```
% Topic is deep learning: classification of fruits

%  Path to train set directory
trainDatasetPath = fullfile('C:\Users\OMBATI\Desktop\matlab\project-one\COURSE WORK\train');

% Create an imageDatastore using the path
imds = imageDatastore(trainDatasetPath, 'IncludeSubfolders', true, 'LabelSource', 'foldernames'

img = readimage(imds, 1);
size(img)
```

```
ans = 1×3
   100   100     3
```

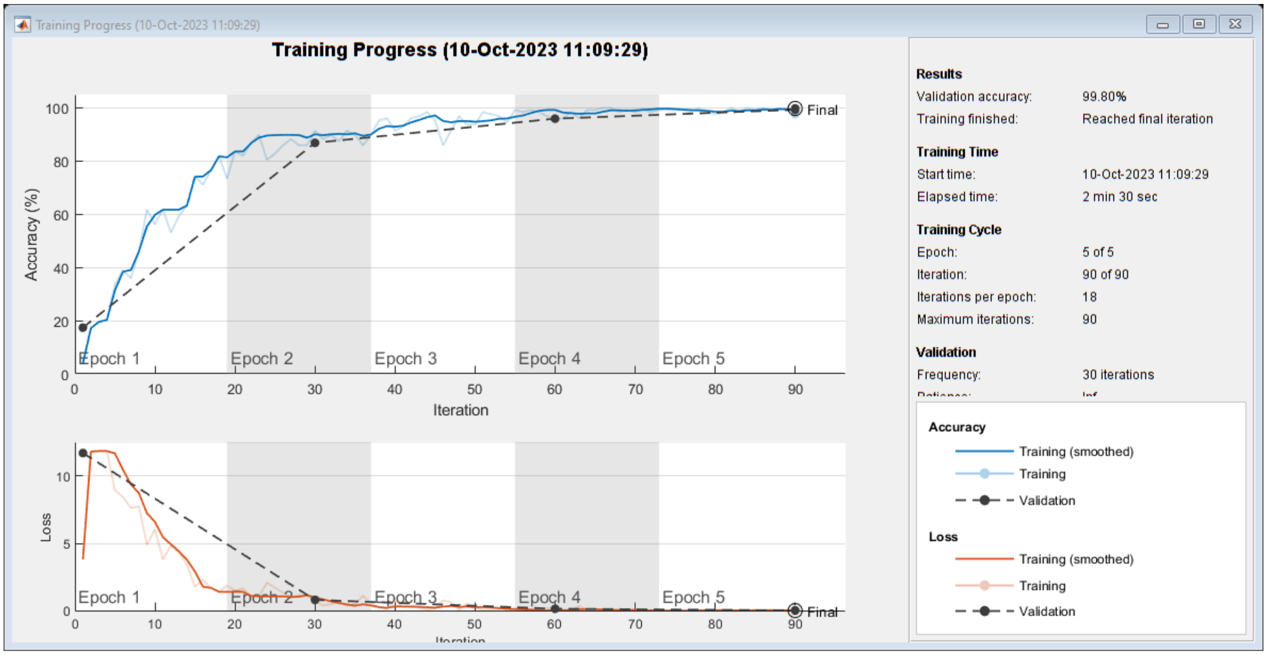
```

% Number of images per category
tbl = countEachLabel(imds);

% Adjust the number of images in the training set to be balanced
% Determine the smallest amount of images in a category
minSetCount = min(tbl{:, 2});

% Limit the number of images to reduce the time it takes
% Run this example.
maxNumImages = 100;
minSetCount = min(maxNumImages, minSetCount);

% Use splitEachLabel method to trim the set.
imds = splitEachLabel(imds, minSetCount, 'randomize');

% Each set now has exactly the same number of images.
countEachLabel(imds)
```

```
ans = 33×2 table
```

	Label	Count
1	Apple Bra...	100
2	Apple Gra...	100
3	Apricot	100
4	Avocado	100
5	Banana	100
6	Blueberry	100
7	Cactus fr...	100
8	Cantaloupe	100
9	Cherry	100
10	Clementine	100
11	Corn	100
12	Cucumber ...	100

	Label	Count
13	Grape Blue	100
14	Kiwi	100
15	Lemon	100
16	Limes	100
17	Mango	100
18	Onion White	100
19	Orange	100
20	Papaya	100
21	Passion F...	100
22	Peach	100
23	Pear	100
24	Pepper Gr...	100
25	Pepper Red	100
26	Pineapple	100
27	Plum	100
28	Pomegranate	100
29	Potato Red	100
30	Raspberry	100
31	Strawberry	100
32	Tomato	100
33	Watermelon	100

```
% Specify Training and Validation Sets
numTrainFiles = 70;
[imdsTrain, imdsValidation] = splitEachLabel(imds, numTrainFiles, 'randomize');





% Define the convolutional neural network architecture

layers = [
    imageInputLayer([100 100 3])

    convolution2dLayer(3, 8, 'Padding', 'same')
    batchNormalizationLayer
    reluLayer
    maxPooling2dLayer(2, 'Stride', 2)

    convolution2dLayer(3, 16, 'Padding', 'same')
    batchNormalizationLayer
    reluLayer

    maxPooling2dLayer(2, 'Stride', 2)

    convolution2dLayer(3, 32, 'Padding', 'same')
    batchNormalizationLayer
    reluLayer

    fullyConnectedLayer(33) % Change to 33 output units
    softmaxLayer
    classificationLayer];

% Initialize arrays to store readable images and labels
readableImages = {};
readableLabels = [];

% Loop through the imageDatastore and store readable images and labels
for i = 1:numel(imdsTrain.Files)
    try
        img = readimage(imdsTrain, i);
        % If the image is successfully read, store it and its label
        readableImages{end+1} = img;
        readableLabels(end+1) = imdsTrain.Labels(i);
    catch
        fprintf('Error reading image: %s\n', imdsTrain.Files{i});
    end
end

% Create a cell array of file paths for the readable images
readableImagePaths = imdsTrain.Files(~cellfun('isempty', readableImages));

% Create an imageDatastore from the readable images and labels
readableImdsTrain = imageDatastore(readableImagePaths, ...
    'Labels', categorical(readableLabels), 'IncludeSubfolders', true);

% Update the options to use the new imageDatastore
options = trainingOptions('adam', ...
    'InitialLearnRate', 0.01, ...
    'MaxEpochs', 5, ...
    'Shuffle', 'every-epoch', ...
    'ValidationData', imdsValidation, ... % Use imdsValidation
    'ValidationFrequency', 30, ...
    'Verbose', false, ...
    'Plots', 'training-progress');


net = trainNetwork(imdsTrain, layers, options);
```



```
Results
Validation accuracy:      99.80%
Training finished:        Reached final iteration
Training Time
Start time:               10-Oct-2023 11:09:29
Elapsed time:             2 min 30 sec
Training Cycle
Epoch:                    5 of 5
Iteration:                90 of 90
Iterations per epoch:     18
Maximum iterations:       90
Validation
Frequency:                30 iterations
Patience:                 Inf
```

```
% Inspect the first layer
net.Layers(1)
```

```
ans = 
  ImageInputLayer with properties:

                      Name: 'imageinput'
                 InputSize: [100 100 3]

   Hyperparameters
          DataAugmentation: 'none'
             Normalization: 'zerocenter'
    NormalizationDimension: 'auto'
                      Mean: [1×1×3 single]
```

```
% Inspect the last layer
net.Layers(end)
```

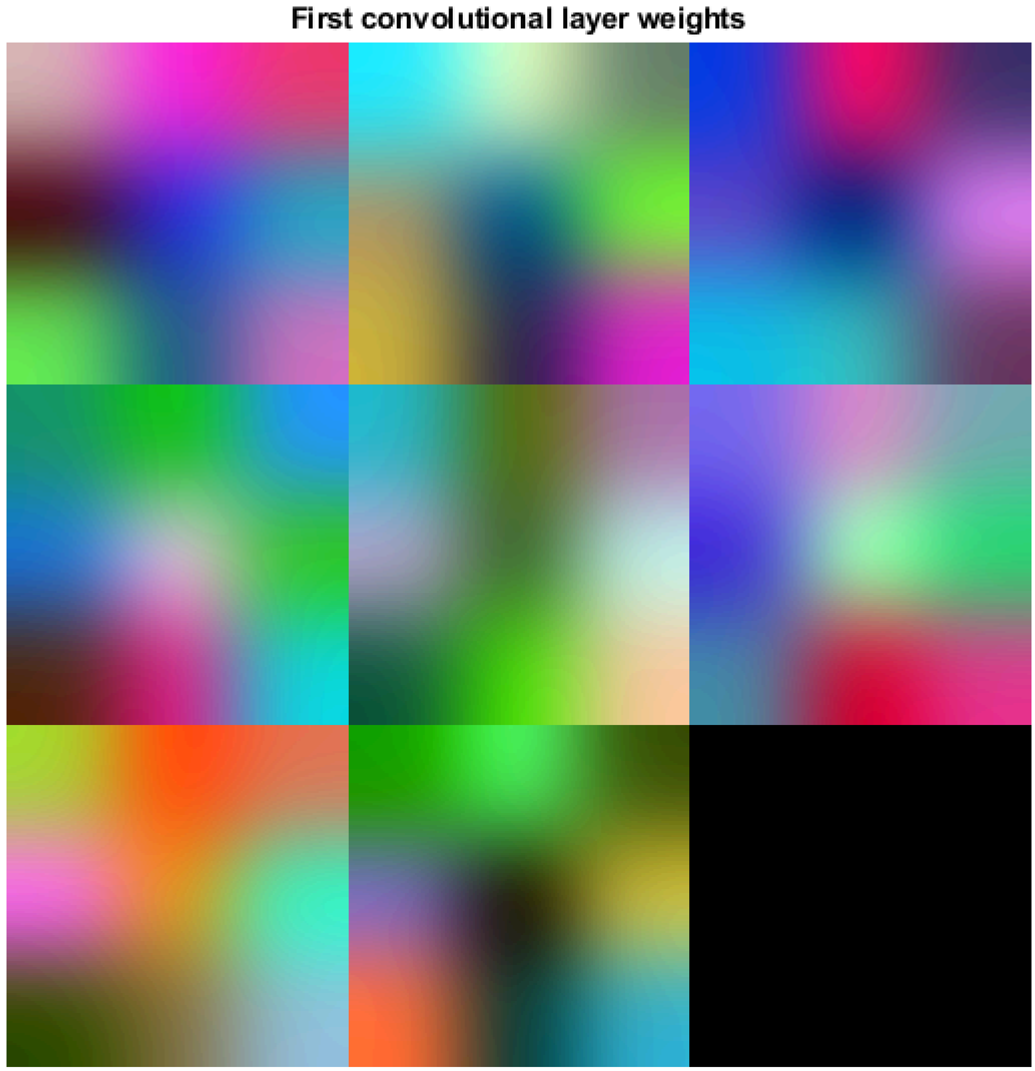
```
ans = 
  ClassificationOutputLayer with properties:

            Name: 'classoutput'
         Classes: [33×1 categorical]
      OutputSize: 33

   Hyperparameters
    LossFunction: 'crossentropyex'
```

```
% Number of class names for ImageNet classification task
numel(net.Layers(end).ClassNames)
```

```
ans = 33
```

```
% Get the network weights for the second convolutional layer
```

```
w1 = net.Layers(2).Weights;

% Scale and resize the weights for visualization
w1 = mat2gray(w1);
w1 = imresize(w1,5);

% Display a montage of network weights.

figure
montage(w1)
title('First convolutional layer weights')
```



```
% Classify validation data
YPred = classify(net, imdsValidation);
```

```
YValidation = imdsValidation.Labels;



% Calculate the confusion matrix
confMat = confusionmat(YValidation, YPred);

% Calculate the sum of each row (actual class)
rowSum = sum(confMat, 2);

% Divide each element in the confusion matrix by the corresponding row sum
confMatPercentage = confMat ./ rowSum;

% Display the confusion matrix in percentage form
disp("Confusion Matrix (Percentage Form):");
```

```
Confusion Matrix (Percentage Form):
```

```
disp(confMatPercentage);
```

```
  Columns 1 through 16

    1.0000         0         0         0         0         0         0         0         0         0         0
         0    1.0000         0         0         0         0         0         0         0         0         0
         0         0    1.0000         0         0         0         0         0         0         0         0
         0         0         0    1.0000         0         0         0         0         0         0         0
         0         0         0         0    1.0000         0         0         0         0         0         0
         0         0         0         0         0    1.0000         0         0         0         0         0
         0         0         0         0         0         0    1.0000         0         0         0         0
         0         0         0         0         0         0         0    1.0000         0         0         0
         0         0         0         0         0         0         0         0    0.9667         0         0
         0         0         0         0         0         0         0         0         0    1.0000         0
         0         0         0         0         0         0         0         0         0         0    1.0000
         0         0         0         0         0         0         0         0         0         0         0    1.
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
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         0         0         0         0         0         0         0         0         0         0         0
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         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0

  Columns 17 through 32

         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0    0.0333
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0    0.0333         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0         0
    1.0000         0         0         0         0         0         0         0         0         0         0
         0    1.0000         0         0         0         0         0         0         0         0         0
         0         0    1.0000         0         0         0         0         0         0         0         0
         0         0         0    1.0000         0         0         0         0         0         0         0
         0         0         0         0    1.0000         0         0         0         0         0         0
         0         0         0         0         0    1.0000         0         0         0         0         0
         0         0         0         0         0         0    1.0000         0         0         0         0
         0         0         0         0         0         0         0    1.0000         0         0         0
         0         0         0         0         0         0         0         0    1.0000         0         0
         0         0         0         0         0         0         0         0         0    1.0000         0
         0         0         0         0         0         0         0         0         0         0    1.0000
         0         0         0         0         0         0         0         0         0         0         0    1.
         0         0         0         0         0         0         0         0         0         0         0
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         0         0         0         0         0         0         0         0         0         0         0
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         0         0         0         0         0         0         0         0         0         0         0

  Column 33

         0
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         0
         0
         0
         0
         0
    1.0000
```

```matlab
% Calculate accuracy
accuracy = sum(YPred == YValidation) / numel(YValidation);
disp(['Validation accuracy: ', num2str(accuracy)]);
```

```
Validation accuracy: 0.99798
```