Stanford CS248A: Computer Graphics
Participation Exercise 8

This exercise is graded for CREDIT ONLY. Serious attempts to answer the problems will be given full credit, even if the answers are incorrect.

PRACTICE PROBLEM 1: Miscellaneous Questions (NOT REQUIRED FOR CREDIT)

A. It's nearing the end of the quarter and to blow off some steam you decide to go out clubbing to celebrate the end of CS248! You check the club's website and learn that tonight is "yellow light night", where the entire dance floor is illuminated in yellow-looking light that is emitted from light sources that have red, green, and blue primaries. Your friend, who is in a glum mood, says, "I find it hard to party because I'm so sad that CS248 is almost over! I wish I could wear black tonight to show off my feelings, but I only have red shirts and blue shirts to choose from." You tell your friend, "Oh you can still look like you are wearing black!" Which shirt to you advise your friend to wear, and why?

B. Give one reason why color representations that explicitly separate the luminance (brightness) and chroma components of a color (e.g., hue-saturation-brightness (HSB) or Y'CbCr) can be useful color representations compared to RGB.

C. Imagine the human visual system could directly measure and interpret the full spectrum of incident light. (That is, your brain received and used full spectral information $L(\lambda)$ rather than just the response of S,M,L-cones). Why would this change to human perception make recording and displaying digital images and rendering pictures far more challenging? (Hint: consider reproducing the appearance of a real world scene on a display. The word metamer might be useful.)

D. Describe the biological reason why, even though a spectrum may contain power over all wavelengths, human perception of color is only three-dimensional. We'd like to see the phrase "response function" in your answer.

E. Imagine if all three types of cone cells in your eye had *the same spectral response function*. If this were the case, would you have color vision (the ability to differentiate different colors)? Why or why not?

F. In the image compression lecture I showed you an example where I added a significant amount of noise to an image and, as a result, the compressed size of the resulting JPG compressed file grew substantially. (Assume both files were compressed with the same JPG quality setting, or in other words, the same quantization matrix.) Describe why the image with more noise compresses less.

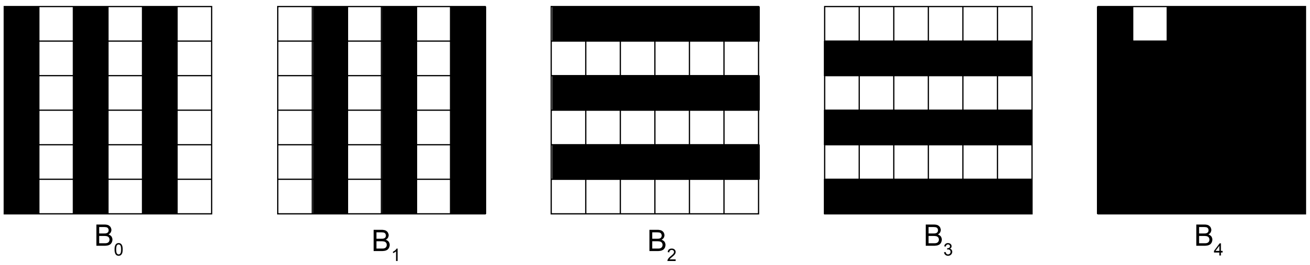
G. Which image do you think will be compressed to a smaller file size using JPG compression? Please describe why. Your explanation should reference the state of the coefficient matrix after the quantization step. What properties of each image make one more compressible than the other?

A

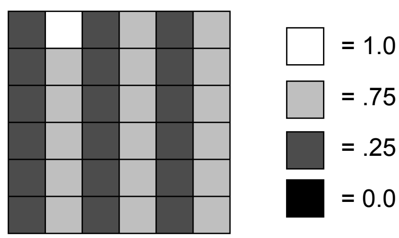
B

PRACTICE PROBLEM 2: A Weird Compression Scheme (NOT REQUIRED FOR CREDIT)

In class we talked about how JPG compression represents 8×8 pixel image patches in the 2D *cosine basis*. Now consider a very different image representation scheme that represents 6×6 pixel patches in terms of a linear combination of these five base patches.



A. Consider representing the following 6×6 image in terms of the base patches above. What are the coefficients of the image under this representation? Explain why, **for the specific case of this image**, we have devised a very efficient image compression scheme. (Hint: what is the size of the 6×6 image in the pixel basis? What about the size of the representation in terms of the image patches above?)



B. Although the compression scheme in part A can be very efficient for some images, the problem with the scheme is that is cannot accurately represent all 6×6 images. Draw one example of an image that cannot be represented as a combination of the provided "basis" images.