Color Histograms

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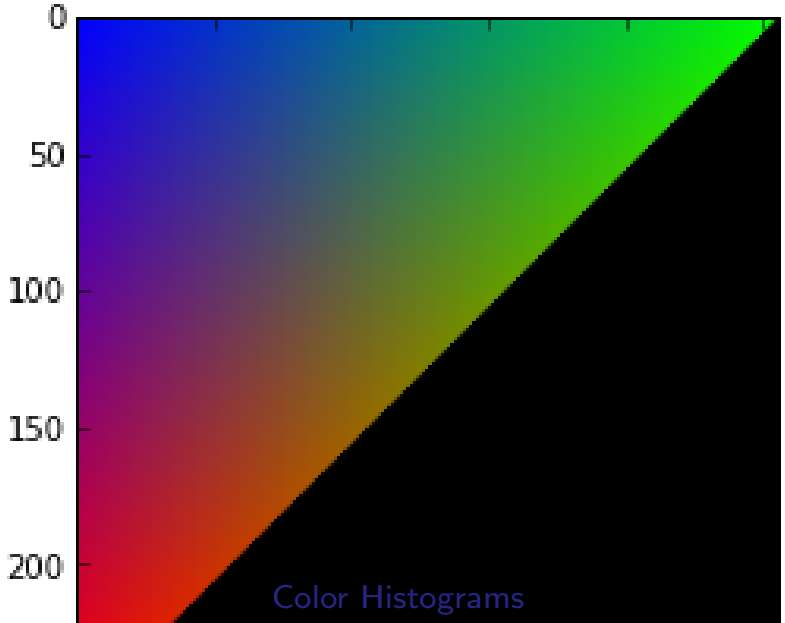
Simple Color Histograms

simple visualization of projected RGB space

```
cspace = zeros((256,256,3))
for i in range(256):
    for j in range(256):
        x = (i/255.0)
        y = (j/255.0)
        if x+y>1: continue
        z = 1-x-y
        rgb = array([x,y,z])
        cspace[i,j,:] = rgb
imshow(cspace)
```

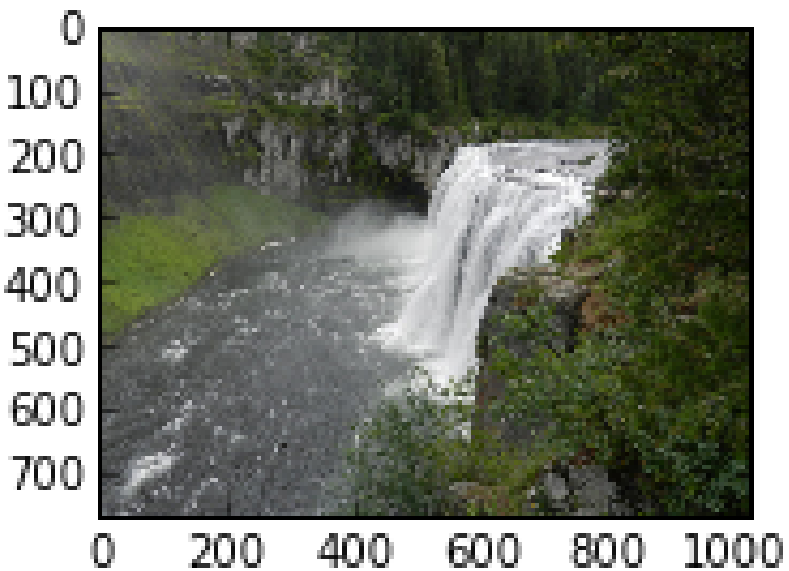


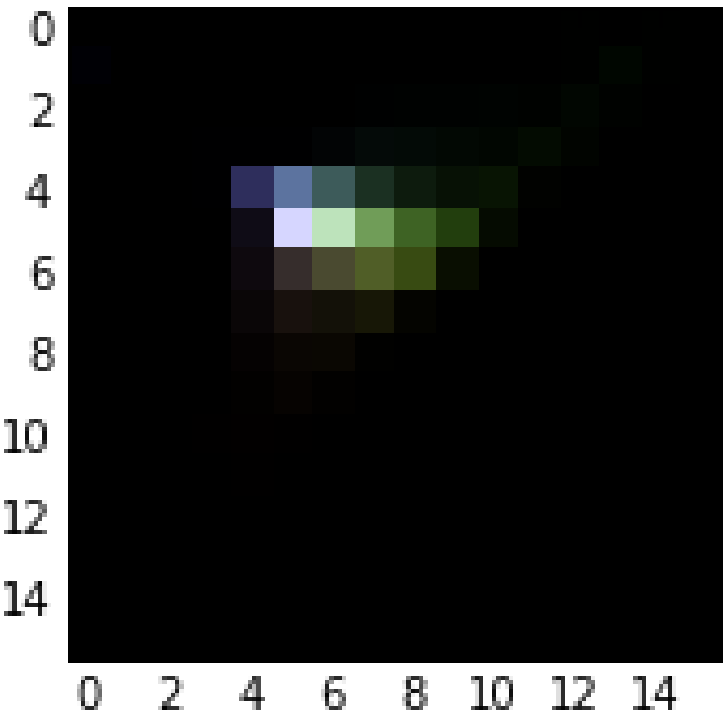
color histogram in projected RGB space

```
def chist(image,r=15):
    if image.dtype==dtype('B'): image = image/255.0
    result = zeros((r+1,r+1))
    assert image.ndim==3
    rgb = image.reshape(-1,3)
    intensity = sum(rgb,axis=1)
    rgb = rgb[(intensity>0.02)*(intensity<0.98)]
    rgb = r*rgb*1.0/sum(rgb,axis=1)[:,newaxis]
    xy = array(rgb,'i')[:,:2]
    index = xy[:,0]*r+xy[:,1]
    counts = Counter(index)
    for k,v in counts.items(): result[k//r,k%r] = v
    return result
```

computing a color histogram of an image

```
image = imread("raw_images/DSCN0314.JPG")
subplot(121); imshow(image)
c = chist(image); c = c*1.0/amax(c)
cs = (c[:,:,newaxis]**.5)*cspace[::16,::16,:]; cs = cs*1.0/amax(cs)
subplot(122); imshow(cs,interpolation='nearest',cmap=cm.gray)
```





Perceptually More Uniform Spaces

Better Color Space

The projected RGB space above is not a very good space to work in because differences in color are not uniform:

- colors that appear similar have different RGB vectors
- colors that appear different have similar RGB vectors

Other color spaces reduce these effects.

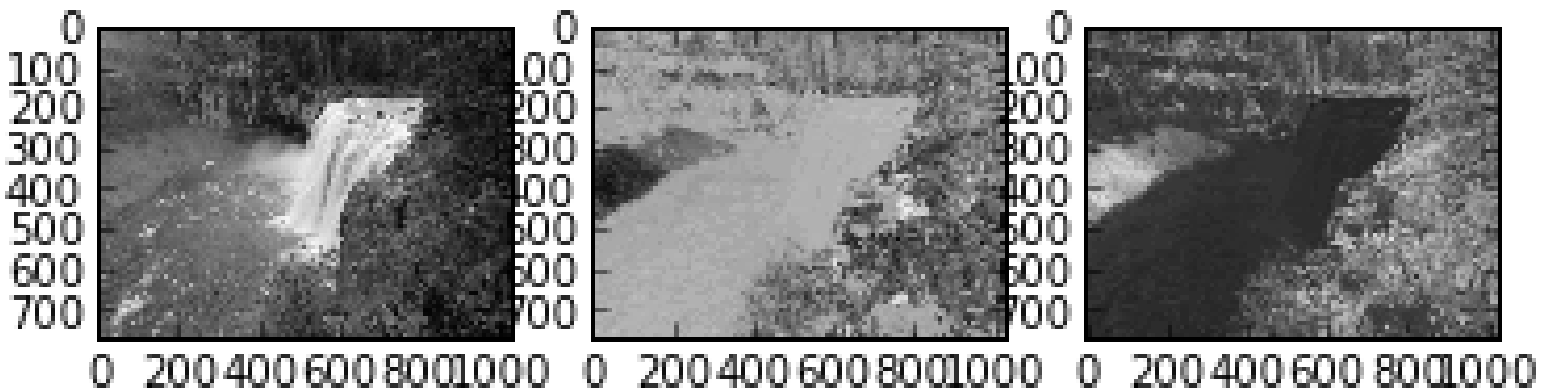
The *Lab* space is a popular color space.

Lab coordinates refer to: L intensity; a , b color opponent channels.

conversion to Lab color space

```
1 from skimage import io,color
2 lab = color.rgb2lab(image)
3 for i in range(3):
4     subplot(1,3,i+1); imshow(lab[:,:,i],cmap=cm.gray)
5     print amin(lab[:,:,i]),amax(lab[:,:,i])
```

```
0.174926254719 100.0
-23.2297308765 10.3329353714
-11.9753707941 48.5577698808
```

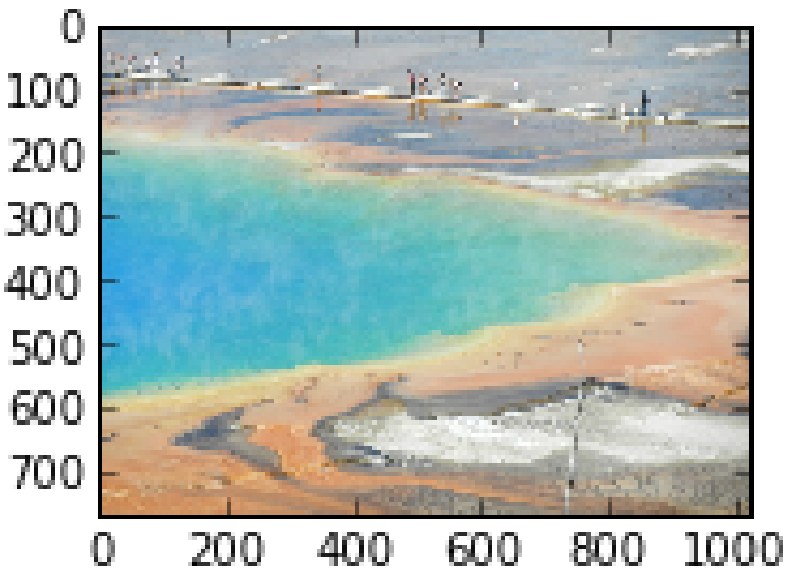


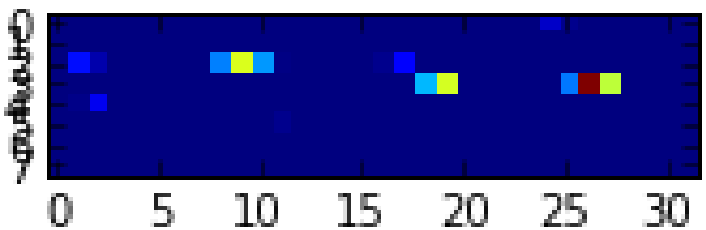
Let's rewrite the `chist` function. Now it computes color histograms using intensity and color information, and using an Lab color space. Computation of the histogram is loop-free.

```
def chist(image,iq=3,cq=7):
    lab = color.rgb2lab(image).reshape(-1,3)
    lab = lab[lab[:,0]>1.0]
    lab[:,0] = lab[:,0]*iq/100.0
    lab[:,1] = (lab[:,1]+128.0)*cq/255.0
    lab[:,2] = (lab[:,2]+128.0)*cq/255.0
    index = ifloor(lab[:,0])*cq*cq+ifloor(lab[:,1])*cq+ifloor(lab
        [:,2])
    counts = Counter(index)
    result = zeros((iq+1)*(cq+1)*(cq+1))
    for k,v in counts.items(): result[k] = v
    return result
```

Let's visualize the output. Note that we get four intensity levels of 8x8 color histograms.

```
image = imread("raw_images/DSCN0243.JPG")
subplot(121); imshow(image)
subplot(122); imshow(chist(image).reshape(8,-1)**.5,interpolation='
    nearest')
```





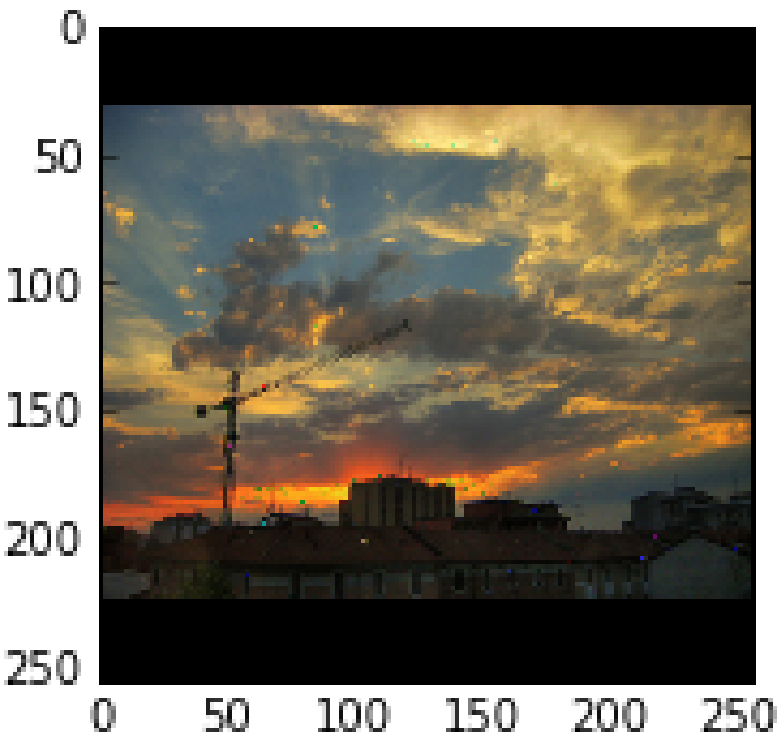
Precomputing Histograms

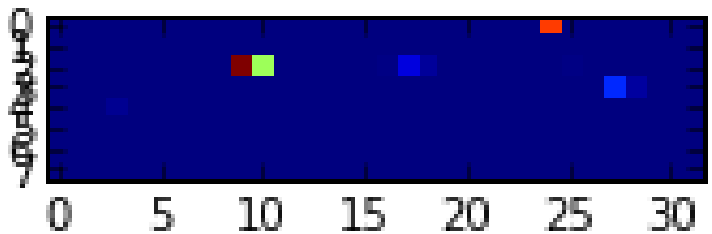
We now just use the low resolution “icons” stored in HDF5 to compute the color histograms. This is sufficient for histogram-based retrieval.

```
1 hdf = tables.openFile("1k.h5","r")
```

Computation of color histograms is very simple now using list comprehensions.

```
1 hists = [chist(image) for image in hdf.root.icons]
2
3 subplot(121); imshow(hdf.root.icons[20])
4 subplot(122); imshow(hists[20].reshape(8,-1),interpolation='nearest
      ')
```





Histogram Search

For searching by color histogram similarity, we use the *cosine distance*.

That is, each histogram is viewed as a vector, and the dissimilarity between vectors is given by:

$$d(u, v) = 1 - \frac{u \cdot v}{||u||\ ||v||}$$

Distance calculations are efficiently implemented by `scipy.spatial.distance`

(For large scale nearest neighbor search, we use a different approach.)

search by color histogram similarity

```
def search_example():
    figsize(12,8)
    from scipy.spatial import distance
    for ff,t in enumerate([0,20,40,60,80]):
        dists = distance.cdist(hists[t].reshape(1,-1),hists,metric=
            'cosine')[0]
        nearest = argsort(dists)
        for f,i in enumerate(nearest[:5]):
            subplot(5,5,ff*5+f+1); axis("off"); imshow(hdf.root.
                icons[i]); title("%d␣%.2f"%(i,dists[i]))
```

```
1 search_example()
```