# Questions:

1. What is the difference between an interleaved image representation and a planar image representation in memory?

***Answer:***

Interleaved pixels are compact and are arranged so that the components of each pixel in the image are contiguous.
Example for a single pixel: [R, G, B]. For an image: [R1, G1, B1, R2, G2, B2, ...].
Planar pixels are arranged so that the individual components, for example, the red components, of all pixels in the image are grouped together.
Example for an image: [R1, R2, ..., G1, G2, ..., B1, B2, ...].

2. Give a couple of subjective explanations of what a filter can do.

***Answer:***

Filters can enhance specific features in an image, such as detecting edges, sharpening or smoothing textures.
Filters can suppress noise in an image, for example, using Gaussian blur or median filters to reduce random speckle noise.
Filters can transform an image for feature extraction, such as applying the Sobel filter to highlight horizontal or vertical edges.

3. What are a couple of ways of handling boundary issues (the edges of the image) when applying a filter?

***Answer:***

The traditional ways of handling boundary issues like zero padding, replication padding, reflective padding, gaussian padding, but in recent years, there are some more ways of handling these issues, for example:
**Iteration Space Partitioning for GPUs**: This method divides the computation into regions that can be processed independently, optimizing performance on parallel architectures like GPUs. By partitioning the iteration space, it reduces the overhead associated with conditional statements needed for boundary handling, enhancing efficiency.
**Center Symmetric Padding Method:** This approach analyzes the gradient near the image boundaries. If a sharp gradient is detected, it applies a center symmetric padding to preserve edge information and minimize artifacts. This method ensures that the padded regions maintain consistency with the image's internal structures,

leading to improved filtering results.

4. If you have a 3x3 filter, how many operations per pixel are required for convolution? What about a 5x5 filter? What about a 7x7 filter? What about a 1x11 filter?

***Answer:***

Convolution involves multiplying and summing the filter values with the corresponding image pixels. For a filter of size N×N, there are $N^2$ multiplications and $N^2-1$ additions per pixel.

- **3x3 filter**: $3^2$=9 multiplications + 8 additions = **17 operations per pixel**.
- **5x5 filter**: $5^2$=25 multiplications + 24 additions = **49 operations per pixel**.
- **7x7 filter**: $7^2$=49 multiplications + 48 additions = **97 operations per pixel**.
  **1x11 filter**: 1×11=11 multiplications + 10additions = **21 operations per pixel**.

5. Full convolution is convolution where the result contains all possible ways the two filters could overlap. What happens if you do full convolution between the following two filters?

```
[1   2   1]      | -1 |
             X   | 0 |
                 | 1 |
```

***Answer:***

Performing full convolution involves overlapping the filters at all possible positions, creating a 2D result by combining the two 1D filters, The output is a 3x3 filter:

$$\begin{matrix} 1*-1 & 2*-1 & 1*-1 \\ 0*1 & 0*2 & 0*1 \\ 1*1 & 1*2 & 1*1 \end{matrix}$$

result is:

```
|-1 -2 -1|
|0 0   0|
|1 2   1|
```