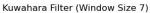
## question 3

```
from PIL import Image
import numpy as np
import matplotlib.pyplot as plt
# Kuwahara filter function with variable window size
def kuwahara filter(image, window size=5):
    img = np.array(image, dtype=float)
    pad size = window size // 2
    padded img = np.pad(img, pad size, mode='reflect')
    rows, cols = img.shape
    result img = np.zeros like(img)
    for y in range(rows):
        for x in range(cols):
            # Extract the window (window size x window size)
            window = padded img[y:y+window size, x:x+window size]
            # Divide the window into four subregions
            top left = window[:pad size+1, :pad size+1]
            top right = window[:pad size+1, pad size:]
            bottom left = window[pad size:, :pad size+1]
            bottom right = window[pad size:, pad size:]
            # Calculate the mean and variance for each subregion
            regions = [top left, top right, bottom left, bottom right]
            means = [np.mean(region) for region in regions]
            variances = [np.var(region) for region in regions]
            # Find the region with the smallest variance
            min variance idx = np.argmin(variances)
            result img[y, x] = means[min variance idx]
    return result img.astype(np.uint8)
# Load an image (grayscale)
image path = 'image bmp.bmp' # Replace with your image path
image = Image.open(image path).convert('L') # Convert to grayscale
# Apply Kuwahara filter with different window sizes
kuwahara result 5 = kuwahara filter(image, window size=5)
kuwahara result 7 = kuwahara filter(image, window size=7)
kuwahara result 9 = kuwahara filter(image, window size=9)
# Plot the original and filtered images for different window sizes
plt.figure(figsize=(12, 8))
```

```
plt.subplot(2, 2, 1)
plt.imshow(image, cmap='gray')
plt.title("Original Image")
plt.axis('off')
plt.subplot(2, 2, 2)
plt.imshow(kuwahara result 5, cmap='gray')
plt.title("Kuwahara Filter (Window Size 5)")
plt.axis('off')
plt.subplot(2, 2, 3)
plt.imshow(kuwahara_result_7, cmap='gray')
plt.title("Kuwahara Filter (Window Size 7)")
plt.axis('off')
plt.subplot(2, 2, 4)
plt.imshow(kuwahara_result_9, cmap='gray')
plt.title("Kuwahara Filter (Window Size 9)")
plt.axis('off')
plt.tight layout()
plt.show()
```











Kuwahara Filter (Window Size 9)

