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MASTER IN ARTIFICIAL INTELLIGENCE

COMPUTATIONAL VISION

Retrieval of Images Based on Texture

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1 Introduction

For this report we evaluate the capabilities of texture-features extracted with the Leung-Malik (LM) filter bank of finding images similar to a given one. In the following sections we will extract descriptors based on texture filters and then use a knn-search algorithm to retrieve the most fitting images.

2 Leung-Malik Filter Bank

We use the Matlab code provided by the Visual Geometry Group of Oxford University to create the LM filter bank¹. The bank consists of 48 different filters at different scales and orientations: 36 first and second derivatives of Gaussians at 6 different orientations and 3 scales, 8 Laplacian of Gaussian (LOG) filters, and 4 Gaussian filters. Figure 1 shows the filters visualized as heat maps.

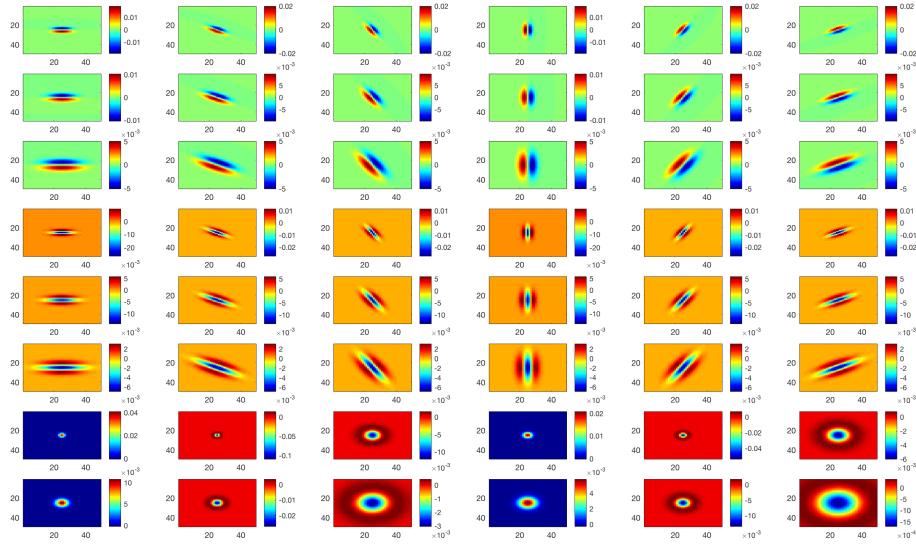


Figure 1: Visualization of LM filter bank

3 Texture Descriptors

4 Class Feature Matrices

When applying the convolutions of the LM filter bank, responses for the filters are usually different in different parts of an image. In order to describe an image's texture with a small but expressive number of descriptors, we need to aggregate the responses of the image for each filter into single values. For this we can calculate descriptive metrics such as mean, standard deviation, or median. We construct a feature matrix for each class (forest, buildings, and sunset) of images with each row corresponding to an image and each column corresponding to the aggregated response of this image to a filter of the LM filter bank.

¹<http://www.robots.ox.ac.uk/~vgg/research/texclass/filters.html>

5 Visualizing Class Feature Differences

6 KNN Search for Similar Images

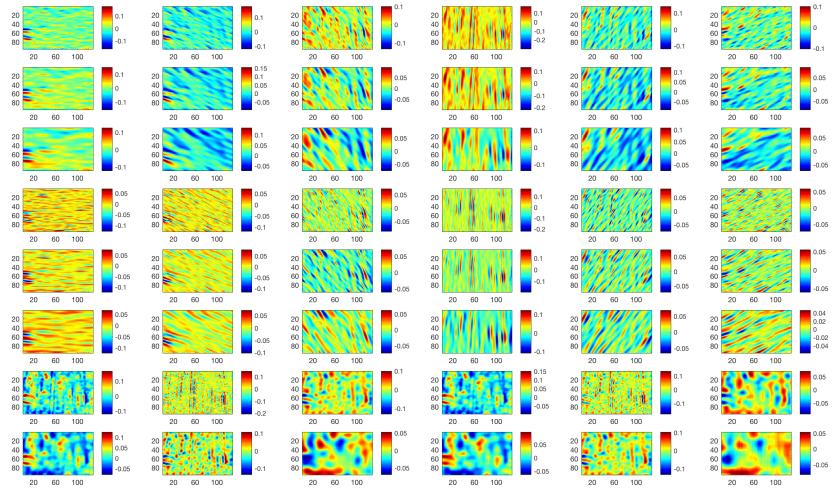
looking at the separability of color:

```
featureModes =  
1 0 0 0 0  
ans =  
0.4222  
featureModes =  
0 1 0 0 0  
ans =  
0.6333  
featureModes =  
0 0 1 0 0  
ans =  
0.5778  
featureModes =  
0 0 0 1 0  
ans =  
0.5333  
featureModes =  
0 0 0 0 1  
ans =  
0.4000  
featureModes =  
0 0 0 0 1  
ans =  
0.7556  
featureModes =  
1 0 0 0 0  
ans =  
0.5333  
featureModes =  
0 1 0 0 0  
ans =  
0.7111  
featureModes =  
0 0 1 0 0  
ans =  
0.5889  
featureModes =  
0 0 0 1 0  
ans =  
0.6889  
featureModes =  
0 0 0 0 1  
ans =  
0.5000  
featureModes =
```

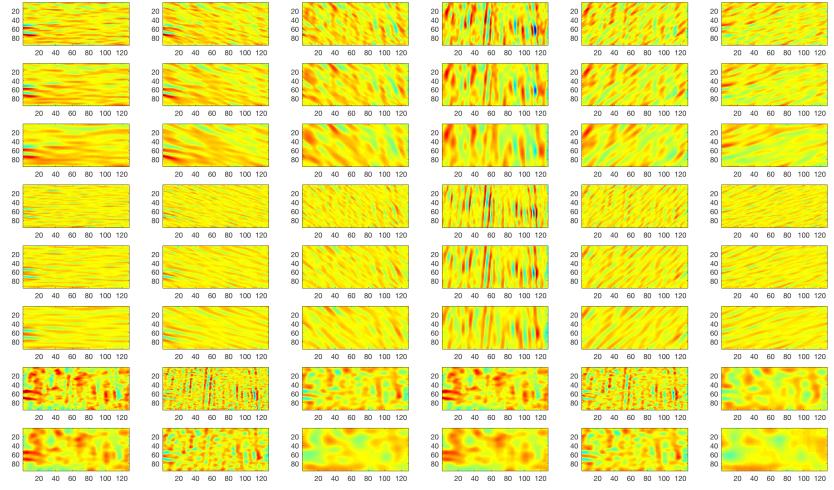
```
1 1 1 1 1 0
ans =
0.4556
featureModes =
1 1 1 1 1 1
ans =
0.5111
```



(a) Example image `forest_9`



(b) Responses of `forest_9` to the LM filter bank

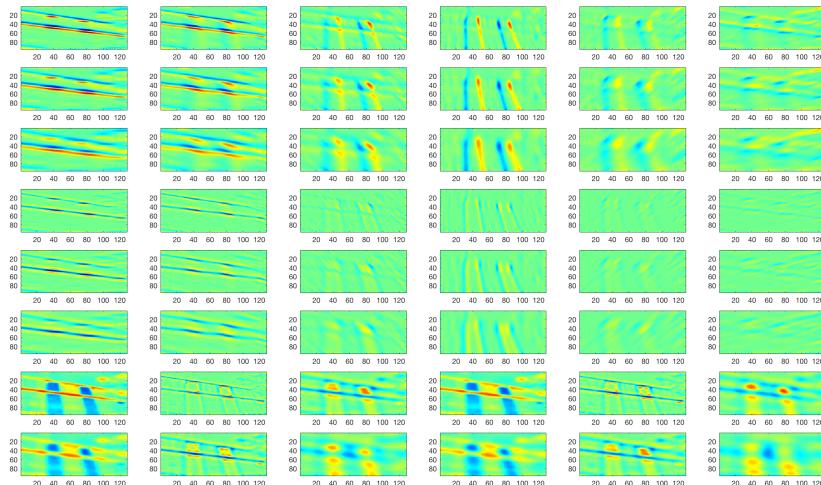


(c) Normalized responses of `buildings_2` to the LM filter bank. The heat map colors are relative to the global minimum (-0.2982) and maximum (0.1799) of responses for this particular image.

Figure 2: Visualization of the LM filter bank responses applied on a forest image

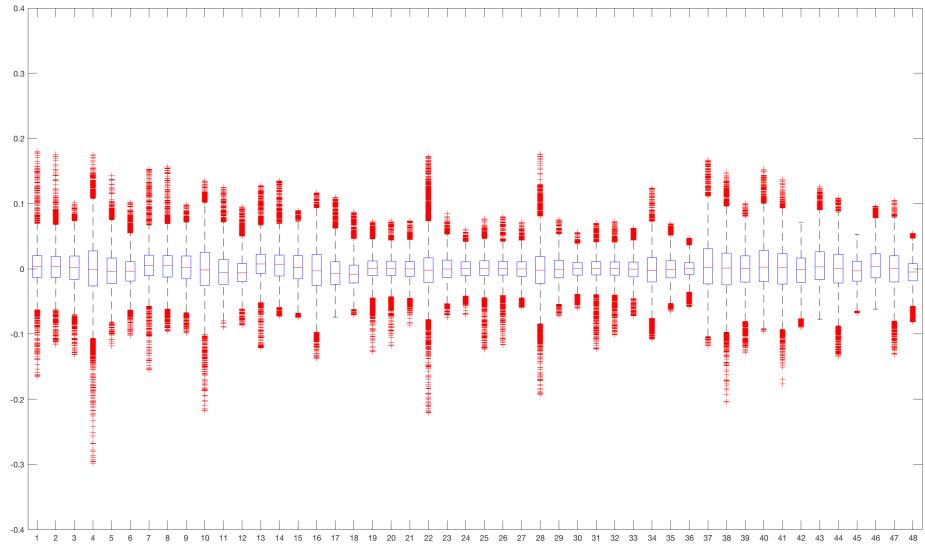


(a) Example image `buildings_2`

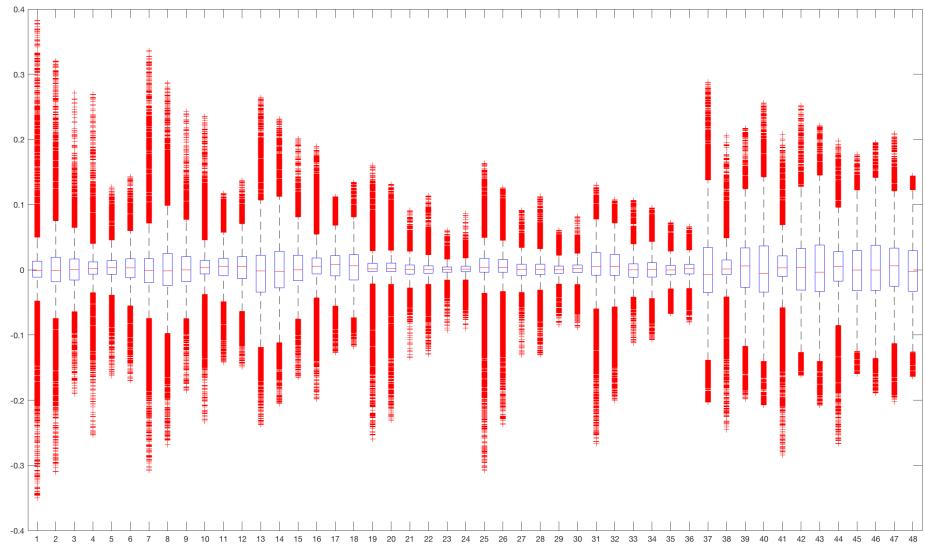


(b) Normalized responses of `buildings_2` to the LM filter bank. The heat map colors are relative to the global minimum (-0.3498) and maximum (0.3828) of responses for this particular image.

Figure 3: Visualization of the LM filter bank responses applied on a buildings image

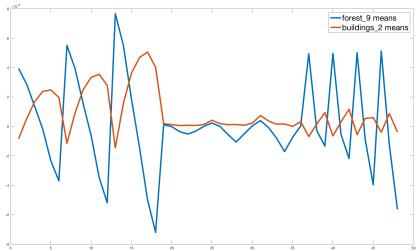


(a) test

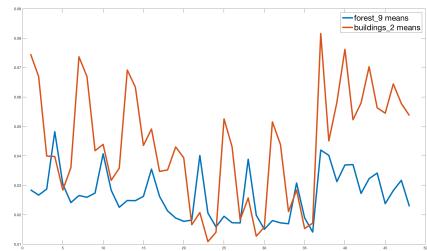


(b) test

Figure 4: cap



(a) test



(b) test

Figure 5: cap

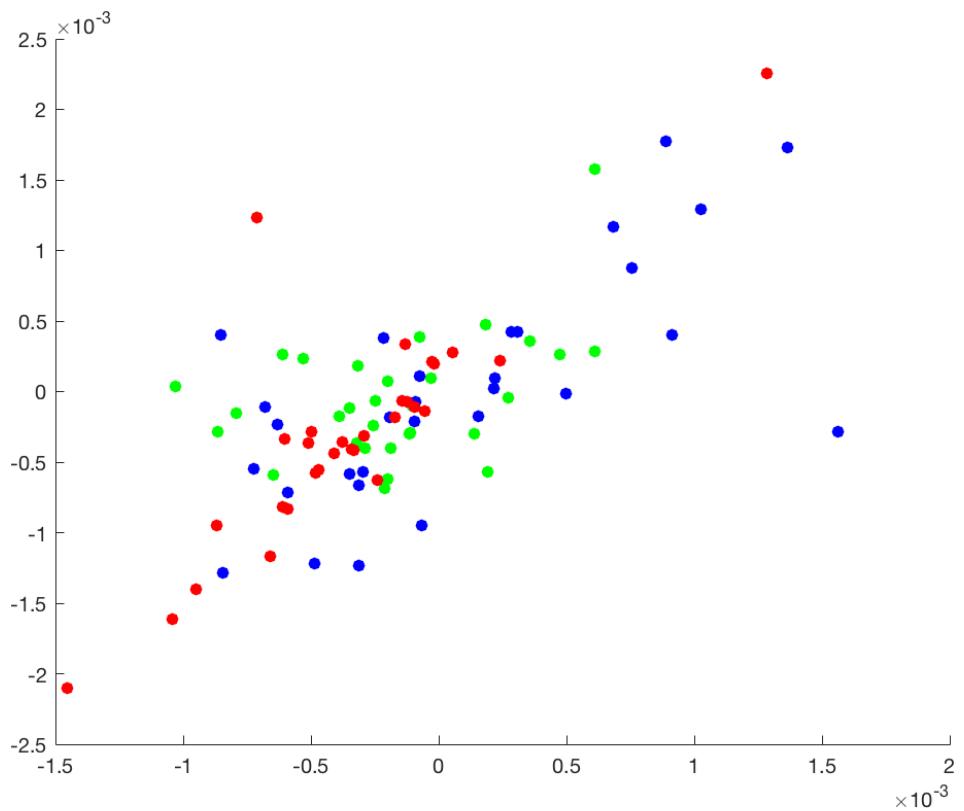


Figure 6: test

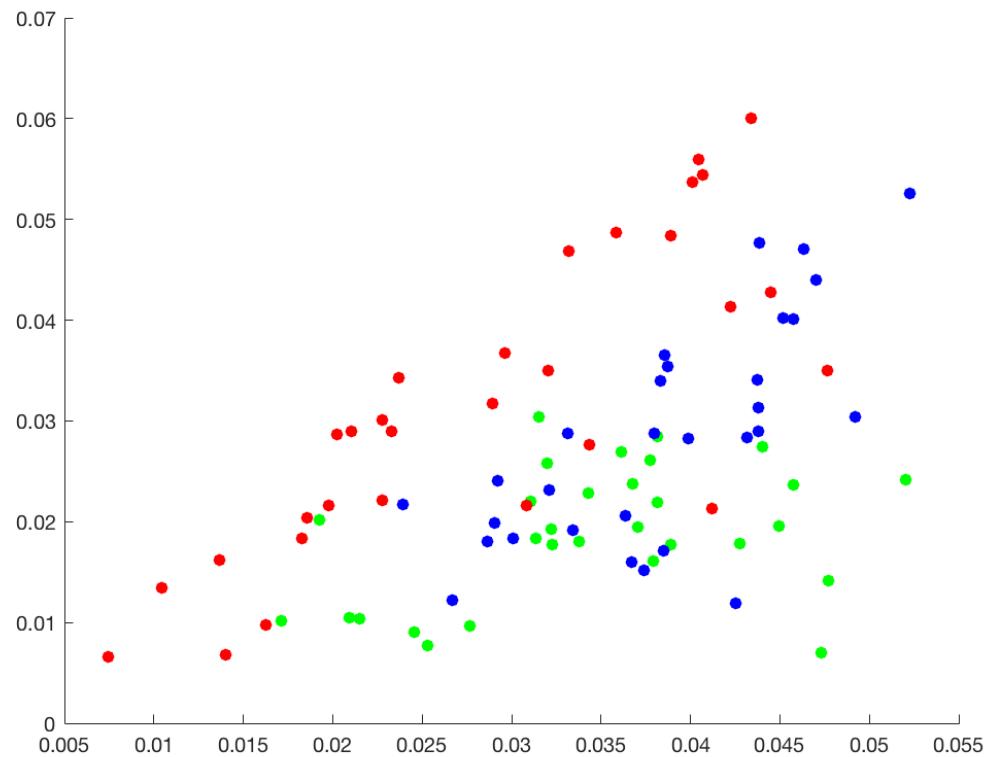


Figure 7: test

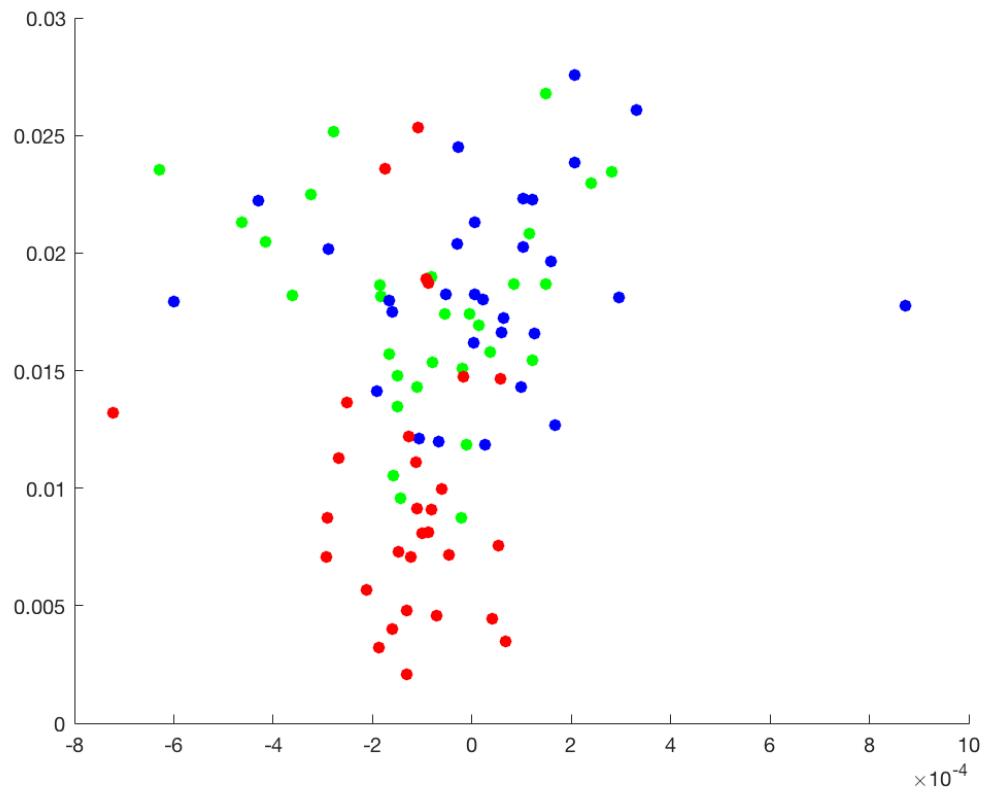
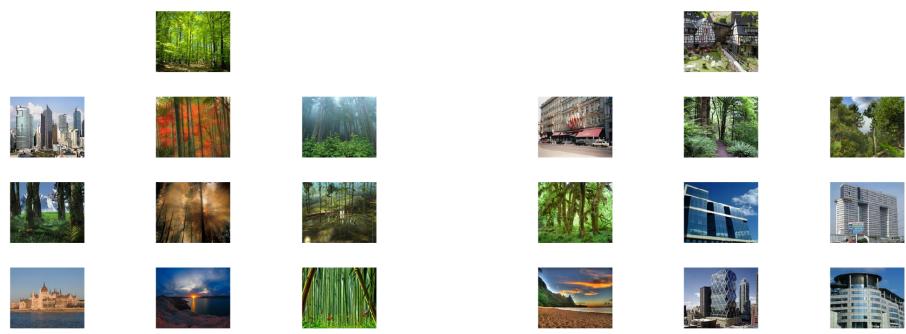


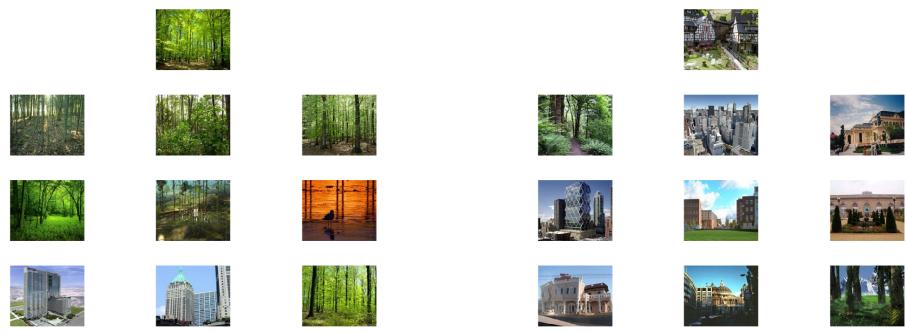
Figure 8: test



(a) test

(b) test

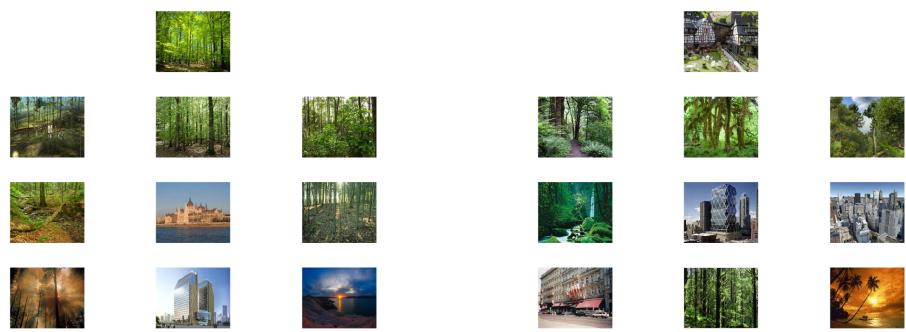
Figure 9: cap 100000



(a) test

(b) test

Figure 10: cap 010000



(a) test

(b) test

Figure 11: cap 111110

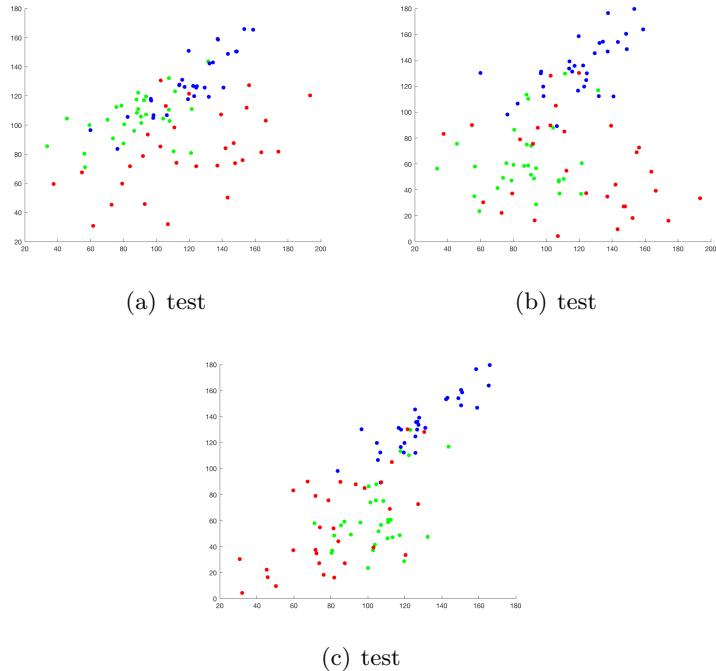
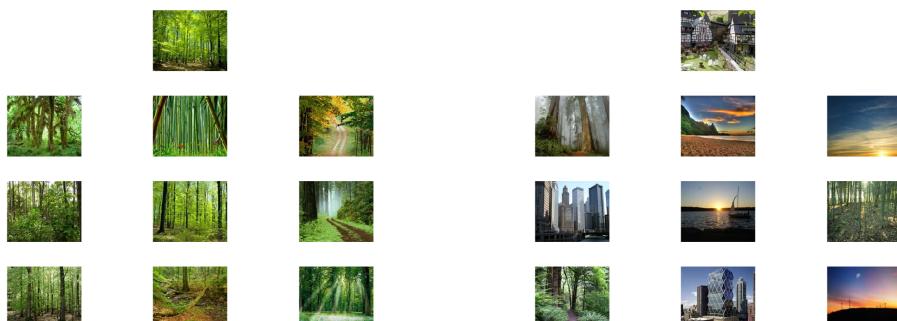


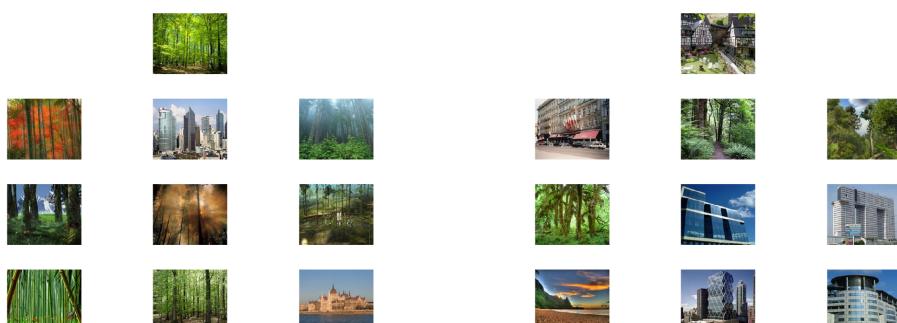
Figure 12: Separability of RGB features



(a) test

(b) test

Figure 13: cap 000001



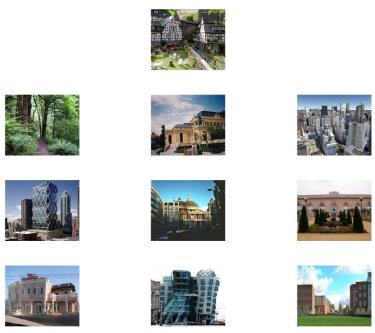
(a) test

(b) test

Figure 14: cap 100001



(a) test



(b) test

Figure 15: cap 010001

Appendices