How Computer Stores/Displays Images?

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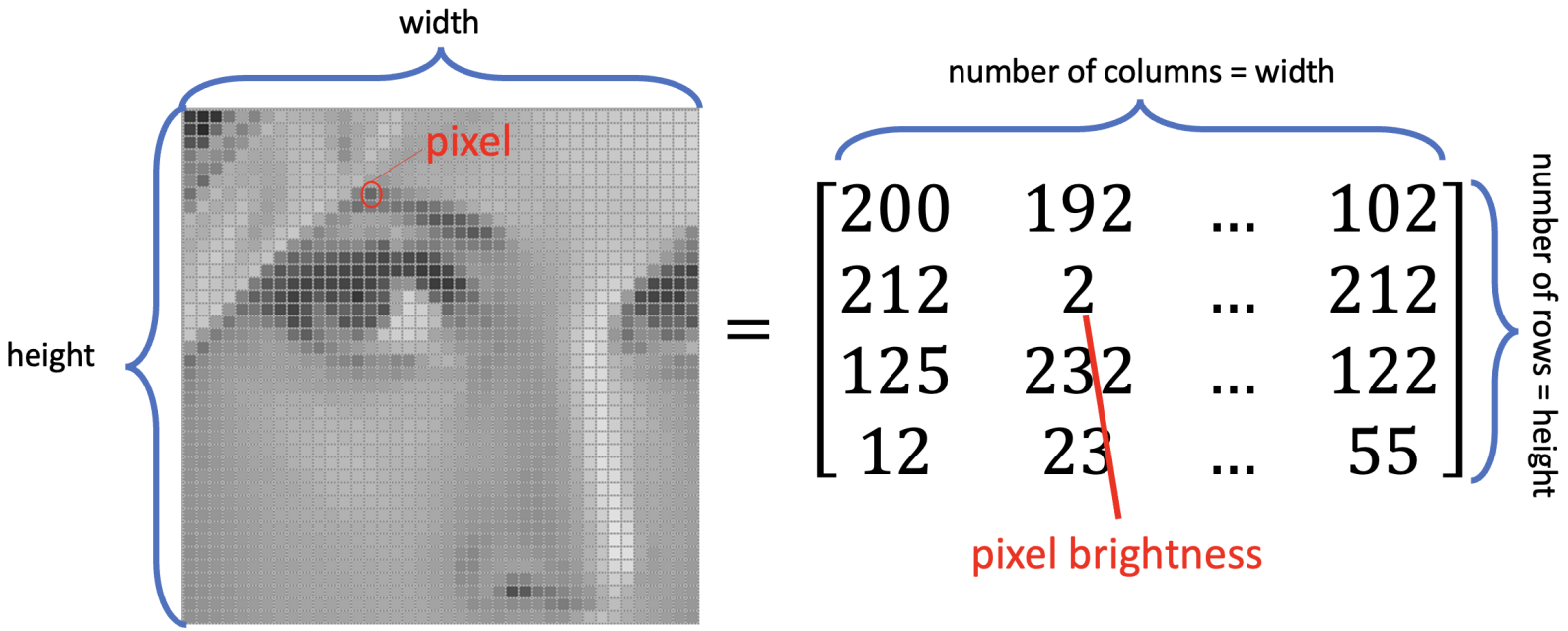
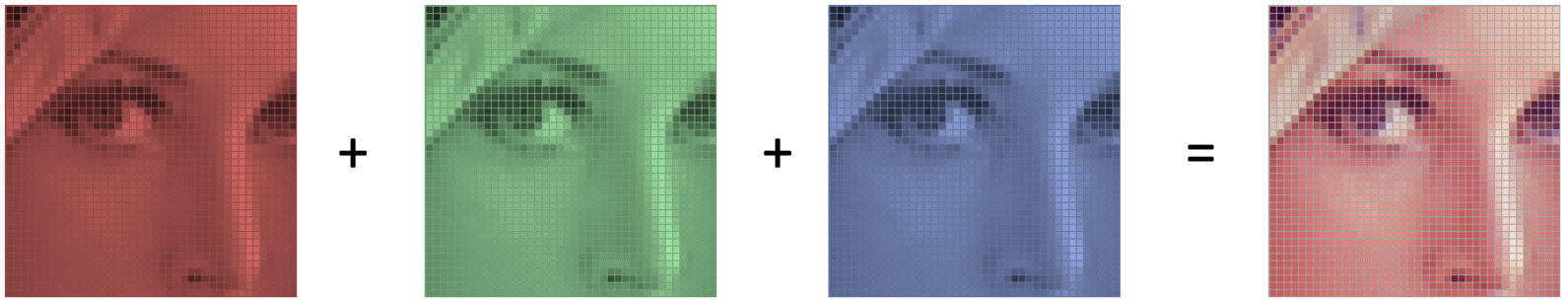
Images are Matrices



- Grayscale images are expressed as matrices in computer.
- A pixel in the image corresponds to an element in the matrix.
- Each element of the matrix indicate the brightness of a pixel. There are usually 256 levels of brightness, 0 is darkest while 255 is brightest.

Colored Images are Matrices too



- One colored image is expressed as **three** individual matrices:
  - Three matrices indicate brightness in Red, Green and Blue tones (RGB).
  - Computer can display a colored image by stacking three images together.

Images Files are Flattened Matrices

- **Image files** usually store images as flattened matrices.
  - Many file system (such as tape) can only support sequential read/write.
  - Recall, flattening a matrix is

$$\begin{bmatrix} 1, & 2 \\ 3, & 4 \end{bmatrix} \Longrightarrow [1, 2, 3, 4].$$

  - Check Lab 4 homework for more details.
- Knowing these facts, we can build a "textual image viewer" using C programming language.

Building an Image Viewer

- Suppose you have obtained an `int` array `a` with length `M*N`.
  - It contains a flattened matrix `[12, 232, ..., 254]`
  - Let the "unflattend" matrix be $A \in \mathbb{N}^{m \times n}$.
  - Matrix A represents an image with width `N` and height `M`.
- Let us create a `char` 2D array `c`, which is `M` by `N`.
  - `c[i][j] = ' '` if $A_{i,j} \leq 85$
  - `c[i][j] = 'I'` if $85 < A_{i,j} \leq 170$
  - `c[i][j] = 'M'` if $170 < A_{i,j} \leq 255$

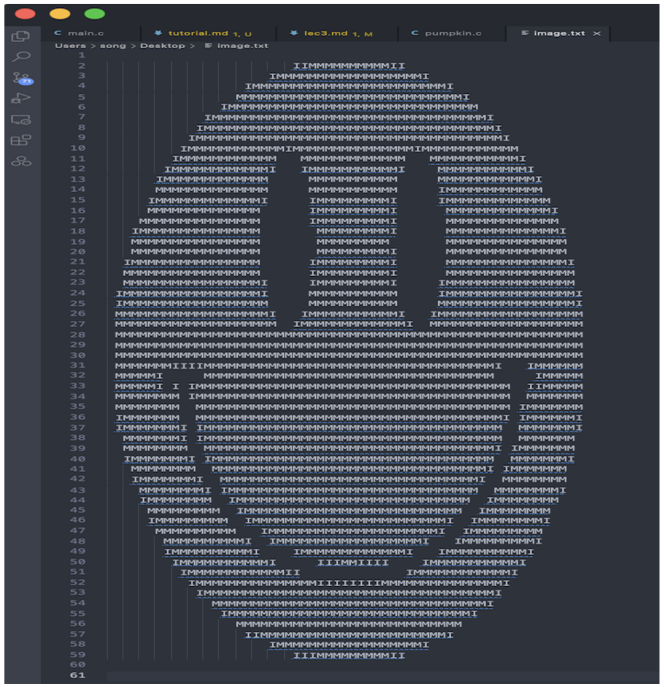
Building an Image Viewer

- Write the 2D `char` array into a text file
    - This has been taken care of in the skeleton code.
- Open that text file using a text editor using fixed-with fonts.
    - You can use Visual Studio Code in our labpack.
    - Adjust the font size so the entire 2D char array can be fitted in one screen.
- Appreciate your image from a short distance away!
    - Why does it work?

Building an Image Viewer

PNG file

TXT file



Get Started

- Use the provided skeleton file as a starting point.
- Image file read/write has already been taken care of.
- You only need to convert a flattened `int` array to a 2D `char` array.