Question

Image Compression using Indexed Images

- A) Implement a function that takes an image and the number of colors as input, and compresses the image in indexed format and returns the output. In this format, the color table is followed by the image matrix. Then, implement a function to display the indexed image (output of the first function). Use the k-means algorithm for color clustering.
- B) First, convert the input image to different color spaces that we have learned in the course within the first function. Then perform compression with a limited number of colors. Compare the quality of the compressed images with each other.

Solution

1. compress_image(image, num_colors): This function takes an input image and the desired number of colors as parameters.
- It first converts the image from the default BGR format (used by OpenCV) to the RGB format using cv2.cvtColor() function. This is because the k-means clustering algorithm expects input in RGB format.
- The image is then reshaped into a 2D array of pixels using the reshape() method with -1 as the first argument, which automatically determines the number of rows based on the number of columns and channels in the image. The shape of the original image is accessed using the shape attribute, and [:-1] is used to exclude the channel dimension (since it's not needed for reshaping).
- Next, the k-means clustering algorithm is applied using KMeans class from scikit-learn. The n_clusters parameter is set to the desired number of colors for compression.
- The fit() method of the KMeans class is called on the reshaped pixels to perform clustering and obtain cluster labels for each pixel.
- The cluster labels are then reshaped back into the original image shape to create a compressed image where each pixel is replaced with its corresponding cluster label using compressed_labels.reshape(image.shape[:-1]).
- Finally, the unique cluster centers (which represent the reduced color palette) are obtained using the cluster_centers_ attribute of the KMeans object, and the color table is created by converting the cluster centers to uint8 data type using astype(np.uint8).

1. display_compressed_image(color_table, compressed_image): This function takes the color table and the compressed image as parameters.
- It uses the color table to reconstruct the compressed image by indexing the color table with the values in the compressed image. This is done using color_table[compressed_image], which creates a new image where each cluster label is replaced with its corresponding color table index.

- The reconstructed image is displayed using matplotlib. also the size of each image with the exact cluster number specified is labled on each image to demonstrate the size difference

```
import cv2
import numpy as np
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt

def compress_image(image, num_colors):
    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
    pixels = image.reshape(-1, 3)
    kmeans = KMeans(n_clusters=num_colors)
    kmeans.fit(pixels)
    compressed_labels = kmeans.labels_
    compressed_image = compressed_labels.reshape(image.shape[:-1])

    color_table = kmeans.cluster_centers_.astype(np.uint8)

    return color_table, compressed_image

def display_compressed_image(color_table, compressed_image,
num_colors):
    plt.imshow(cv2.cvtColor(color_table, cv2.COLOR_BGR2RGB))
    plt.show()
    reconstructed_image = color_table[compressed_image]
    plt.imshow(reconstructed_image)
    retval, buffer = cv2.imencode('.jpg', reconstructed_image)
    image_size_bytes = len(buffer.tobytes()) / 1000
    label = str(num_colors) + ' clusters: ' + str(image_size_bytes) +
"KB"
    plt.text(50, 50, label, color='white', fontsize=20)
    plt.show()

image = cv2.imread("image2.jpg")

def compress_action(image, num_colors):
  color_table, compressed_image = compress_image(image, num_colors)
  display_compressed_image(color_table, compressed_image, num_colors)

for i in range(1, 32, 1):
  compress_action(image, i)
```

```
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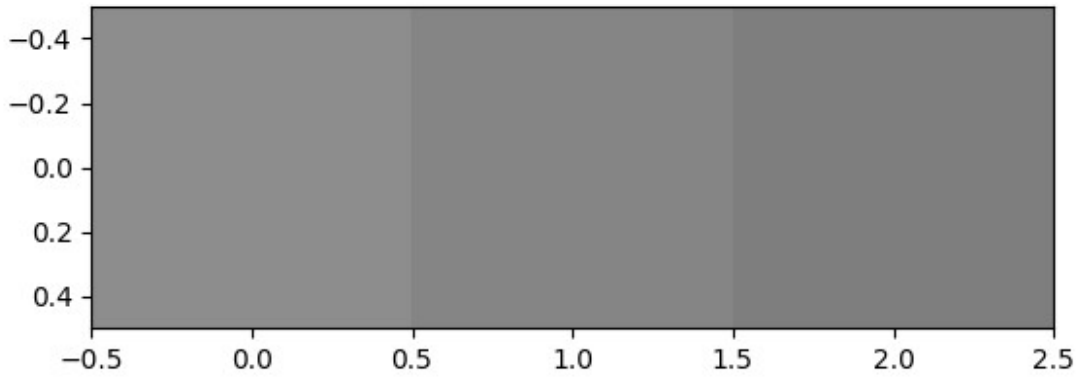

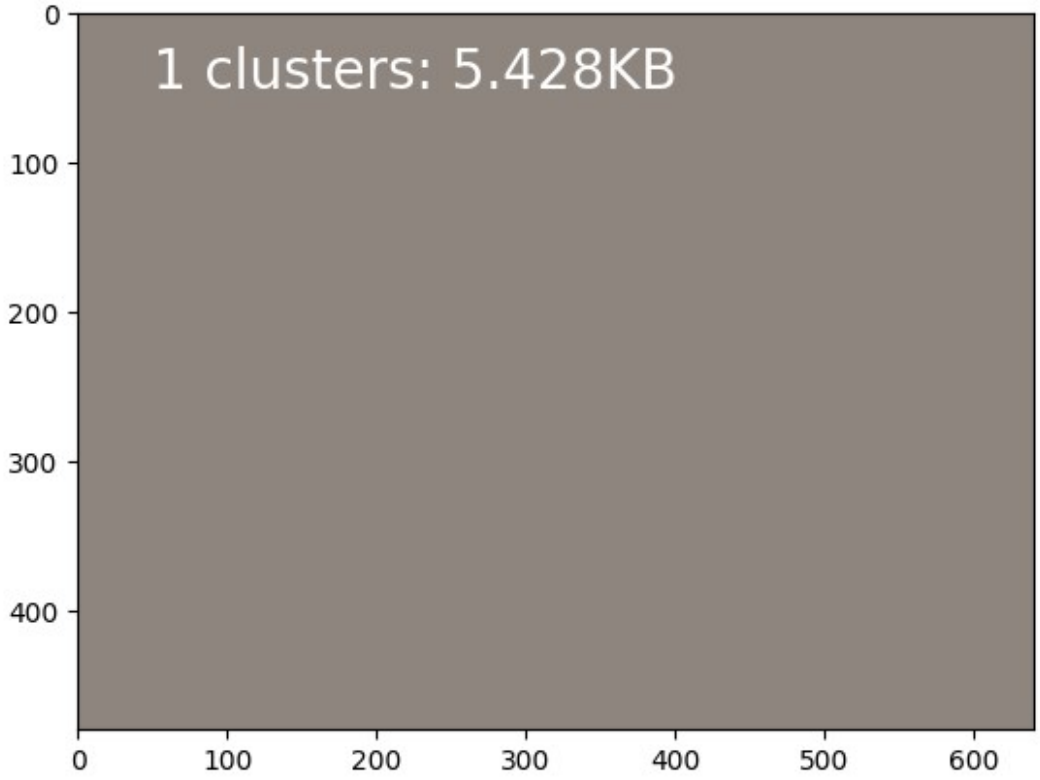


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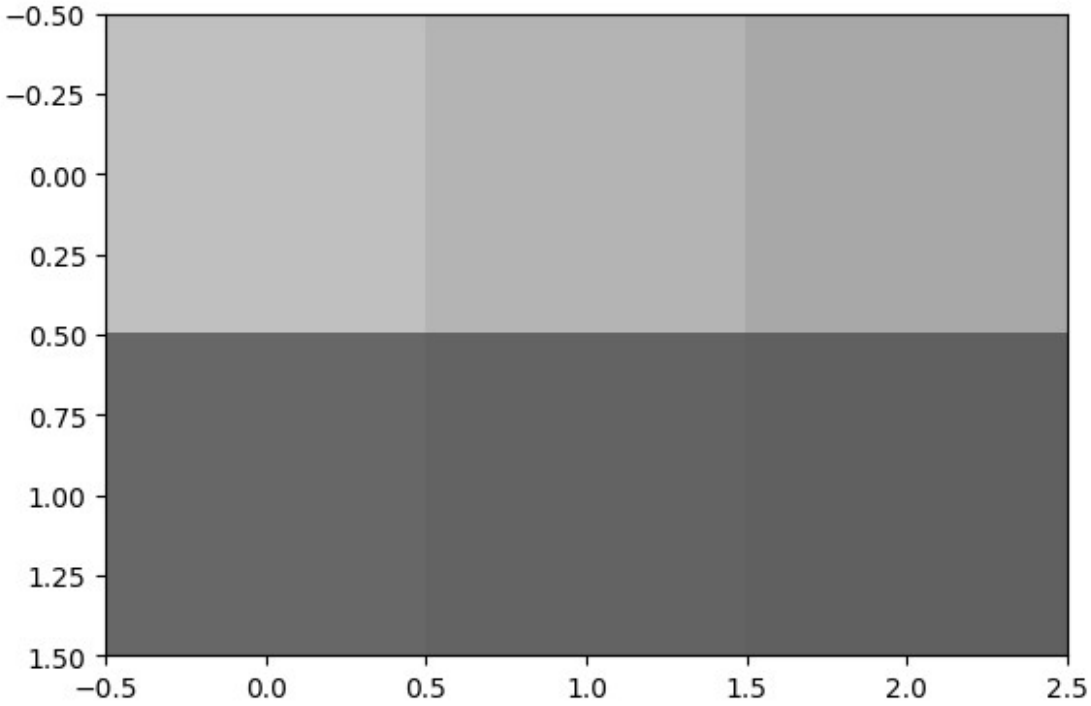

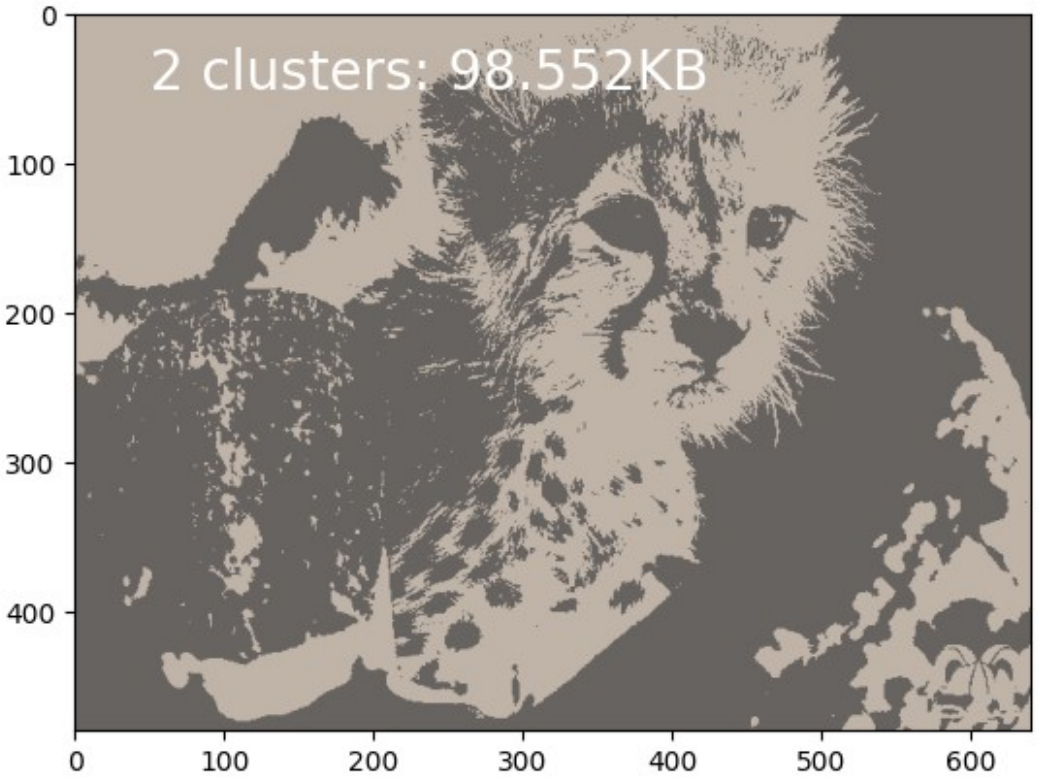


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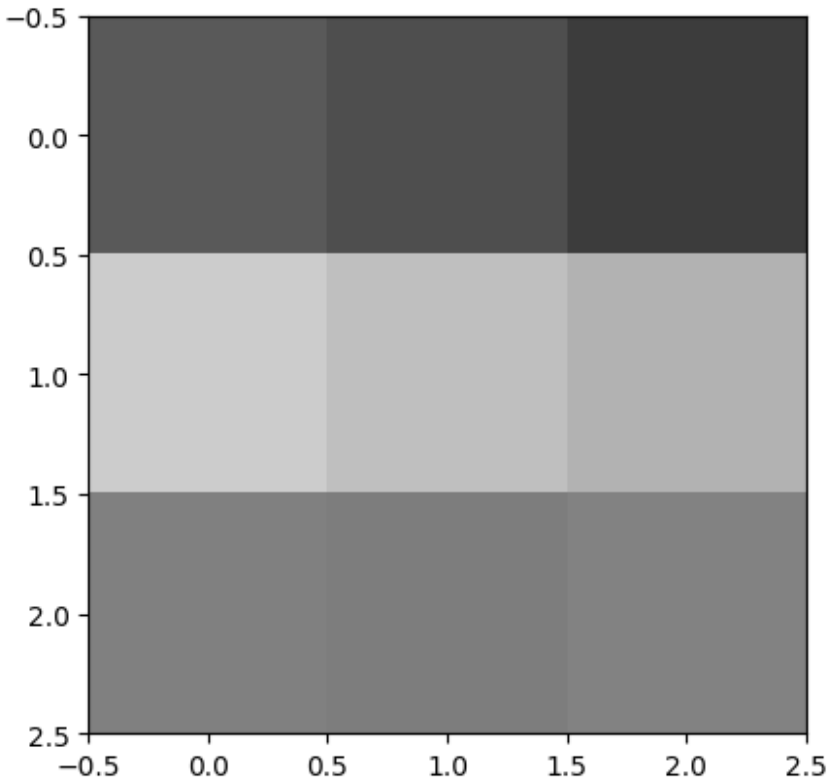

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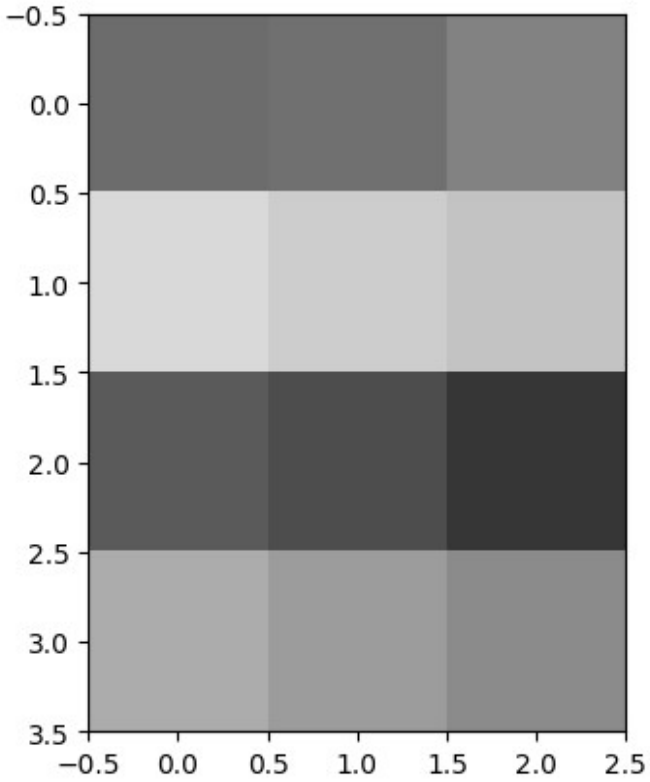
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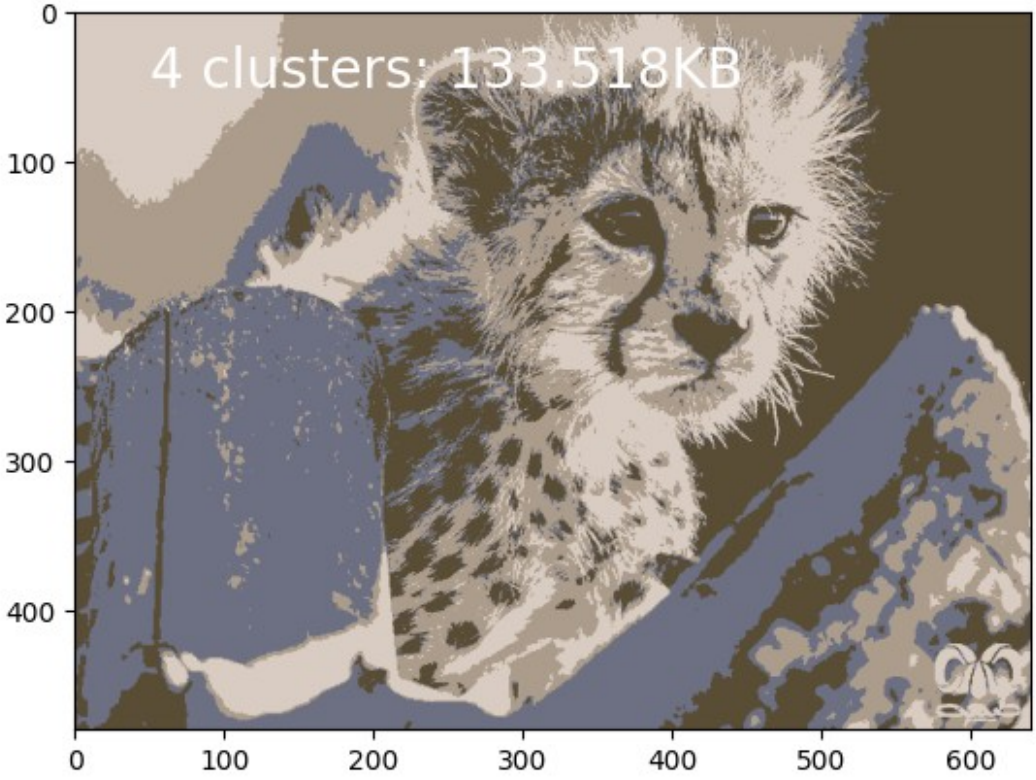
4 clusters: 133.518KB
0
100
200
300
400
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100
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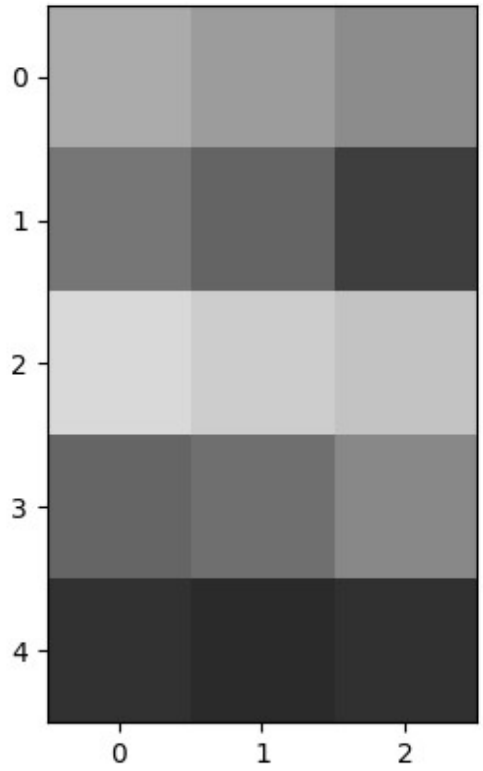

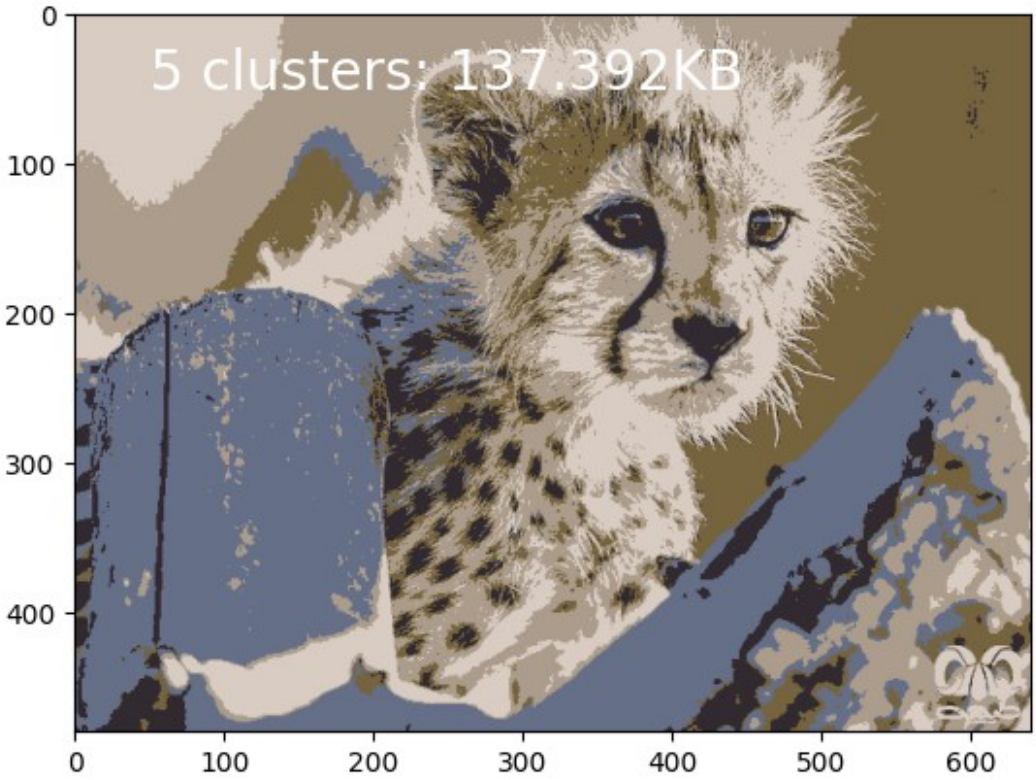


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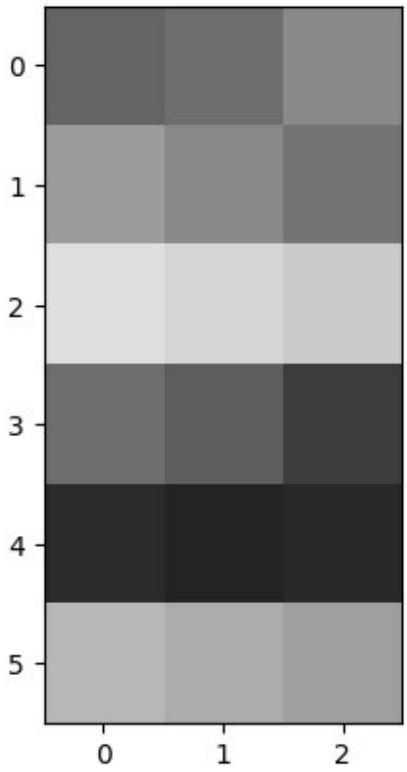

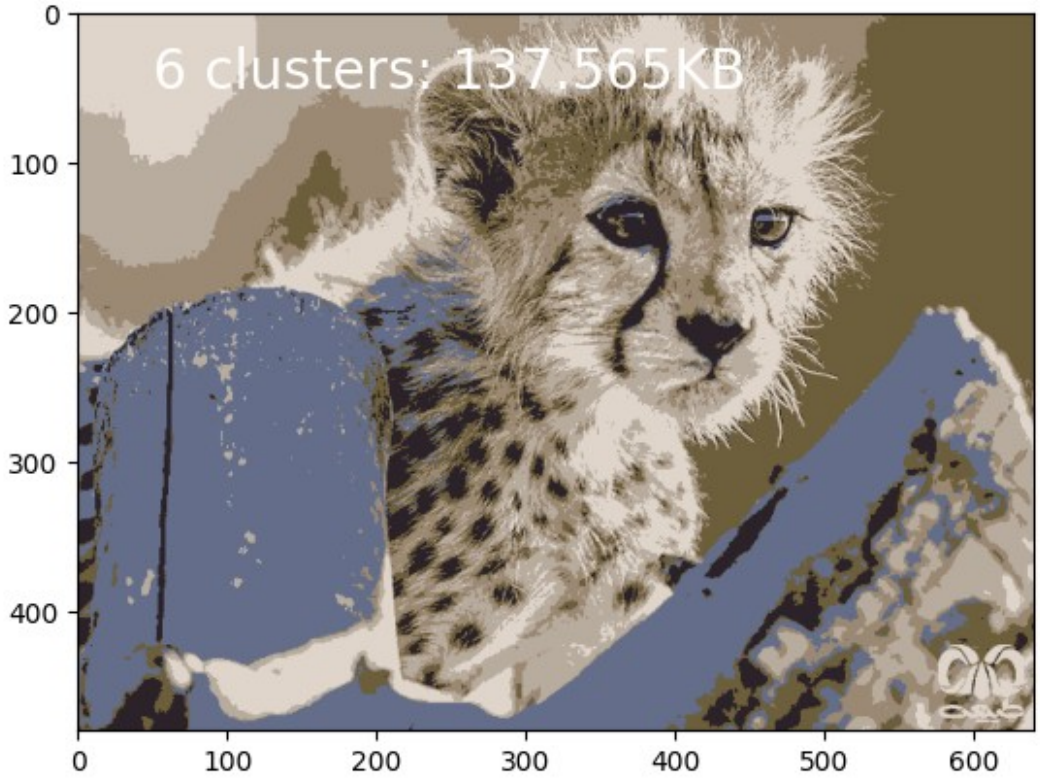


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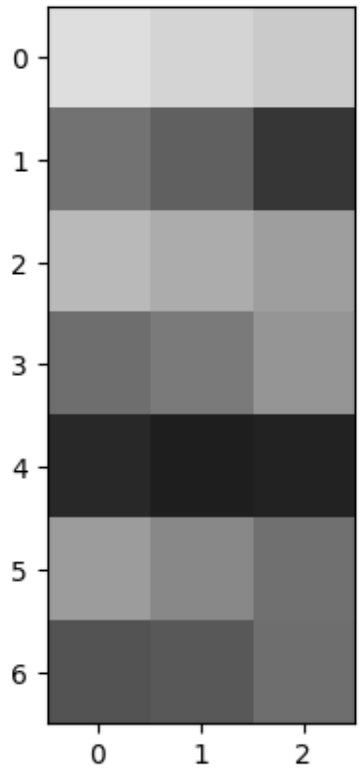

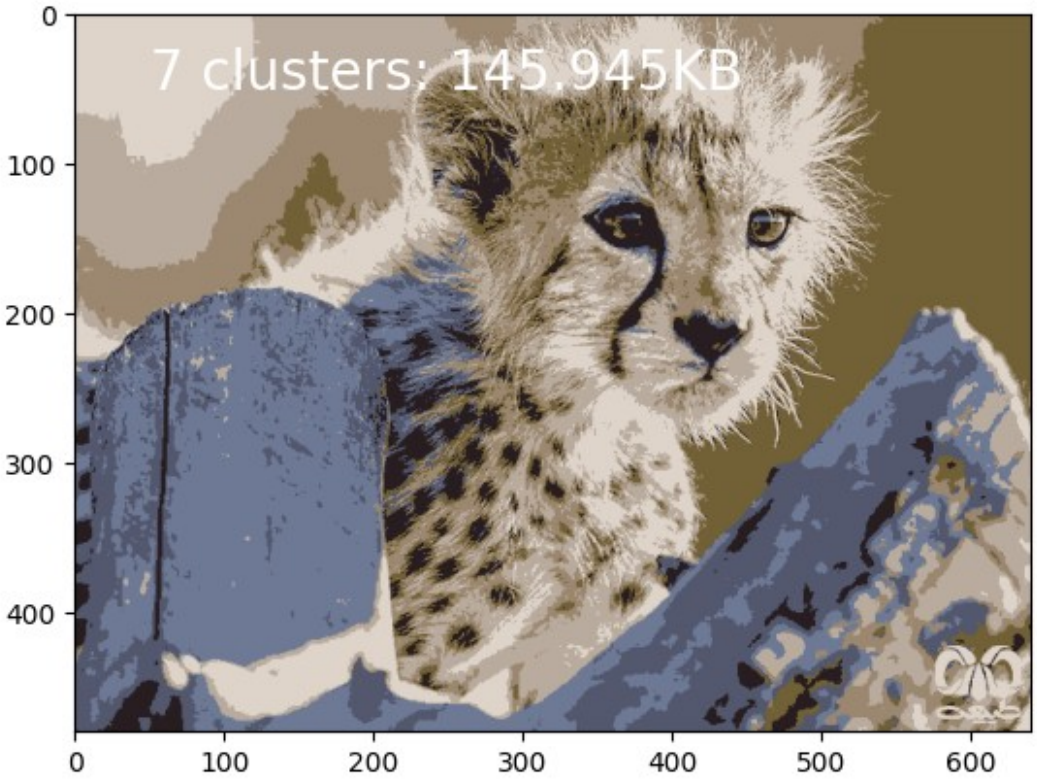


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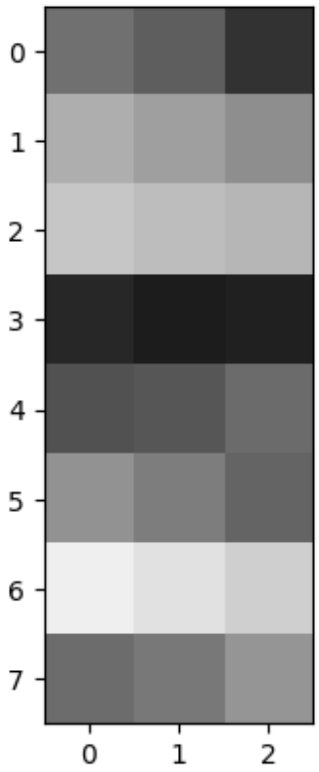

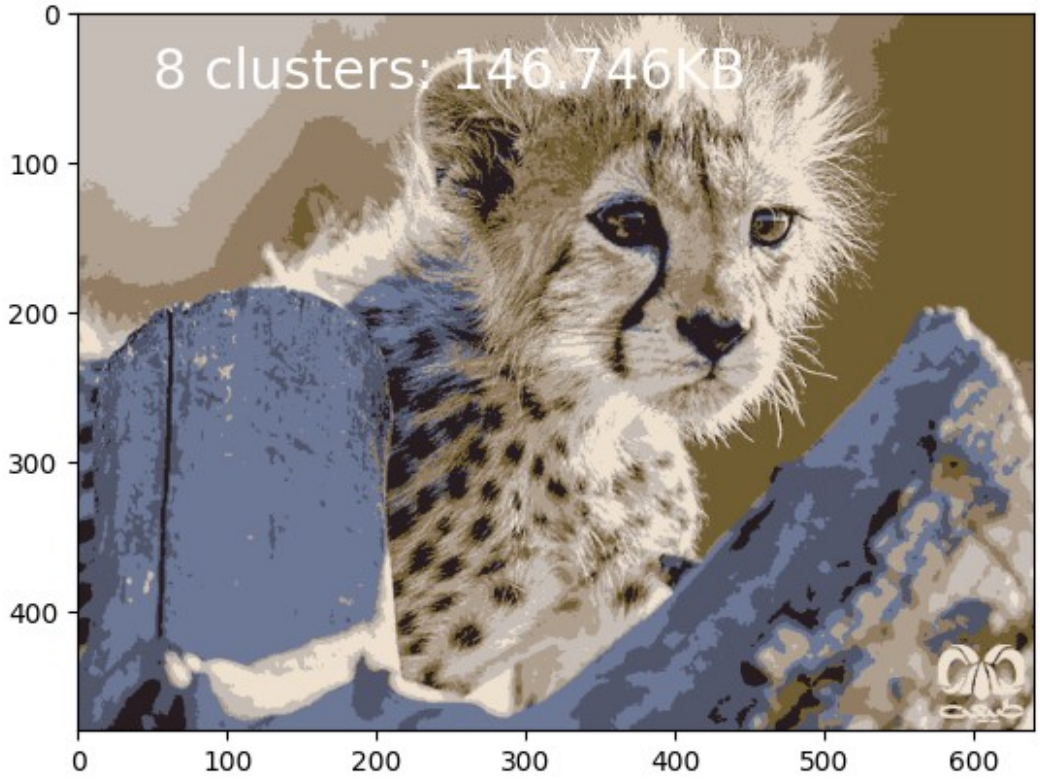


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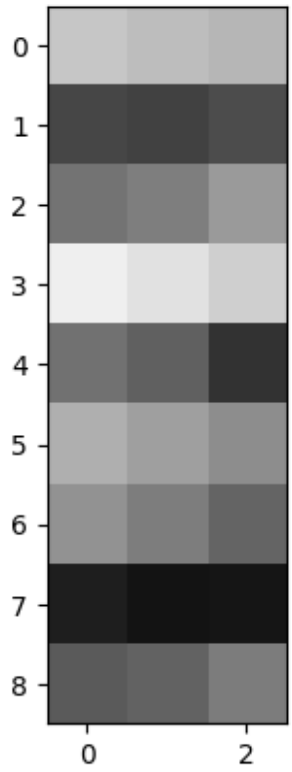

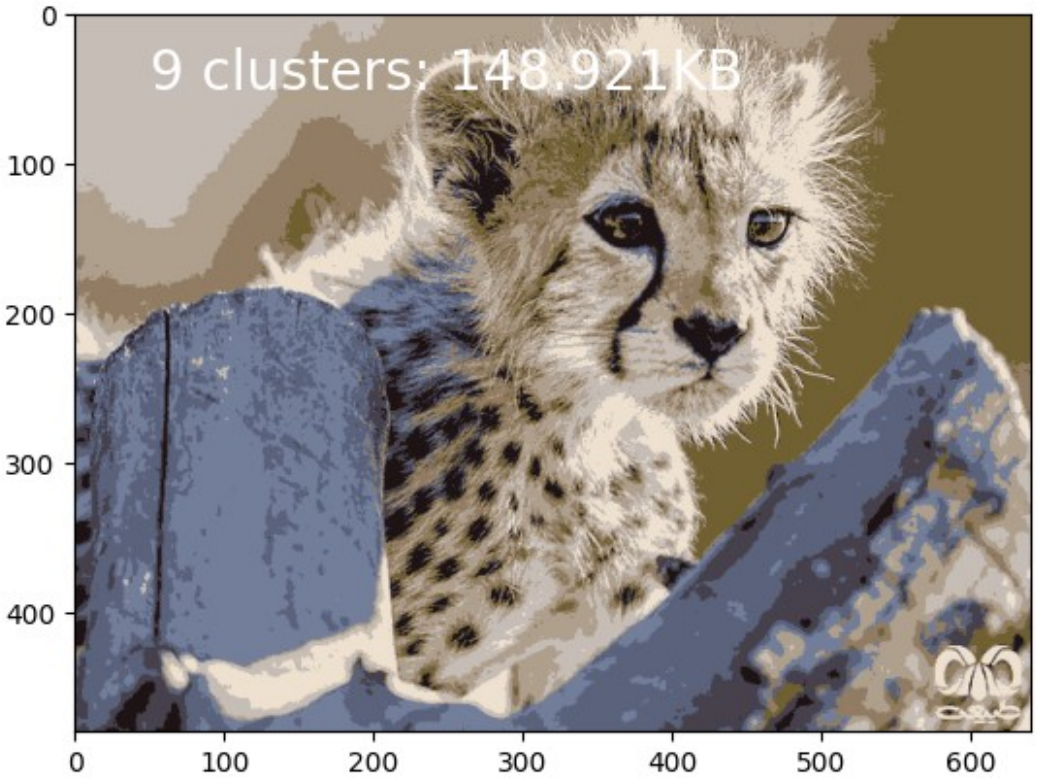


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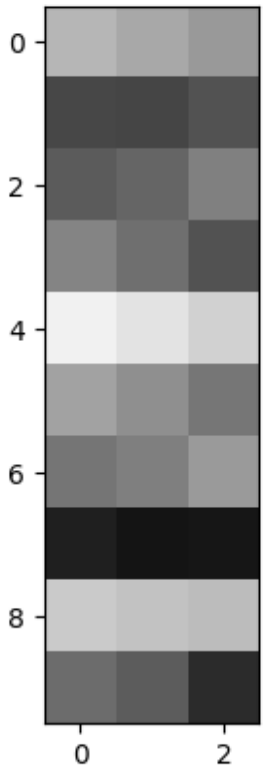

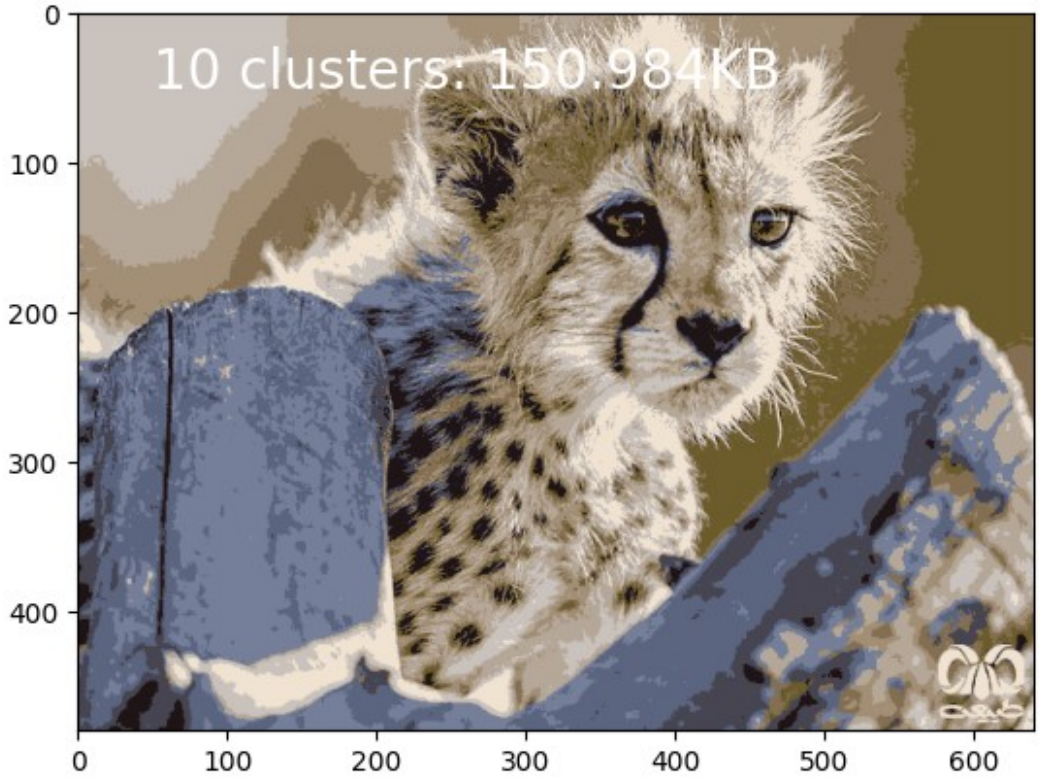


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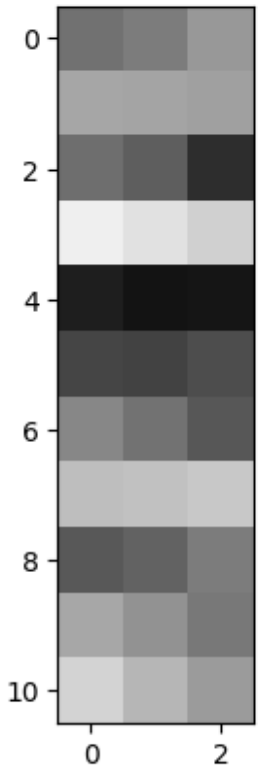

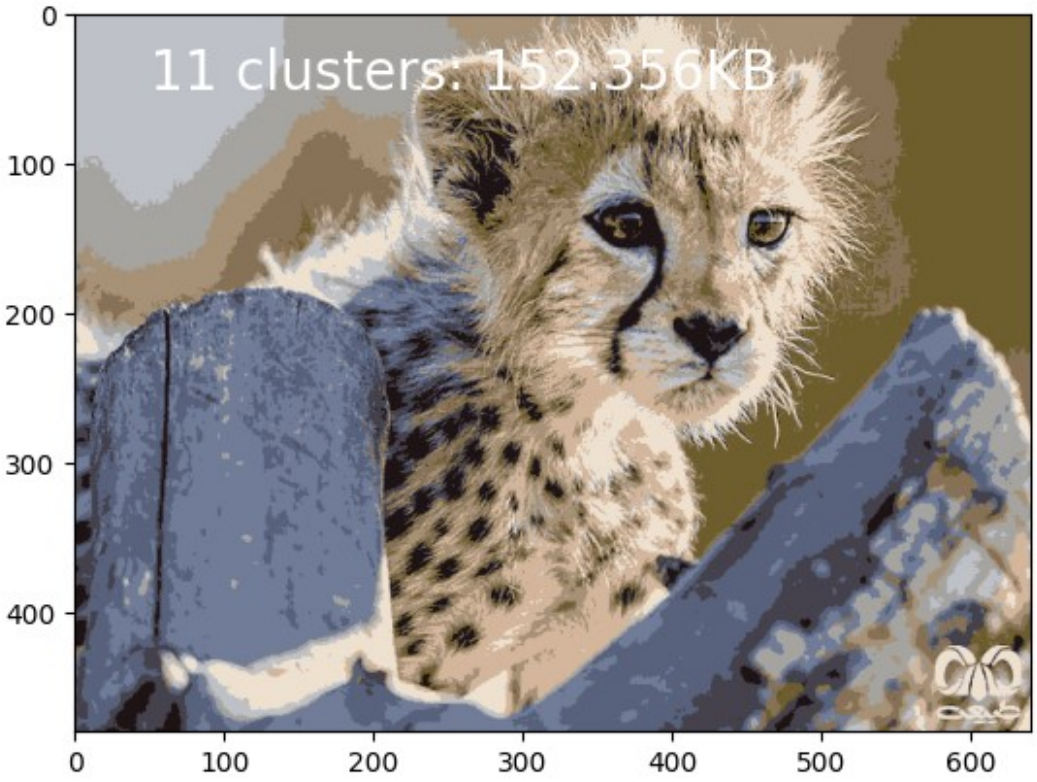


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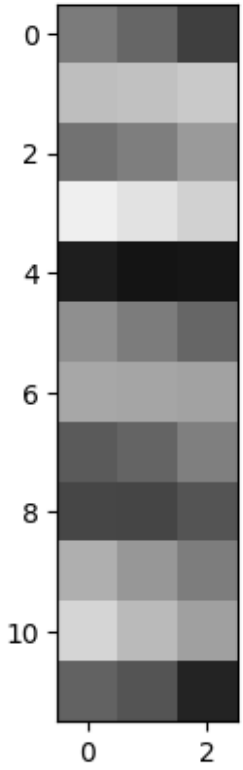

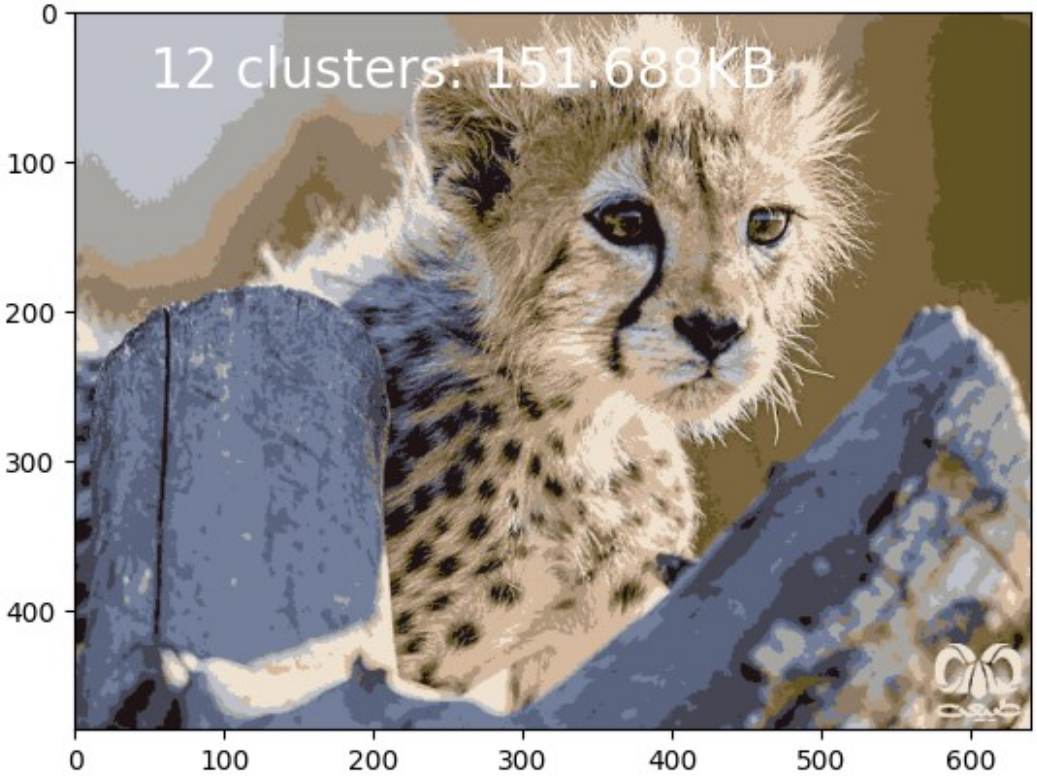


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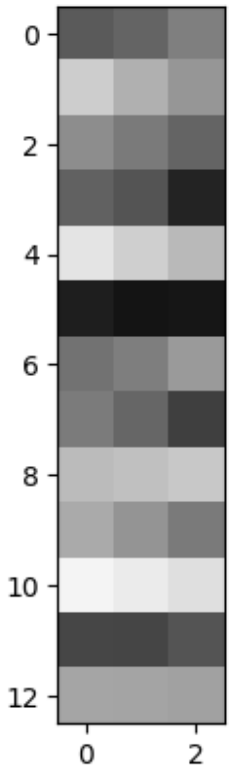

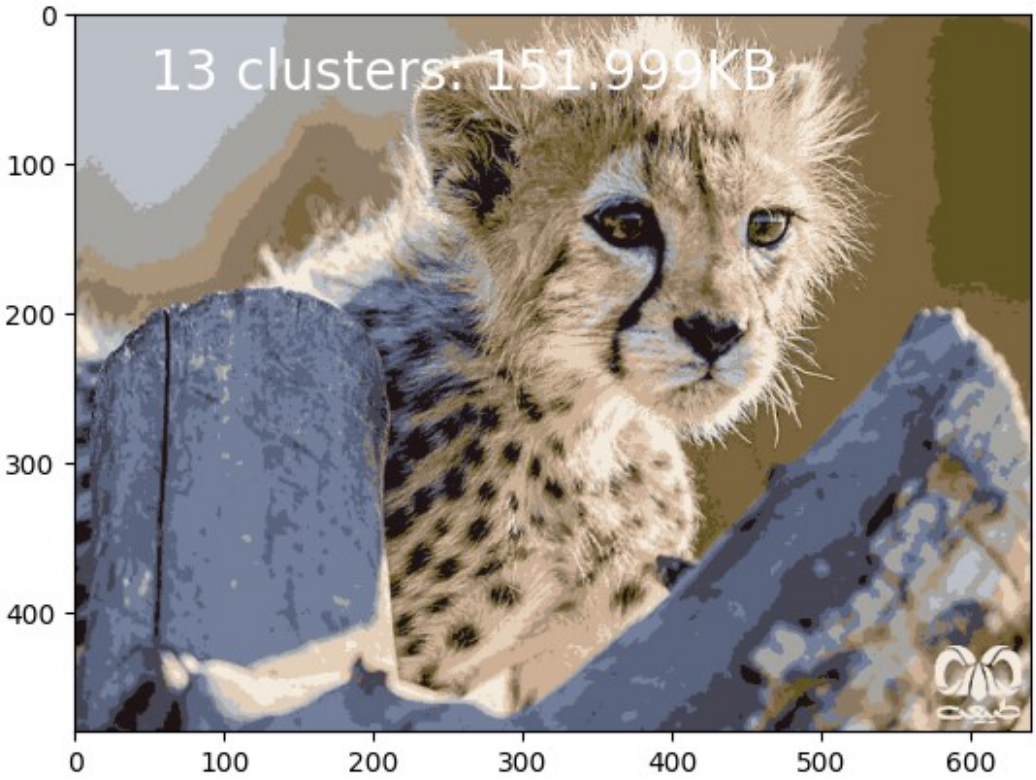


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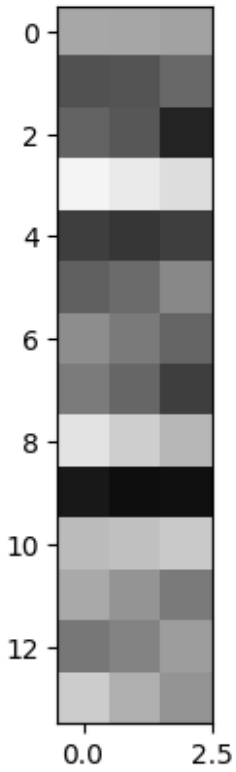

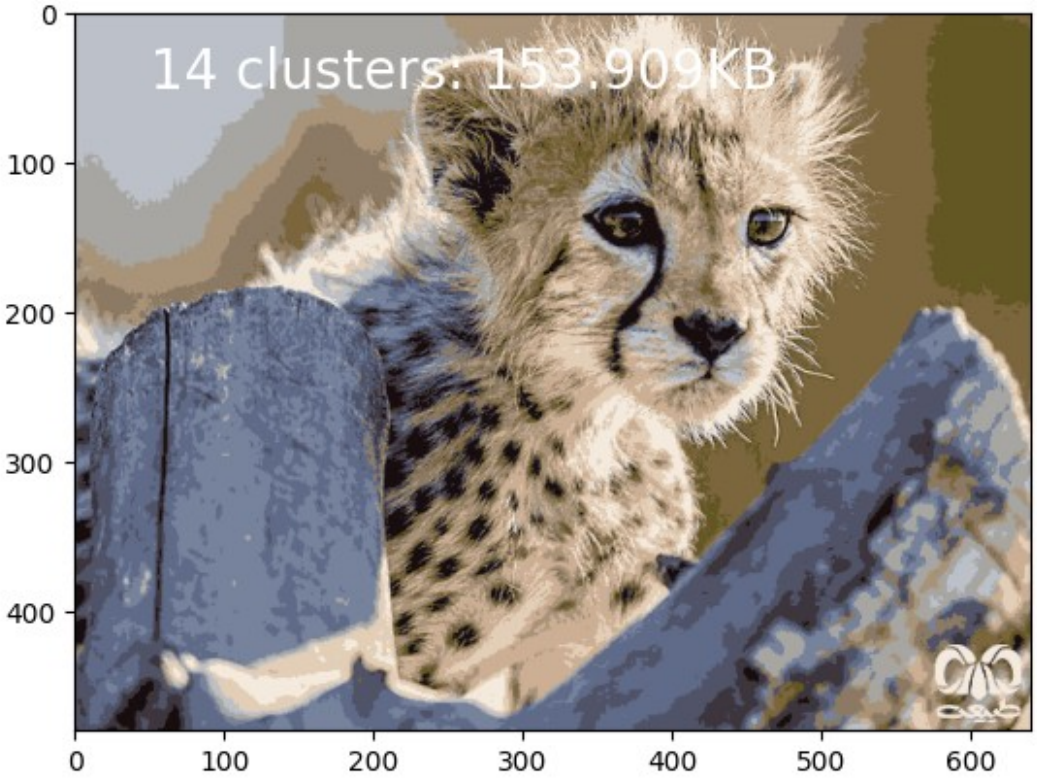


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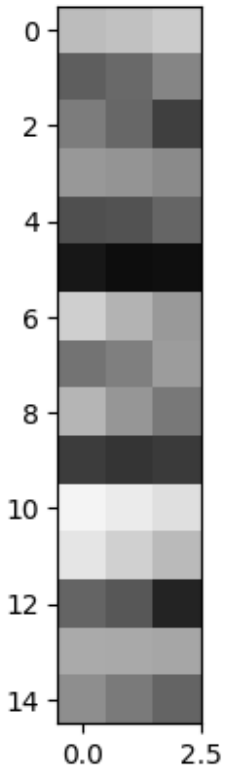

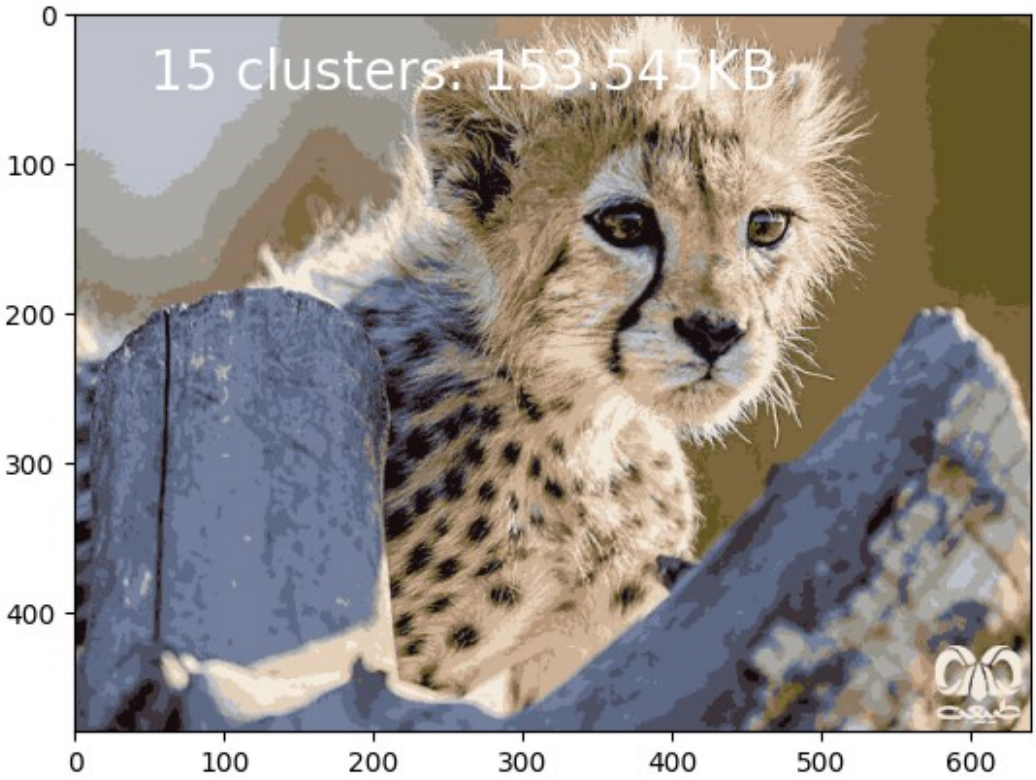


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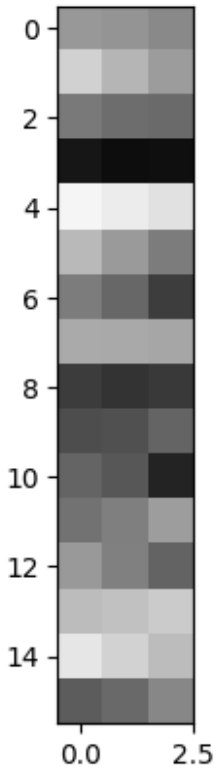

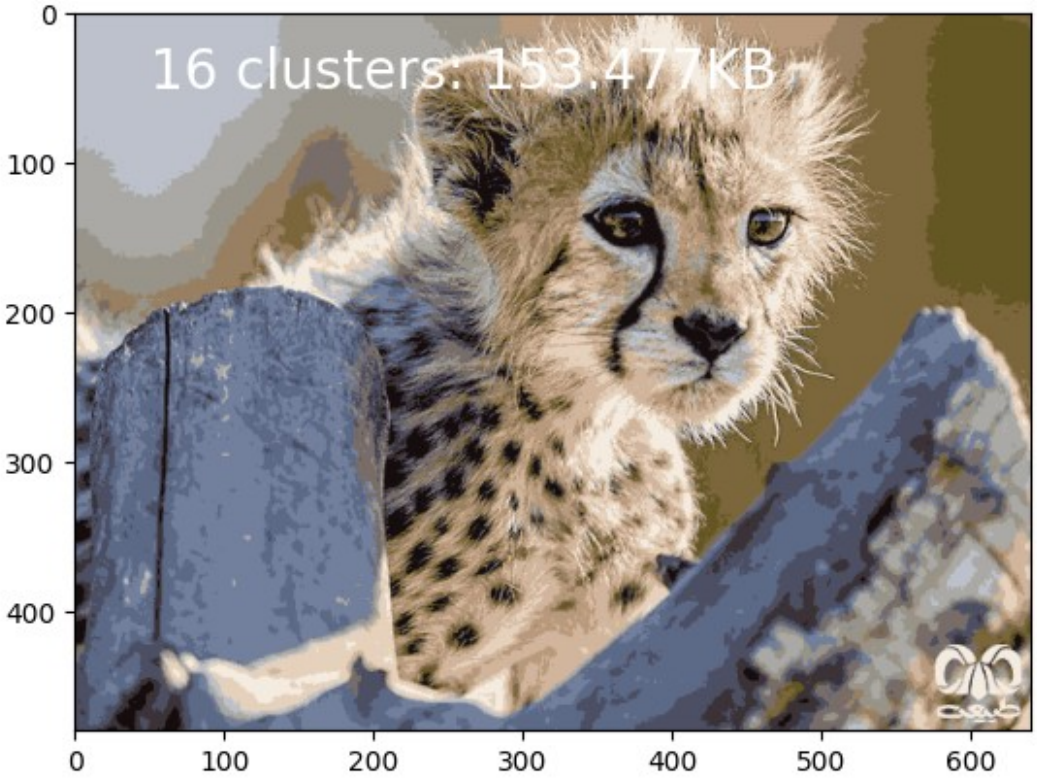


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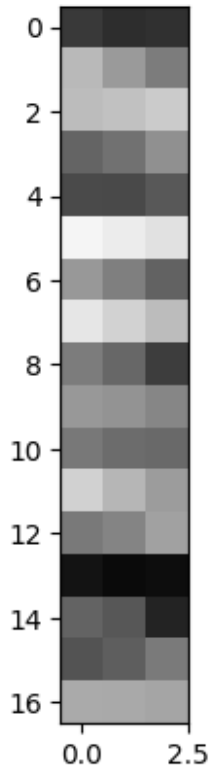

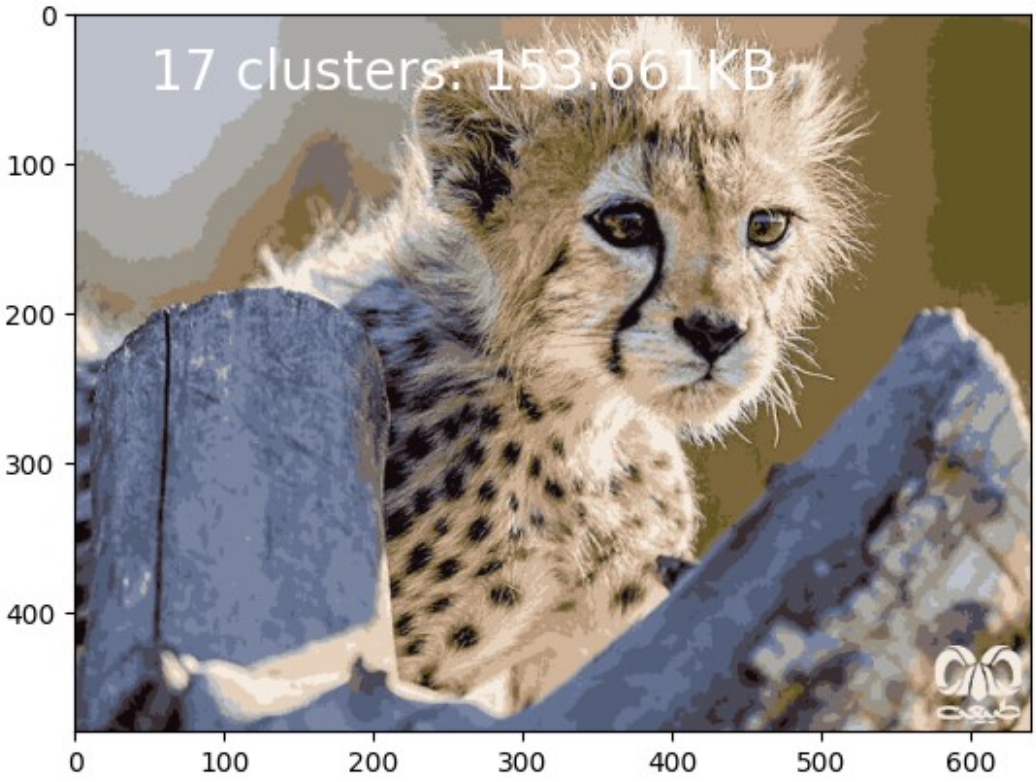


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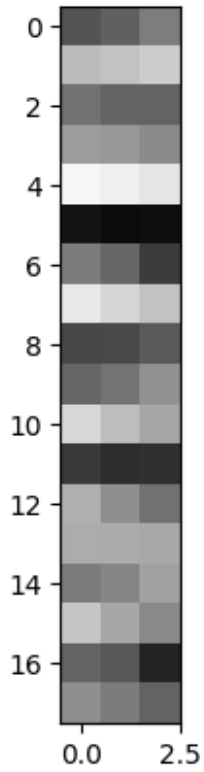

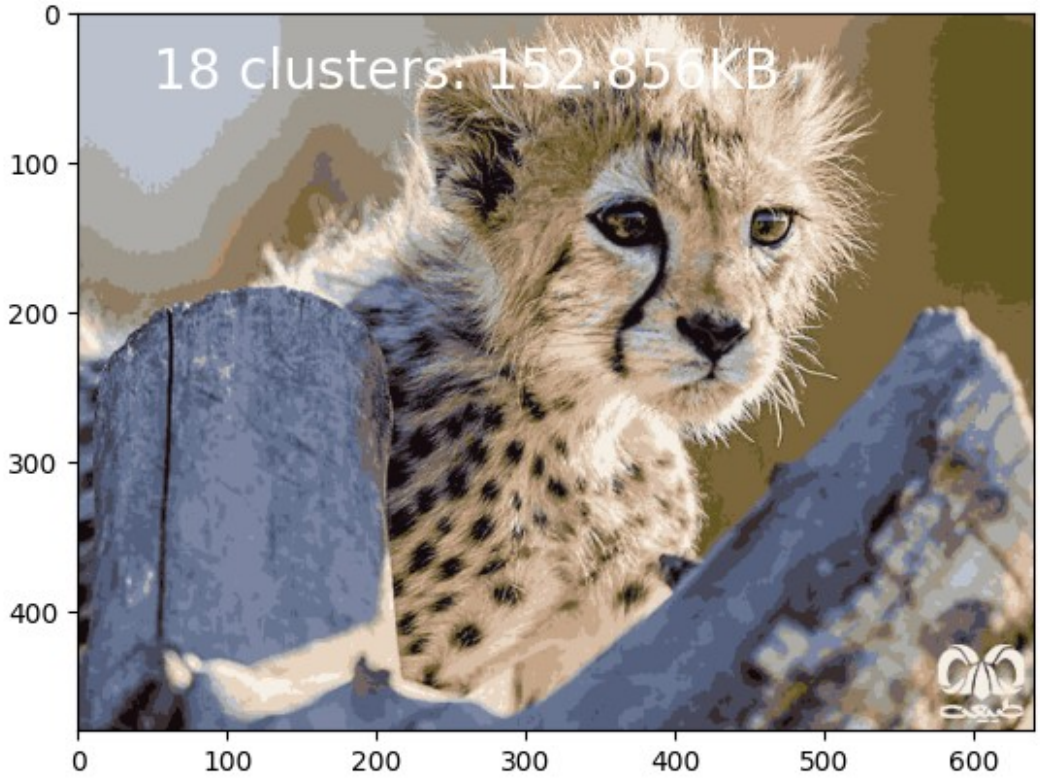


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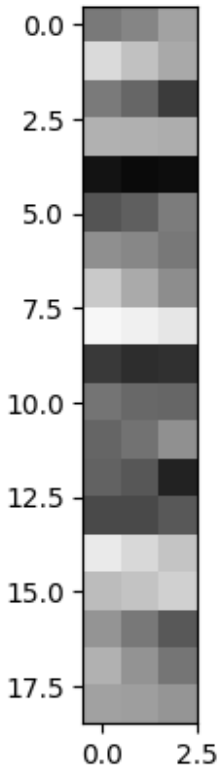

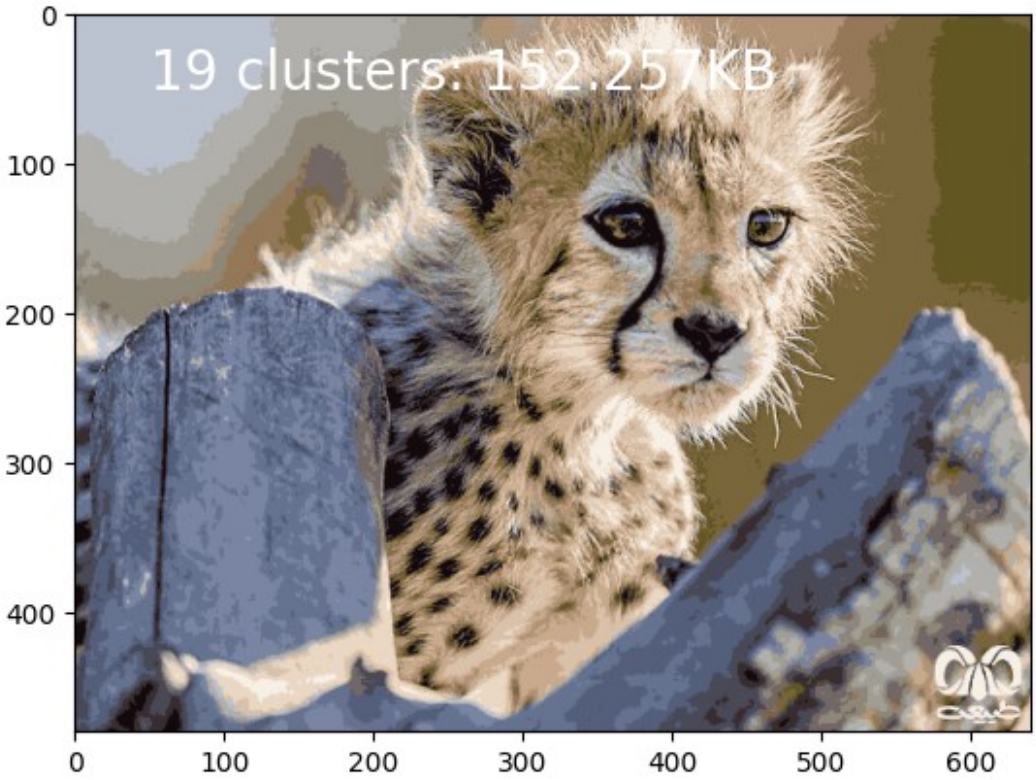


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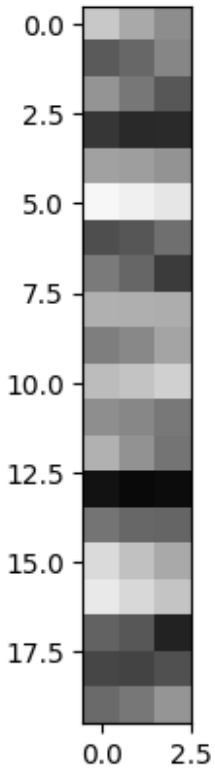

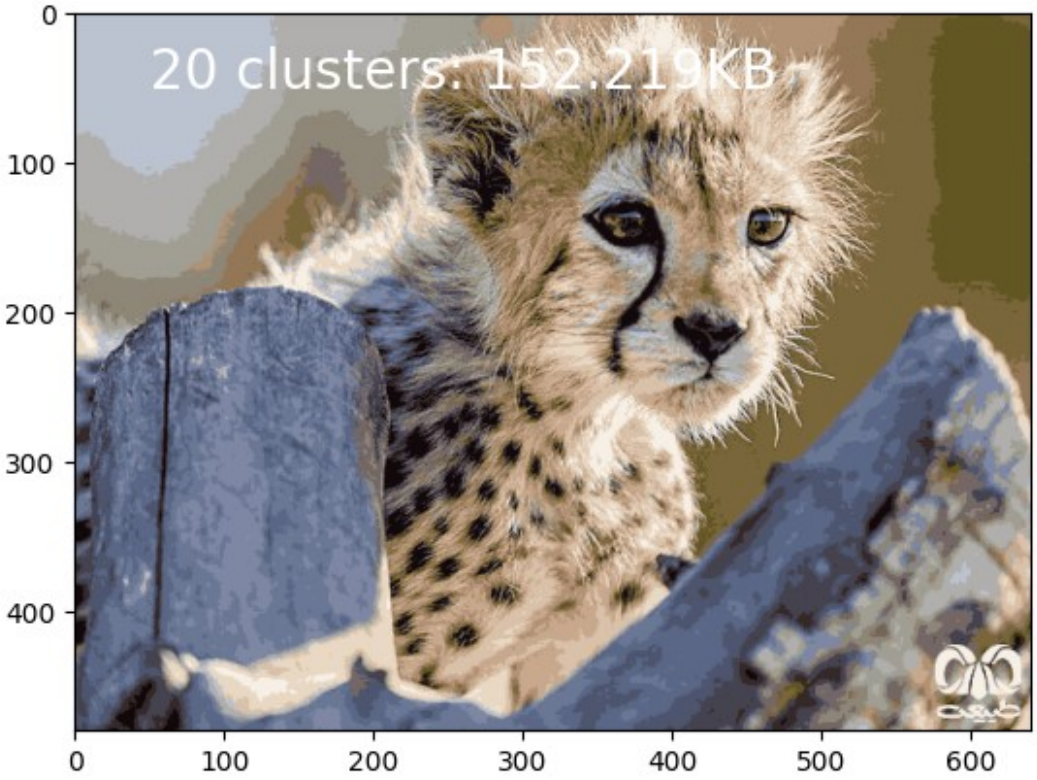


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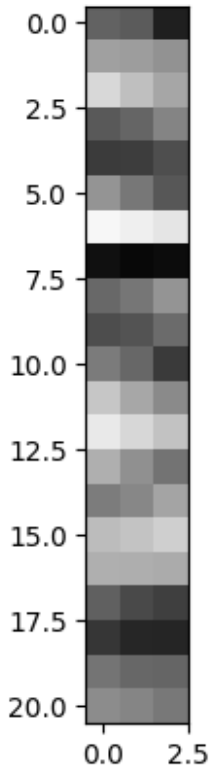

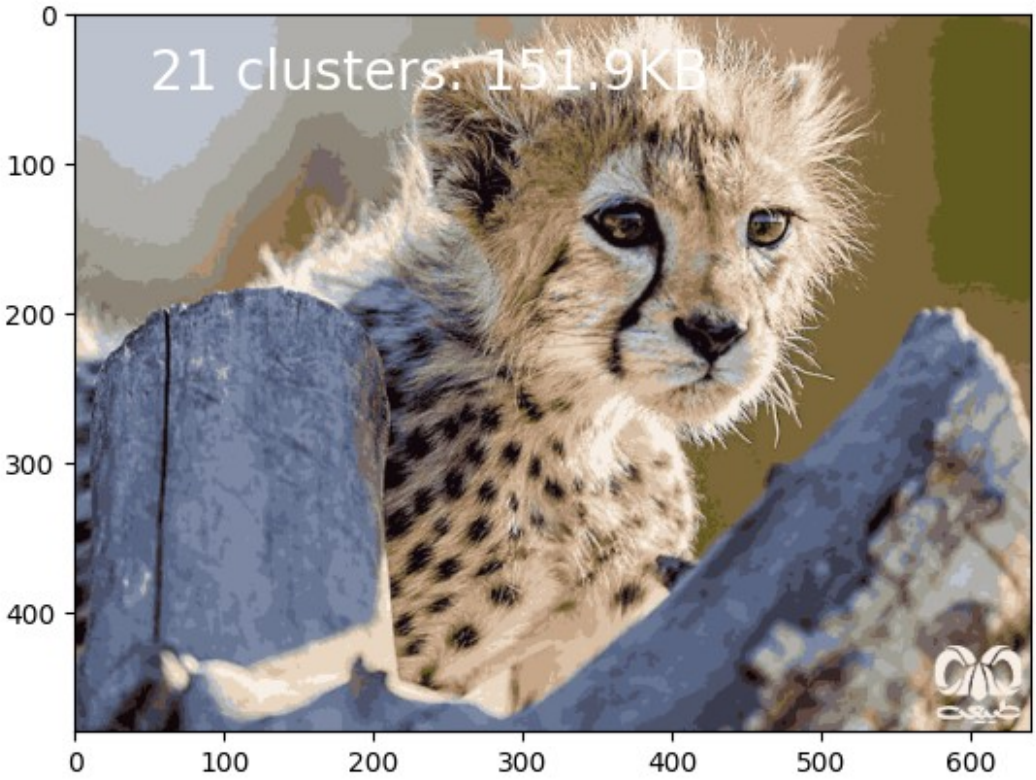


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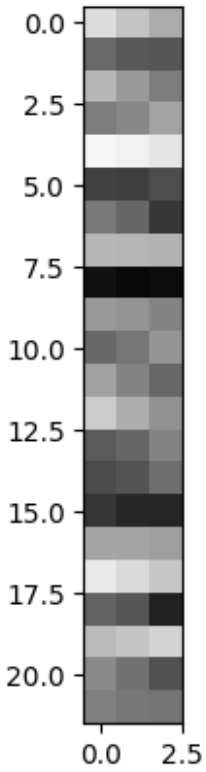

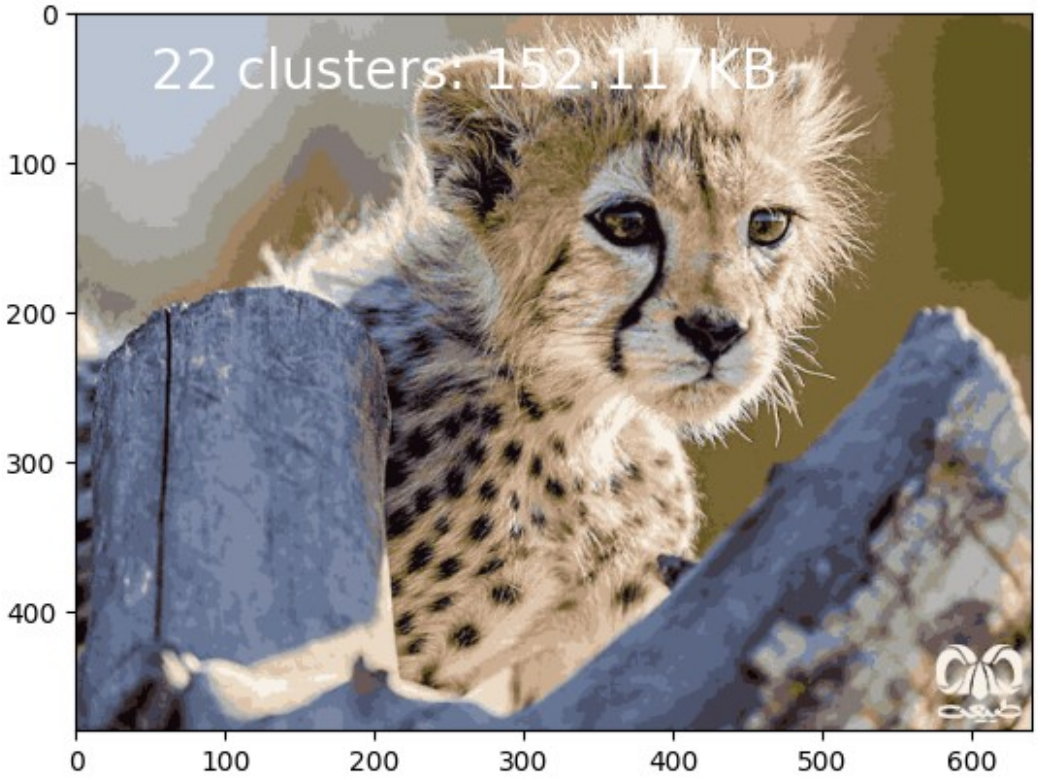


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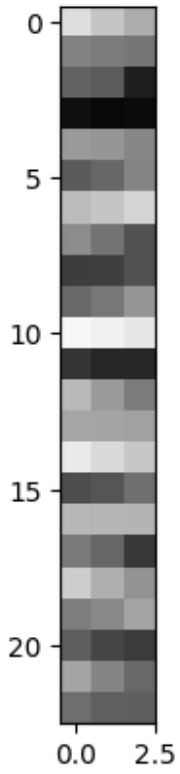

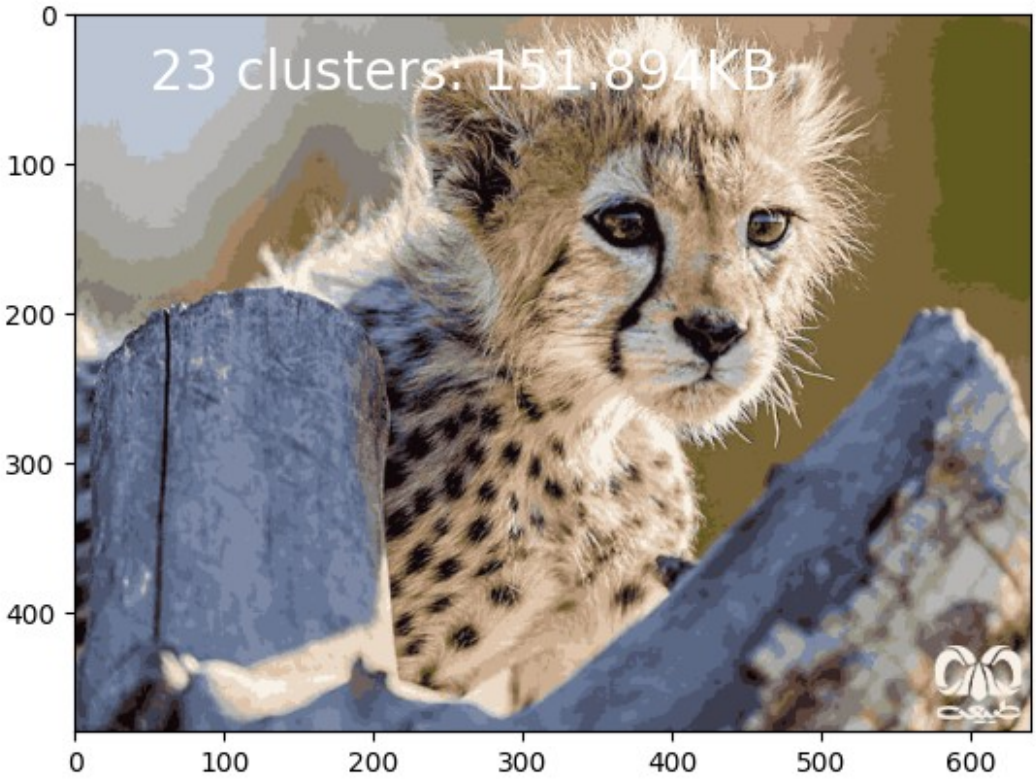


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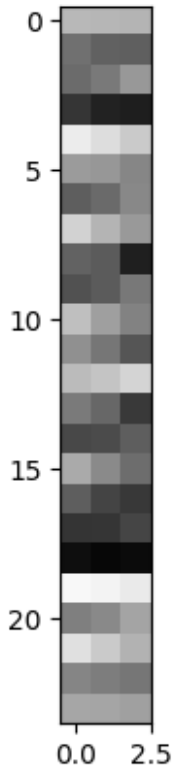

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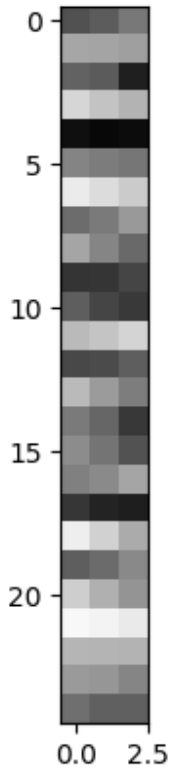

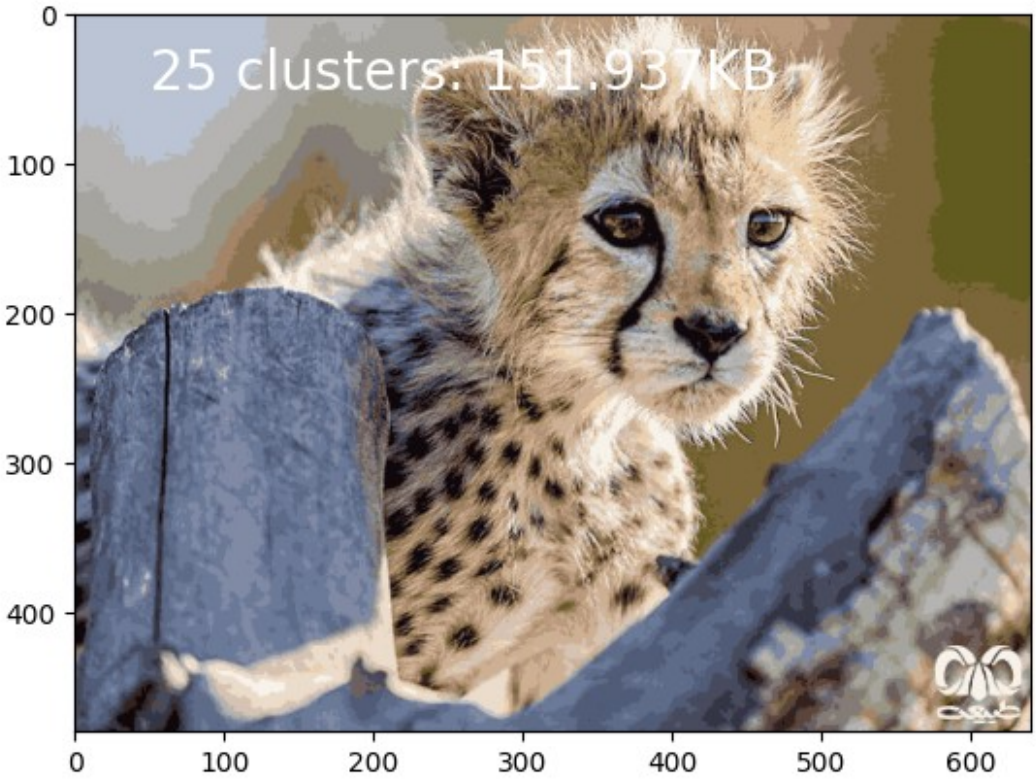


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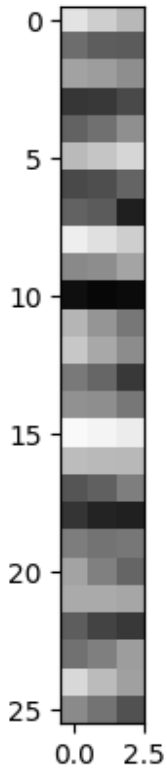

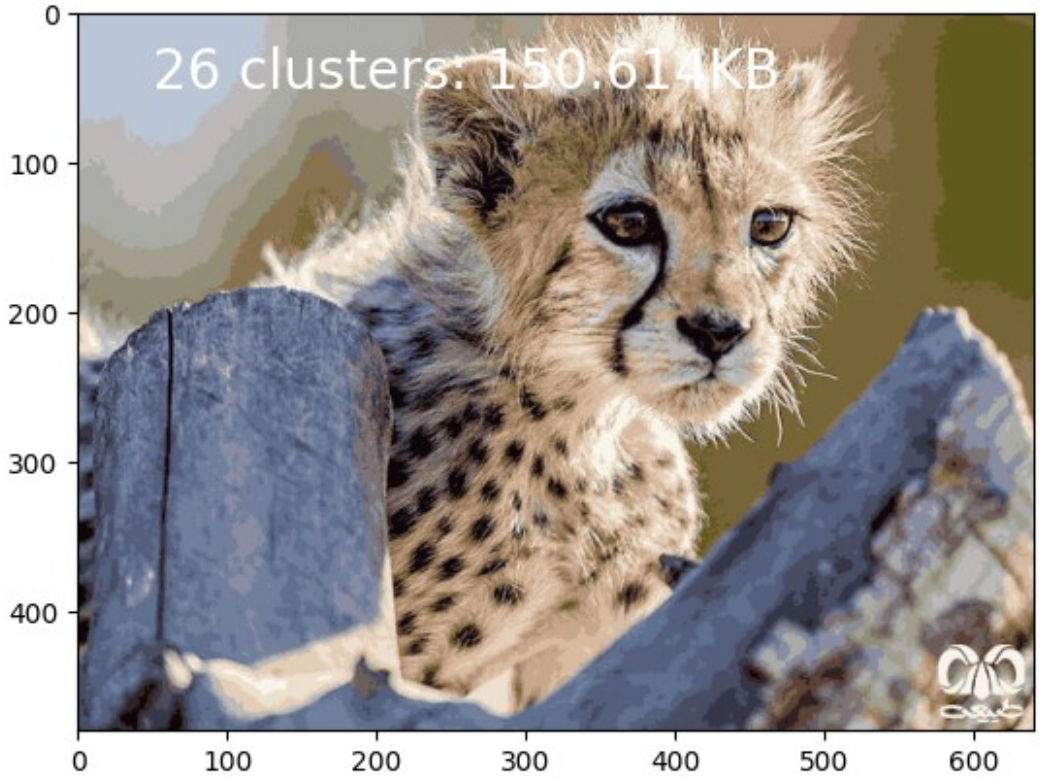


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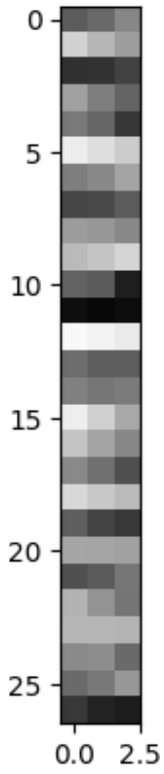

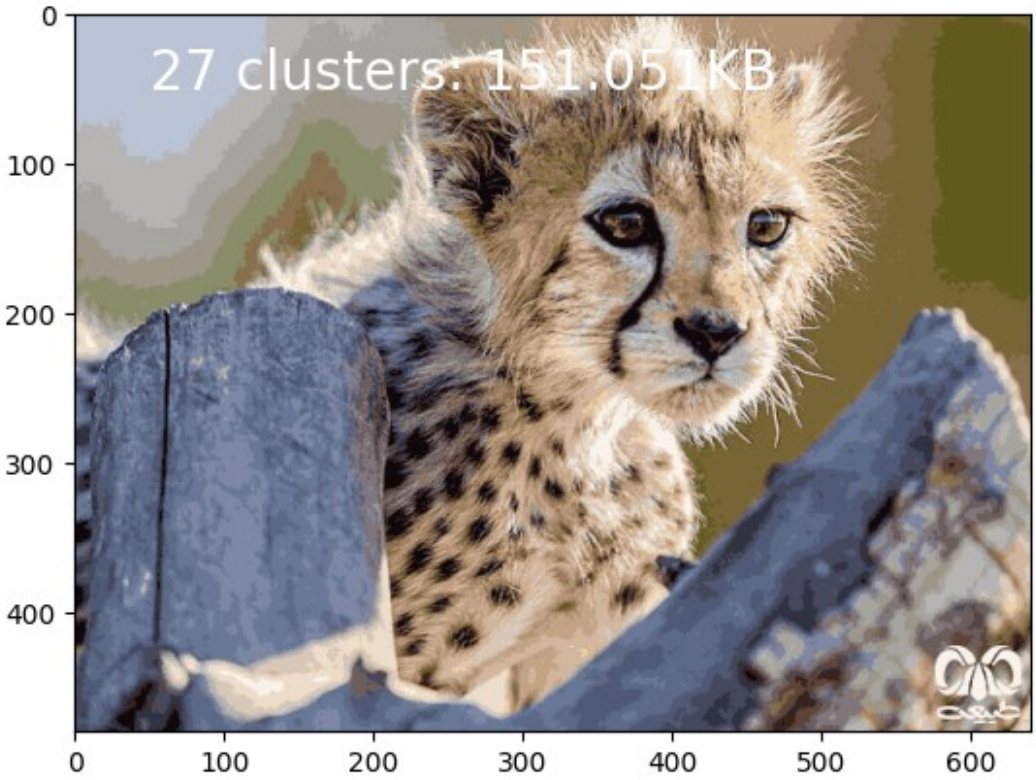


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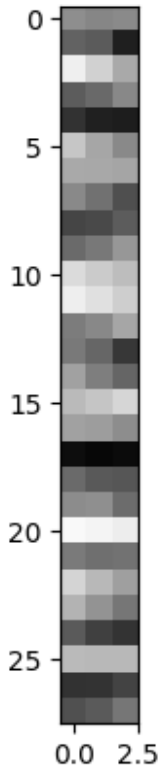

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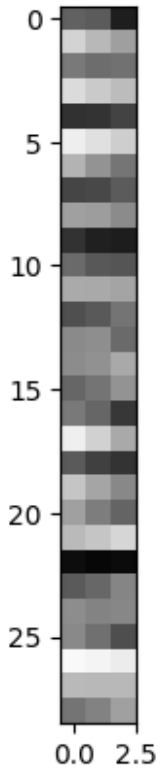

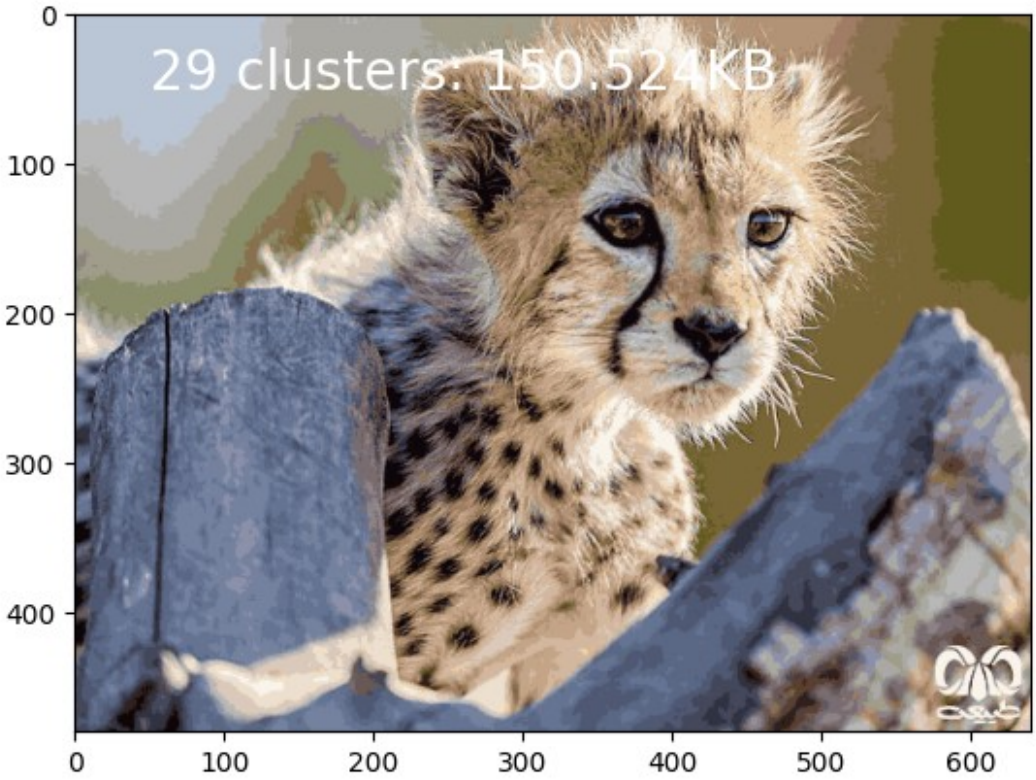


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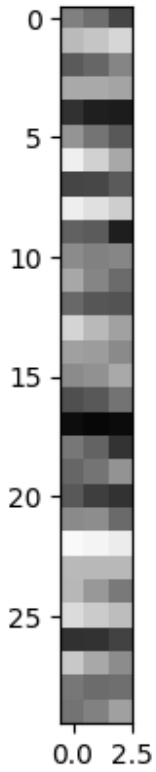

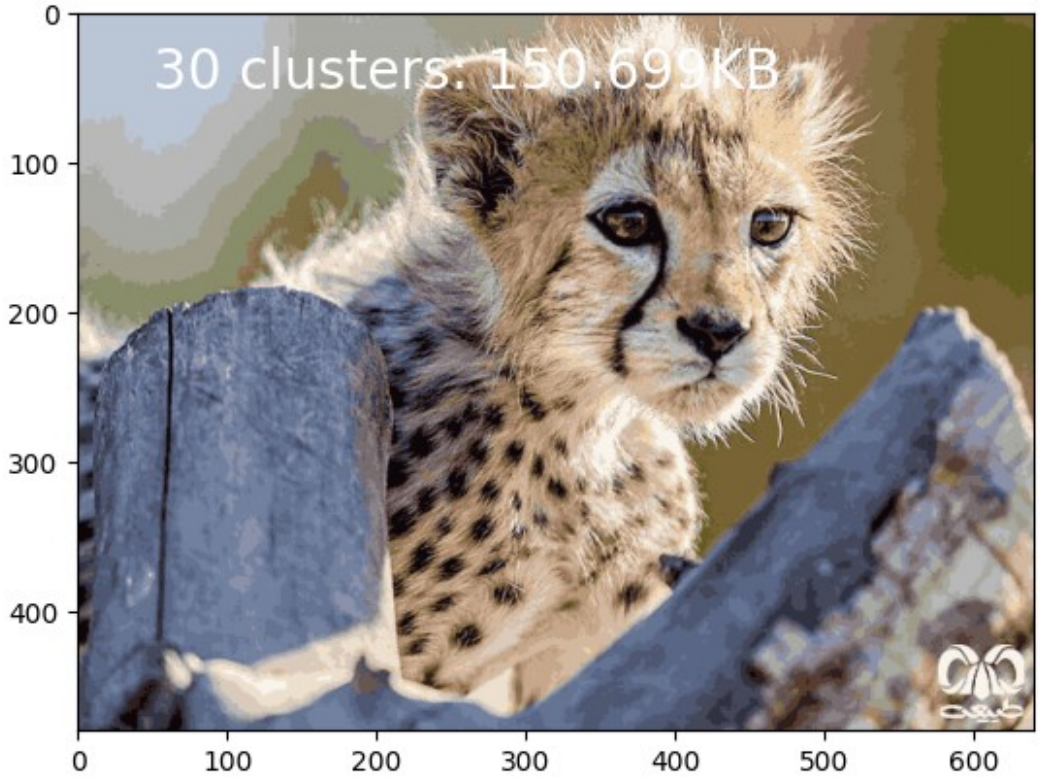


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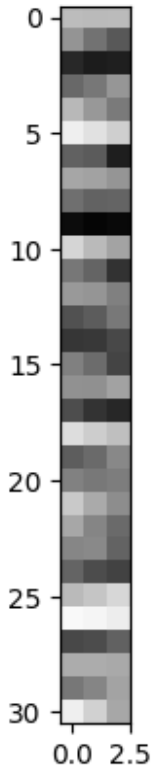

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