (010010100..) code will be passed to microprocessor
 - Output from microprocessor will also be in 0 & 1 (010010100..)
 - Need to be parsed again to the output we require / understand

Computer Programming :

- Question 1 :
 - How do we store the real world data into computers?
 - Especially to the programming language?
- How do we do in real world?
- Simpler question : How do we store information in real world ? Before computers ?
- Take a book / taalapatram
- Take a pen / ghantamu / dabbalamu
- Jot down the ideas

Computer Programming :

Computer Programming :

- Library



Computer Programming :

- Library
- Sections



Computer Programming

- Library
- Sections
- Book Name

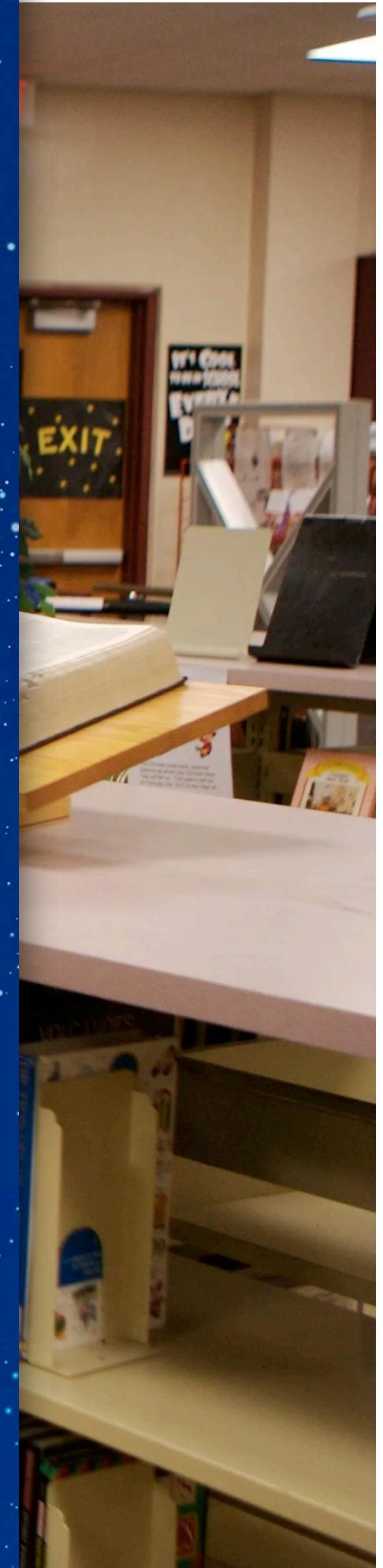
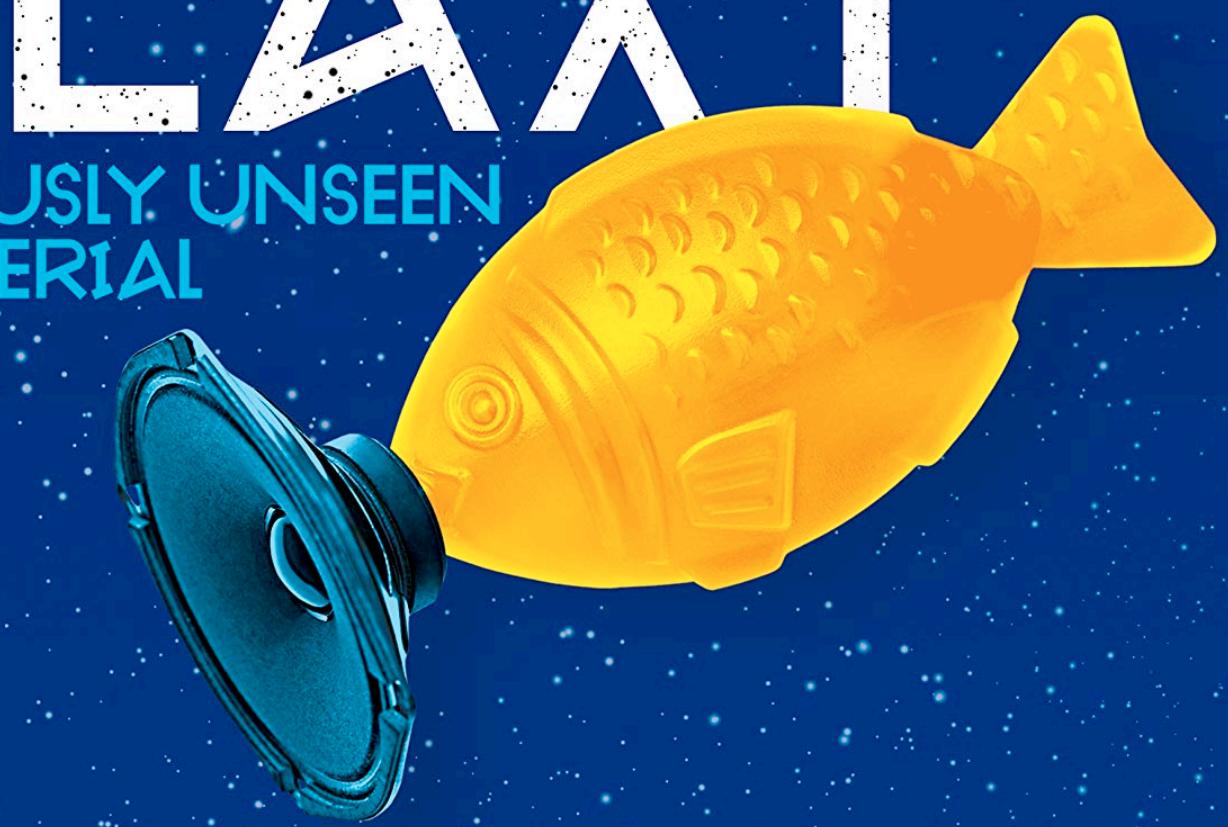


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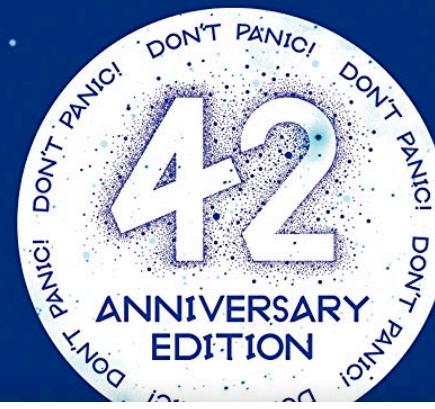
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Chapter 1

The house stood on a slight rise just on the edge of the village. It stood on its own and looked out over a broad spread of West Country farmland. Not a remarkable house by any means—it was about thirty years old, squatish, squarish, made of brick, and had four windows set in the front of a size and proportion which more or less exactly failed to please the eye.

The only person for whom the house was in any way special was Arthur Dent, and that was only because it happened to be the one he lived in. He had lived in it for about three years, ever since he had moved out of London because it made him nervous and irritable. He was about thirty as well, tall, dark-haired and never quite at ease with himself. The thing that used to worry him most was the fact that people always used to ask him what he was looking so worried about. He worked in local radio which he always used to tell his friends was a lot more interesting than they probably thought. It was, too—most of his friends worked in advertising.

On Wednesday night it had rained very heavily, the lane was wet and muddy, but the Thursday morning sun was bright and clear as it shone on Arthur Dent's house for what was to be the last time.

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- What about them in the programming languages?
- C, Python, Matlab

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Computer Programming : Variables

Computer Programming : Variables

C

- int → 2 bytes
- float → 4 bytes
- char
 - 1 byte
- bool
 - 1 bit

Computer Programming : Variables

C

- int → 2 bytes
- float → 4 bytes
- char
 - 1 byte
- bool
 - 1 bit
 - int age = 42
 - float weight = 23.24
 - char first_letter = "a"
 - bool light = True

Computer Programming : Variables

C	Python
• int → 2 bytes	• Integers
• float → 4 bytes	• Float
• char	• Characters/strings
• 1 byte	• Boolean
• bool	
• 1 bit	
	• int age = 42
	• float weight = 23.24
	• char first_letter = "a"
	• bool light = True

Computer Programming : Variables

C	Python
• int → 2 bytes	• Integers
• float → 4 bytes	• Float
• char	• Characters/strings
• 1 byte	• Boolean
• bool	
• 1 bit	
	• x = 42
	• x = 234.23
	• x = "hello"
	• x = True
	• X = False

Computer Programming : Variables

C	Python	Matlab
• int → 2 bytes	• Integers	• Integers
• float → 4 bytes	• Float	• Float
• char	• Characters/strings	• Characters/strings
• 1 byte	• Boolean	• Boolean
• bool		
• 1 bit	• x = 42 • x = 234.23 • x = "hello" • x = True • X = False	

Computer Programming : Variables

C	Python	Matlab
• int → 2 bytes	• Integers	• Integers
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• char	• Characters/strings	• Characters/strings
• 1 byte	• Boolean	• Boolean
• bool		
• 1 bit	• x = 42 • x = 234.23 • x = "hello" • x = True • X = False	• x = 42 • x = 234.23 • x = "hello" • x = True • x = False

Computer Programming : Syntax

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- Syntax = Grammar
- Natural languages rules is Grammar
- Programming languages rules is Syntax
- Each language has its own rules.

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- C says :
 - “Use semicolon (;) after every statement ;”
 - “I will ignore everything after “//” and everything between “/* */” .”

Computer Programming : Syntax

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- Syntax = Grammar
- C says :
 - “Use **semicolon** (;) after every statement ;”
 - “Use **flower brackets** {} to each specify scope”
 - “Will ignore everything after “//” and everything between “/* */ ”.

Computer Programming : Syntax

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- C says :
 - “Use **semicolon** (;) after every statement ;”
 - “Use **flower brackets** {} to each specify scope”
 - “Will ignore everything after “//” and everything between “/* */ ”.
- Python says :
 - “Need **indentation** for scope”
 - “Will ignore everything after “#”.”

Computer Programming : Syntax

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- C says :
 - “Use **semicolon** `;` after every statement ;”
 - “Use **flower brackets** `{}` to each specify scope”
 - “Will ignore everything after `//` and everything between `/* */` ”.
- Python says :
 - “Need **indentation** for scope”
 - “Will ignore everything after `#`”.
- Matlab says :
 - “No need for indentation, semicolons and `{}` ; But I will print if you don’t use `();`”.
 - “Will ignore everything after `%%`”.

Computer Programming : Syntax

C	Python	Matlab
<ul style="list-style-type: none">• int → 2 bytes• float → 4 bytes• char<ul style="list-style-type: none">• 1 byte• bool<ul style="list-style-type: none">• 1 bit• int x = 42• float y = 23.24• char z = "a"• bool a = True	<ul style="list-style-type: none">• Integers• Float• Characters/strings• Boolean<ul style="list-style-type: none">• x = 42• x = 234.23• x = "hello"• x = True• X = False	<ul style="list-style-type: none">• Integers• Float• Characters/strings• Boolean<ul style="list-style-type: none">• x = 42• x = 234.23• x = "hello"• x = True• x = False

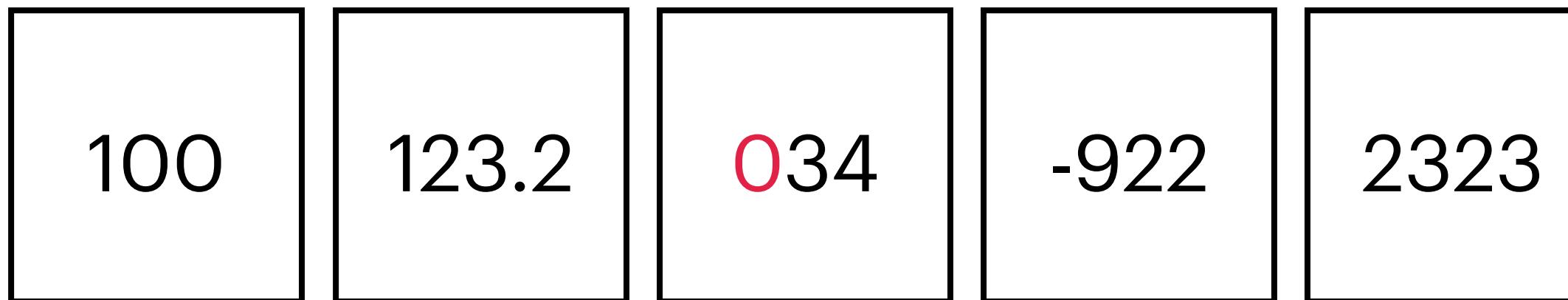
Computer Programming : Syntax

C	Python	Matlab
<ul style="list-style-type: none">• int → 2 bytes• float → 4 bytes• char• 1 byte• bool• 1 bit <div style="border: 2px solid blue; padding: 5px;"><ul style="list-style-type: none">• int x = 42 ;• float y = 23.24 ;• char z = "a" ;• bool a = True ;</div>	<ul style="list-style-type: none">• Integers• Float• Characters/strings• Boolean<ul style="list-style-type: none">• x = 42• x = 234.23• x = "hello"• x = True• X = False	<ul style="list-style-type: none">• Integers• Float• Characters/strings• Boolean<ul style="list-style-type: none">• x = 42• x = 234.23• x = "hello"• x = True• x = False

Computer Programming : Arrays

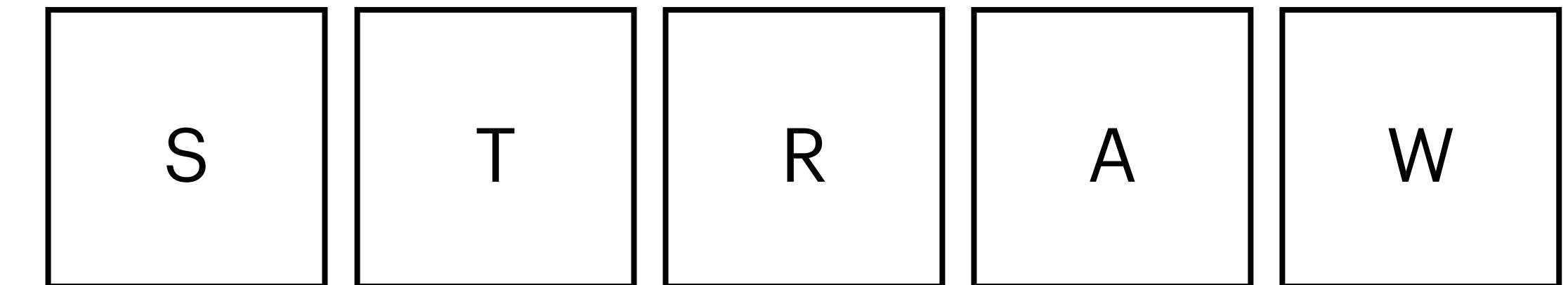
- We need group of values often.
 - Roll numbers, Names, Sentences
 - To store them we need arrays.
-
- C : “I will give only same type arrays.”
 - `int x[100]; float y[100]; char z[100]; bool p[100];`
 - Python : “Take any type you want”
 - `x = [100, 123.345, "Hello, world!", True, False]`
 - `x = ["string", [100, 123.345, "Hello, world!", True, False]]`
 - Matlab : “You can have an array of Numbers”
 - `x = [100, 20.23, 502, 1e2];`

Computer Programming : Arrays & Strings



Arrays

[100, 123.2, 34, -922, 2323]



Strings

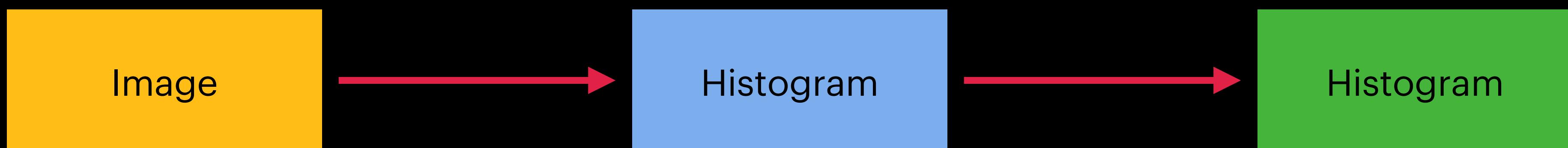
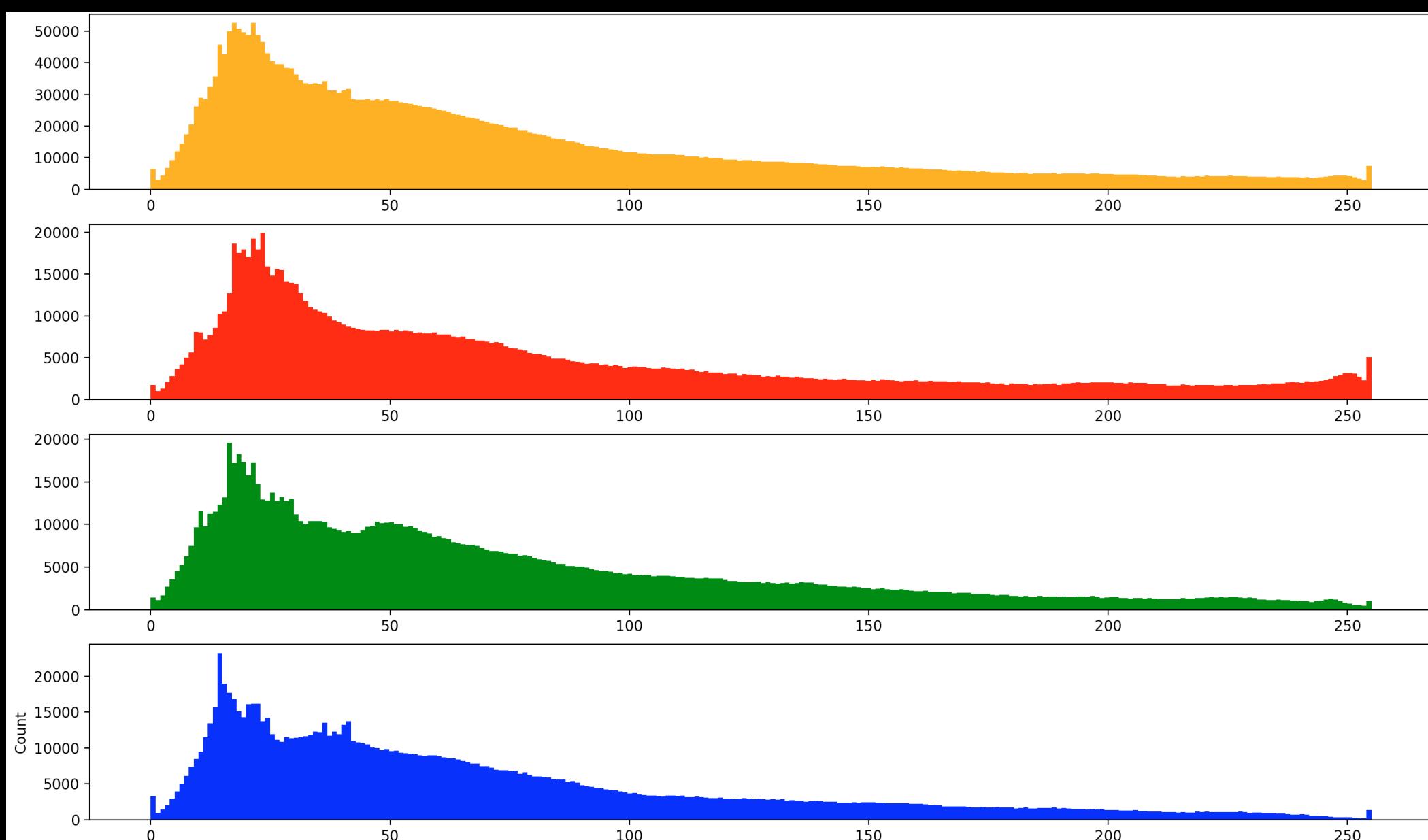
"Straw" or ["s", "t", "r", "a", "w"]

Computer Programming : Functions

- Functions
- Custom Variables :
 - Custom variables in C, Python, Matlab
 - Blueprints
 - Classes
 - Object Oriented Programming
- Libraries
 - Need for libraries
 - Libraries in C, Python, Matlab

Histogram in Python

- Always reiterate inputs
- And where we need to reach from here



Natural Language - Metaphors :

- Up
- Down
- Warm
- Cool

Assignment 2 : George Lakoff and Mark Johnsen - Metaphors we live by (2003)

One person per chapter - 2 to 3 pages max

Koushik and Madhava will assign you.

Markdown :

- Similar to HTML
- Easy to parse
- Online tool : <https://dillinger.io/>
- <https://www.markdowntutorial.com/>
- <https://www.markdownguide.org/cheat-sheet/>

Element	Markdown Syntax
Heading	# H1 ## H2 ### H3
Bold	bold text
Italic	<i>italicized text</i>
Blockquote	>blockquote
Ordered List	1. First item 2. Second item 3. Third item
Unordered List	- First item - Second item - Third item
Code	`code`
Horizontal Rule	---
Link	[title](https://www.example.com)
Image	![alt text](image.jpg)



Thank you

Be Hungry & Active