My Current implementation approach consists of using:

1. **Absolute Difference Thresholding**: This method looks at each pair of corresponding pixels in the two images and highlights the ones that are significantly different. A side-by-side analysis of the contrasts between the two pictures would call out the places where each varies in terms of brightness and dimness, paying attention to the spots where one picture is brighter or darker compared to the other.

2. **Structural Similarity Index (SSIM): SSIM** is a more advanced way of comparing images. Instead of just looking at dark and light areas, it also considers textures and patterns. This helps in understanding how similar the overall structures in the images are.

3. **Feature Matching**: This technique tries to find patterns or specific features that both images share. By enabling the detection of comparable items within pictures regardless of perspective or illumination variances, this technique proves rather advantageous for identifying similar objects within images.

First, we prepare the images by applying a Gaussian Blur, which helps smooth out small imperfections and noise, making it easier to compare the important parts of the images. We also convert the images to grayscale, simplifying the comparison process by focusing on the brightness levels rather than the colors.

However, before I fit them into the algorithms, I had to preprocess the images individually based on their needs. For the first image which was the Banana image 1 and image 2 had different resolutions therefore I had to resize image 2 to match image 1 before applying a gaussian blur to reduce noise and converting the images to grayscale for the algorithms I will be using. For the bridge, city, clownfish, and desert images, both images had the same resolution therefore I did not have to resize them to match one another before I applied a gaussian blur and converted it to a grayscale image. For the last image, which was the snow, the images had the same resolutions however, they were not aligned with each other. I had to align the images before applying a gaussian blur and converting it into a grayscale image.

Absolute difference is straightforward and good at spotting clear differences. SSIM is better at understanding the overall similarity between images, and feature matching is great at identifying similar objects within the images.

Several limitations are important to consider. The process is particularly sensitive to how well the images are aligned, even slight discrepancies in positioning or orientation can lead to misleading differences being highlighted or actual similarities being overlooked. Moreover, this method might not always catch subtle details, as it tends to focus more on broader patterns and structures, potentially missing small but important changes. The

effectiveness of feature matching and similar techniques also heavily relies on the clarity and quality of the images, poor quality or highly textured images can make it difficult to accurately match key points. Additionally, these comparison methods demand significant computational resources, which can be challenging when working with large images, numerous images, or in scenarios requiring rapid analysis. Complex scenes packed with details pose another challenge, as they can overwhelm the comparison algorithms, making it difficult to discern meaningful differences. The specific preprocessing task for each image is a big limitation especially considering when working with a large dataset consisting of different images. Lastly, variations in lighting between the two images can impact the comparison, as the methods might attribute the differences to changes in content rather than lighting conditions. These limitations highlight the need for careful consideration and potential adaptation of the methods to suit specific comparison tasks.

For the Banana, it seems that all 3 algorithms performed well as every difference was identified properly.

For the Bridge, SSIM performed the best as it correctly identified the change of color for the bridge. However, since there is no real scene difference in the images other than color, we could say this is negligible.

For the City, SSIM and Feature Matching identified all differences correctly. Absolute Difference Threshold was missing 1 difference. Which was one window from the tower.

For the Clownfish, all three algorithms performed well and identified all the differences.

For the Desert, SSIM and Feature Matching identified all differences correctly. Absolute Difference Threshold was missing 1 difference. Which was the pyramid on the left.

For the Snow, all three algorithms performed well and identified all the differences, However, SSIM was more noisy and Absolute Difference Threshold had a more clear image of the differences.

Further refinements may include adaptive thresholding methods, incorporating machine learning models allows for more delicate examination of pictorial parallels and variances, and investigating progressive characteristic descriptors could bolster the reliability of characteristic correlating even in challenging conditions. There is also potential in creating a unified framework that combines these methods, leveraging their respective strengths to provide a comprehensive image comparison solution.