2. How do adaptive filters adapt to local variations in images, and what advantages do they offer over fixed filters in tasks like image denoising and edge detection?

Answer: Adaptive filter is a filter that is used in image processing task, which dynamically changes their parameter based on the local characteristics of the image. Adaptive filter changes their values of kernel coefficient based on the texture, noise level of the image.

Adaptive filters adapt to local variations in images:

First of all, the adaptive filter analyses the characteristics of the neighbourhood pixel around each of the pixel of interest. Then the adaptive filter tries to update the parameter or kernel coefficient based on the information gathered. This adjustment can include the update of filters size and shape of the filters. Then adaptive filter applies this updated parameter to the pixel of interest. Then they iterate over and over the pixel and update the parameter.

Advantages over fixed filters in tasks like image denoising and edge detection:

Image denoising: Adaptive filter provide advantage over fixed filter in case of denoising because, adaptive filter analyses the characteristics of the neighbourhood pixel around each of the pixel of interest. Then these adaptive filters update the kernel coefficient and size of the kernel corresponding the noise. When the noise is higher the kernel size is high so that it does not get affected by the noise. It dynamically changes its values and size as compare to fixed filter in which we have to manually change.

Edge detection: Adaptive filter adjust based on the local image structures. It adapts its parameter and kernel based on the local image, so it is easy to distinguish between the noise and the image features, hence the adaptive filter as compare to the fixed filter maintain to preserve the edge detection.