Flower Classification

Dataset

path to flower photos

```
% load from saved workspace. to not run again
% load workspace_variables\workspace_var

% here its in same directory as the matlab file, if not provide the path (eg:
C:\....)
path = "Data\flower_photos";
```

datastore creation

```
ds = imageDatastore(path, "IncludeSubfolders", true, "LabelSource", "foldernames");
```

Split into randomized training and testing sets

```
rng default
[trainImgs,testImgs] = splitEachLabel(ds,0.6,"randomized");
```

Preprocessing

Get Network and its layers

```
net = googlenet
```

```
net =
  DAGNetwork with properties:

         Layers: [144×1 nnet.cnn.layer.Layer]
    Connections: [170×2 table]
     InputNames: {'data'}
    OutputNames: {'output'}
```

input layer properties, getting the requirement

```
ly = net.Layers;
ly1 = ly(1).InputSize;
inputSZ = ly1(1:2);
```

updating datastore size

```
trainImgs = augmentedImageDatastore(inputSZ, trainImgs);
testImgs = augmentedImageDatastore(inputSZ, testImgs);
```

Number of categories

```
categos = numel(categories(ds.Labels));
```

New Network

modify GoogLeNet

layers

```
layers = layerGraph(net);
```

Modify the classification and output layers

```
% fully connected layer
newFc = fullyConnectedLayer(categos,"Name","fc_nw");
layers = replaceLayer(layers,"loss3-classifier",newFc);

% output layer
newOut = classificationLayer("Name","out_nw");
layers = replaceLayer(layers,"output",newOut);
```

Training algorithm

Training algorithm is set to SGDM

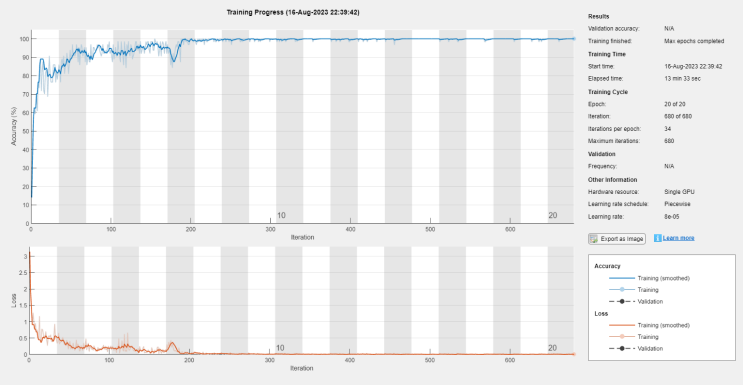
```
% learning rate set to 0.001
options = trainingOptions("sgdm", ...
    'MaxEpochs',20,...
    'MiniBatchSize', 64, ...
    "InitialLearnRate", 0.01, ...
    "LearnRateSchedule","piecewise", ...
    "LearnRateDropFactor", 0.2, ...
    "LearnRateDropPeriod", 5, ...
    "Momentum", 0.9, ...
    "Shuffle","once", ...
    'Plots','training-progress');
```

Perform training

```
[flowernet,info] = trainNetwork(trainImgs, layers, options);
```

```
Training on single GPU.
Initializing input data normalization.
|=========================================================================================|
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Mini-batch  |  Base Learning  |
|         |             |   (hh:mm:ss)   |   Accuracy   |     Loss     |      Rate       |
|=========================================================================================|
|       1 |           1 |       00:00:03 |       14.06% |       3.1381 |          0.0100 |
|       2 |          50 |       00:00:56 |       89.06% |       0.2738 |          0.0100 |
|       3 |         100 |       00:02:01 |       93.75% |       0.1722 |          0.0100 |
|       5 |         150 |       00:03:04 |       98.44% |       0.0885 |          0.0100 |
|       6 |         200 |       00:04:08 |      100.00% |       0.0145 |          0.0020 |
|       8 |         250 |       00:05:05 |      100.00% |       0.0065 |          0.0020 |
|       9 |         300 |       00:06:03 |      100.00% |       0.0087 |          0.0020 |
|      11 |         350 |       00:06:56 |      100.00% |       0.0048 |          0.0004 |
|      12 |         400 |       00:07:53 |      100.00% |       0.0012 |          0.0004 |
|      14 |         450 |       00:08:48 |      100.00% |       0.0124 |          0.0004 |
|      15 |         500 |       00:09:48 |      100.00% |       0.0130 |          0.0004 |
|      17 |         550 |       00:10:52 |      100.00% |       0.0044 |      8.0000e-05 |
|      18 |         600 |       00:11:48 |      100.00% |       0.0044 |      8.0000e-05 |
|      20 |         650 |       00:12:54 |      100.00% |       0.0015 |      8.0000e-05 |
|      20 |         680 |       00:13:33 |      100.00% |       0.0029 |      8.0000e-05 |
```

```
|=========================================================================================|
Training finished: Max epochs completed.
```



Save the new Network

```
save workspace_variables\flowernet.mat flowernet;
```

Test the model

```
preds = classify(flowernet, testImgs);
```

Evaluate the results

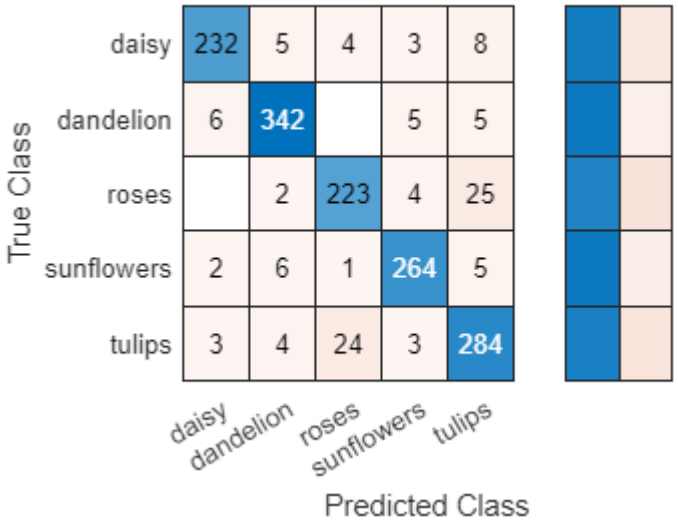
Accuracy

```
categ = extractBetween(testImgs.Files, "flower_photos\", "\");
accuracy = nnz(preds == categ) / numel(preds)
```

```
accuracy = 0.9212
```

Confusion Matrix

```
confusionchart(categorical(categ), preds, "RowSummary","row-normalized");
```



Analyze misclassifications

Confusion matrix

```
% file of all the test images test set
paths = string(testImgs.Files);

% actual category of the flowers in test set
trueCat = extractBetween(paths, "flower_photos\", "\");

% original
org = categorical(trueCat);

% confusion matrix
cm = confusionmat(org, preds);

% Split into correct and incorrect classifications
% yes is diagonal elements i.e. predicted correctly
yes = diag(cm);

% elements other than diagonal, i.e. wrongly predicted
no = cm - diag(yes);
```

Misclassification rate for each letter

```
misratebyflwrs = sum(no,2) ./ sum(cm,2);
```

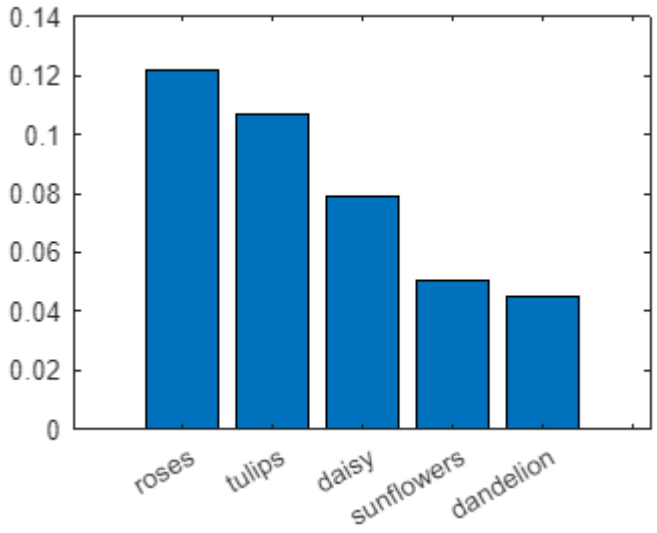
Table with letter names and misclassification rate

```
flwrs = categories(ds.Labels);

misratebyflwrs = table(flwrs,misratebyflwrs,'VariableNames',
["Flowers","MisClassRate"]);

% Sort by worst misclassification
misratebyflwrs = sortrows(misratebyflwrs,"MisClassRate","descend")
```

misratebyflwrs = 5×2 table

	Flowers	MisClassRate
1	'roses'	0.1220
2	'tulips'	0.1069
3	'daisy'	0.0794
4	'sunflowers'	0.0504
5	'dandelion'	0.0447

```
bar(misratebyflwrs.MisClassRate)
xticks(1:26)
xticklabels(misratebyflwrs.Flowers)
```



Individual Category misclassification

```
flw = "roses";
```

True class that were misclassified as something else

```
% the flower category selected (in drop down menu),
% and select the misclassified among that category
% i.e. category 'flwr' and wrong predcited
misclassidx = (trueCat == flw) & (string(preds) ~= trueCat);
```

Table of the misclassified observations, with the predicted letter

```
% name of the wrong category predicted, instead of category 'flw'
wrongPred = string(preds(misclassidx));

% files of wrong predicted flowers of category 'flw'
files_categoryPred = paths(misclassidx);
```

Plot

```
num = numel(wrongPred);

k = 1;

wr_pred_img = files_categoryPred(k);

imshow(wr_pred_img);
title("Predicted: "+wrongPred(k)+"  ->   Actual: "+flw)
```

Predicted: tulips -> Actual: roses

Saving all the workspace variables to .mat file

```
save workspace_variables\workspace_var;
```