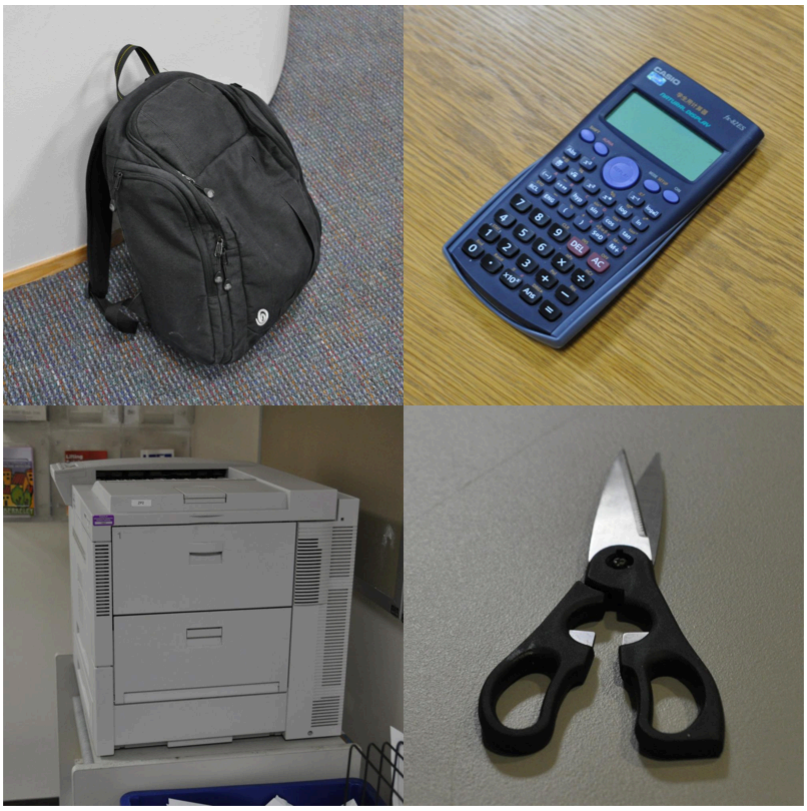
```
% 6. Refer to the Bag of Features example MATLAB
% source code provided in the classroom's classwork
% page. In your homework, pick an object category
% that would be commonly seen in any household
% (e.g. cutlery) and pick 5 object types (e.g.
% for cutlery pick spoon, fork, butter knife,
% cutting knife, ladle). Present your performance
% evaluation.
```

```
%% Load Image Dataset
imds=imageDatastore('./q7_image/office_images','IncludeSubfolders',true,'LabelSource','folderna

% inspect the number of images per category, as well as category labels
tbl=countEachLabel(imds)
```

tbl = 5×2 table

	Label	Count
1	backpack	10
2	calculator	10
3	pen	10
4	printer	10
5	scissors	10

```
% visualization
figure
montage(imds.Files(1:16:end))
```



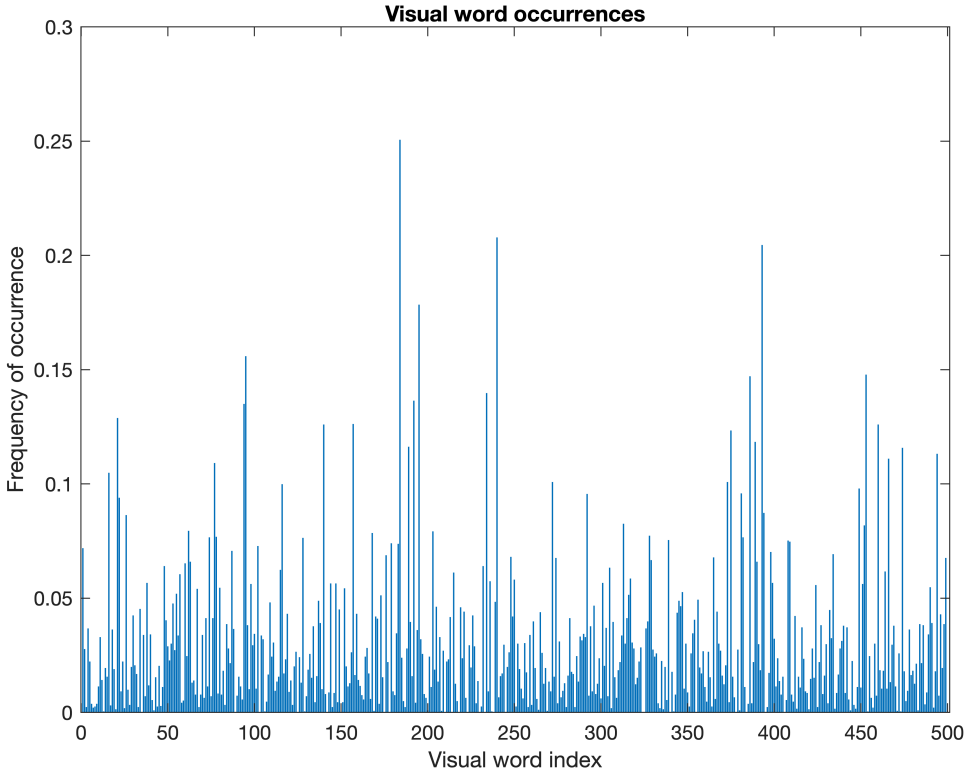
```
%% Prepare Training and Validation Image Sets
[trainingSet, validationSet] = splitEachLabel(imds, 0.6, 'randomize');
```

```
%% Create a Visual Vocabulary and Train an Image Category Classifier

% Creating Bag-Of-Features.
bag = bagOfFeatures(trainingSet);
```

```
Creating Bag-Of-Features.
-------------------------
* Image category 1: backpack
* Image category 2: calculator
* Image category 3: pen
* Image category 4: printer
* Image category 5: scissors
* Selecting feature point locations using the Grid method.
* Extracting SURF features from the selected feature point locations.
** The GridStep is [8 8] and the BlockWidth is [32 64 96 128].

* Extracting features from 30 images...done. Extracted 1875000 features.

* Keeping 80 percent of the strongest features from each category.

* Using K-Means clustering to create a 500 word visual vocabulary.
* Number of features          : 1500000
* Number of clusters (K)      : 500

* Initializing cluster centers...100.00%.
```

```
* Clustering...completed 30/100 iterations (~11.76 seconds/iteration)...converged in 30 iterations.

* Finished creating Bag-Of-Features
```

```
% Encoding images using Bag-Of-Features.
img = readimage(imds, 1);
featureVector = encode(bag, img);

% Plot the histogram of visual word occurrences
figure
bar(featureVector)
title('Visual word occurrences')
xlabel('Visual word index')
ylabel('Frequency of occurrence')
```




```
%% Training an image category classifier for 5 categories.
categoryClassifier = trainImageCategoryClassifier(trainingSet, bag);
```

```
Training an image category classifier for 5 categories.
--------------------------------------------------------
* Category 1: backpack
* Category 2: calculator
* Category 3: pen
* Category 4: printer
* Category 5: scissors

* Encoding features for 30 images...done.

* Finished training the category classifier. Use evaluate to test the classifier on a test set.
```

```
%% Evaluate Classifier Performance

% on training set
confMatrix = evaluate(categoryClassifier, trainingSet);
```

```
Evaluating image category classifier for 5 categories.
-------------------------------------------------------

* Category 1: backpack
* Category 2: calculator
* Category 3: pen
* Category 4: printer
* Category 5: scissors

* Evaluating 30 images...done.

* Finished evaluating all the test sets.

* The confusion matrix for this test set is:


                                  PREDICTED
KNOWN         | backpack   calculator   pen    printer   scissors
---------------------------------------------------------------------
backpack      | 1.00       0.00         0.00   0.00      0.00
calculator    | 0.00       0.67         0.00   0.17      0.17
pen           | 0.00       0.00         1.00   0.00      0.00
printer       | 0.00       0.00         0.00   1.00      0.00
scissors      | 0.00       0.00         0.33   0.00      0.67

* Average Accuracy is 0.87.
```

```
% on validation set
confMatrix_val = evaluate(categoryClassifier, validationSet);
```

```
Evaluating image category classifier for 5 categories.
-------------------------------------------------------

* Category 1: backpack
* Category 2: calculator
* Category 3: pen
* Category 4: printer
* Category 5: scissors

* Evaluating 20 images...done.

* Finished evaluating all the test sets.

* The confusion matrix for this test set is:


                                  PREDICTED
KNOWN         | backpack   calculator   pen    printer   scissors
---------------------------------------------------------------------
backpack      | 1.00       0.00         0.00   0.00      0.00
calculator    | 0.00       0.50         0.00   0.00      0.50
pen           | 0.00       0.00         1.00   0.00      0.00
printer       | 0.00       0.00         0.00   1.00      0.00
scissors      | 0.00       0.00         1.00   0.00      0.00
```

```
* Average Accuracy is 0.70.
```

```
% Compute average accuracy
avg_acc = mean(diag(confMatrix_val));
```

```
%% show example
% read an image
img = imread(fullfile('./q7_image/office_images','backpack','frame_0001.jpg'));
figure
imshow(img)
```

```
% run classification
[labelIdx, scores] = predict(categoryClassifier, img);
labelName = categoryClassifier.Labels(labelIdx);
disp(labelName)
```

```
    {'backpack'}
```