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1. Give an intuitive definition of the meaning of eigenvectors in the context of image analysis (think about the faces example).

   In image analysis, especially in facial recognition, you can think of eigenvectors as the variables that capture the key patterns in a set of images.

   For instance, if we have a bunch of face images, the eigenvectors represent the main ways these faces vary. The first eigenvector might highlight big differences, like overall lighting or face shape, while later ones capture finer details like eyes, nose, or mouth.

2. You have the set of eigenvalues 0.3, 0.25, 0.24, 0.12, 0.06, 0.02, 0.01
   A. What is the dimensionality of original data?
      7 dimensions

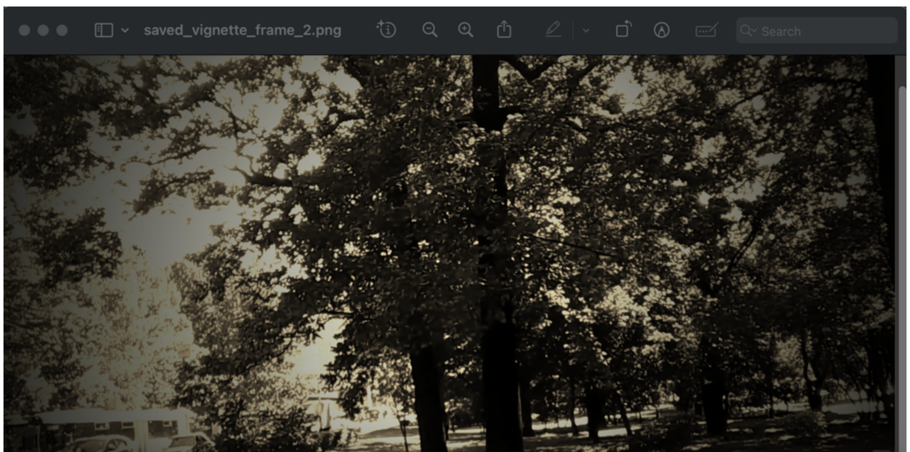
   B. How many dimensions of the data would you need to keep representing 75% of the variation?
      total sum of eigenvalues = 1
      75% of total variation = 0.75
      Cumulative sums: 0.3(30%) 0.3+ 0.25 = 0.55(55%) 0.55 + 0.24 = 0.79(79%)
      Therefore, 3 dimensions will be needed to represent 75% of the variation.

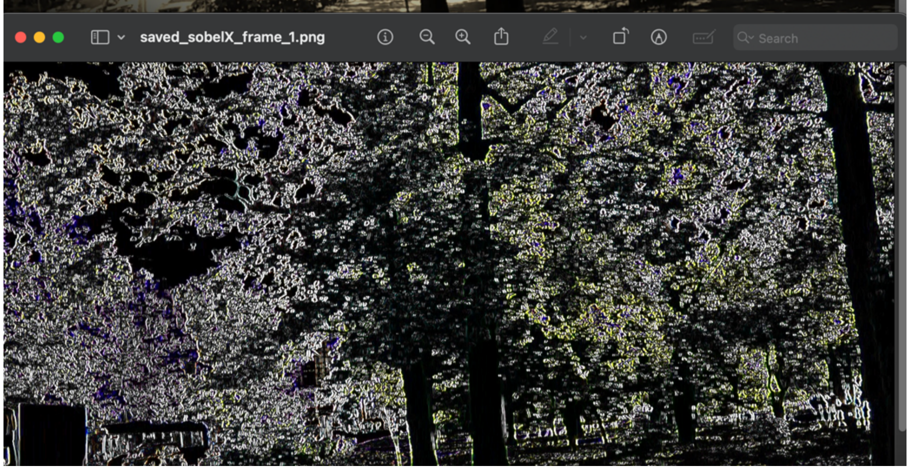
   C. How many dimensions of the data would you need to keep representing 90% of the variation?
      Cumulative sums: 0.3(30%) 0.3 + 0.25 = 0.55 (55%) 0.55 + 0.24 = 0.79(79%)
      0.79 + 0.12 = 0.91(91%)
      Therefore, 4 dimensions will be needed to represent 90% of the variation.

   D. If you wanted to see best visualization of the data in 2-D, how would you do it?
      We can first compute A matrix (covariance matrix) to capture relationships between features. Next, we computer the mean and set up D matrix as A – mean. Then, we construct SVD(D) and get the eigenvectors (cols of u or rows of v transpose of t) to represent the variance in the data. We then select the top 2 (N) eigenvectors, corresponding to the highest eigenvalues, as the primary principal components (PC1 and PC2). The data is projected onto these components to create a 2D representation (e1, e2), which is then visualized using a scatter plot to identify matching patterns.

3. Find an example of aliasing in visual media. It can be spatial, temporal, or spectral aliasing. Include either a link to your example or the example itself in your submission, along with a description.
   Spectral aliasing in video occurs when high-frequency motion, like a rapidly spinning wheel, is sampled at too low a rate, causing the motion to be inaccurately represented in terms of speed or direction. This results in visual distortions, such as the object appearing to move in reverse or at a slower pace. To avoid this problem, a higher frame rate or capturing more frames per second can help ensure accurate motion representation.
   Example link: https://en.wikipedia.org/wiki/Wagon-wheel_effect

4. Select two different textures and use your project 1 program to show the gradient magnitude for each texture. Would average energy of gradient magnitude be a useful feature for differentiating these two images?






```
cathyqindembp:Project 1. Video-special effects cathyqin$ ./hw4
Average Energy for Texture 1: 52.0219
Average Energy for Texture 2: 220.703
```

The program outputs the average energy values for both textures (52 and 220). The average energy of the gradient magnitude can serve as a useful feature to distinguish between the two textures if the difference is noticeable to classify or differentiate between the textures effectively.

5. When using Law's texture filters, why do you think it is helpful to divide the responses by the Gaussian filter (L5 x L5)?

   Dividing by the L5 × L5 Gaussian filter helps even out brightness variations, so the texture features aren't affected by changes in lighting. It boosts contrast, making textures stand out more clearly against the background. This also makes the analysis more consistent and reliable, no matter the lighting or scale.