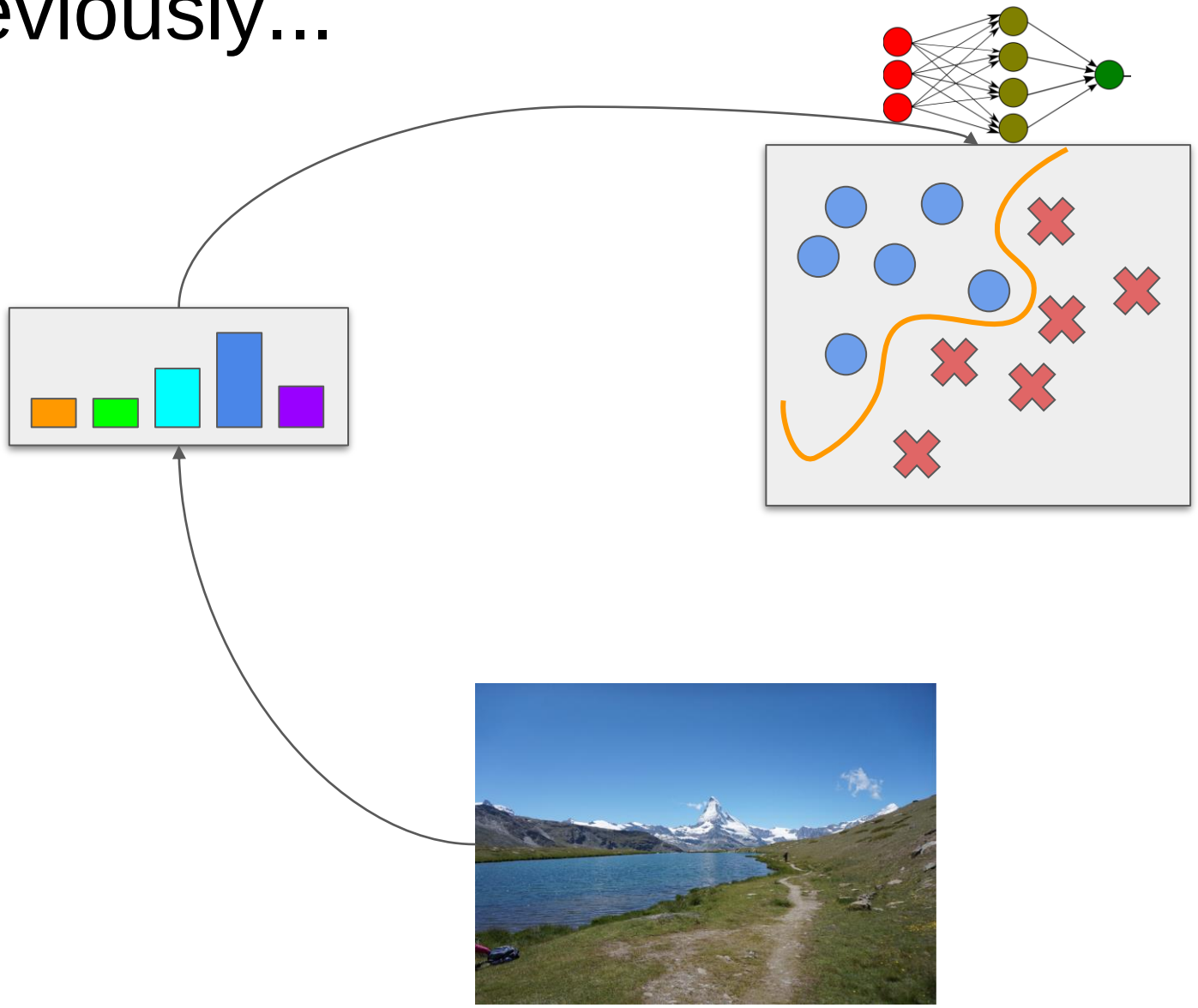
Pattern Recognition
Lecture 01-1

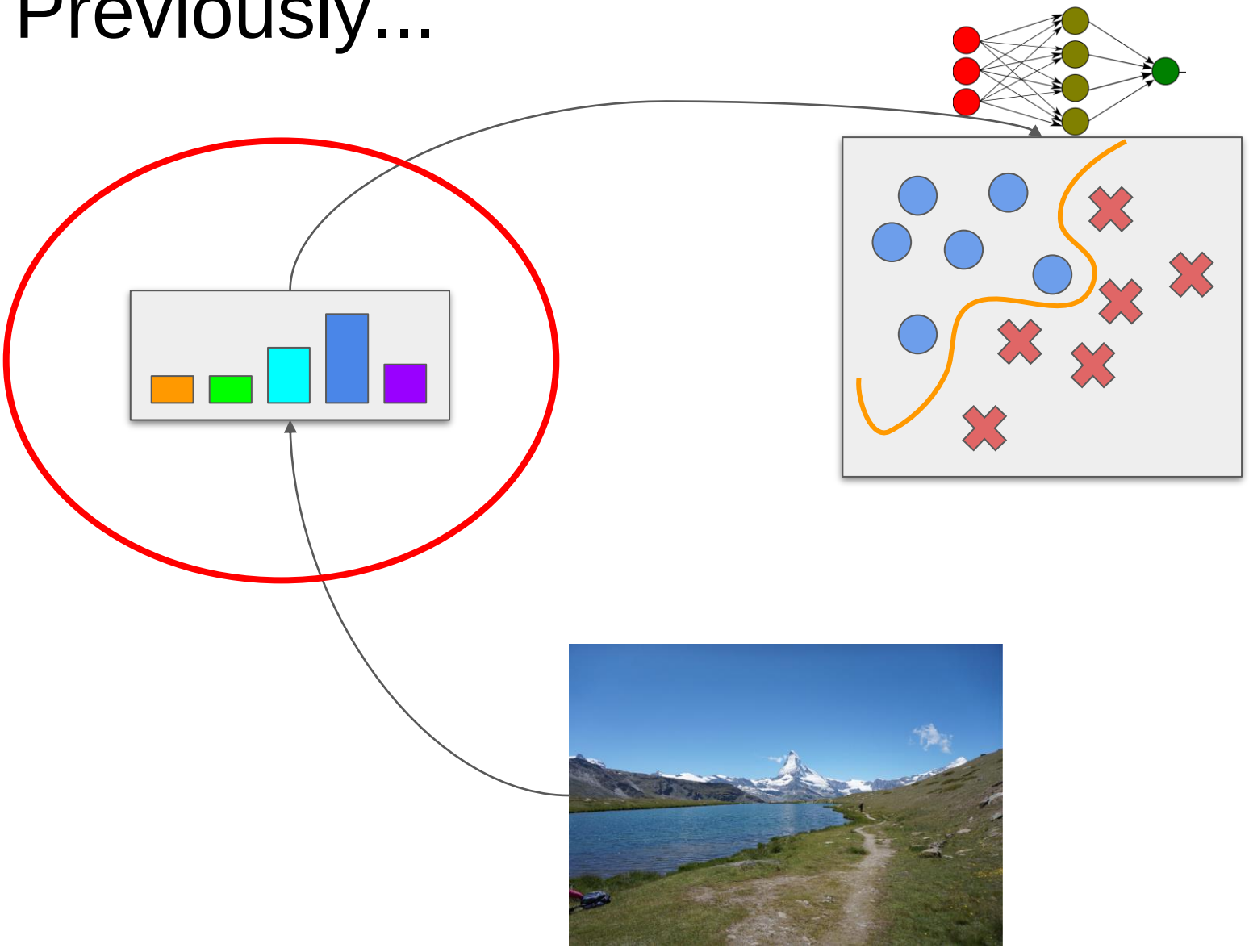
Feature Representation & HOG

Prof. Jongwon Choi
Chung-Ang University
Fall 2022

Previously...



Previously...



Today

- Color Spaces
- Color Histogram
- Histogram of Oriented Gradients (HOG)

Computer Vision?

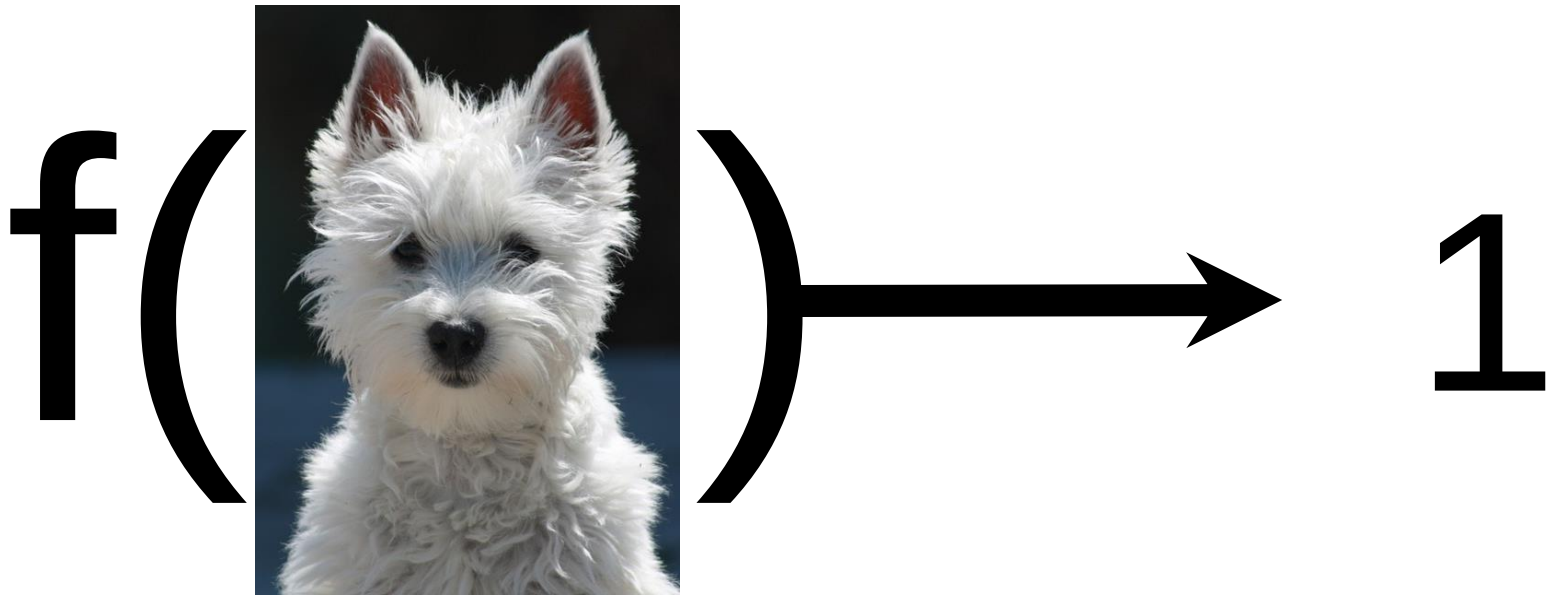
Computer Vision?

f() → ?

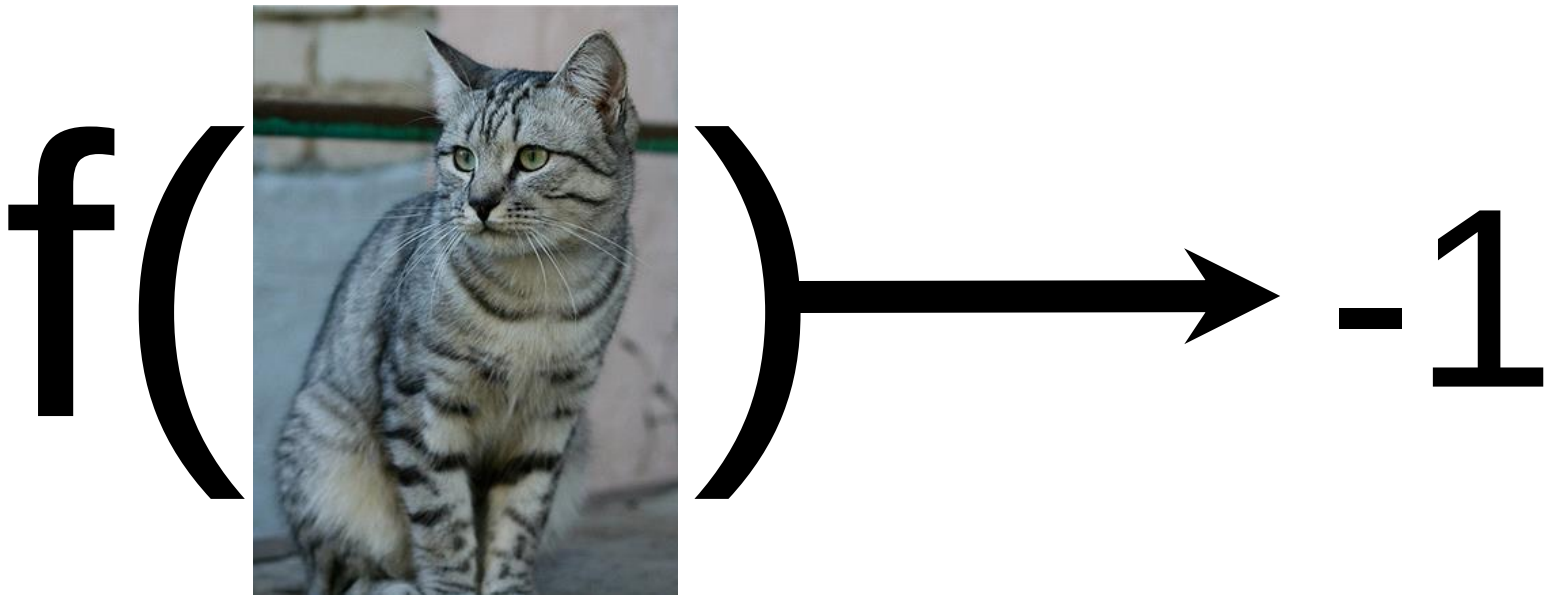
Computer Vision?

f() → Dog

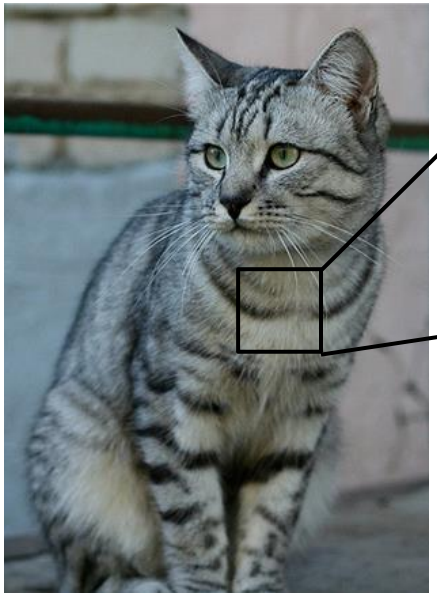
Computer Vision?



Computer Vision?



What the computer sees

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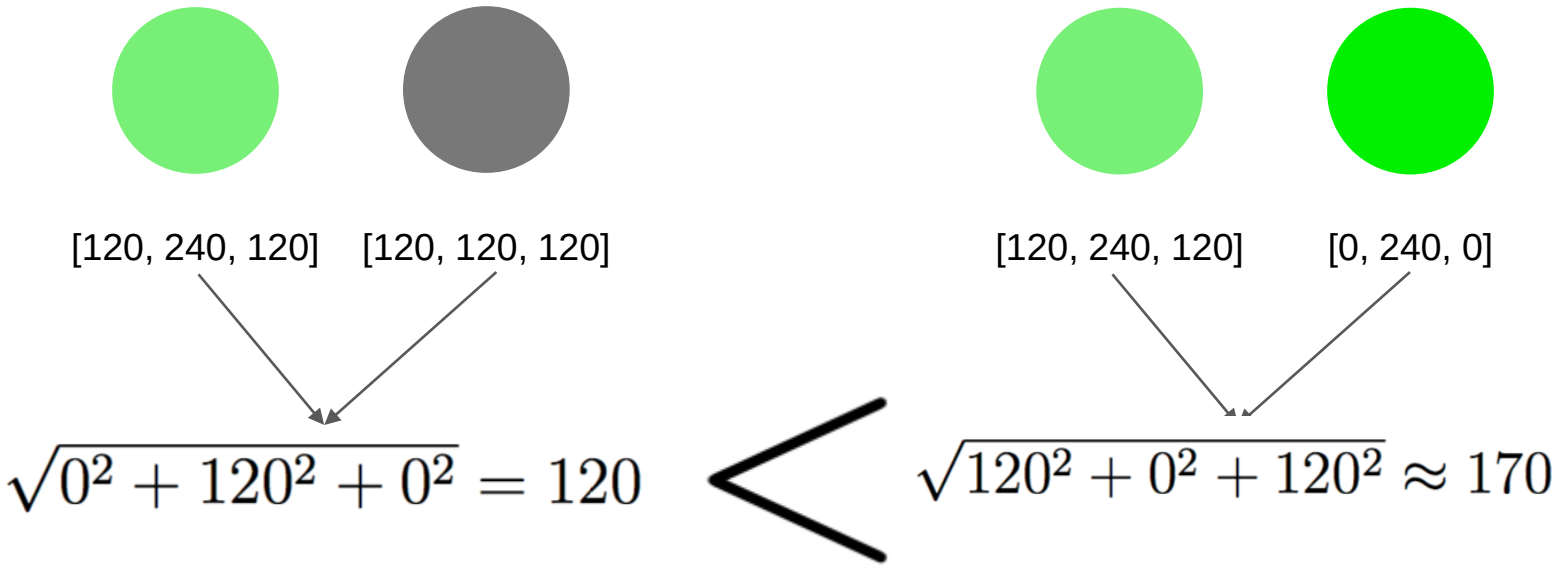
```

An image is just a big grid of numbers between [0, 255]:

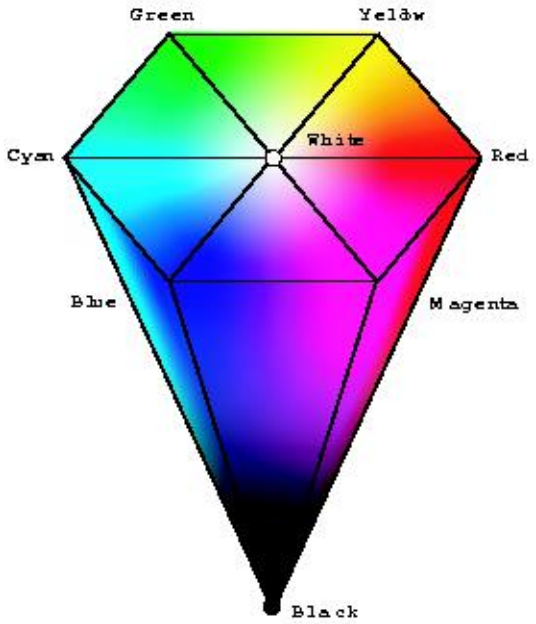
e.g. 800 x 600 x 3 = 1,440,000 (3 channels RGB)

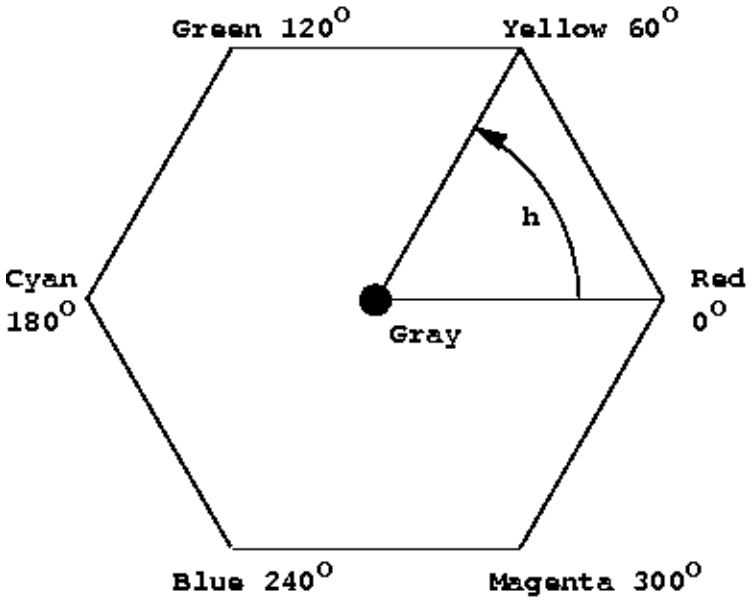
RGB is not really how color is perceived

Which of the two colors look alike?



HSV color space

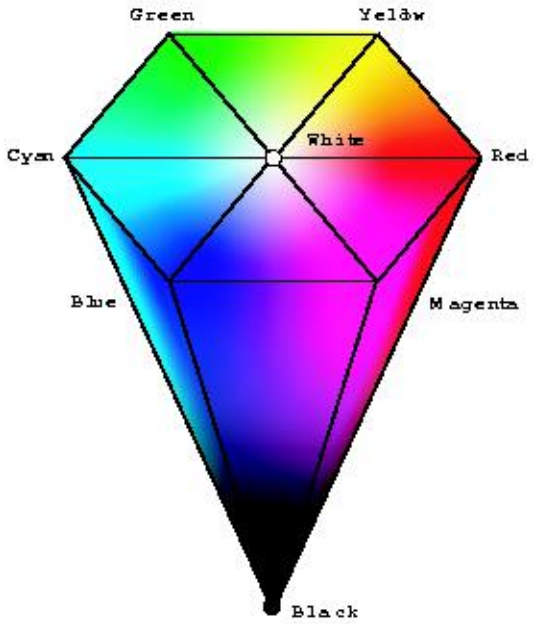


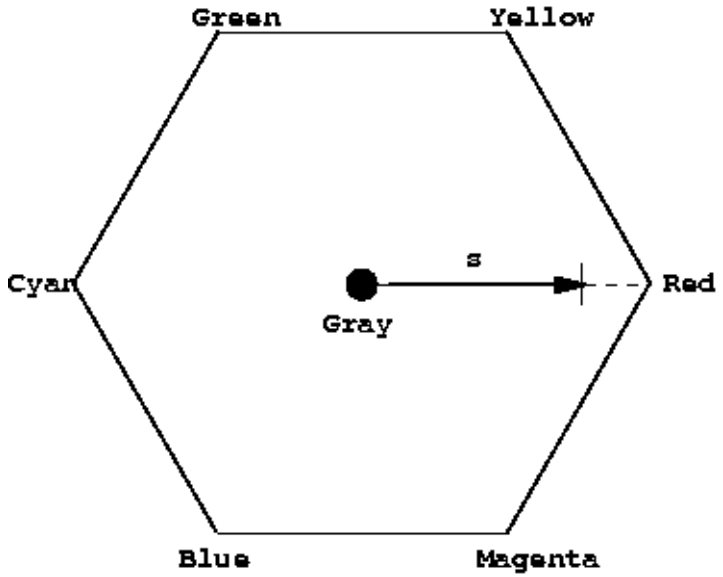


Hue, an angular measure (0 … 360)

Slides based on Color Principles for Computer Graphics by Donald House

HSV color space

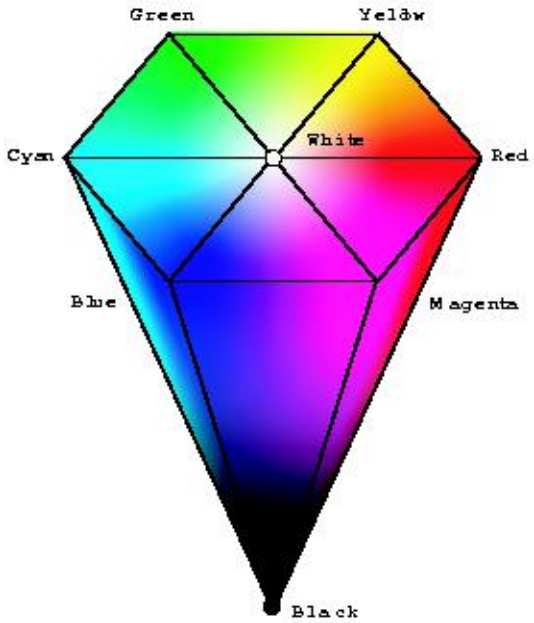


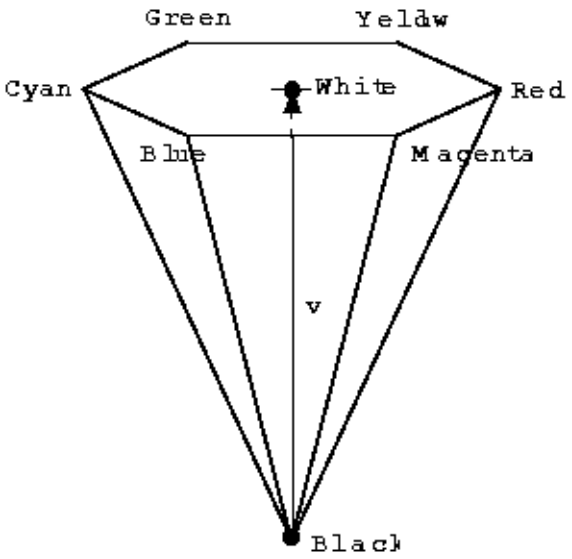


Saturation, a fractional measure (0.0 … 1.0)

Slides based on Color Principles for Computer Graphics by Donald House

HSV color space

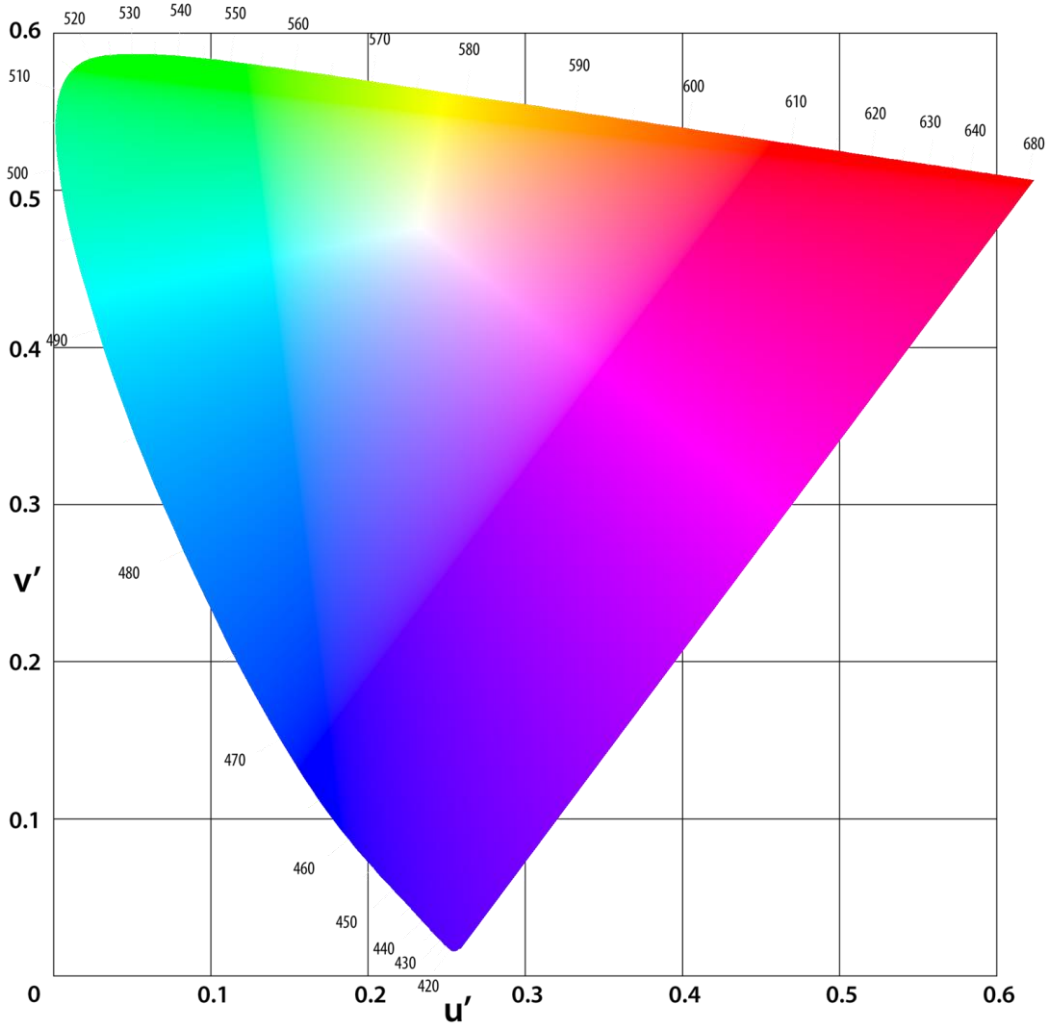




Value, a fractional measure (0.0 … 1.0)

Slides based on Color Principles for Computer Graphics by Donald House

CIE Luv: Perceptually uniform



Importance of color spaces

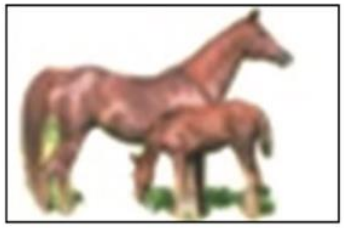
[Khattab et al. 2014]

Importance of color spaces

[Khattab et al. 2014]

Importance of color spaces

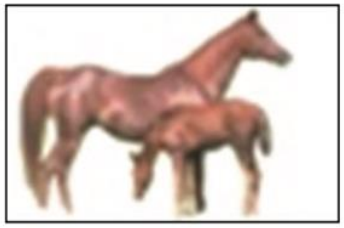
[Khattab et al. 2014]



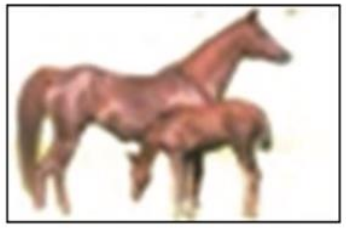
RGB

YUV

XYZ



CMY



HSV

Importance of color spaces

[Khattab et al. 2014]

RGB

YUV

XYZ

CMY

HSV

Importance of color spaces

[Khattab et al. 2014]

RGB

YUV

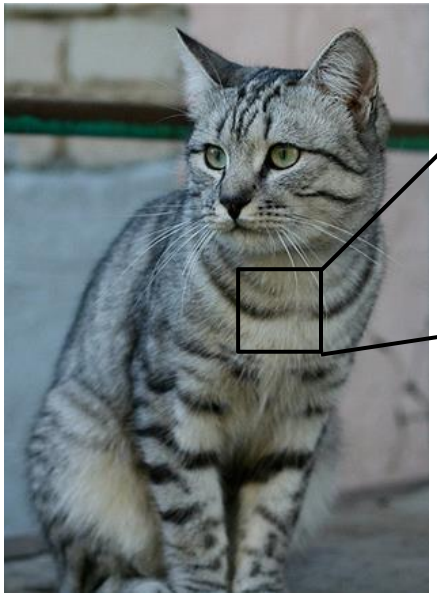
XYZ

CMY

HSV

Is having good color representation enough?

What the computer sees

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```

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Challenges: Illumination

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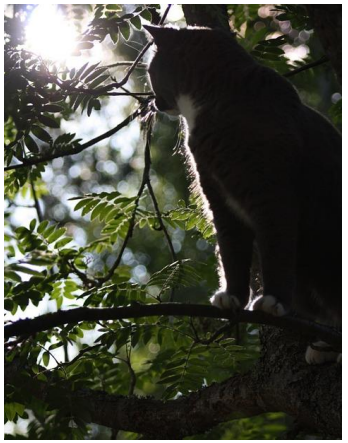

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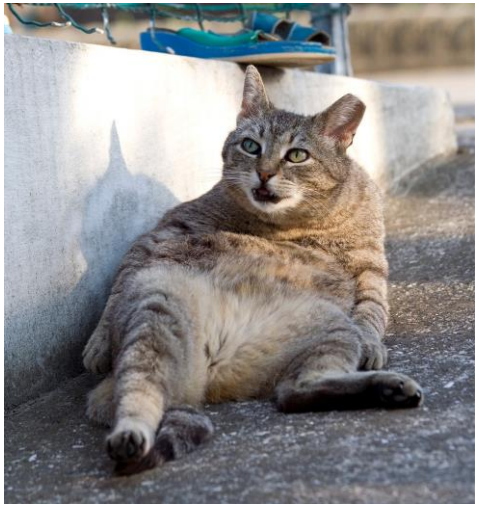
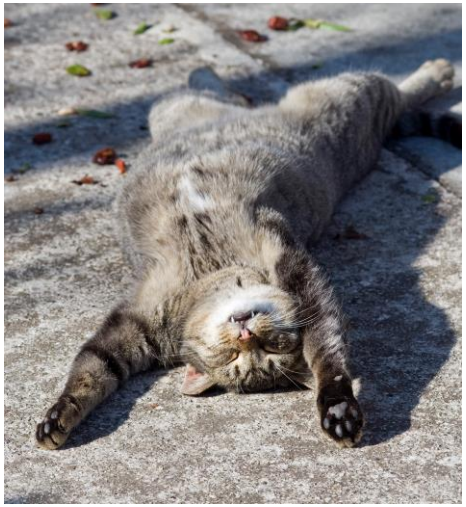
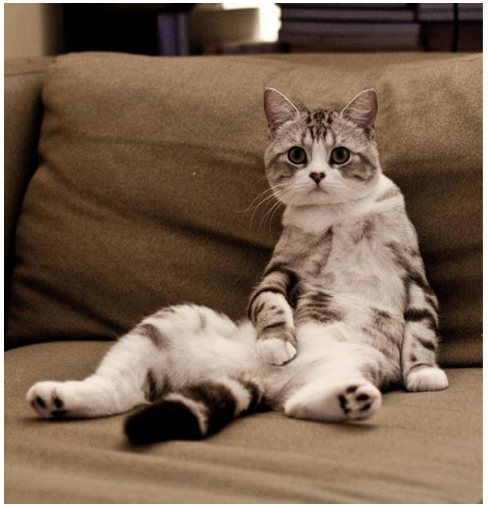
Challenges: Deformation







Challenges: Occlusion

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Challenges: Background clutter

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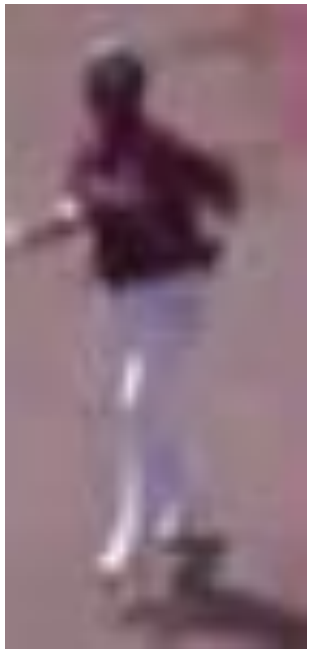
Color Histogram

Color histograms



Color histograms

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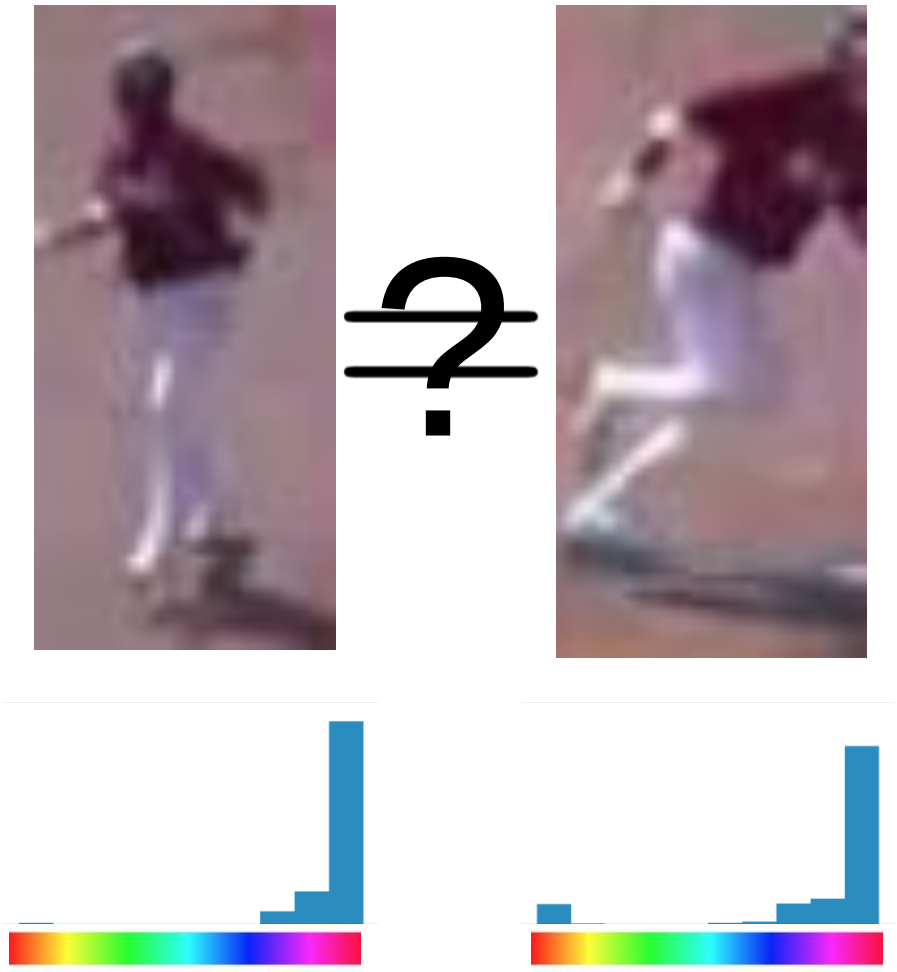
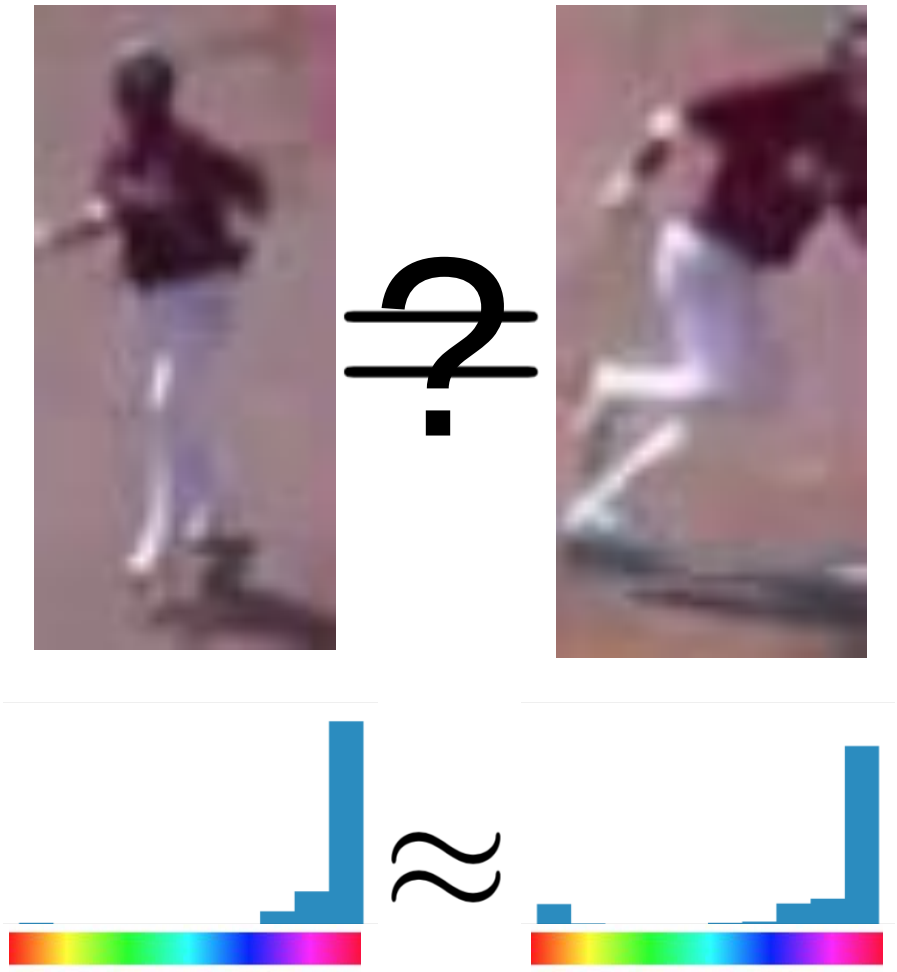
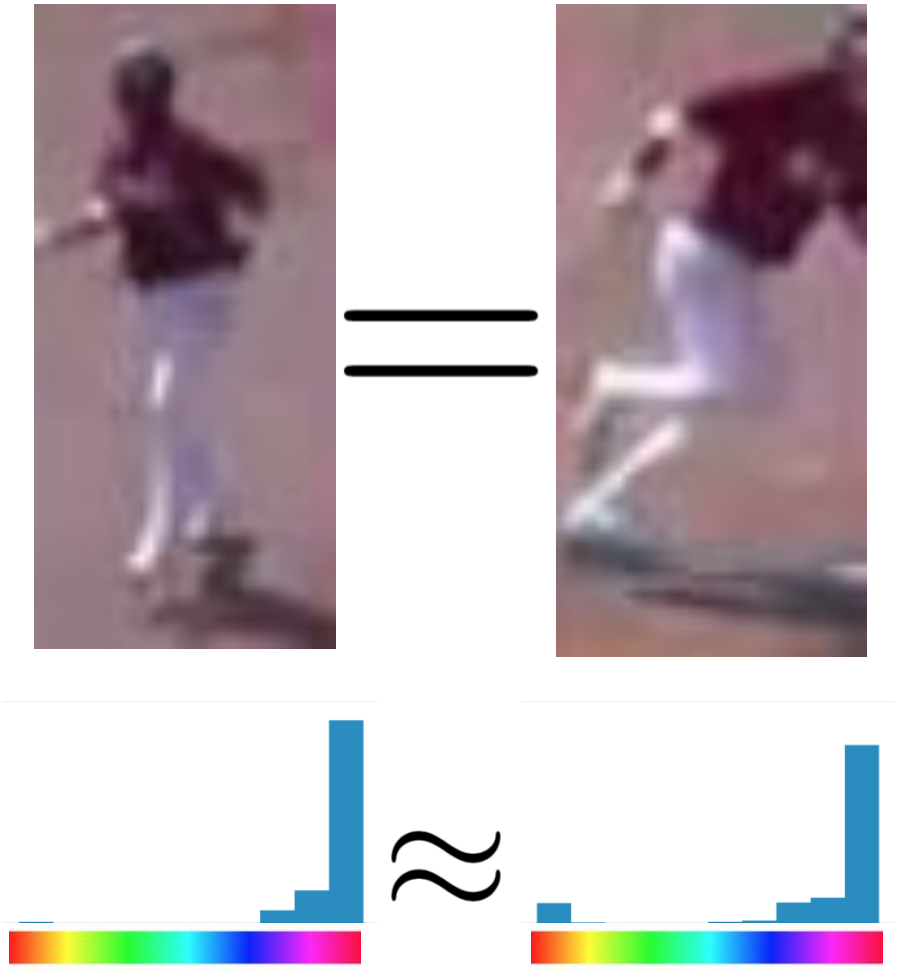


Color histograms



Color histograms



Color histograms

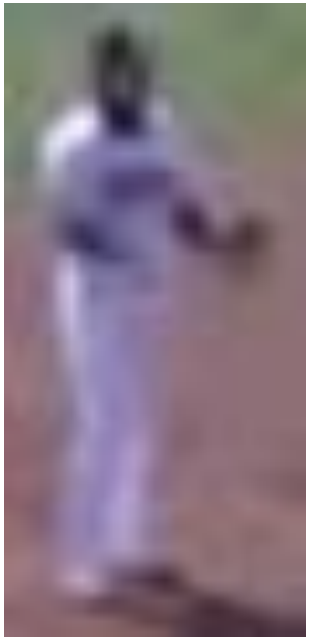
Color histograms

Color histograms

Color histograms

Color histograms

Color histograms: example



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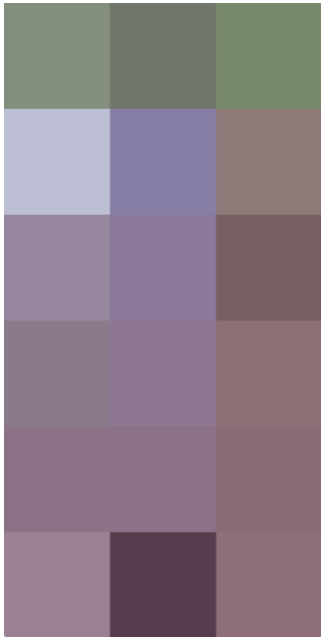

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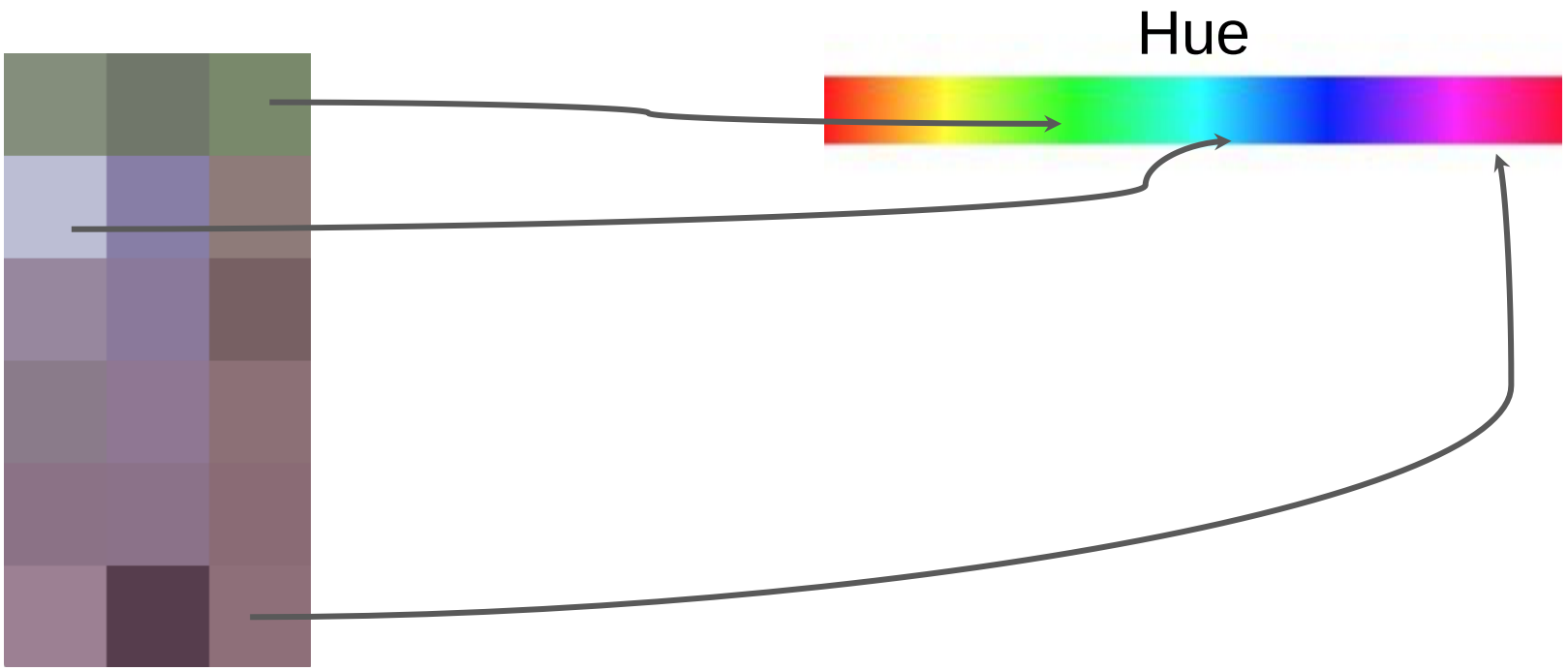
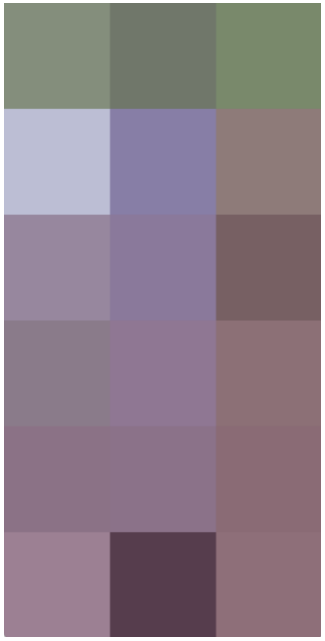
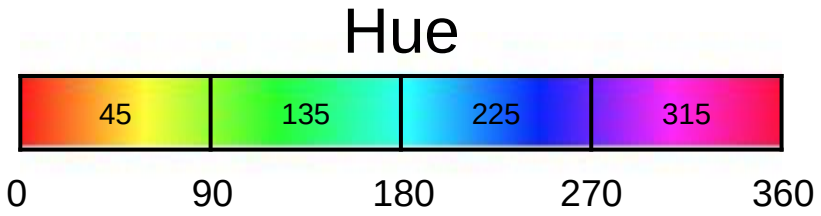


Color histograms: example





Color histograms: example

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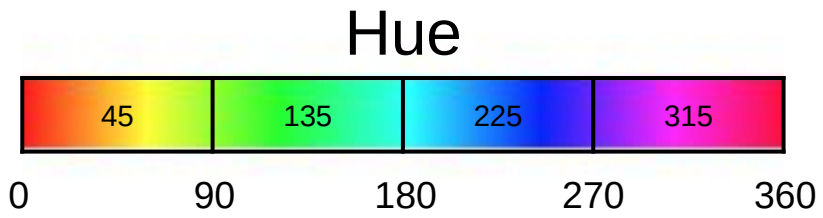
236	254	6
280	270	352
300	290	348
312	302	342
320	322	342



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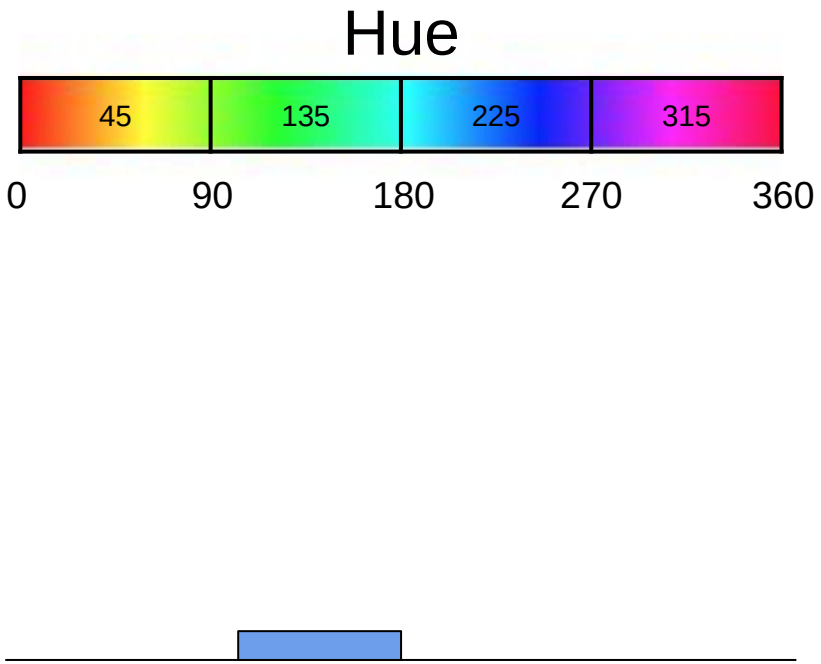

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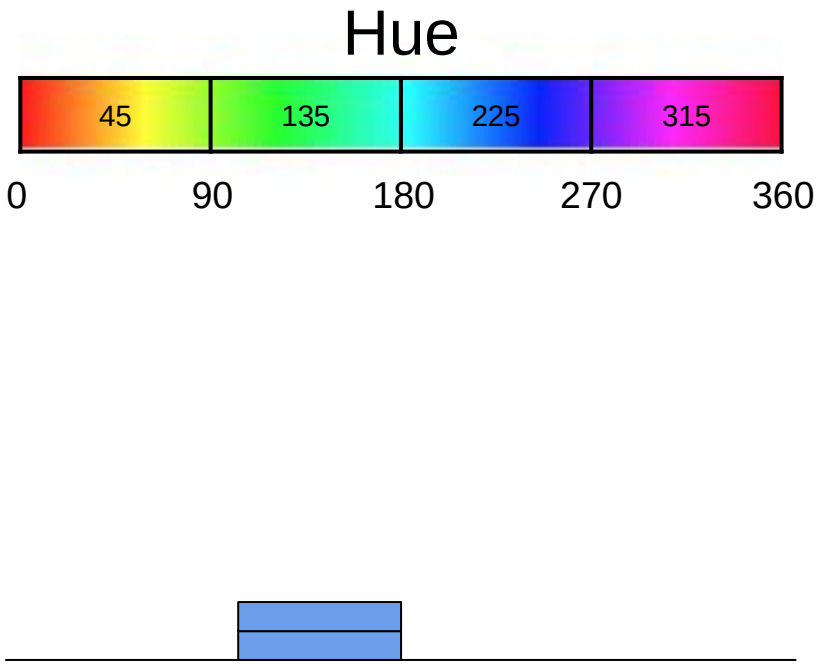

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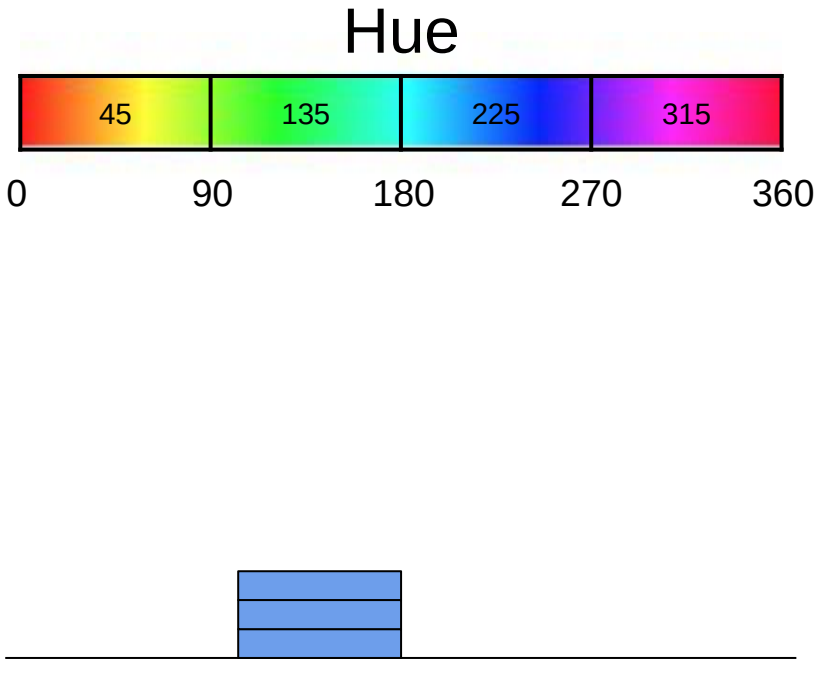

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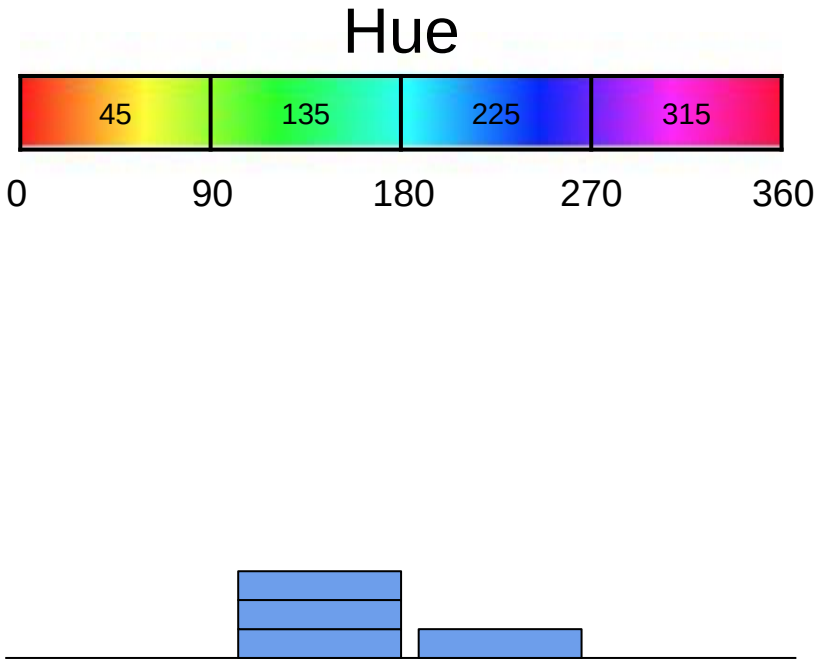

Color histograms: example

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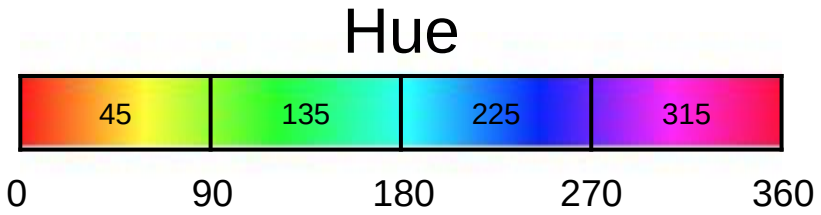
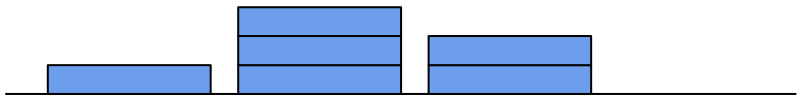
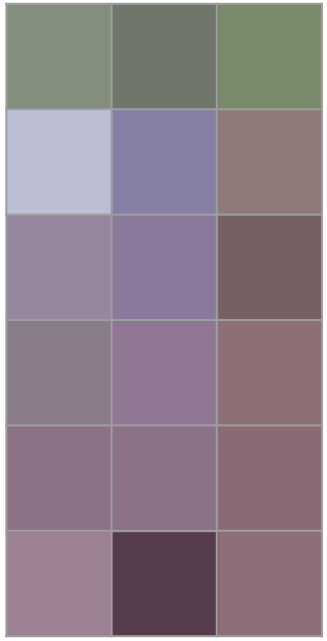
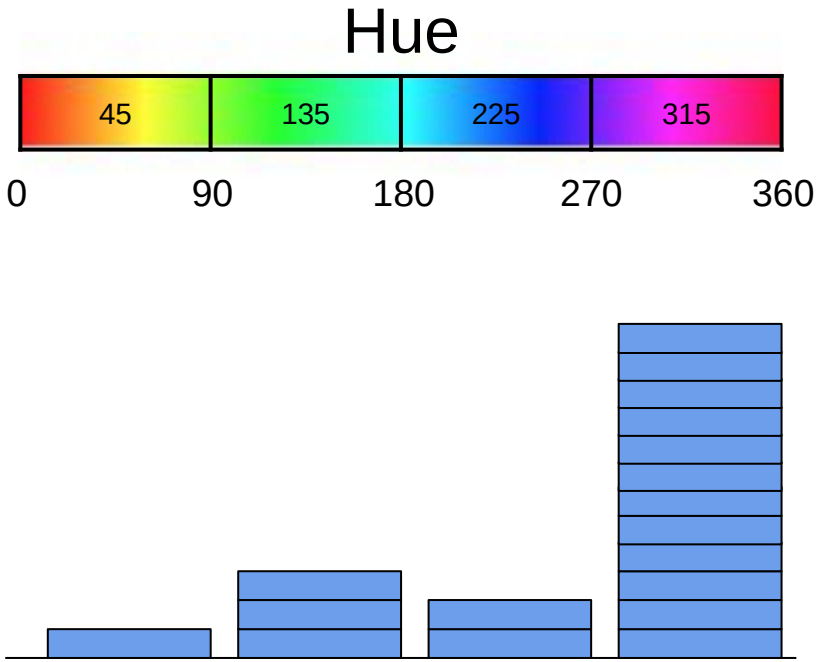




Color histograms: example





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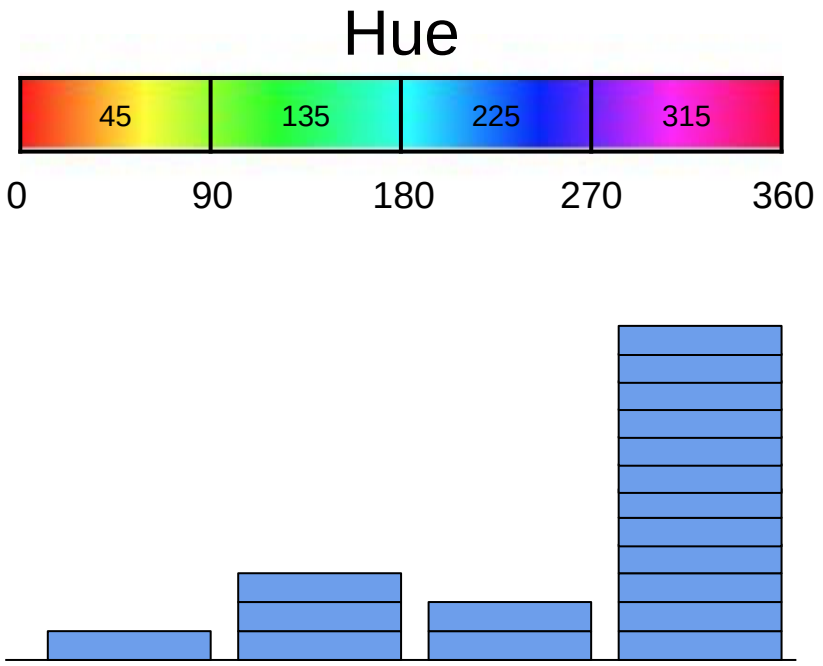

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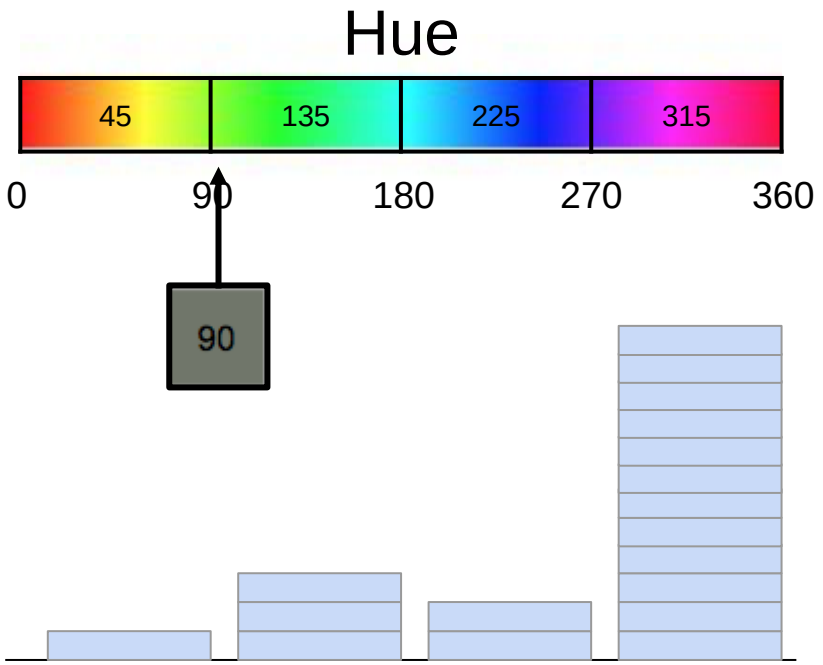

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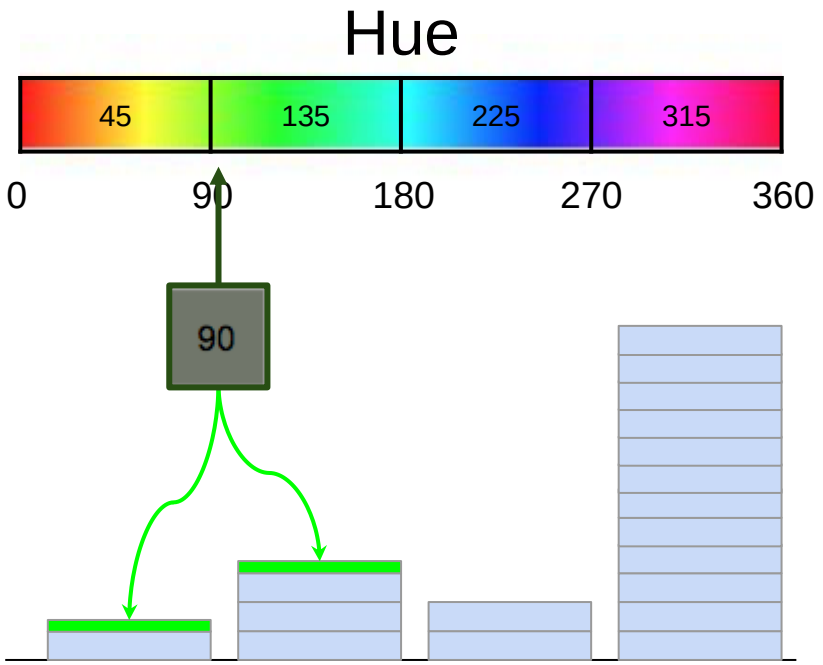
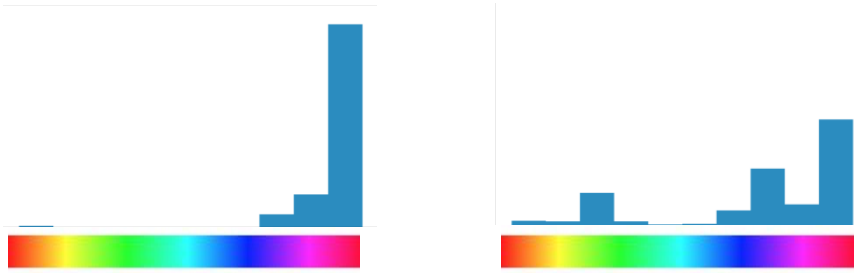


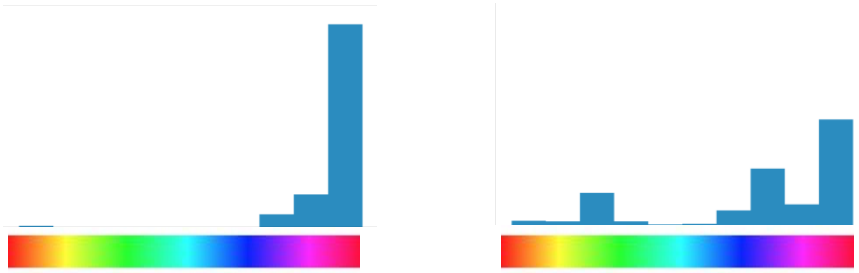
Color histograms

Color histograms

Metric: Bhattacharyya Coefficient

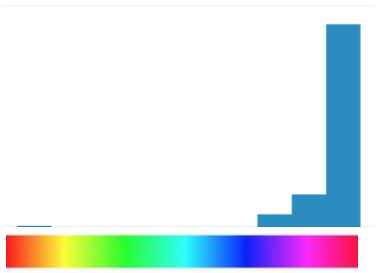


Metric: Bhattacharyya Coefficient



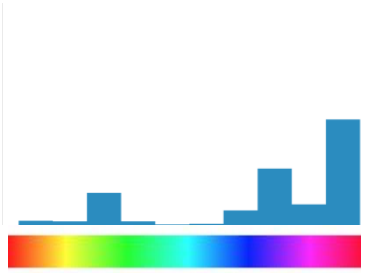
$p(u)$ $q(u)$

Metric: Bhattacharyya Coefficient



$$p(u)$$

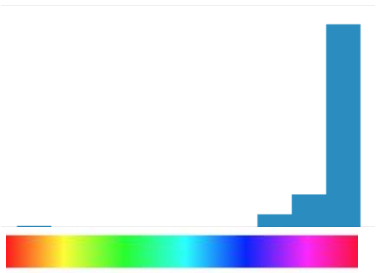
$$\sum_u p(u) = 1$$



$$q(u)$$

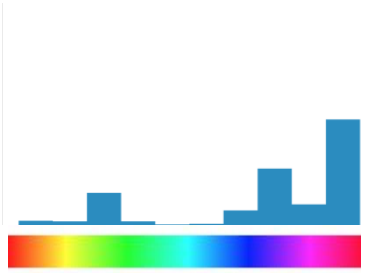
$$\sum_u q(u) = 1$$

Metric: Bhattacharyya Coefficient



$$p(u)$$

$$\sum_u p(u) = 1$$

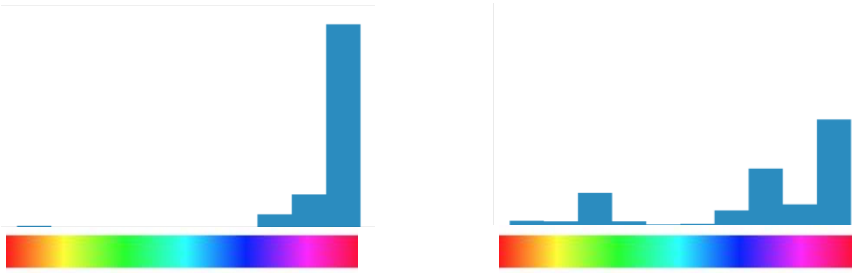


$$q(u)$$

$$\sum_u q(u) = 1$$

$$BC\,(p,q) = \sum_u \sqrt{p(u)q(u)}$$

Metric: Bhattacharyya Coefficient



$p(u)$

$\sum_u p(u) = 1$

$q(u)$

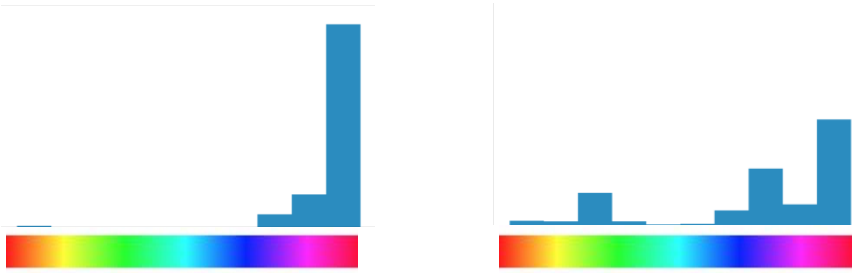
$\sum_u q(u) = 1$

$$0 \leq BC(p,q) = \sum_u \sqrt{p(u)q(u)} \leq 1$$

Different

Same

Metric: Bhattacharyya Coefficient



$$p(u) \qquad q(u)$$

$$\sum_u p(u) = 1 \qquad \sum_u q(u) = 1$$

$$0 \leq BC(p,q) = \sum_u \sqrt{p(u)q(u)} \leq 1$$

Different

if $p(u) = q(u)$

Same

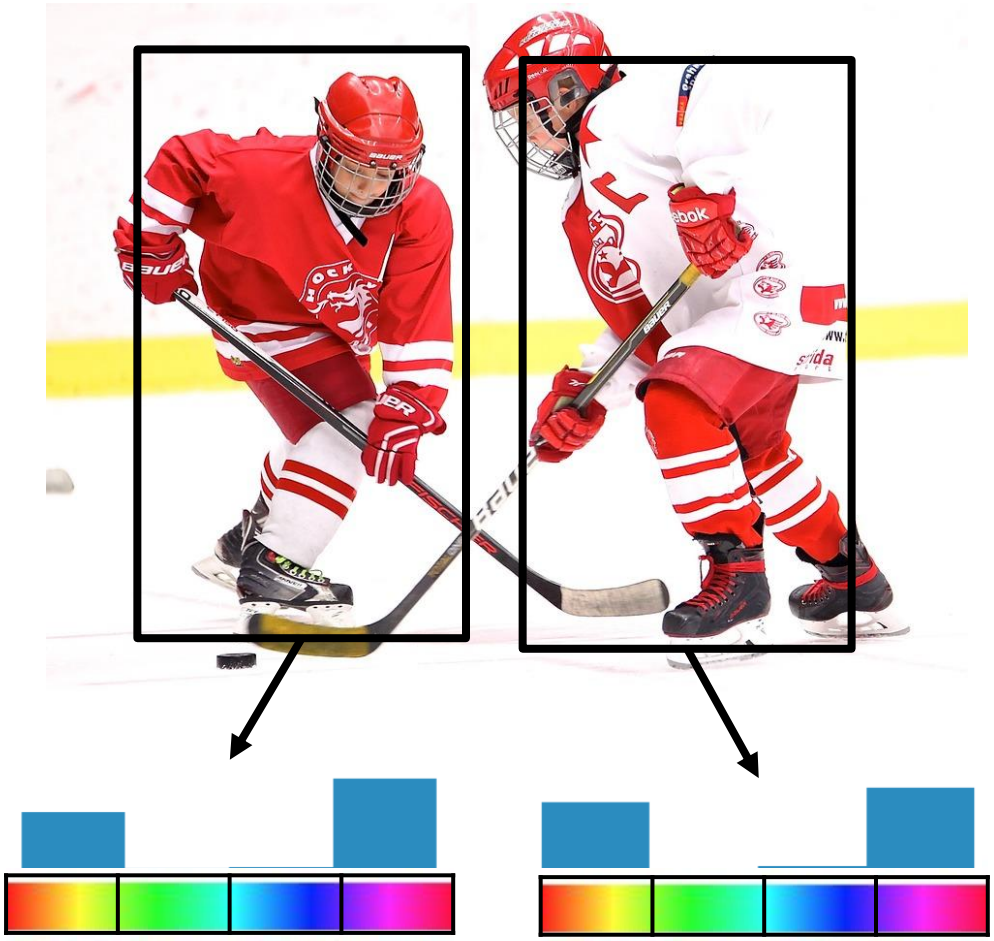
$$\sum_u \sqrt{p(u)p(u)} = \sum_u p(u) = 1$$

BC distance example

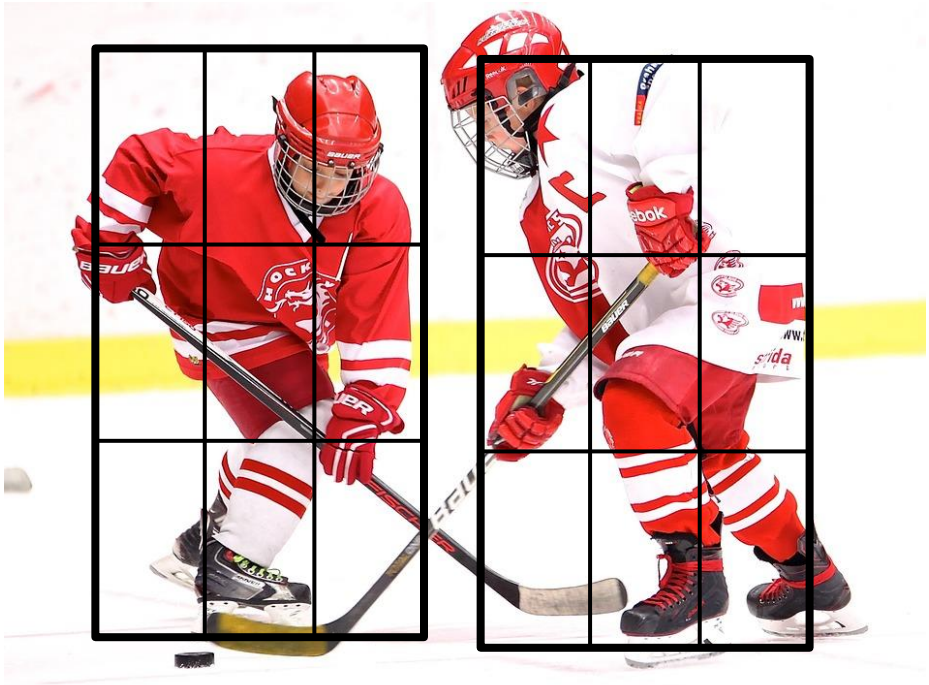
BC distance example

Obvious problem

Obvious problem

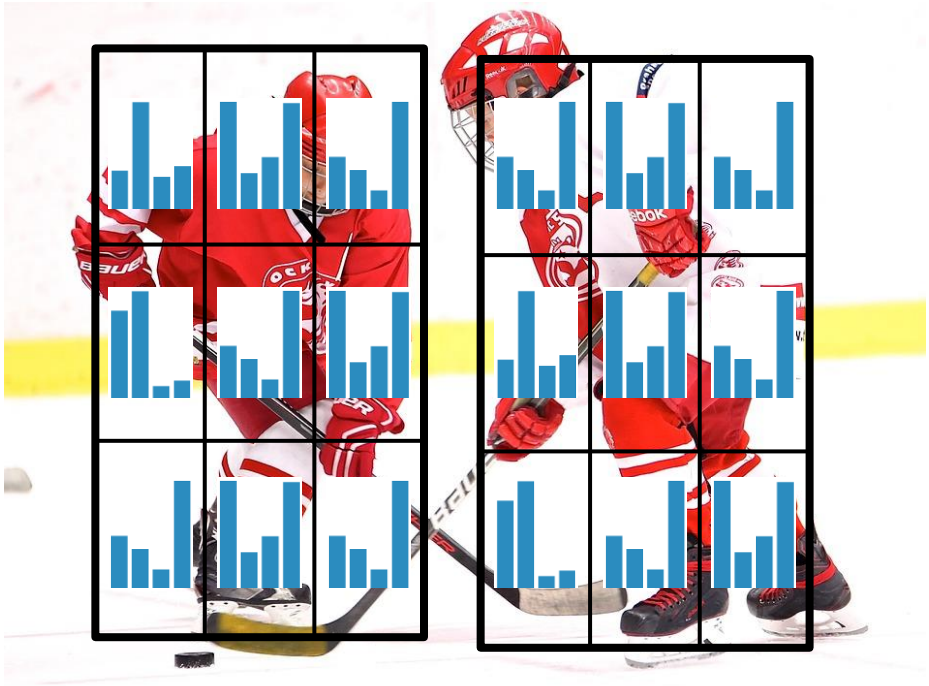


A solution



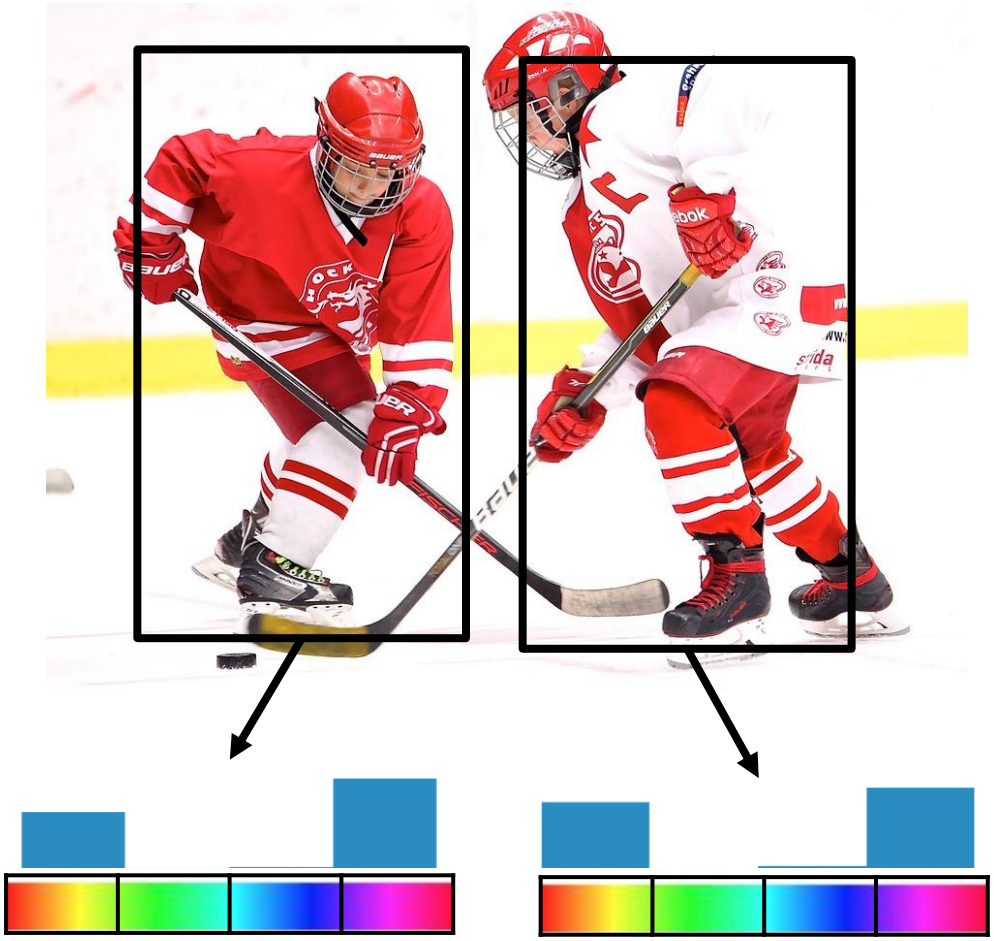
Divide image into
multiple regions?

A solution

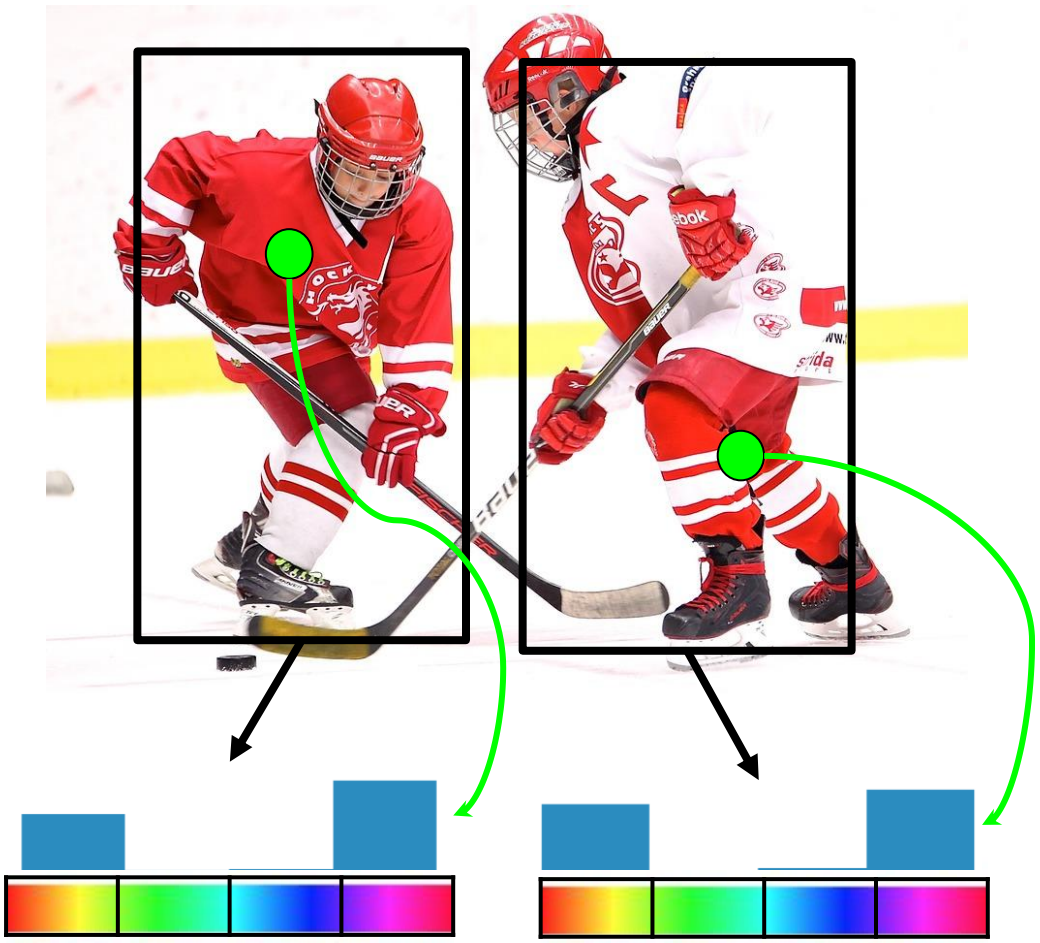


Divide image into
multiple regions?

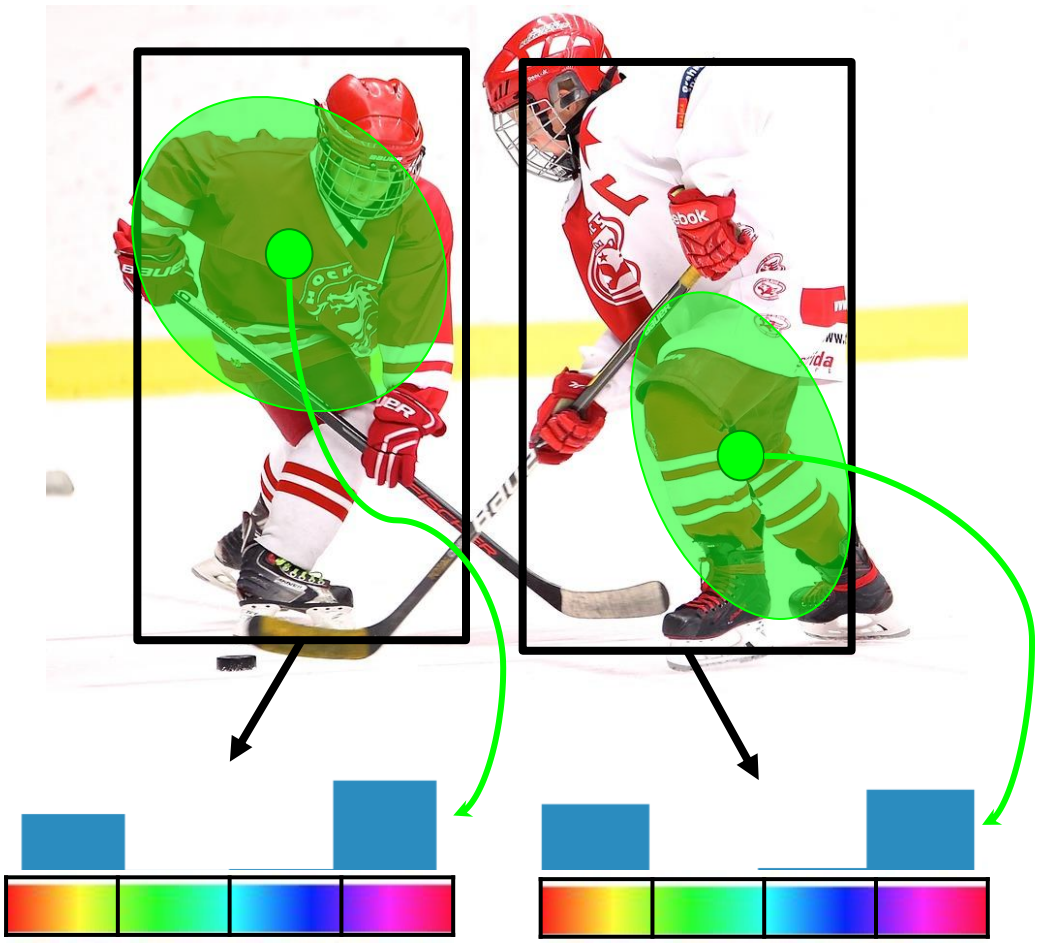
Color Spatiograms



Color Spatiograms



Color Spatiograms

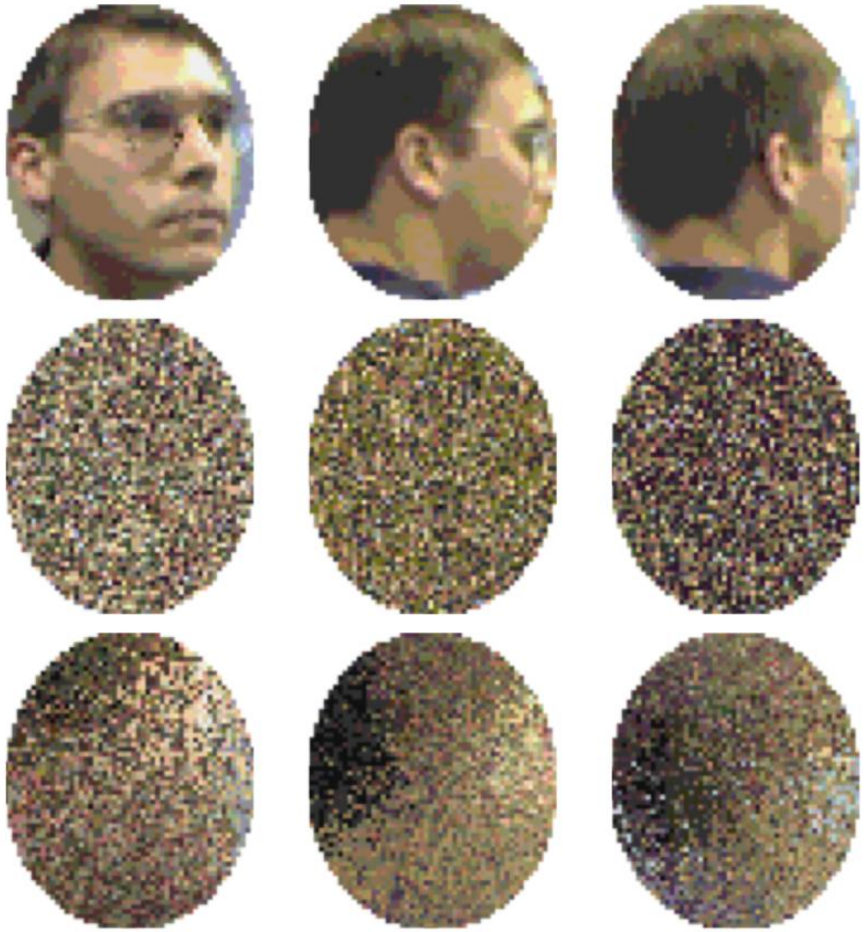


Color Histogram vs Spatiograms

Original

What histogram sees

What spatiogram sees



Spatiograms Versus Histograms for Region-Based Tracking

[Virchfield and Rangarajan, 2005]

So far...

- Color spaces
  - The very first stage is also important
- Color histograms
  - Means to abstract images into robust data