




Compare

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	Level	Completed	Goal
	Beginner	6	9
	Intermediate	3	
	Advanced	0	Total Completed
	Expert	0	9 9

Compare

CSCI 5722: Computer Vision

Fall 2024

Dr. Tom Yeh



Large Vision Model's ability to compare images

Select a recent travel photo of yours. Paste it to image 1. Make a copy and paste it to image 2. Make some small modifications to image 2. Your goal is to see if a large vision model can compare them and find the differences. Take a screenshot of both images and use the screenshot as the “image” prompt. Add a text prompt. Experiment with different prompts and share the best one.

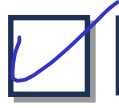




(cont.) Prompt

LLM used: ChatGPT 4o

Compare this original image with a second one that I will share with you and tell me the differences that you see and describe them to me



(cont.) Response

Comparing the two images, here are the primary differences:

Color Inversion:

The second image has an inverted or negative color effect, where colors are the opposite of the original. For example, the greens of the trees in the first image have turned into purples and blues in the second image, and the sky, which is originally blue, has turned into darker orange or brownish shades.

Brightness and Contrast:

The second image has increased contrast due to the inversion, making details such as facial features, the glasses, and the landscape sharper in terms of dark-light contrast.

Tilted Perspective:

The second image appears to be slightly tilted or skewed to the right, possibly a result of some transformation or editing, whereas the first image is in a standard upright position.

Compare Pixels

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Q: Which looks like X the most? A or B?

X

2	1	0
0	1	3
-3	1	2

A

2	1	3
0	1	3
4	1	-2

B

1	1	0
2	1	4
-2	1	3

Count Different Pixels

X

2	1	0
0	1	3
-3	1	2

A

2	1	0
0	1	3
4	1	-2

$X \neq A$

{ distance | similarity }

Σ { min | max }

--

--

B

1	1	0
2	1	4
-2	1	3

$X \neq B$

--

--

L1

a.k.a. _____

{ distance | similarity }

X

2	1	0
0	1	3
-3	1	2

A

2	1	0
0	1	3
4	1	-2

$|X - A|$

Σ

{ min | max }

B

1	1	0
2	1	4
-2	1	3

$|X - B|$

☒ ☐ L1 Distance

X		
0	1	2
1	1	3
3	0	2

A		
2	1	0
0	1	3
4	1	-2

$ X - A $		
2	0	2
1	0	0
1	1	4

Σ
11

a

{ min | max }



B		
1	1	0
2	1	4
-2	1	3

$ X - B $		
1	0	2
1	0	1
5	1	1

12

b



a + b =
23

L2

a.k.a. _____ { distance | similarity }

X

2	1	0
0	1	3
-3	1	2

A

2	1	0
0	1	3
4	1	-2

$(X - A)^2$

Σ

$\sqrt{\square}$

{ min | max }

B

1	1	0
2	1	4
-2	1	3

$(X - B)^2$

☒ ☐ L2 Distance

X		
0	1	2
1	1	3
3	0	2

A		
2	1	0
0	1	3
4	1	0

$(X - A)^2$		
4	0	4
1	0	0
1	1	4

Σ $\sqrt{\frac{\quad}{\quad}}$ { min | max }

a

B		
1	1	0
2	1	4
2	1	3

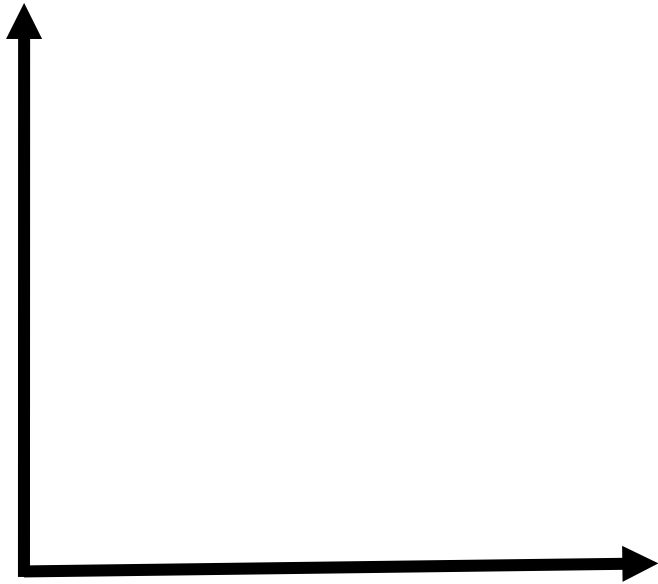
$(X - B)^2$		
1	0	4
1	0	1
1	1	1

☒

b

$a + b =$
 25

Cosine



$$\cos () = \frac{\boxed{}}{\boxed{}}$$

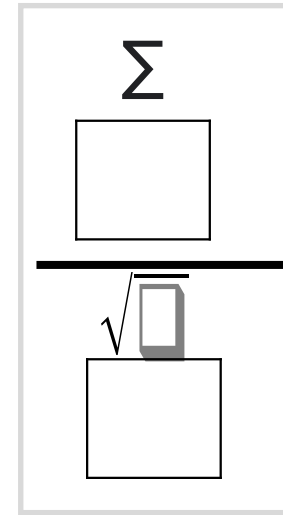
$$\cos () = \frac{\boxed{}}{\boxed{}}$$

Cosine { distance | similarity } { min | max }

X		
2	1	0
0	1	3
-3	1	2

A		
2	1	0
0	1	3
4	1	-2

X .* A		

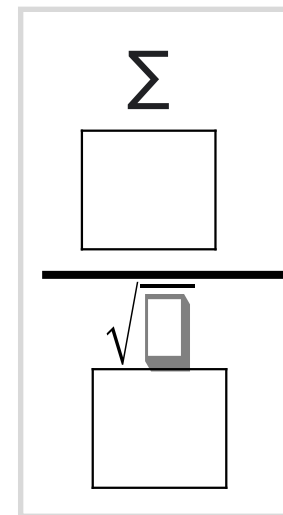


Σ

A .* A		

B		
1	1	0
2	1	4
-2	1	3

X .* B		



Σ

B .* B		

☒ ☐ Cosine Similarity

X		
0	1	1
2	0	2
2	1	0

A		
3	0	3
3	0	0
0	0	3

$X \cdot A$		
0	0	3
6	0	0
0	0	0

$$\frac{\sum}{\sqrt{\square}}$$

a

$$\frac{\sum}{\square}$$

b

$A \cdot A$		
9	0	9
9	0	0
0	0	9

B		
0	2	0
2	0	2
2	0	3

$X \cdot B$		
0	2	0
4	0	4
4	0	0

$$\frac{\sum}{\sqrt{\square}}$$

c

$$\frac{\sum}{\square}$$

d

$B \cdot B$		
0	4	0
4	0	4
4	0	9

$$a+b=45;$$

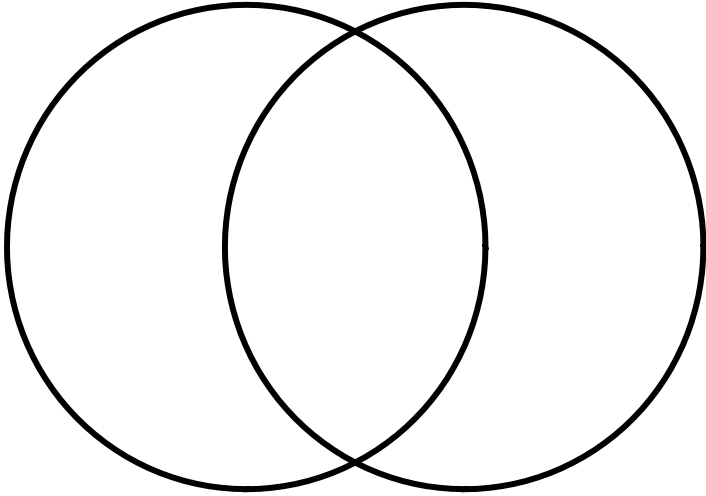
$$c+d=39$$

Scoreboard: Who is more like X?

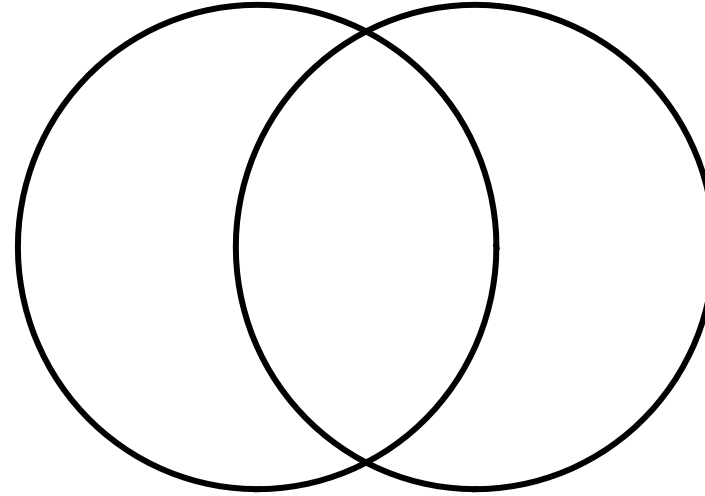
Metric	A	B
Diff		
L1		
L2		
Cosine		

Draw distance vs similarity

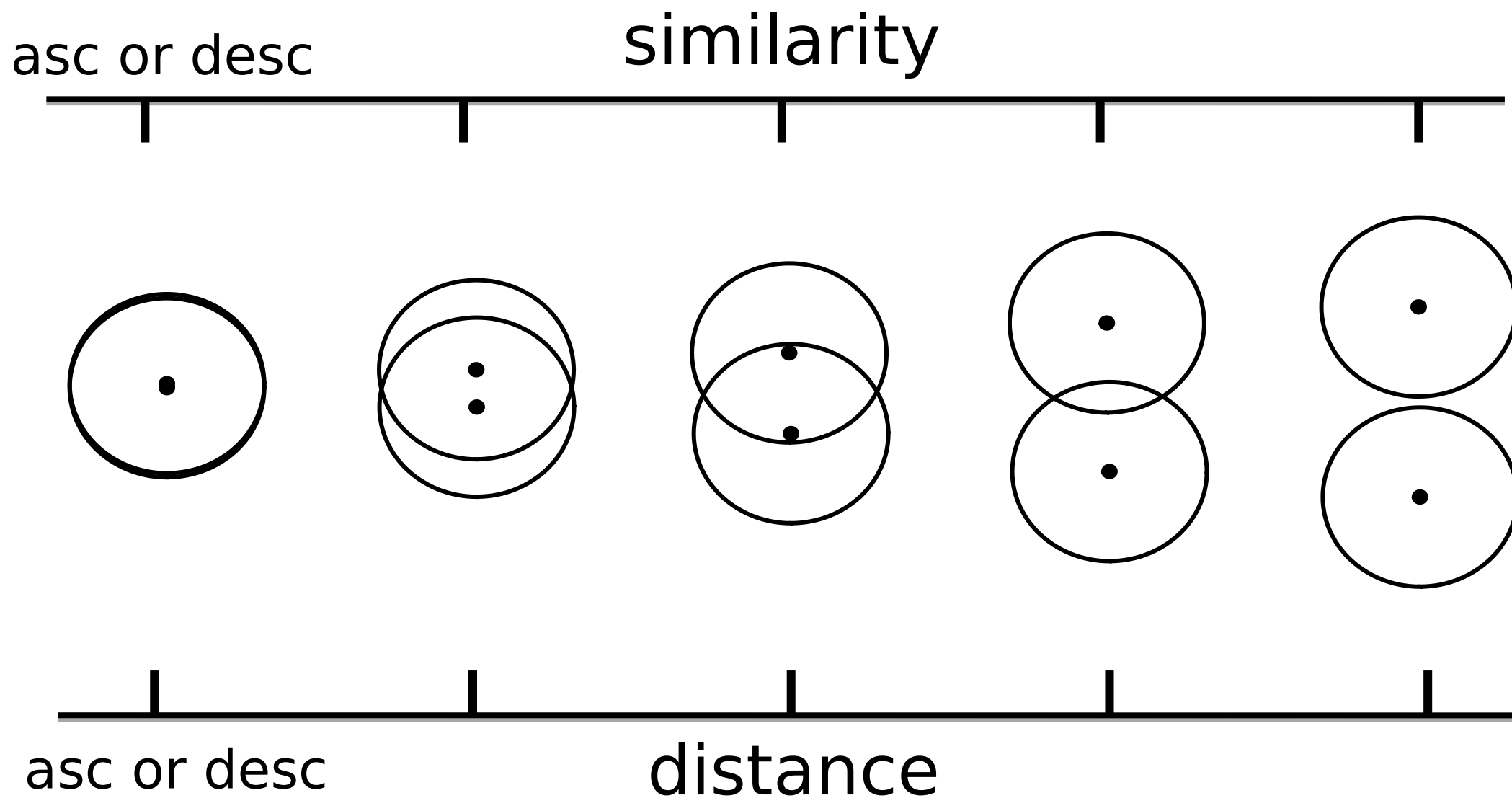
distance



similarity



Distance vs similarity on a scale of 1 to 5



Similarity vs. Distance

	distance	θ	$\cos(\theta)$	similar	difference
alike					
not alike					

Compare Many Images

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Find images similar to a query image ($L1 < 3$)

Time
Complexity

0	0	1
7	1	1
1	0	1

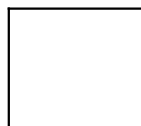
0	1	0
2	0	0
0	1	2

1	0	0
0	1	0
0	0	1

0	1	0
2	4	0
9	1	2

1	0	0
0	1	0
0	1	1

1	0	0
0	1	0
0	0	1



☒ ☐ Find similar images by $L1 < 2$

0	0	1
0	1	1
1	0	1

0	1	0
0	0	0
0	1	0

0	0	1
0	1	0
0	0	0

0	1	0
0	1	0
1	0	1

1	0	1
0	1	0
1	0	0

0	0	1
0	1	0
1	0	0

.	.	.
.	.	
.	.	

.		
.		.
		.

.	.	.
.	.	.
	.	.

.		
.	.	.
.	.	

	.	.
.	.	.
.	.	.

a

b

c
☒

d

e
☒

$a+b+c+d+e$
 $= 12$

Find images similar to a query image (cosine)

0	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	0
7	1	1	2	0	0	0	1	0	2	4	0	0	3	0	0	1
1	0	1	0	1	2	0	0	1	9	1	2	1	1	2	0	1

1	0	0
0	1	0
0	0	1

Cosine similarity for many images via **Matrix Multiplication**

K_1^T	0	0	1	7	1	1	1	0	1
K_2^T	0	1	0	2	0	0	0	1	2
K_3^T	1	0	0	0	1	0	0	0	1
K_4^T	0	1	0	0	3	0	1	1	2
K_5^T	1	0	0	0	1	0	0	1	1

Q
1
0
0
0
1
0
0
0
1

Calculate

Q
1
0
0
0
1
0
0
0
1

K_1^T	0	0	1	7	1	1	1	0	1	
K_2^T	0	1	0	2	0	0	0	1	2	
K_3^T	1	0	0	0	1	0	0	0	1	
K_4^T	0	1	0	0	3	0	1	1	2	
K_5^T	1	0	0	0	1	0	0	1	1	

☒ ☐ Batch calculate cosine similarity

Q

0	1	0
1	1	0
0	1	0

K₁

4	1	1
0	2	1
0	1	1

K₂

2	0	0
0	2	0
0	1	0

Q

.
.
.
.
.

Flatten by row major, c-style

K ₁ ^T	4	1	1	0	2	1	0	1	1
K ₂ ^T	2	0	0	0	2	0	0	1	0

K^TQ

a 4
b 3

$\frac{K^T Q}{\sqrt{\sum K_{ij}^2}}$

e 0.8
1

$\sqrt{\sum K_{ij}^2}$

c 5
d 3

K_{ij}²

16	1	1	0	4	1	0	1	1
4	0	0	0	4	0	0	1	0

$$a+b = 7; c+d+e = 8.8$$

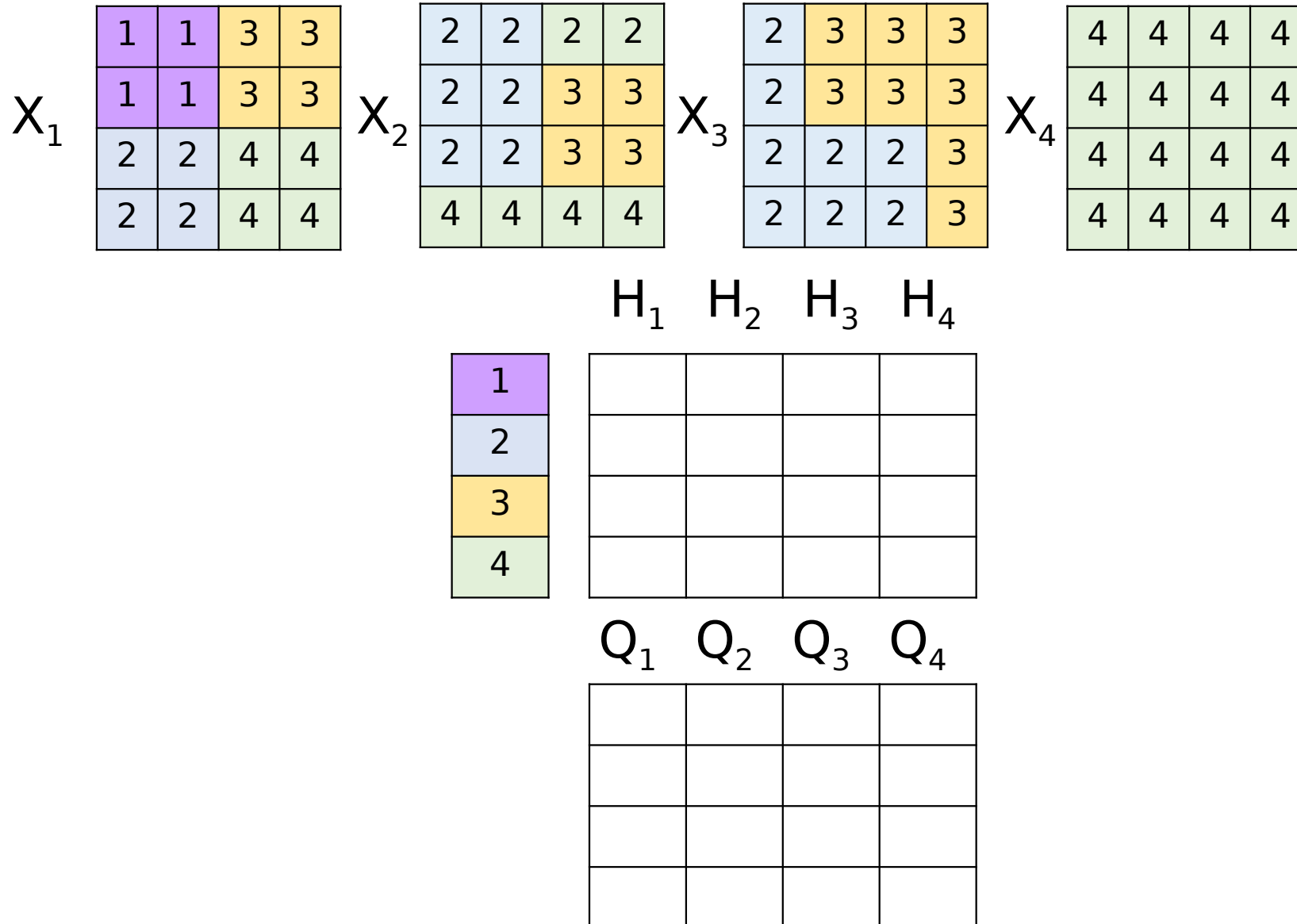
Compare Distributions

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Pixels \rightarrow Histograms \rightarrow Distributions



How do we compare distributions?

P	Q ₁	Q ₂	Q ₃	Q ₄
0.2 5	0.2 5	0	0	0
0.2 5	0.2 5	0.5	0.5	0
0.2 5	0.2 5	0.2 5	0.5	0
0.2 5	0.2 5	0.2 5	0	1

Cross-Entropy: Definition

Cross-Entropy is a measure of the
{ similarity | distance } between two
{ probability distributions | log
likelihoods } for a given
random variable or set of events

Calculate Cross Entropy as a Matrix Multiplication

X	$-\log_2^x$
1	0
0.5	1
0.25	2
0.125	3
...	
2^{-32}	32
0	NaN

	Q ₁	Q ₂	Q ₃	Q ₄
	0.2 5	0	0	0
	0.2 5	0.5	0.5	0
	0.2 5	0.2 5	0.5	0
	0.2 5	0.2 5	0	1
		2		
		2		
		9.2 5		

p^T

0.2 5	0.2 5	0.2 5	0.2 5
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☒ ☐ Find Q most similar to P by Cross Entropy

X	\log_2^x
1	0
0.5	-1
0.25	-2
0.125	-3
2^{-32}	-32
0	NaN

	Q_1	Q_2	Q_3	Q_4	
	0.25	0.25	0.5	2^{-32}	
	0.25	0.5	2^{-32}	1	
	2^{-32}	0.25	0.5	2^{-32}	
	0.5	2^{-32}	2^{-32}	2^{-32}	
					$-\log_2^Q$
P^T					
0	0.5	0.5	0		$-\sum P \log_2^Q$
	a	b	c	d	

$a+b = 18.5$; $c+d = 32.5$

argmin

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32