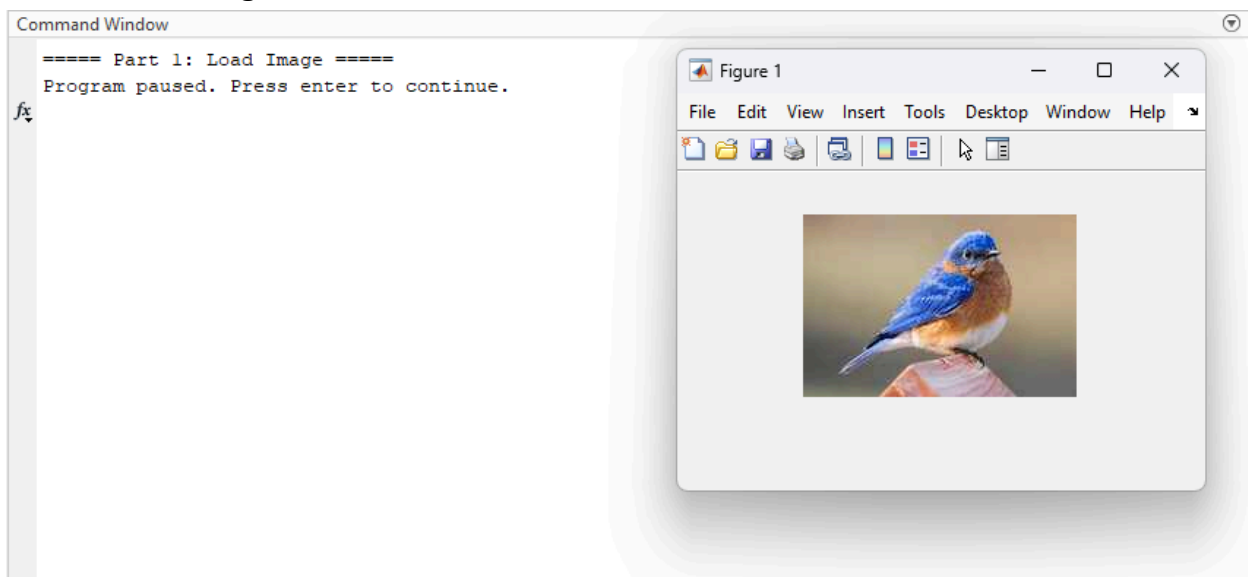Brandon Nguyen
COMPE510 - Fall 2025
827813045
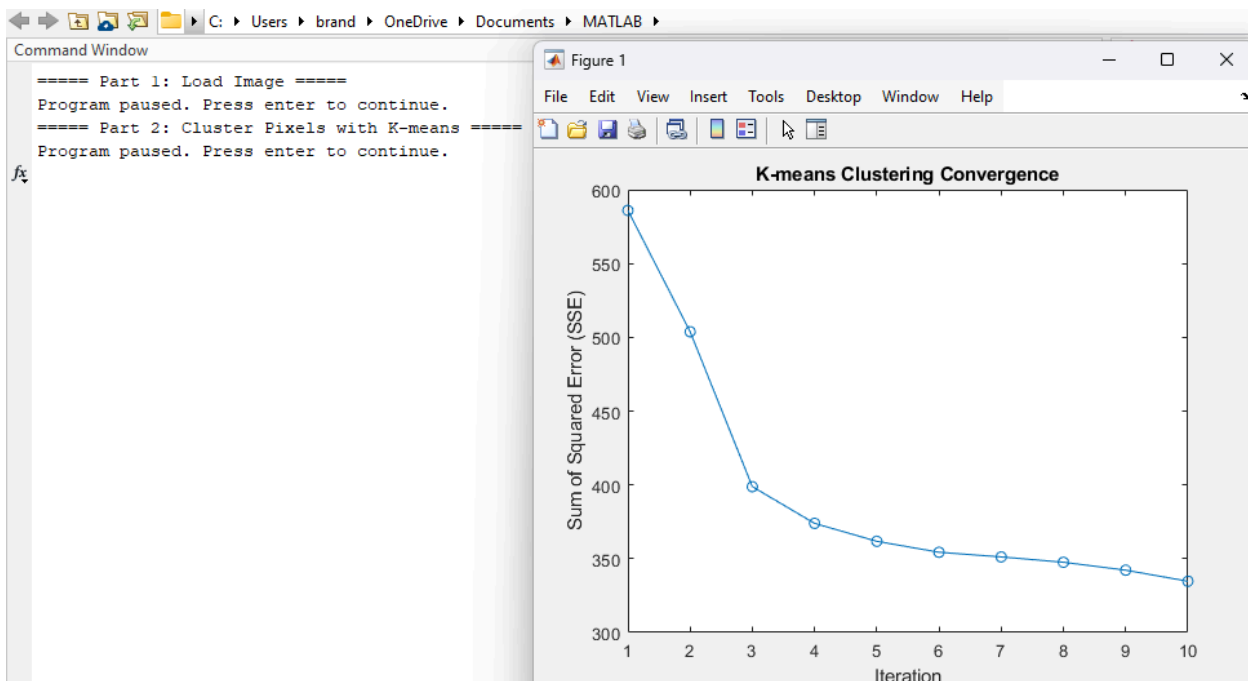
Programming Assignment 7 - Clustering (K-Means)

A) Results
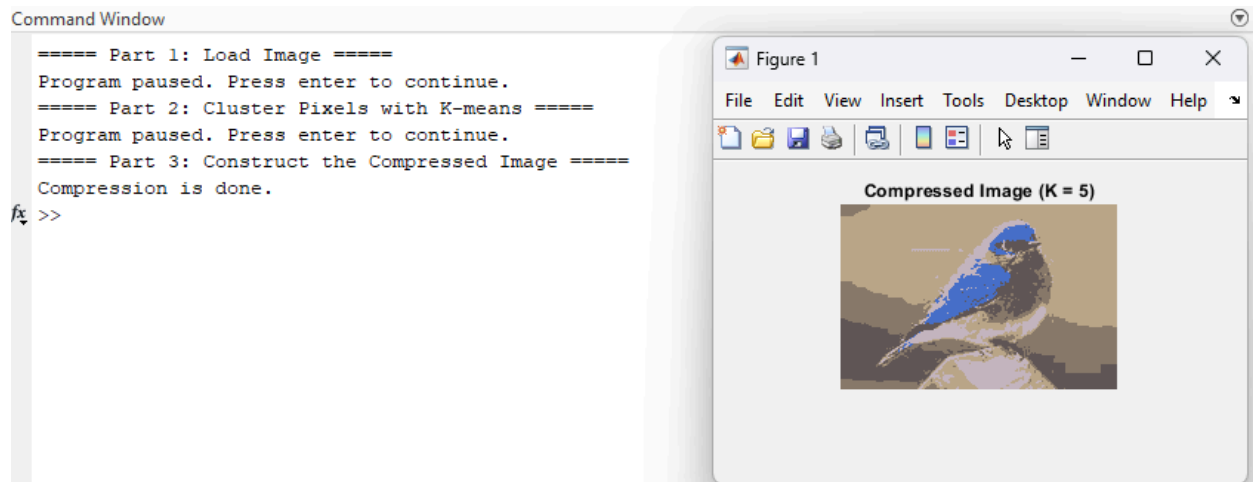
- **Load Image**

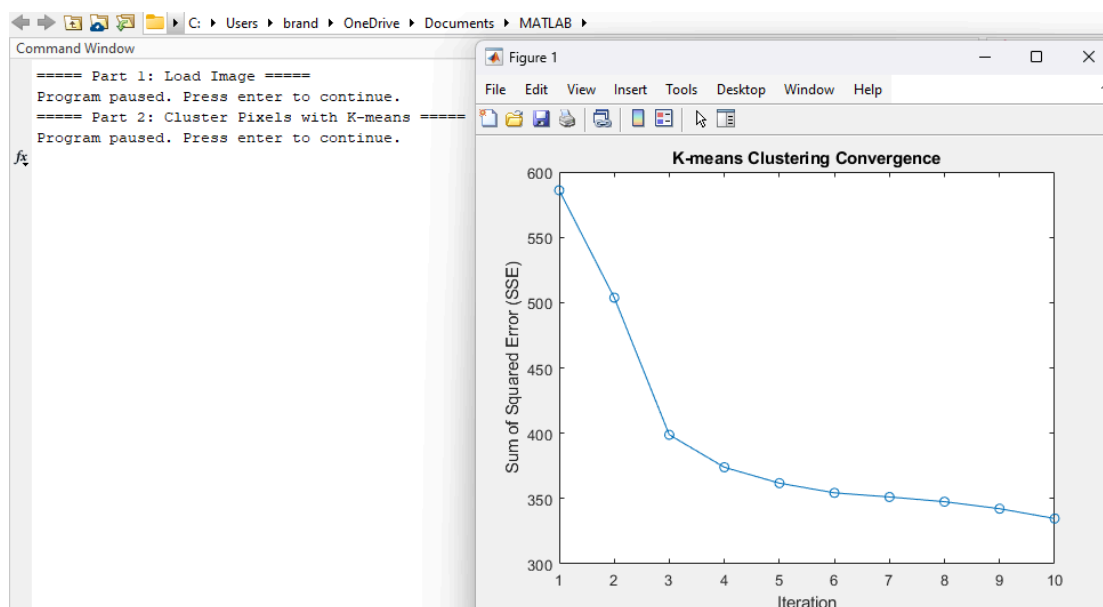- **Cluster pixels with K-means (K = 5, default value)**

- **Construct the compressed image**

Command Window

```
===== Part 1: Load Image =====
Program paused. Press enter to continue.
===== Part 2: Cluster Pixels with K-means =====
Program paused. Press enter to continue.
===== Part 3: Construct the Compressed Image =====
Compression is done.
fx >>
```

Figure 1
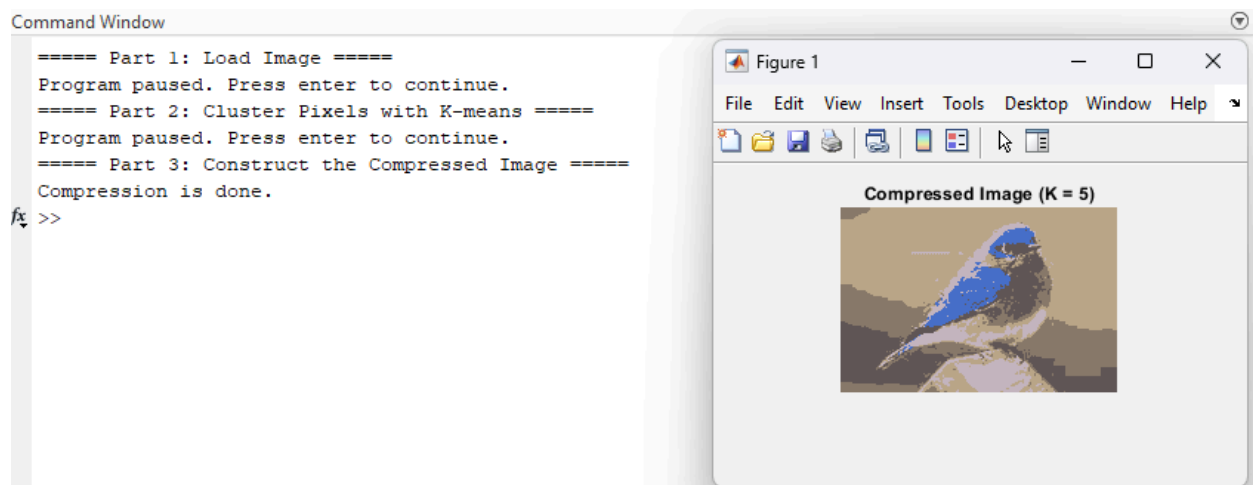
File Edit View Insert Tools Desktop Window Help
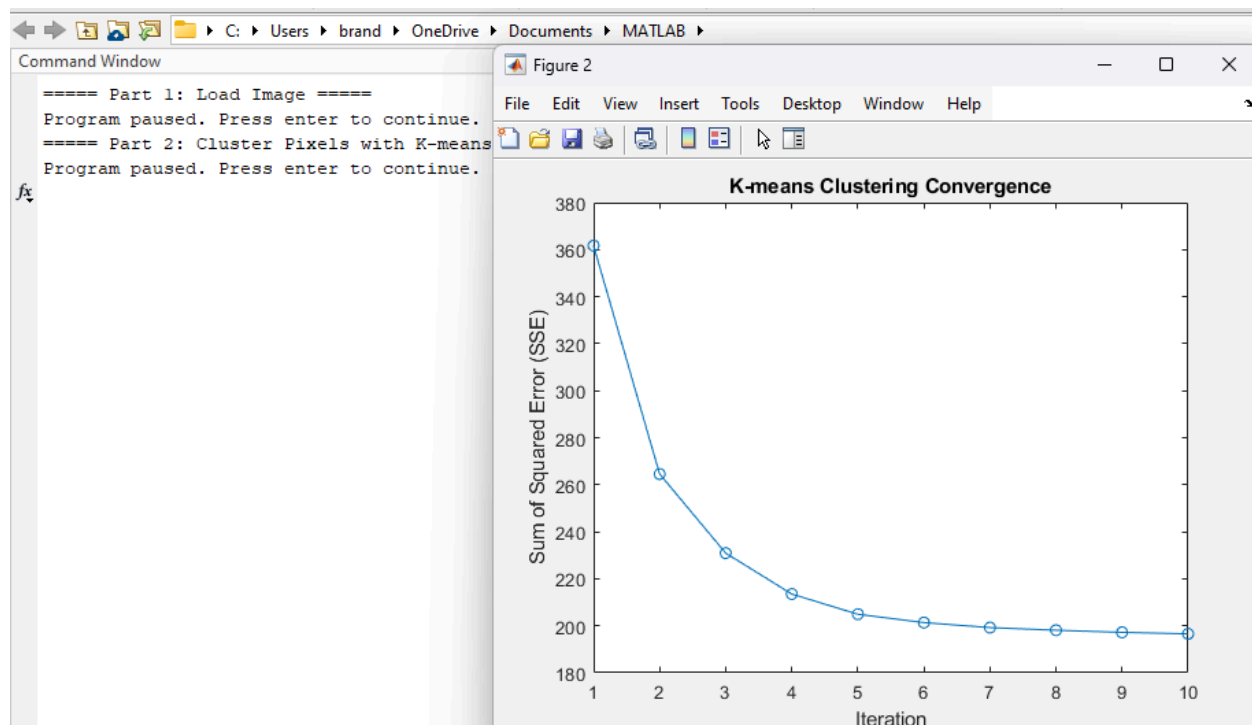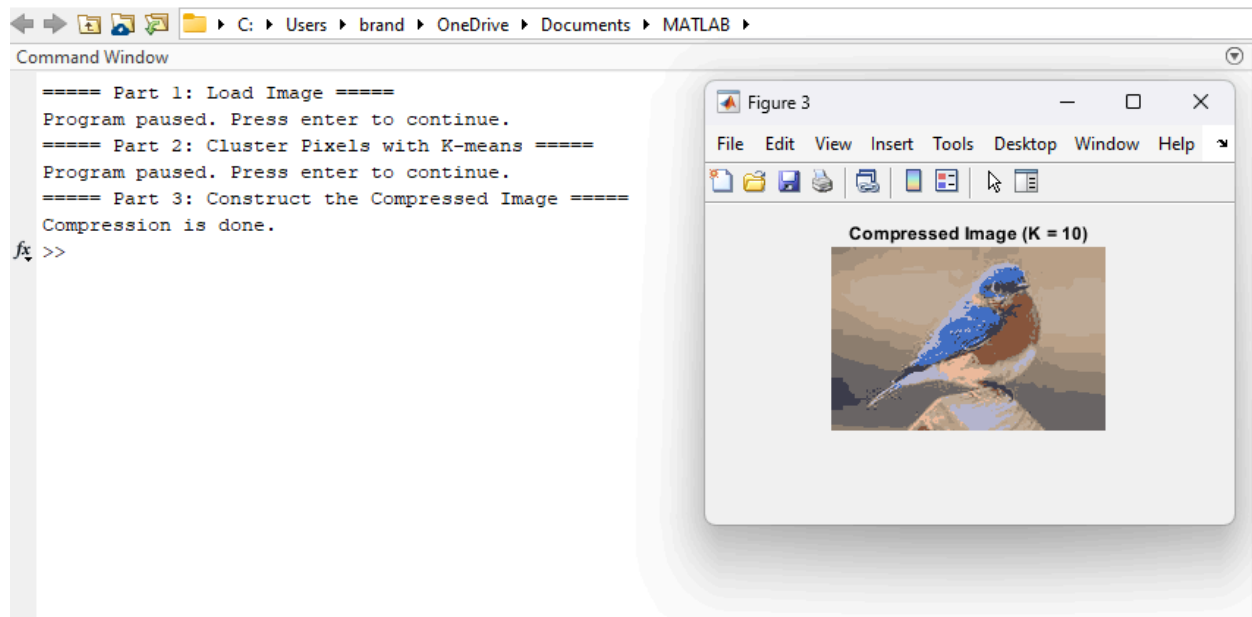
Compressed Image (K = 5)

B) Questions

- **Graph of SSE and compressed images when K = 5, 10, 20. Explain the impact of K values on image quality and convergence.**
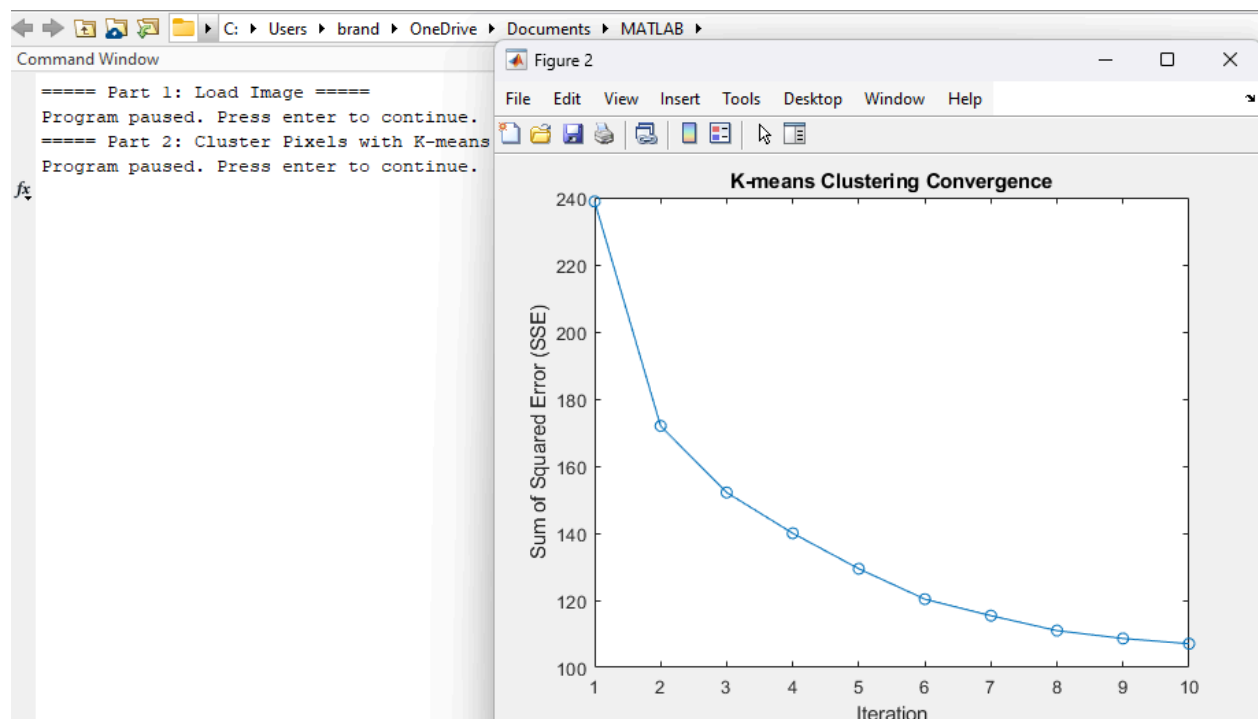
K = 5

Command Window

```
===== Part 1: Load Image =====
Program paused. Press enter to continue.
===== Part 2: Cluster Pixels with K-means =====
Program paused. Press enter to continue.
===== Part 3: Construct the Compressed Image =====
Compression is done.
fx >>
```

Figure 1

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Compressed Image (K = 5)

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Command Window

```
===== Part 1: Load Image =====
Program paused. Press enter to continue.
===== Part 2: Cluster Pixels with K-means =====
Program paused. Press enter to continue.
fx
```

Figure 1

File Edit View Insert Tools Desktop Window Help

K-means Clustering Convergence

(SSE convergence plot: Sum of Squared Error (SSE) vs Iteration, from ~587 at iteration 1 decreasing to ~333 at iteration 10)

K = 10

Command Window

```
===== Part 1: Load Image =====
Program paused. Press enter to continue.
===== Part 2: Cluster Pixels with K-means =====
Program paused. Press enter to continue.
===== Part 3: Construct the Compressed Image =====
Compression is done.
fx >>
```

Figure 3

File Edit View Insert Tools Desktop Window Help

Compressed Image (K = 10)

Command Window

```
===== Part 1: Load Image =====
Program paused. Press enter to continue.
===== Part 2: Cluster Pixels with K-means
Program paused. Press enter to continue.
fx
```

Figure 2

File Edit View Insert Tools Desktop Window Help

K-means Clustering Convergence

Sum of Squared Error (SSE) vs Iteration

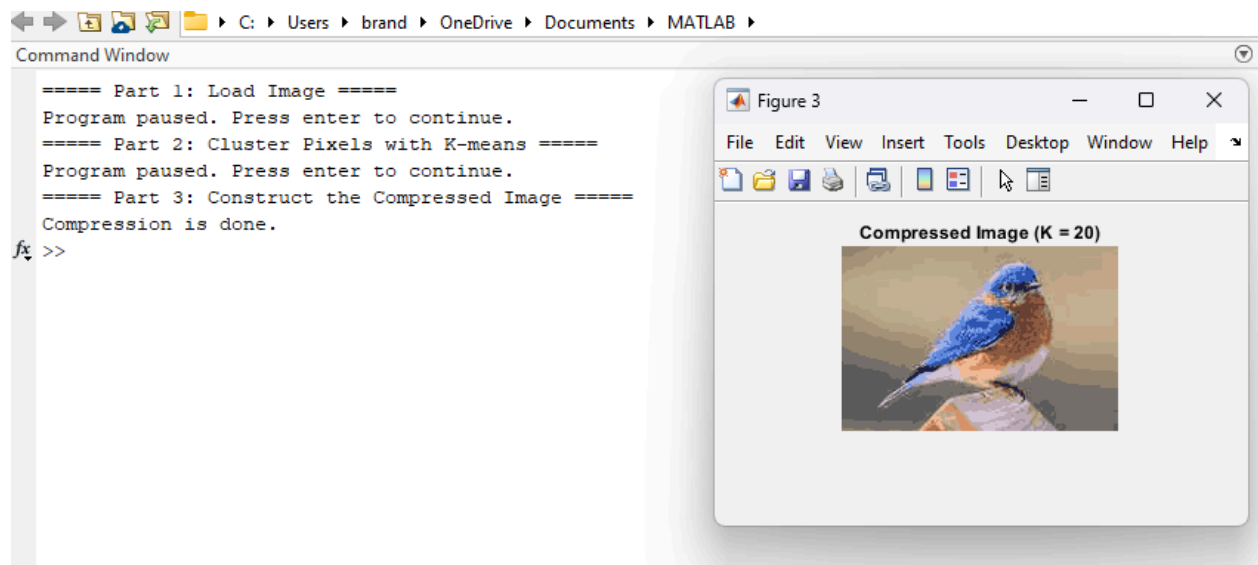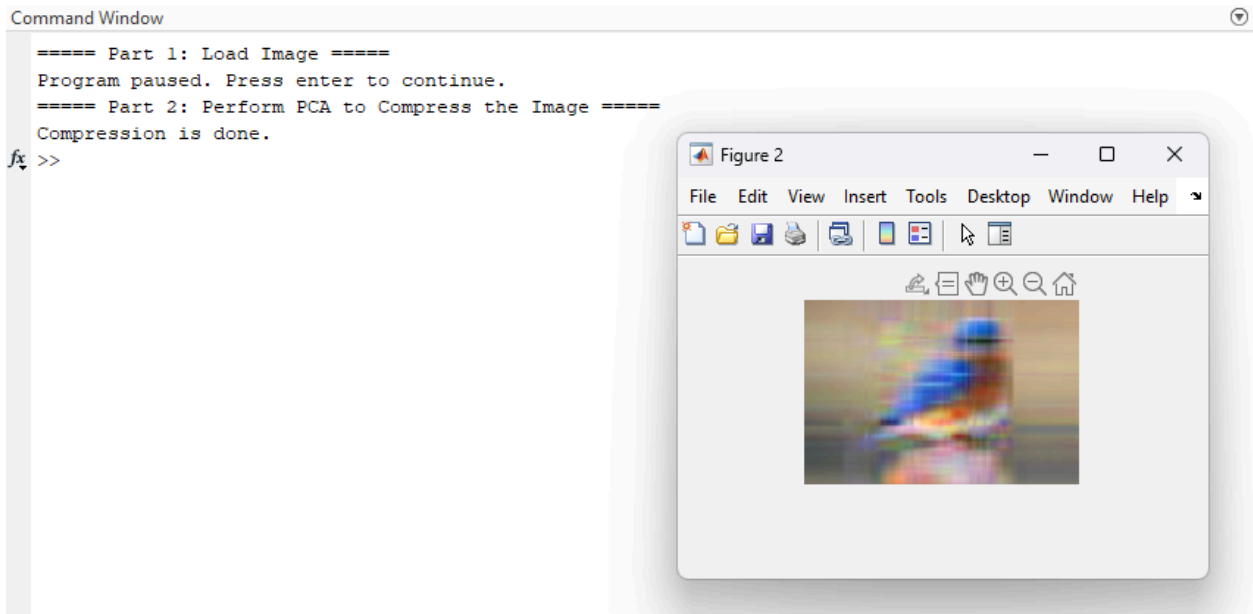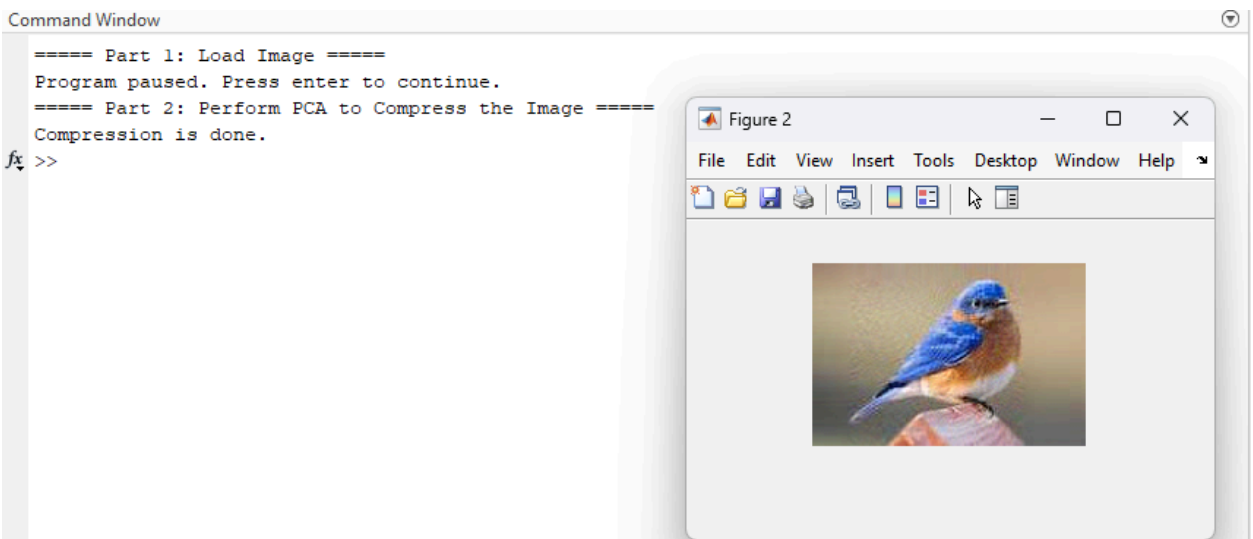**K = 20**

It is clear that the K value has a big effect on the outcome of the image quality and convergence. The K value in this code represents the number of clusters, or unique colors, used to represent an image. In other words, if we increase the K value, then the image will have more color detail and quality, but it will also have less compression and take a longer time to run. On the other hand, decreasing the K value will mean that the image will be compressed and faster to compute, but the tradeoffs are lower quality and detail.

- **Compare the results of PCA and K-Means Clustering for image compression. Which method produced visually better compressed images? Which was faster or easier to implement? Which method do you think preserves structure, and which one preserves color variation better?**
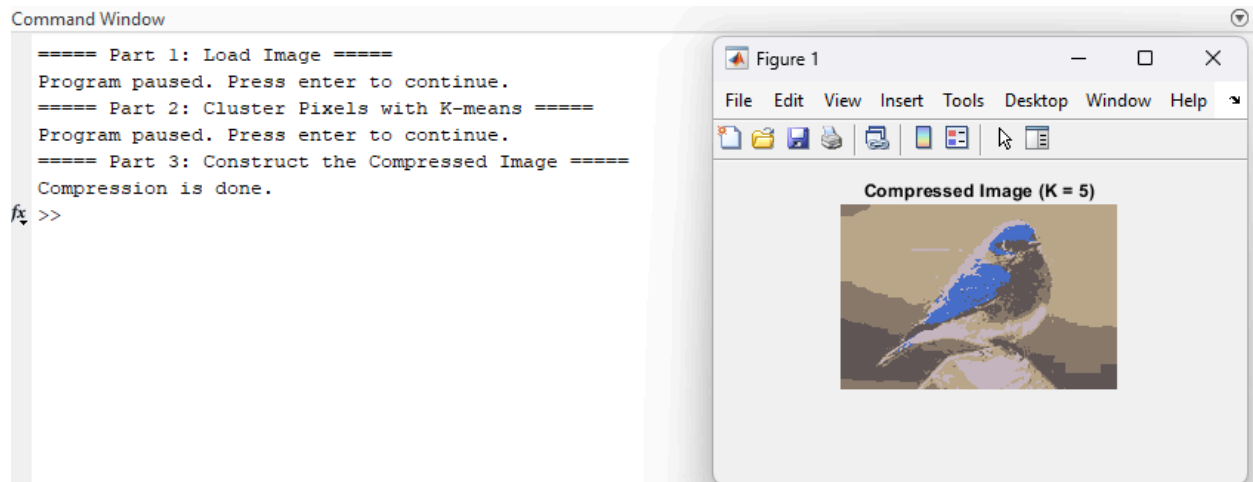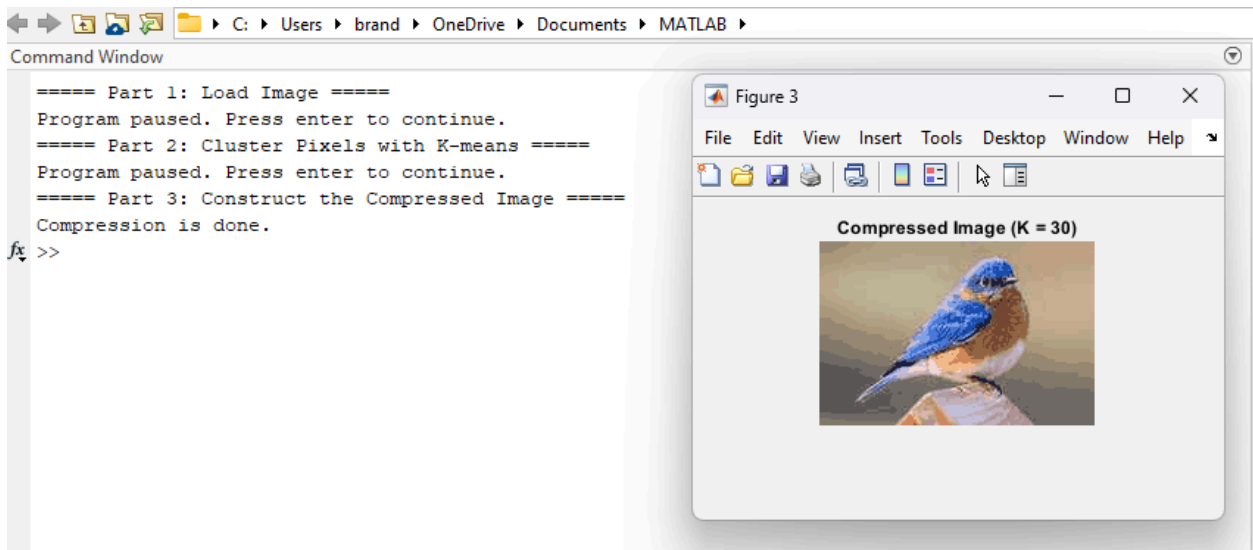
PCA K = 5

PCA = 30

K-Means Clustering K = 5

K-Means Clustering K = 30

When comparing the results of two machine learning image compression algorithms and methods like PCA and K-Means Clustering, we must take into account factors like better quality, efficiency, preservation of the original image, and color variation. Using the results provided above and general knowledge, we will be deciding the better algorithm method for each of the four categories. Starting with which method produces better visually compressed images, PCA takes this one with better preservation and reconstruction when compressing images. Secondly, for which one is easier and faster to implement, K-Means Clustering wins because it is simpler and easier to run. Lastly, the method that is better at preserving image structure is PCA, while K-Means Clustering is better at color variation preservation.

C) Summary

In this seventh and last programming assignment, I believe that the implementation of the main program file went well in order to simulate the K-Means Clustering ML algorithm. The things that went well regarding this seventh assignment include loading the image, and compressing the image using various values of K. This can be seen in the pictures above as the differing values of K slowly improved the quality of the image per compression until it was somewhat similar to the original image. Overall, this seventh assignment was efficient in teaching me about new topics like K-Means Clustering, how to compress images using Matlab using a secondary method, and how it relates to machine learning.