Quizzes
Please discuss one application which can benefit from image processing.
Write your function in pseudo code that converts the mxn GIF image shown in slide9 to a grayscale image with the greyscale range [0,255]. Please state your RGB->grey converter clearly.
Q1: \textit{imresize}(x, 1/2) takes every other pixel as shown below:

\[
\begin{array}{cccccc}
  x_{11} & x_{12} & x_{13} & x_{14} & x_{15} & x_{16} & \ldots \\
  x_{21} & x_{22} & x_{23} & x_{24} & x_{25} & x_{26} & \ldots \\
  x_{31} & x_{32} & x_{33} & x_{34} & x_{35} & x_{36} & \ldots \\
  x_{41} & x_{42} & x_{43} & x_{44} & x_{45} & x_{46} & \ldots \\
  x_{51} & x_{52} & x_{53} & x_{54} & x_{55} & x_{56} & \ldots \\
  x_{61} & x_{62} & x_{63} & x_{64} & x_{65} & x_{66} & \ldots \\
  \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\end{array}
\]

\[\rightarrow \text{imresize}(x, 1/2) \rightarrow\]

\[
\begin{array}{cccccc}
  & & & & & & \\
  x_{22} & x_{24} & x_{26} & \ldots \\
  x_{42} & x_{44} & x_{46} & \ldots \\
  x_{62} & x_{64} & x_{66} & \ldots \\
  \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\end{array}
\]

Describe an improvement of the method which does not totally abandon odd rows and columns when the image is down-sampled by \(1/2\).
Q2: Write an algorithm in pseudo-code that decomposes a grayscale image into the 8 binary images of bit planes (let I be the original image, I(x,y) the intensity value at pixel position (x,y), and I.width and I.height the width and height of I, respectively.)
The table on the right gives the number of pixels at each of the gray level 0-7 in an image with those gray values only. Draw the histogram corresponding to these gray level and then perform a histogram equalization and draw the resulting histogram.
**Quiz 5**

- **Given the image:**

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Perform convolution using the masks below. What feature does each mask highlight? (You may pad the image with the max of neighboring pixels)

\[ h_1 = \begin{bmatrix} -1 & -1 & -1 \\ 2 & 2 & 2 \\ -1 & -1 & -1 \end{bmatrix} \quad h_2 = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \]
Prove that 0\textsuperscript{th} and 1\textsuperscript{st} order general interpolation are indeed nearest-neighbor and linear interpolation, respectively. It is sufficient to demonstrate this in 1D.
Quiz6

- When transforming one image to another (e.g. via rotation), the new pixel positions are not necessarily integers. Describe the steps necessary to obtain the intensity values of the new image from the old one.
Q1: What is the Jacobian matrix for
- Similarity transformation
- Euclidean transformation
- Translation

Which of them preserve the area?
Q2: Determine the final transformation \([A_3, B_3]\) in terms of the known \(A_i\) and \(B_i\):

- \([A_3, B_3]\) taking \(x_1\) to \(x_3\), given

\[
x_3 = B_2 + A_2 x_2
\]

\[
x_2 = B_1 + A_1 x_1
\]

- \([A_3, B_3]\) taking \(x_2\) to \(x_1\), given

\[
x_2 = B_1 + A_1 x_1
\]
By hand, compute the DFT of each of the following sequences:

- [2,3,4,5]
- [-9,8,-7,6]
- [-9,-8,-7,-6]

Compute the inverse transform as well.
Continuing from the in-class exercise, show that $H(u,v)$ is indeed a lowpass filter. Hint: expressing the function in our familiar centered format, i.e. replacing $u$ by $(u-M/2)$, and $v$ by $(v-N/2)$.

\[ H(u, v) = \frac{1}{2} \left[ \cos\left(\frac{2\pi u}{M}\right) + \cos\left(\frac{2\pi v}{N}\right) \right] \]
Q: The white bars in the test pattern shown are 7 pixels wide and 210 pixels high. The separation between bars is 17 pixels. What would this image look like after application of

(1) a 3x3 arithmetic mean filter
(2) a 9x9 arithmetic mean filter
(3) a 7x7 geometric mean filter
(4) a 9x9 min filter

Choose your answer from one of the following.
Quiz10
For the study of currency exchange, a professor of archeology needs to restore a bunch of blurred images of coins. The cause of blurring was the camera being out of focus when the picture were taken. Fortunately, the original camera used to take the photos, and other representative coins of the same era are still available. Propose a step-by-step solution to the problem.

(hint: You need to first synthesize the blurred image using whatever is available to you, and undo the blurring.)