

CS 474/674 Image Processing and Interpretation
Fall 2025 – Prof. Bebis
Sample Quiz – Solutions

1. **[25 pts]** What is the difference between image sampling and image quantization, and which of the two has a greater impact on overall image quality?

Image sampling determines the **spatial resolution** of an image while image quantization determines the **intensity resolution** of an image. Image sampling tends to have a greater impact on perceived image quality, because spatial resolution loss is more noticeable than slight reductions in gray-level depth.

2. **[25 pts]** What is the difference between contrast stretching and contrast compression, and under what circumstances would each technique be preferred?

Contrast stretching **expands** the range of pixel intensity values so that they span a wider interval. Contrast compression **reduces** the range of pixel intensity values so that they occupy a smaller interval. Contrast stretching is useful for **amplifying** the contrast of an image (e.g., when detail is lost due to a narrow range of intensities) while contrast compression is useful for **suppressing** the contrast of an image (e.g., when detail is lost due to very high dynamic range).

3. **[25 pts]** What is the goal of histogram equalization, why is it effective, and what fundamental theoretical principle underlies its operation?"

The goal of histogram equalization is to **enhance image contrast** by redistributing pixel intensity values more evenly across the range of pixel values. In many images, pixel intensities are concentrated in a narrow range. By spreading out these values, we can better see important details in an image. Histogram equalization is based on **probability theory** and the **cumulative distribution function (CDF)**. By mapping the pixel values of an image through the CDF transformation, we obtain a new image that has an approximately **uniform histogram** in theory.

4. **[25 pts]** Explain the difference between histogram equalization and histogram specification. In what situation would histogram specification be preferred over histogram equalization?

Histogram equalization is an **automatic** technique that remaps the input image, so its intensity values are spread across an approximately **uniform histogram**. In contrast, histogram specification requires a **user-defined target histogram** and transforms the image, so its distribution **matches** that target. Histogram specification is often preferred when equalization produces **unsatisfactory** results or when specific **constraints** are needed for the output, such as normalizing medical images acquired from different scanners.