```
close all;
clear variables;
clc;
```

```
folder = "CUB_200_2011_Subset20classes";
trainingImageNames = readtable(fullfile(folder, "train.txt"), 'ReadVariableNames', false);
trainingImageNames.Properties.VariableNames = {'index', 'imageName'};
validationImageNames = readtable(fullfile(folder, "validate.txt"), 'ReadVariableNames', false);
validationImageNames.Properties.VariableNames = {'index', 'imageName'};
testImageNames = readtable(fullfile(folder, "test.txt"),'ReadVariableNames', false);
testImageNames.Properties.VariableNames = {'index', 'imageName'};
classNames = readtable(fullfile(folder, "classes.txt"), 'ReadVariableNames', false);
classNames.Properties.VariableNames = {'index', 'className'};
imageClassLabels = readtable(fullfile(folder, "image_class_labels.txt"), 'ReadVariableNames', fa
imageClassLabels.Properties.VariableNames = {'index', 'classLabel'};
folder = "CUB_200_2011_Subset20classes/";
trainingImageList = strings(height(trainingImageNames), 1);
for iI = 1:height(trainingImageNames)
    trainingImageList(iI) = string(fullfile(folder, "images/", ...
        string(cell2mat(trainingImageNames.imageName(iI)))));
end
validationImageList = strings(height(validationImageNames), 1);
for iI = 1:height(validationImageNames)
    validationImageList(iI) = string(folder + "images/" + ...
        string(cell2mat(validationImageNames.imageName(iI))));
end
testImageList = strings(height(testImageNames), 1);
for iI = 1:height(testImageNames)
    testImageList(iI) = string(folder + "images/" + ...
        string(cell2mat(testImageNames.imageName(iI))));
end
trainingImageDS = imageDatastore(trainingImageList, 'labelSource', 'foldernames', ...
    'FileExtensions', {'.jpg'});
trainingImageDS.ReadFcn = @readImagesIntoDatastore;
validationImageDS = imageDatastore(validationImageList, 'labelSource', 'foldernames', ...
    'FileExtensions', {'.jpg'});
validationImageDS.ReadFcn = @readImagesIntoDatastore;
testImageDS = imageDatastore(testImageList, 'labelSource', 'foldernames', ...
    'FileExtensions', {'.jpg'});
```

```
testImageDS.ReadFcn = @readImagesIntoDatastore;
countEachLabel(trainingImageDS)
countEachLabel(validationImageDS)
countEachLabel(testImageDS)
```

```
% target_size = [100, 100];
% target_size = [224, 224];
target_size = [227, 227];

% resizing using transform operation
training_image_datastore_resized = transform(trainingImageDS, @(image_i) imresize(image_i, target_size)
validation_image_datastore_resized = transform(validationImageDS, @(image_i) imresize(image_i, test_image_datastore_resized = transform(testImageDS, @(image_i) imresize(image_i, target_size)

% Combine transformed datastores and labels
training_labels = arrayDatastore(trainingImageDS.Labels);
training_combined_datastore = combine(training_image_datastore_resized, training_labels);
validation_labels = arrayDatastore(validationImageDS.Labels);
validation_combined_datastore = combine(validation_image_datastore_resized, validation_labels)
test_labels = arrayDatastore(testImageDS.Labels);
test_labels = arrayDatastore(testImageDS.Labels);
test_combined_datastore = combine(test_image_datastore_resized, test_labels);
```

```
% alex net
net = alexnet;
analyzeNetwork(net);
disp(net.Layers(1).InputSize);
```

227 227 3

```
% replace last 3 layers
fullnetwork = [
   net.Layers(1:end-3)
   fullyConnectedLayer(20)
   softmaxLayer
   classificationLayer];
```

```
if (gpuDeviceCount() > 0)
    disp('Found GPU:');
    disp(gpuDeviceTable);
    gpu_device = gpuDevice(1);
    reset(gpu_device); % Clear previous values that might still be on the GPU
```

end

```
Found GPU:

Index Name ComputeCapability DeviceAvailable DeviceSelected

1 "GRID T4-8Q" "7.5" true true
```

```
% learning_rate = 0.01;
learning_rate = 0.001;
% learning_rate = 0.0001;
% batch_size = 8;
batch_size = 16;
% batch_size = 32;
% epochs = 5;
epochs = 10;
% epochs = 20;
options = trainingOptions('sgdm', ...
        'InitialLearnRate', learning_rate, ...
        'MiniBatchSize', batch_size, ...
        'MaxEpochs', epochs, ...
        'Verbose', true, ...
        'Shuffle', 'every-epoch', ...
        'VerboseFrequency', 1, ...
        'ValidationData', validation_combined_datastore, ...
        'Plots', 'training-progress');
myCNN = trainNetwork(training_combined_datastore, fullnetwork, options);
```

Training on single GPU. Initializing input data normalization.

- 1	========	==========						==========
j	Epoch	Iteration	Time Elapsed	Mini-batch	Validation	Mini-batch	Validation	Base Learni
	I	I	(hh:mm:ss)	Accuracy	Accuracy	Loss	Loss	Rate
	=======	=========					=========	=========
	1	1	00:00:15	6.25%	4.50%	7.3396	4.3582	0.00
	1	2	00:00:17	6.25%		6.9450		0.00
	1	3	00:00:17	12.50%		4.9394		0.00
	1	4	00:00:18	0.00%		4.3873		0.00
	1	5	00:00:19	12.50%		3.5754		0.00
	1	6	00:00:19	6.25%		4.2893		0.00
	1	7	00:00:20	0.00%		4.4383		0.00
	1	8	00:00:20	0.00%		4.0233		0.00
	1	9	00:00:21	18.75%		2.7982		0.00
ĺ	1	10	00:00:22	18.75%		3.3752	ĺ	0.00
	1	11	00:00:22	6.25%		3.2727		0.00
	1	12	00:00:23	18.75%		3.2662		0.00
	1	13	00:00:24	31.25%		2.4300		0.00
İ	1	14	00:00:24	18.75%		2.9432		0.00
j	1	15	00:00:25	6.25%		2.9381	İ	0.00
j	1	16	00:00:25	6.25%		2.9450	İ	0.00

1 4	1 4-	1 00.00.00	C 0=0/ I		2 6420 1	ı
1	17	00:00:26	6.25%		3.6129	ļ
1	18	00:00:27	0.00%		2.9674	
1	19	00:00:28	12.50%		3.1299	
	20	00:00:28	12.50%		2.9686	!
1	21	00:00:29	12.50%		3.0667	ļ
1	22	00:00:30	18.75%		2.7699	!
1	23	00:00:31	0.00%		3.4351	ļ
1	24	00:00:31	25.00%		2.9671	ļ ļ
1	25	00:00:32	12.50%		2.8399	ļ
1	26	00:00:33	18.75%		2.5103	
1	27	00:00:34	6.25%		2.9434	Į.
1	28	00:00:34	18.75%		2.6216	
1	29	00:00:35	12.50%		2.6468	
1	30	00:00:36	18.75%		2.7181	l
1	31	00:00:37	6.25%		3.0246	1
1	32	00:00:37	18.75%		2.3711	l
1	33	00:00:38	18.75%		2.6979	
1	34	00:00:39	12.50%		2.6536	
1	35	00:00:39	25.00%		2.6850	
1	36	00:00:40	31.25%		2.5256	I
1	37	00:00:41	25.00%		2.8786	
1	38	00:00:42	31.25%	I	2.3215	
1	39	00:00:42	31.25%		2.6148	
1	40	00:00:43	25.00%		2.4112	
1	41	00:00:43	18.75%		2.9439	1
2	42	00:00:44	12.50%		2.5545	j
2	43	00:00:45	25.00%		2.4002	
2	44	00:00:45	37.50%		2.4445	
2	45	00:00:46	25.00%	İ	2.1846	j
2	46	00:00:47	6.25%	İ	3.2476	j
2	47	00:00:47	18.75%		2.5808	Ì
2	48	00:00:48	37.50%	İ	2.2749	j
2	49	00:00:48	25.00%	ĺ	2.3665	ĺ
2	50	00:00:56	43.75%	27.03%	1.9142	2.3476
2	51	00:00:57	25.00%	ĺ	2.2765	ĺ
j 2	52	00:00:58	37.50%	İ	2.4006	j
2	53	00:00:58	6.25%		2.5978	1
2	54	00:00:59	6.25%		2.4859	
2	55	00:01:00	31.25%		2.2830	1
2	56	00:01:00	43.75%	İ	1.7461	j
2	57	00:01:01	31.25%		2.0384	
2	58	00:01:01	25.00%		2.1611	1
2	59	00:01:02	37.50%	I	2.0167	
2	60	00:01:03	50.00%	ĺ	2.0076	
2	61	00:01:03	43.75%	I	2.2200	
2	62	00:01:04	18.75%		2.3680	
2	63	00:01:05	56.25%		1.2604	
2	64	00:01:05	43.75%	I	1.7044	
2	65	00:01:06	43.75%	I	1.9129	
2	66	00:01:07	31.25%		2.0499	I
2	67	00:01:07	37.50%		2.2922	
2	68	00:01:08	31.25%		2.1615	I
2	69	00:01:09	43.75%		1.9634	I
2	70	00:01:09	43.75%		2.0550	
2	71	00:01:10	50.00%	ĺ	1.7028	
j 2	72	00:01:11	50.00%	İ	1.6336	į
2	73	00:01:11	50.00%	ĺ	1.2396	
2	74	00:01:12	31.25%	İ	1.8780	j
j 2	75	00:01:13	37.50%	į	1.6421	j
j 2	76	00:01:13	43.75%	į	1.4895	j
j 2	77	00:01:14	43.75%	i	2.1408	j
j 2	78	00:01:14	37.50%	i	2.0596	j
j 2	79	00:01:15	37.50%	i	1.8422	j
j 2	80		37.50%	i	1.7108	į
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2	81	00:01:16	37.50%	I	1.7553	
j 2 j	82	00:01:16	50.00%	i	1.6810	i
3	83	00:01:18	56.25%	i	1.1936	i
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3	84	00:01:18	75.00%	ļ	!	ļ
3	85	00:01:19	43.75%	ļ	1.5679	!
3	86	00:01:19	43.75%		2.0903	ļ.
3	87	00:01:20	56.25%		1.4398	l
3	88	00:01:20	56.25%		1.8109	I
3	89	00:01:21	43.75%	İ	1.5263	İ
3	90	00:01:21	25.00%	i	2.1300	İ
3	91	00:01:22	56.25%	i	1.2412	i
3	92	00:01:23	56.25%	i	1.7399	i
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3	93	00:01:24	31.25%	ļ	1.9659	!
3	94	00:01:24	37.50%	ļ	1.8281	!
] 3	95	00:01:25	56.25%	ļ	1.1386	ļ .
3	96	00:01:26	75.00%		0.9719	l
3	97	00:01:26	43.75%		1.2897	1
3	98	00:01:27	43.75%		1.5033	1
3	99	00:01:28	50.00%	i	1.5255	İ
3	100	00:01:37	68.75%	52.25%	1.2351	1.4623
3	101	00:01:37	37.50%	JZ•ZJ/0	1.8055	1.7023
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3	102	00:01:38	37.50%	ļ	1.7111	ļ
3	103	00:01:39	75.00%		0.9294	ļ
3	104	00:01:39	56.25%	I	1.0385	
3	105	00:01:40	56.25%		1.1292	l
3	106	00:01:41	68.75%		1.1804	I
3	107	00:01:41	75.00%		0.8348	1
3	108	00:01:42	75.00%	i	0.9566	İ
3	109	00:01:42	56.25%	i	1.1739	i
3	110	00:01:42	50.00%	!	1.4377	i
		!!	:	· ·	:	ł
3	111	00:01:44	75.00%		0.7455	ļ
3	112	00:01:44	62.50%	ļ	1.4833	!
3	113	00:01:45	50.00%		1.6934	l
3	114	00:01:45	31.25%		2.3558	l
3	115	00:01:46	50.00%		1.8215	I
3	116	00:01:46	50.00%	İ	1.2591	İ
3	117	00:01:47	68.75%	İ	1.1837	İ
j 3 j	118	00:01:47	87.50%	i	0.5861	i
3	119	00:01:48	56.25%	i	1.1680	i
	120	00:01:40	43.75%	· ·	1.8538	i
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3	121	00:01:49	56.25%	ļ	1.2622	!
3	122	00:01:50	62.50%	ļ	1.0853	
3	123	00:01:50	50.00%	I	1.4173	
4	124	00:01:51	87.50%		0.6856	
4	125	00:01:52	50.00%		1.5647	
4	126	00:01:52	75.00%	İ	0.8761	
j 4 j	127	00:01:53	87.50%	į	0.6659	j
4	128	00:01:53	87.50%	i	0.6514	j
4	129	00:01:54	81.25%	i i	0.4947	
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4	130	00:01:54	68.75%	ļ	0.8742	
4	131	00:01:55	75.00%	!	0.6360	ļ
4	132	00:01:55	68.75%	ļ	0.8395	!
4	133	00:01:56	87.50%		0.4062	
4	134	00:01:56	62.50%	I	0.8811	
4	135	00:01:57	68.75%	j	0.8989	j
j 4 j	136	00:01:57	93.75%	į	0.3176	j
4	137	00:01:58	75.00%	i	0.8771	İ
4	138	00:01:58	56.25%	ļ	1.0679	
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4	139	00:01:59	68.75%	ļ	0.7884	ļ
4	140	00:01:59	81.25%	ļ	0.7602	ļ
4	141	00:02:00	68.75%		1.1319	
4	142	00:02:01	68.75%		0.5447	
4	143	00:02:01	81.25%		0.5872	
j 4 j	144	00:02:02	62.50%	į	1.0691	j
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	4	145	00:02:02	68.75%		0.9861	
	4	146	00:02:03	81.25%		0.7454	
	4	147	00:02:04	81.25%	1	0.6363	
i	4	148	00:02:04	68.75%	į	1.0188	į
i	4	149	00:02:05	93.75%	i	0.5149	i
i	4	150	00:02:13	62.50%	59.91%	1.3723	1.2077
ŀ	4	151	00:02:13	68.75%	JJ.J±/0	1.1993	1.20//
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-	4	152	00:02:14	75.00%	ļ	1.0551	ļ
ļ	4	153	00:02:15	81.25%	!	0.5473	
ļ	4	154	00:02:15	56.25%	ļ	1.2792	ļ
	4	155	00:02:16	62.50%	ļ	1.2312	ļ
	4	156	00:02:17	62.50%		0.8669	
	4	157	00:02:18	68.75%		0.8918	
	4	158	00:02:18	68.75%		1.2533	
İ	4 İ	159 İ	00:02:19	75.00%	į	0.7894	İ
i	4	160	00:02:20	68.75%	į	1.0639	į
i	4	161	00:02:21	87.50%	i	0.4500	i
i	4	162	00:02:22	75.00%	i	0.7475	i
ŀ	:	163	00:02:22	75.00%	<u> </u>	0.6459	l I
- !	4	· ·			ļ		ļ
ļ	4	164	00:02:22	56.25%	ļ	1.4605	ļ
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ļ	5	166	00:02:25	93.75%		0.1574	ļ
-	5	167	00:02:26	81.25%		0.6617	
	5	168	00:02:27	81.25%		0.4252	
	5	169	00:02:27	81.25%		0.5766	
	5	170	00:02:28	87.50%		0.3479	
ĺ	5	171	00:02:29	81.25%	İ	0.3278	İ
i	5	172	00:02:30	87.50%	į	0.4555	į
i	5	173	00:02:31	93.75%	i	0.2906	i
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ŀ	5	175	00:02:32	87.50%	i i	0.3614	i i
ŀ	5	176	00:02:33	81.25%	<u> </u>	0.4835	-
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- !	5	177	00:02:34	68.75%	ļ	0.6912	ļ
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ļ	5	179	00:02:35	87.50%	ļ	0.6538	ļ
	5	180	00:02:36	75.00%	ļ	0.7205	ļ
	5	181	00:02:37	87.50%		0.3781	
	5	182	00:02:37	87.50%		0.4147	
	5	183	00:02:38	87.50%		0.2869	
- 1	5	184	00:02:39	87.50%	1	0.5038	
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ij	5	187	00:02:41	93.75%	İ	0.1958	i
i	5	188	00:02:42	93.75%	i	0.2858	
-	5	189	00:02:42	93.75%	i i	0.3220	
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-	5	191	00:02:45	81.25%	ļ	0.4108	
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- 1	5	195	00:02:48	93.75%		0.1383	
	5	196	00:02:49	93.75%		0.3773	
	5	197	00:02:49	93.75%		0.2097	
j	5	198	00:02:50	93.75%	j	0.2217	j
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7 257 00:03:46 93.75% 0.1364 7 258 00:03:46 93.75% 0.1154 7 259 00:03:47 87.50% 0.3162 7 260 00:03:48 87.50% 0.3132 7 261 00:03:48 100.00% 0.0707 7 262 00:03:49 93.75% 0.2844 7 263 00:03:49 100.00% 0.1162 7 264 00:03:50 81.25% 0.3186	ĺ	! 		i				
7 258 00:03:46 93.75% 0.1154 7 259 00:03:47 87.50% 0.3162 7 260 00:03:48 87.50% 0.3132 7 261 00:03:48 100.00% 0.0707 7 262 00:03:49 93.75% 0.2844 7 263 00:03:49 100.00% 0.1162 7 264 00:03:50 81.25% 0.3186	i i	1 						
7 259 00:03:47 87.50% 0.3162 7 260 00:03:48 87.50% 0.3132 7 261 00:03:48 100.00% 0.0707 7 262 00:03:49 93.75% 0.2844 7 263 00:03:49 100.00% 0.1162 7 264 00:03:50 81.25% 0.3186	l I	[
7 260 00:03:48 87.50% 0.3132 7 261 00:03:48 100.00% 0.0707 7 262 00:03:49 93.75% 0.2844 7 263 00:03:49 100.00% 0.1162 7 264 00:03:50 81.25% 0.3186	[
7 261 00:03:48 100.00% 0.0707 7 262 00:03:49 93.75% 0.2844 7 263 00:03:49 100.00% 0.1162 7 264 00:03:50 81.25% 0.3186	ļ	!						
7 262 00:03:49 93.75% 0.2844 7 263 00:03:49 100.00% 0.1162 7 264 00:03:50 81.25% 0.3186	ļ	!						
7 263 00:03:49 100.00% 0.1162 7 264 00:03:50 81.25% 0.3186		ĺ	0.0707		100.00%	00:03:48	261	7
7 263 00:03:49 100.00% 0.1162 7 264 00:03:50 81.25% 0.3186		1	0.2844		93.75%	00:03:49	262	7
7 264 00:03:50 81.25% 0.3186	į	ĺ	0.1162		100.00%	00:03:49	263	7
	į	İ		i				:
7 265 00:03:51 100.00% 0.0683	i	İ	0.0683	i	100.00%	00:03:51	265	7
7 266 00:03:52 87.50% 0.4150		1 						
	i i	1 						
7 267 00:03:52 100.00% 0.0685	ļ	 						
7 268 00:03:53 81.25% 0.4179	- [!	:
7 269 00:03:53 81.25% 0.3673	ļ.	!						
7 270 00:03:54 100.00% 0.0152	ļ	!						
7 271 00:03:55 100.00% 0.0202	1				•			
7 272 00:03:55 93.75% 0.1095		1	0.1095		93.75%	00:03:55	272	7

0.00 0.00 0.00 0.00

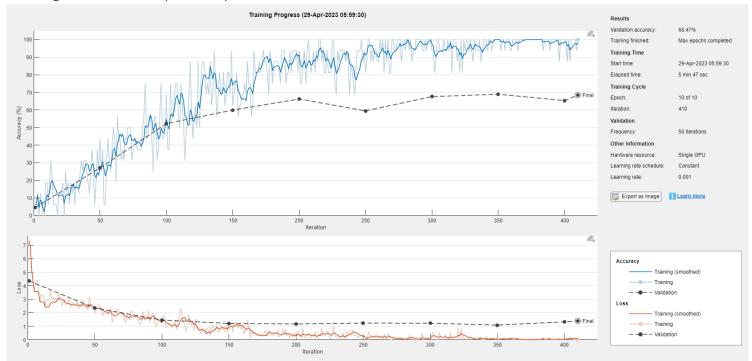
7	273	00:03:56	93.75%		0.1744	
j 7 j	274	00:03:57	100.00%	j	0.0975	j
j 7 j	275	00:03:57	100.00%	j	0.0376	j
j 7 j	276	00:03:58	100.00%	i	0.0729	i
7	277	00:03:59	87.50%	i	0.1924	i
7	278	00:03:59	93.75%	i	0.1656	i
7 7	279	00:04:00	100.00%	i	0.0380	i
7	280	00:04:01	93.75%	ł	0.1004	i
7 7	281	00:04:01	100.00%		0.0154	
7 7	282	00:04:01	100.00%		0.0878	l I
7 7	283	00:04:03	:		0.1461	ŀ
			93.75% 100.00%	ļ	:	l I
7	284	00:04:03	!		0.1234	ļ
7	285	00:04:04	87.50%		0.3379	ļ
7	286	00:04:04	93.75%		0.0925	ļ
7	287	00:04:04	93.75%		0.1610	ļ
8	288	00:04:06	100.00%		0.0134	ļ
8	289	00:04:07	100.00%	ļ	0.0615	į.
8	290	00:04:07	100.00%	ļ	0.0013	ļ
8	291	00:04:08	100.00%		0.0074	
8	292	00:04:08	100.00%		0.0261	
8	293	00:04:08	93.75%		0.1475	
8	294	00:04:09	93.75%		0.4637	
8	295	00:04:10	100.00%		0.0101	
8	296	00:04:10	93.75%	j	0.1428	j
8	297	00:04:11	100.00%	j	0.0588	j
j 8 j	298	00:04:11	100.00%	j	0.0848	j
8	299	00:04:12	100.00%	i	0.0896	į
8	300 İ	00:04:19	93.75%	67.57%	0.1719	1.2248
8	301	00:04:20	93.75%	i	0.3290	i
8	302	00:04:20	81.25%	i	0.5571	i
8	303	00:04:21	87.50%	i	0.2277	i
8	304	00:04:22	100.00%	i	0.0458	i
8	305	00:04:22	100.00%	i	0.0227	i
8	306	00:04:23	93.75%	i	0.0561	i
8	307	00:04:23	93.75%	i	0.5452	i i
8	308	00:04:24	93.75%	ł	0.1154	i
8	309	00:04:25	100.00%	i	0.0165	i
8	310	00:04:26	93.75%		0.1681	i
8	311	00:04:26	93.75%		0.3782	i
8	312	00:04:27	100.00%		0.1161	
8	313	00:04:28	93.75%		0.1552	-
	!	!	!		:	l I
8	314	00:04:28	100.00%		0.0358	
8	315	00:04:29	81.25% 100.00%	l I	0.5450	
8	316	00:04:30			0.0420	
8	317	00:04:30	100.00%	l I	0.0750	
8	318	00:04:31	100.00%		0.2056	
8	319	00:04:32	87.50%	ļ	0.2339	
8	320	00:04:33	93.75%	ļ	0.2119	ļ
8	321	00:04:33	81.25%	ļ	0.8752	ļ
8	322	00:04:34	100.00%	ļ	0.0264	
8	323	00:04:35	81.25%	ļ	0.8193	ļ
8	324	00:04:35	100.00%	ļ	0.0822	ļ
8	325	00:04:36	93.75%	ļ	0.1921	ļ
8	326	00:04:36	100.00%	ļ	0.0844	ļ
8	327	00:04:37	100.00%	ļ	0.0151	ļ
8	328	00:04:37	93.75%		0.1101	
9	329	00:04:39	100.00%		0.1017	
9	330	00:04:39	93.75%		0.2090	
9	331	00:04:40	87.50%		0.1642	
9	332	00:04:40	100.00%	ĺ	0.0742	
9	333	00:04:41	93.75%	j	0.1922	j
9	334	00:04:42	93.75%	ĺ	0.0800	j
9	335	00:04:42	93.75%	j	0.1666	j
9	336	00:04:43	100.00%	j	0.0695	j
- 1	1		1	ı		'

	9	337	00:04:43	87.50%	l I	0.2148		
	9	338	00:04:44	93.75%		0.0675		
	9	339	00:04:45	100.00%		0.0128		
ļ	9	340	00:04:45	100.00%	ļ	0.0038		
ļ	9	341	00:04:46	100.00%		0.0366		
ļ	9	342	00:04:46	93.75%	ļ	0.2350		
ļ	9	343	00:04:47	100.00%		0.0241		
ļ	9	344	00:04:48	100.00%		0.0769		
ļ	9	345	00:04:48	93.75%		0.1003		ļ
-	9	346	00:04:49	100.00%		0.0766		
- !	9	347	00:04:49	100.00%	ļ	0.0958		
-	9	348	00:04:50	100.00%		0.0193		
-	9	349	00:04:51	100.00%	 	0.0687	1 0015	
ł	9	350 351	00:04:58 00:04:59	100.00% 100.00%	68.92%	0.0216 0.0147	1.0845	l I
ł	9 9	351	00:04:59	93.75%		0.0673		l I
H	9	l 353	00:05:00	100.00%		0.0337		!
H	9	354	00:05:00	100.00%		0.0974		!
i	9	355	00:05:01	93.75%	 	0.1644		!
i	9	356	00:05:01	100.00%	 	0.0338		!
-	9	357	00:05:03	100.00%		0.0849		İ
i	9	358	00:05:04	100.00%	i	0.0262	i	
i	9	359	00:05:04	93.75%	i	0.1415	i	İ
i	9	360	00:05:05	93.75%	i	0.1035		İ
i	9	361	00:05:06	100.00%	i	0.0486		İ
i	9	362	00:05:06	100.00%	İ	0.0198		İ
i	9	363	00:05:07	100.00%	İ	0.0329	İ	İ
i	9	364	00:05:08	100.00%	İ	0.0509	İ	İ
j	9	365	00:05:08	93.75%	İ	0.1351	İ	ĺ
	9	366	00:05:09	100.00%		0.0017		
	9	367	00:05:10	100.00%		0.0446		
	9	368	00:05:10	100.00%		0.0263		
	9	369	00:05:10	100.00%		0.0122		
ļ	10	370	00:05:12	100.00%		0.0060		
ļ	10	371	00:05:12	100.00%		0.0292		
ļ	10	372	00:05:13	100.00%		0.0251		<u> </u>
ļ	10	373	00:05:13	100.00%		0.0102		ļ
ļ	10	374	00:05:14	100.00%		0.0036		ļ
- !	10	375	00:05:15	100.00%	ļ	0.0465		
-	10	376	00:05:15	100.00%		0.0013		
-	10	377	00:05:16	100.00%		0.0201		
-	10	378 379	00:05:16	100.00%	 	0.0141		
-	10		00:05:17	100.00%	 	0.0415		
- [10 10	380 381	00:05:17 00:05:18	100.00% 100.00%		0.0385 0.0069		I I
-	10	382	00:05:18	100.00%		0.0385		!
l	10	383	00:05:10	100.00%		0.0663		
i	10	384	00:05:20	93.75%	i	0.1512	i	İ
i	10	385	00:05:20	100.00%	i	0.0065	i	İ
i	10	386	00:05:21	100.00%	İ	0.0103	İ	İ
j	10	387	00:05:21	100.00%	j	0.0344	j	İ
į	10	388	00:05:22	100.00%	i	0.0327	l i	
ĺ	10	389	00:05:23	93.75%	İ	0.1387	l İ	
İ	10	390	00:05:23	100.00%	İ	0.0072	l İ	
	10	391	00:05:24	100.00%	I	0.0118		
	10	392	00:05:25	100.00%	ļ l	0.0101		
- [10	393	00:05:25	100.00%	ļ l	0.0231		
ļ	10	394	00:05:26	100.00%	ļ	0.0307		
ļ	10	395	00:05:27	100.00%	ļ	0.0052		<u> </u>
ļ	10	396	00:05:27	87.50%		0.1200		
	10	397	00:05:28	100.00%		0.0206		l
ļ	10	398	00:05:29	100.00%		0.0095		l
- [10	399	00:05:29	100.00%	 	0.0329	4 200=	 -
I	10	400	00:05:36	100.00%	65.32%	0.0526	1.3297	l

0.00 0.00 0.00 0.00 0.00

10 10	405 406	00:05:39 00:05:39	100.00% 100.00%		0.0911 0.0586		0.00 0.00
10 10	407 408	00:05:40 00:05:40	100.00%	ĺ	0.0053 0.0216	İ	0.00 0.00
10	409	00:05:41	93.75%	i	0.1471	i	0.00
10	410	00:05:44	100.00%	68.47%	0.0064	1.3925	0.0

Training finished: Max epochs completed.

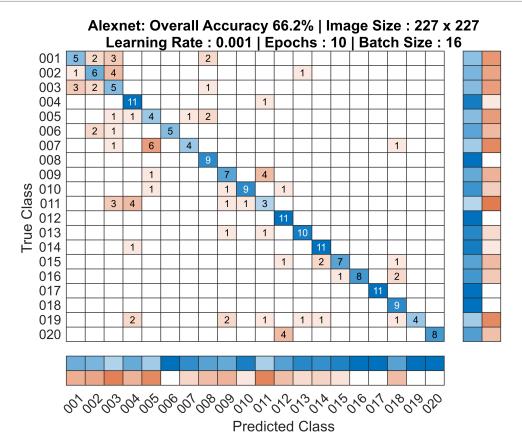


```
target_predictions = classify(myCNN, test_image_datastore_resized);
target_test = testImageDS.Labels;

% Calculate overall accuracy
overall_accuracy = sum(target_predictions == target_test)/numel(target_test) % Output on command
```

overall_accuracy = 0.6622

```
% Show confusion matrix in figure
[matrix, order] = confusionmat(target_test, target_predictions);
figure(2);
confusion_matrix = confusionchart(matrix, order, ...
    'ColumnSummary','column-normalized', ...
    'RowSummary','row-normalized');
title({"Alexnet: Overall Accuracy " + string(round(overall_accuracy*100, 1)) + "%" + ...
    " | Image Size : " + target_size(1) + " x " + target_size(1); ...
```



```
class_wise_correct_recognition_rates = zeros(height(order), 1);
samples_per_row = sum(matrix, 2);
for i = 1:height(order)
    class_wise_correct_recognition_rates(i) = round(100 * matrix(i, i) / samples_per_row(i), 1
end
class_name_labels = table2array(classNames(:,2));
class_wise_recognition_rates = table(class_name_labels, ...
    class_wise_correct_recognition_rates, ...
    'VariableNames',["Class Name", "Correct Recognition Rate (%)"]);
disp("Class Weighted Average Overall Accuracy is " + string(round(overall_accuracy*100, 2)) + '
```

Class Weighted Average Overall Accuracy is 66.22%

```
disp(class wise recognition rates);
```

Class Name	Correct Recognition Rate (%)		
	_		
{'001.Black_footed_Albatross'	}	41.7	
{'002.Laysan_Albatross'	}	50	
{'003.Sooty_Albatross'	}	45.5	
{'004.Groove_billed_Ani'	}	91.7	
{'005.Crested_Auklet'	}	44.4	
{'006.Least_Auklet'	}	62.5	

<pre>{'007.Parakeet_Auklet' {'008.Rhinoceros_Auklet' {'009.Brewer_Blackbird' {'010.Red_winged_Blackbird' {'011.Rusty Blackbird'</pre>	<pre>} } } }</pre>	33.3 100 58.3 75 25
{'012.Yellow_headed_Blackbird' {'013.Bobolink' {'014.Indigo_Bunting'	} } }	100 83.3 91.7
<pre>{'015.Lazuli_Bunting' {'016.Painted_Bunting' {'017.Cardinal' {'018.Spotted_Catbird' {'019.Gray_Catbird' {'020.Yellow_breasted_Chat'</pre>	} } } } }	63.6 72.7 100 100 33.3 66.7