Histogram of Oriented Gradients

What are gradients?
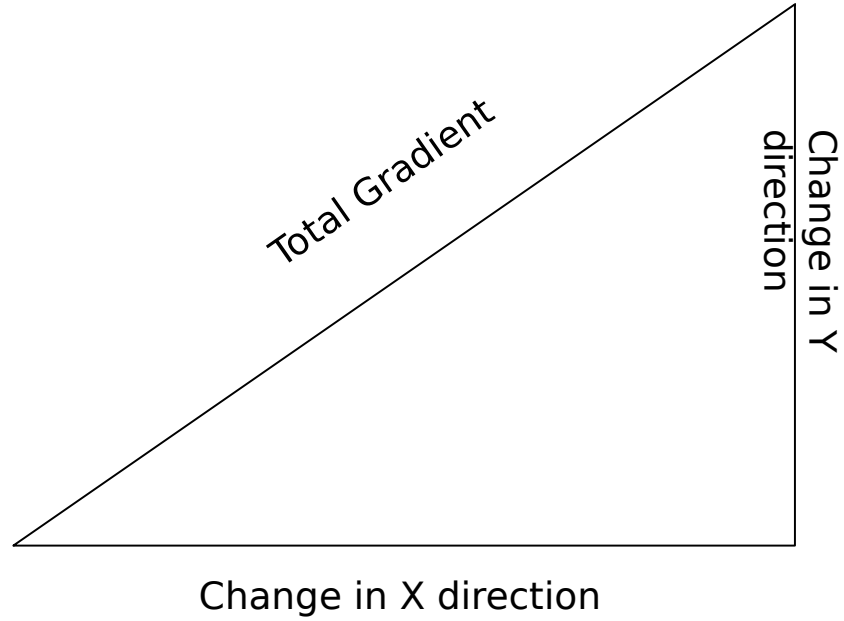
121	10	78	96	125
48	152	68	125	111
145	78	**85**	89	65
154	214	56	200	66
214	87	45	102	45

- Change in X direction(G_x) = 89 - 78 = 11

- Change in Y direction(G_y) = 68 - 56 = 8

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What is orientation?

Orientation refers to the direction of the gradient at a pixel location.

$$\Theta = \operatorname{atan}\left(\frac{\mathbf{G}_y}{\mathbf{G}_x}\right)$$

Gradient Orientation

121	10	78	96	125
48	152	68	125	111
145	78	**85**	89	65
154	214	56	200	66
214	87	45	102	45

$$\Theta = atan\left(\frac{8}{11}\right)$$

Gradient Orientation

121	10	78	96	125
48	152	68	125	111
145	78	85	89	65
154	214	56	200	66
214	87	45	102	45

$$\Theta = \text{atan} \left(\frac{8}{11} \right)$$

$$\Theta = 36$$

What is Magnitude?

121	10	78	96	125
48	152	68	125	111
145	78	**85**	89	65
154	214	56	200	66
214	87	45	102	45

● Change in X direction = 89 - 78 =

11

● Change in Y direction = 68 - 56 =

8   $\sqrt{(11)^2 + (8)^2}$

● Total Gradient Magnitude

Orientation and Magnitude

121	10	78	96	125
48	152	68	125	111
145	78	**85**	89	65
154	214	56	200	66
214	87	45	102	45

● Gradient Magnitude = $\sqrt{11^2 + 8^2}$ = 13.6

● Gradient Orientation = 36

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Method 1: Features using Orientation

121	10	78	96	125
48	152	68	125	111
145	78	85	89	65
154	214	56	200	66
214	87	45	102	45

Method 1: Features using Orientation

121	10	78	96	125
48	152	68	125	111
145	78	85	89	65
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214	87	45	102	45

Frequency															
Angle	1	2	3	4 ...	35	36	37	38	39….	175	176	177	178	179	180

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Method 1: Features using Orientation

121	10	78	96	125
48	152	68	125	111
145	78	85	89	65
154	214	56	200	66
214	87	45	102	45

Frequency						1									
Angle	1	2	3	4 …	35	36	37	38	39….	175	176	177	178	179	180

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Method 1: Features using Orientation

121	10	78	96	125
48	152	68	125	111
145	78	85	89	65
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Frequency							1											
Angle	1	2	3	4 ...	35	36	37	38	39....	175	176	177	178	179	180

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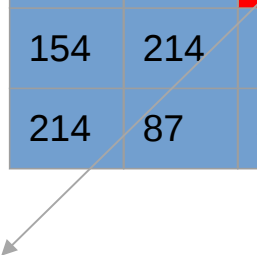
Method 1: Features using Orientation

121	10	78	96	125
48	152	68	125	111
145	78	85	89	65
154	214	56	200	66
214	87	45	102	45

Frequency						1					1					
Angle	1	2	3	4 …	35	36	37	38	39….	175	176	177	178	179	180

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Method 2: Features using Orientation

121	10	78	96	125
48	152	68	125	111
145	78	**85**	89	65
154	214	56	200	66
214	87	45	102	45

Magnitude		1							
Bin	0	20	40	60	80	100	120	140	160

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Method 3: Features using Orientation and Magnitude

Magnitude =
13.6
Orientation = 36

Magnitude								
Bin	0	20	40	60	80	100	120	140	160

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Method 3: Features using Orientation and Magnitude

Magnitude = 13.6
Orientation = 36

Magnitude		13.6						
Bin	0	20	40	60	80	100	120	140	160

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Method 4: Features using Orientation and Magnitude

Magnitude =
13.6
Orientation = 36

(20-36 -
20)/20

(20-36 -
40)/20

Magnitude								
Bin	0	20	40	60	80	100	120	140	160

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Method 4: Features using Orientation and Magnitude

Magnitude = 13.6
Orientation = 36

(20-36 - 20)/20

(20-36 - 40)/20

Magnitude		(4/20)*13.6	(16/20)*13.6						
Bin	0	20	40	60	80	100	120	140	160

Method 4: Features using Orientation and Magnitude

Magnitude = 13.6
Orientation = 36

(20-36 - 20)/20

(20-36 - 40)/20

Magnitude		2.72	10.88						
Bin	0	20	40	60	80	100	120	140	160

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Histogram of Oriented Gradients

● Step 1: Preprocess the Data (64 x 128)

Histogram of Oriented Gradients
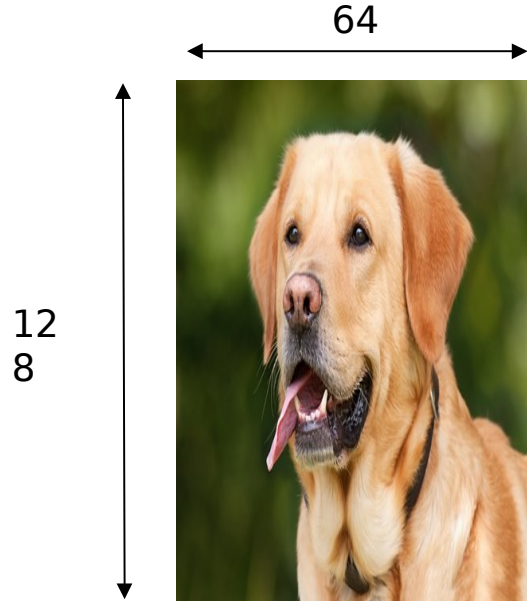
- Step 1: Preprocess the Data (64 x 128)

64

128

Histogram of Oriented Gradients

- Step 1: Preprocess the Data (64 x 128)

- Step 2: Calculate Gradients in direction x and y

Histogram of Oriented Gradients

- Step 1: Preprocess the Data (64 x 128)

- Step 2: Calculate Gradients in direction x and y

121	10	78	96	125
48	152	68	125	111
145	78	85	89	65
154	214	56	200	66
214	87	45	102	45

- Change in X direction(G_x) = 89 - 78 =

- Change in Y direction(G_y) = 68 - 56 =

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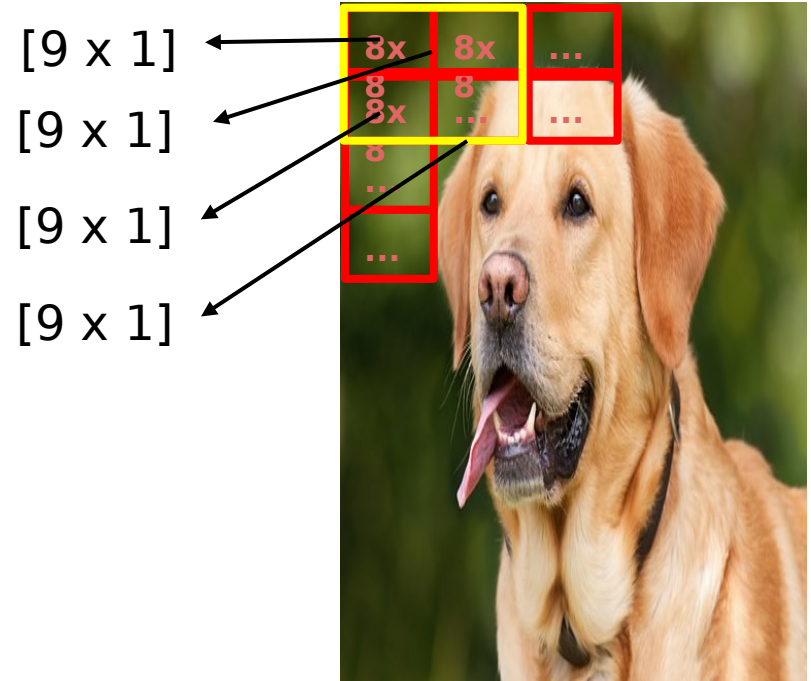Learn everything about analytics

Histogram of Oriented Gradients

- Step 1: Preprocess the Data (64 x 128)

- Step 2: Calculate Gradients in direction x and y

- Step 3: Calculate the magnitude and Orientation

$$\text{Magnitude} = \sqrt{G_y^2 + G_x^2} \qquad \Theta = \text{atan}\left(\frac{G_y}{G_x}\right)$$

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Histogram of Oriented Gradients

● Step 1: Preprocess the Data (64 x 128)

● Step 2: Calculate Gradients in direction x and y

● Step 3: Calculate the magnitude and Orientation

● Step 4: Calculate histogram of gradients for 8x8 p

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Histogram of Oriented Gradients

- Step 1: Preprocess the Data (64 x 128)

- Step 2: Calculate Gradients in direction x and y

- Step 3: Calculate the magnitude and Orientation

- Step 4: Calculate histogram of gradients for 8x8 p

Magnitude									
Bin	0	20	40	60	80	100	120	140	160

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Histogram of Oriented Gradients

- Step 1: Preprocess the Data (64 x 128)

- Step 2: Calculate Gradients in direction x and y

- Step 3: Calculate the magnitude and Orientation

- Step 4: Calculate histogram of gradients for 8x8 p

- Step 5: Normalize gradients for 16 x 16 pixels
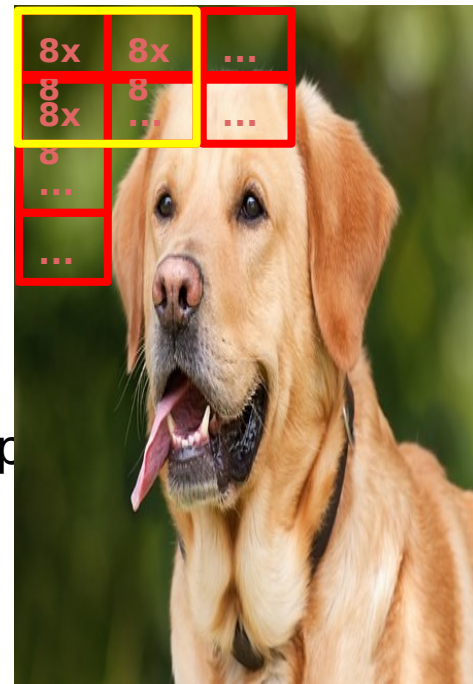
Normalizing

Normalizing

$[9 \times 1]$

$[9 \times 1]$

$[9 \times 1]$

$[9 \times 1]$

$[36 \times 1]$

Vector = $[a_1, a_2, a_3, \ldots a_{36}]$

Normalizing

$$\text{Vector} = [a_1, a_2, a_3, \ldots a_{36}]$$

$$k = \sqrt{(a_1)^2 + (a_2)^2 + (a_3)^2 + \ldots (a_{36})^2}$$

$$\text{Normalised Vector} = \left[\frac{a_1}{k}, \frac{a_2}{k}, \frac{a_3}{k}, \ldots \frac{a_{36}}{k} \right]$$
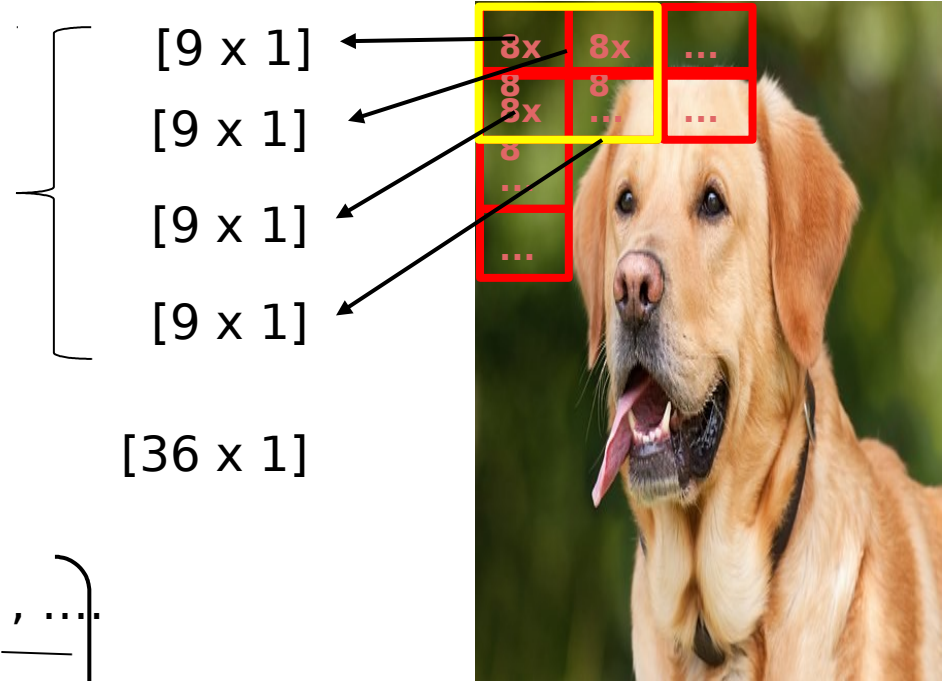
[9 x 1]

[9 x 1]

[9 x 1]

[9 x 1]

[36 x 1]

Histogram of Oriented Gradients

- Step 1: Preprocess the Data (64 x 128)

- Step 2: Calculate Gradients in direction x and y

- Step 3: Calculate the magnitude and Orientation

- Step 4: Calculate histogram of gradients in 8x8 cells (9x1)

- Step 5: Normalize gradients in 16x16 cell (36x1)

- Step 6: Features for the complete image

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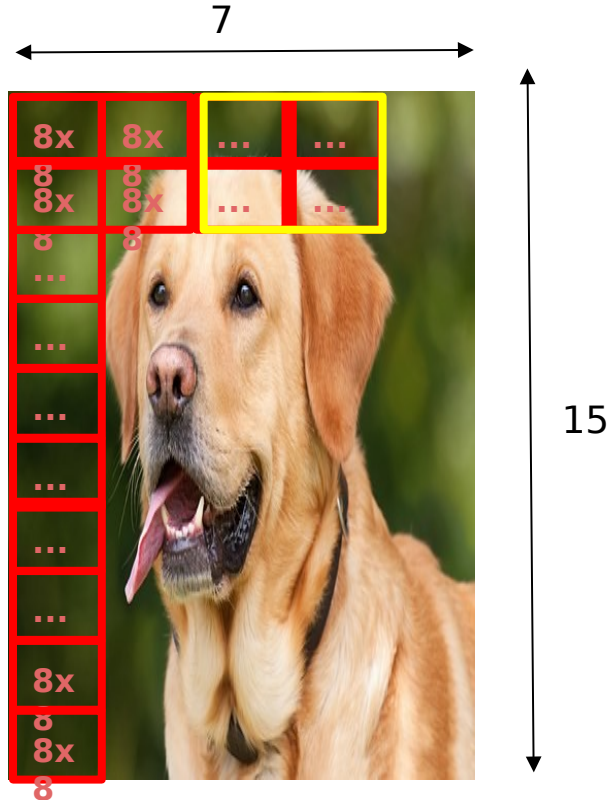
Histogram of Oriented Gradients

Histogram of Oriented Gradients

Histogram of Oriented Gradients

7 x 15 = 105 vectors

105 x [36 x 1] = 3780 features

Thank You!