

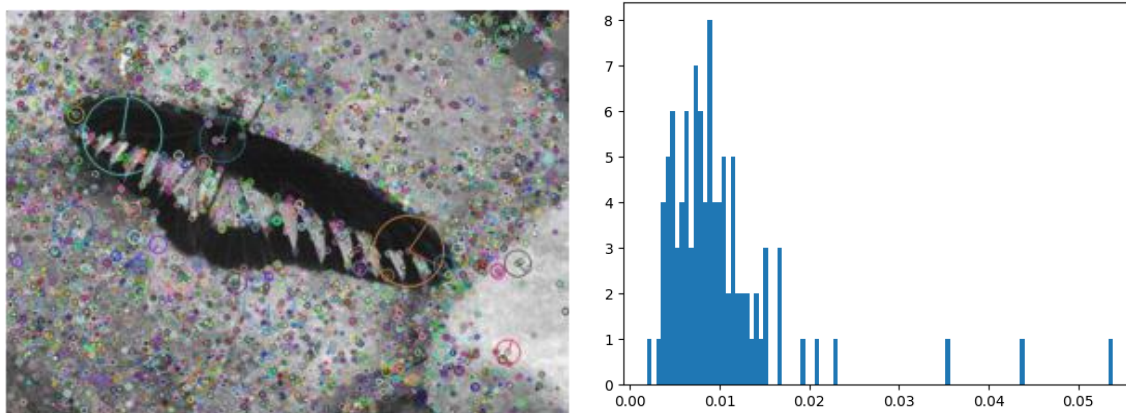
# Project 2 Report

## Code Overview

First, all the training images in the folder are read and added to a list. The first three characters of the filename is used to determine the image class. The class of each training image is also added to a separate list, which will be used for classification purposes later.

Next, for each training image, SIFT computes its features and feature descriptors. This results in a list of arrays of feature descriptors, meaning that each element in the list is an array of feature descriptors corresponding to an image. All of the feature descriptors are then put together into a single large 2D array for clustering.

K-Means is then performed on the feature descriptors to cluster them. For each image's feature descriptors, the closest clusters are computed. A normalized histogram is then created by counting how many feature descriptors was closest to a cluster, for each cluster.



The above steps are repeated for the test images, resulting in a list of histograms of the test images.

The K-Nearest Neighbors method is fit using the training image histograms and the training image class list. Then it predicts the test image classes by using the test image histograms. The Linear SVM and Kernel SVM were fitted and made predictions in the same way.

## Results

The Bag-of-Words classification method resulted in an accuracy of about 70%. The Linear SVM was the worst at about 50%, while the SVM with the radial basis function kernel was impressively around 80% accurate.

These are the confusion matrices for a sample run of the classifications:

### Bag-of-Words (K-Nearest Neighbors)

	Butterfly	Hat	Airplane
Butterfly	9	1	0
Hat	3	5	2
Airplane	3	1	12

### Linear SVM

	Butterfly	Hat	Airplane
Butterfly	9	1	0
Hat	3	5	2
Airplane	3	1	12

### Kernel SVM

	Butterfly	Hat	Airplane
Butterfly	9	1	0
Hat	3	5	2
Airplane	3	1	12

## Possible Areas of Improvement

The Linear SVM and Kernel SVM may perform better if their hyperparameters are tuned. Finding good values for hyperparameters can be obtained through trial and error. However, if the hyperparameters are adjusted too much, it can result in overfitting.

The default method of implementing K-Means takes an extremely long time to run. Mini-Batch K-Means is a lot faster than the default method and gives very similar results as the default method.