Mention a typical grey-level transformation. When to use it?

- A typical grey-level transformation is histogram equalization. It's used to enhance the contrast of an image by redistributing the intensity levels. This transformation is particularly useful in images with backgrounds and foregrounds that are both bright or both dark and in cases where the image has been underexposed or overexposed leading to a concentration of pixels values at certain intensity levels. By applying histogram equalization you can spread out the most frequent intensity values enhancing the global contrast of the image.

What do histogram stretching and compression mean?

- Histogram stretching spreads out the intensities of an image. Useful for images where the pixel values are concentrated in a narrow range resulting in a low contrast image. By stretching out, you map the original ranges of intensities to a wader range and increasing contrast.
- Compression reduces the contrast by narrowing the range of intensity values which can be helpful for images with excessively high contrast or for focusing on specific intensity ranges.

What are the principles of histogram equalization?

- Histogram equalization is based on the principle of redistributing the pixel intensity values of an imag to enhance its contrast. It uses the cumulative distribution function of the pixel intensities to create a uniform and 'flatter' histogram aiming to make each intensity level equally probable. This results in improved contrast, especially in images with a narrow range of intensity values.

What are the differences between lowpass, bandpass and highpass filters?

- **Low pass**: Allows frequencies below a certain cut-off frequenc to pass. It's to remove high frequency noise or to blur images

  High pass:Allows frequency above a certain cut-off to pass. Useful for enhancing or detecting edges in mages or removing low-freq drift in signals.

Bandpass Filter: Allows a specific range of frequencies to pass. Used to isolate frequencies within a particular band.

Why are ideal lowpass filter rarely used in practice?

Rarely used in practive due to their impractical characteristics and side effects:

Ring artifacts: Have a sharp cutoff in freq domain which leads to ringing artifics in the spatial domain. Causes oscillations or ripples near sharp transitions in the image

Computation: They are not practical for real time processing due to computational inefficiency and the complexity of implementation.

What characteristics does a Gaussian filter have?

- Has several key characteristics:

Normal distribution shape: It's impulse response follows a Gaussian distribution curve. This results in a bell-shaped curve in both the spatial and frequency domain.s

Smooth Filtering: Provide a smooth isotropic filtering making them ideal for tasks like blurring and noise reduction without favoring any particular direction

Separability : Makes them computational effective

Preserves image edges: Saves edges and in the frequency domain the filter also has a Gaussian shape providing a natural and smooth transition between passed and other frequencies.

What is the difference between mean and median filters?

Mean Filter:

Operation: Replaces each pixel value with the average (mean) of the pixel values in its neighborhood.

Effect: Smoothens the image by averaging out the values, which can blur the edges.

Noise Reduction: Effective against Gaussian noise.

Drawback: Can blur sharp edges and fine details.

Median Filter:

Operation: Replaces each pixel value with the median of the pixel values in its neighborhood.

Effect: Maintains sharper edges compared to the mean filter, as the median is less sensitive to extreme values (like noise).

Noise Reduction: Particularly effective against salt-and-pepper noise.

Drawback: More computationally intensive than the mean filter and may not be as effective for certain types of noise or blurring effects.

How can you do sharpening?

- There are several techniques. The most common of which are:

Unsharp masking:A blurred version of the image is created and is substraced from the original image to create a mask. The mask is then added back to the image enhancing the edges and details.

Highpass filtering:Apply a highpass filter to the image to extract edges. Add the high freq details back to the original image to enhance sharpness.

Laplacian Filter: Apply a Laplacian filter which highlights regions of rapid intensity change. Combine the Laplacian result with the original image to sharpen edges and details.

Edge enhancing: Use Sobel filter

How can you approximate a first order derivative?

- Can be done by backward difference, forward difference or central difference. Central difference between the most common

What is a Laplacian?

- No clue