Neural-Network 4

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```
clear
clc
```

Exercise-1

导入预训练好的 AlexNet,并确定该网络输入图像的大小以及分类种类的名称

```
net = alexnet;                                  % 将 Alexnet 导入工作区
% analyzeNetwork(net)
inputSize = net.Layers(1).InputSize;            % 获取 Alexnet 输入层中输入图像的大小
classNames = net.Layers(end).ClassNames;        % 获取 Alexnet 输出层中的分类
```

读入两幅 MATLAB 自带的 RGB 图像，并将图像的大小变换成与 Alexnet 输入层中输入图像相同的大小

```
I = imread('car_2.jpg');
figure
imshow(I)
```

```
I = imresize(I,inputSize(1:2));

J= imread('kobi.png');
figure
imshow(J)
```

```
J = imresize(J,inputSize(1:2));
```

基于 Alexnet 对两幅输入的图像进行分类

```
[label1,scores1] = classify(net,I);
[label2,scores2] = classify(net,J);
```

在图像上显示分类结果及概率

```
figure
imshow(I)
title(string(label1) + ", " + num2str(100*scores1(classNames == label1),3) + "%");
```


```
figure
imshow(J)
title(string(label2) + ", " + num2str(100*scores1(classNames == label2),3) + "%");
```

Exercise-2

导入预训练好的 GoogleNet,并确定该网络输入图像的大小以及分类种类的名称

```
net = googlenet;                                    % 将 GoogleNet 导入工作区
% analyzeNetwork(net)
inputSize = net.Layers(1).InputSize;                % 获取 GoogleNet 输入层中输入图像的大
小
classNames = net.Layers(end).ClassNames;            % 获取 GoogleNet 输出层中的分类
```

读入两幅 RGB 图像，并将图像的大小变换成与 GoogleNet 输入层中输入图像相同的大小

```
I = imread('./images/deer.jpg');
figure
imshow(I)
```

```
I = imresize(I,inputSize(1:2));
```

```
J= imread('./images/horse.jpg');
figure
imshow(J)
```

```
J = imresize(J,inputSize(1:2));
```

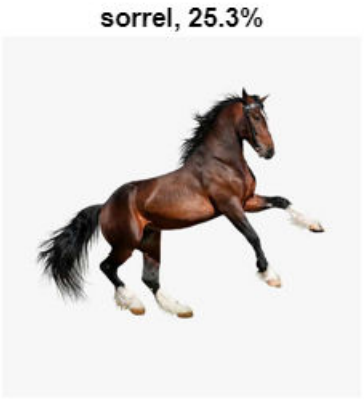
基于 GoogleNet 对两幅输入的图像进行分类

```
[label1,scores1] = classify(net,I);
[label2,scores2] = classify(net,J);
```

在图像上显示分类结果及概率

```
figure
imshow(I)
title(string(label1) + ", " + num2str(100*scores1(classNames == label1),3) + "%");
```

```
figure
imshow(J)
title(string(label2) + ", " + num2str(100*scores2(classNames == label2),3) + "%");
```



Comparison

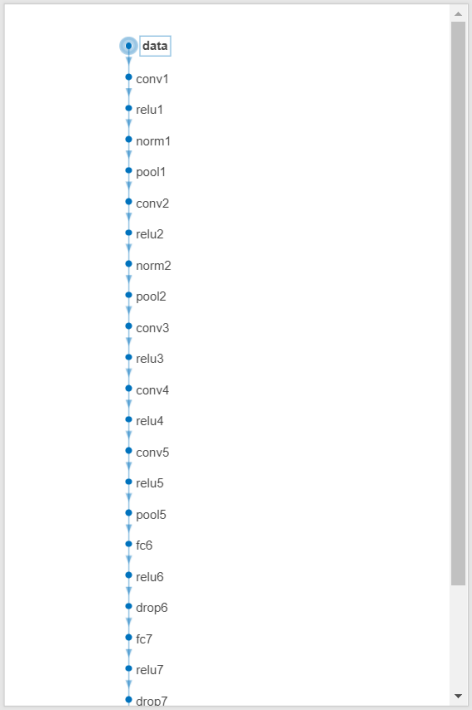
Deep Learning Network Analyzer

Analysis for trainNetwork usage

Name: net

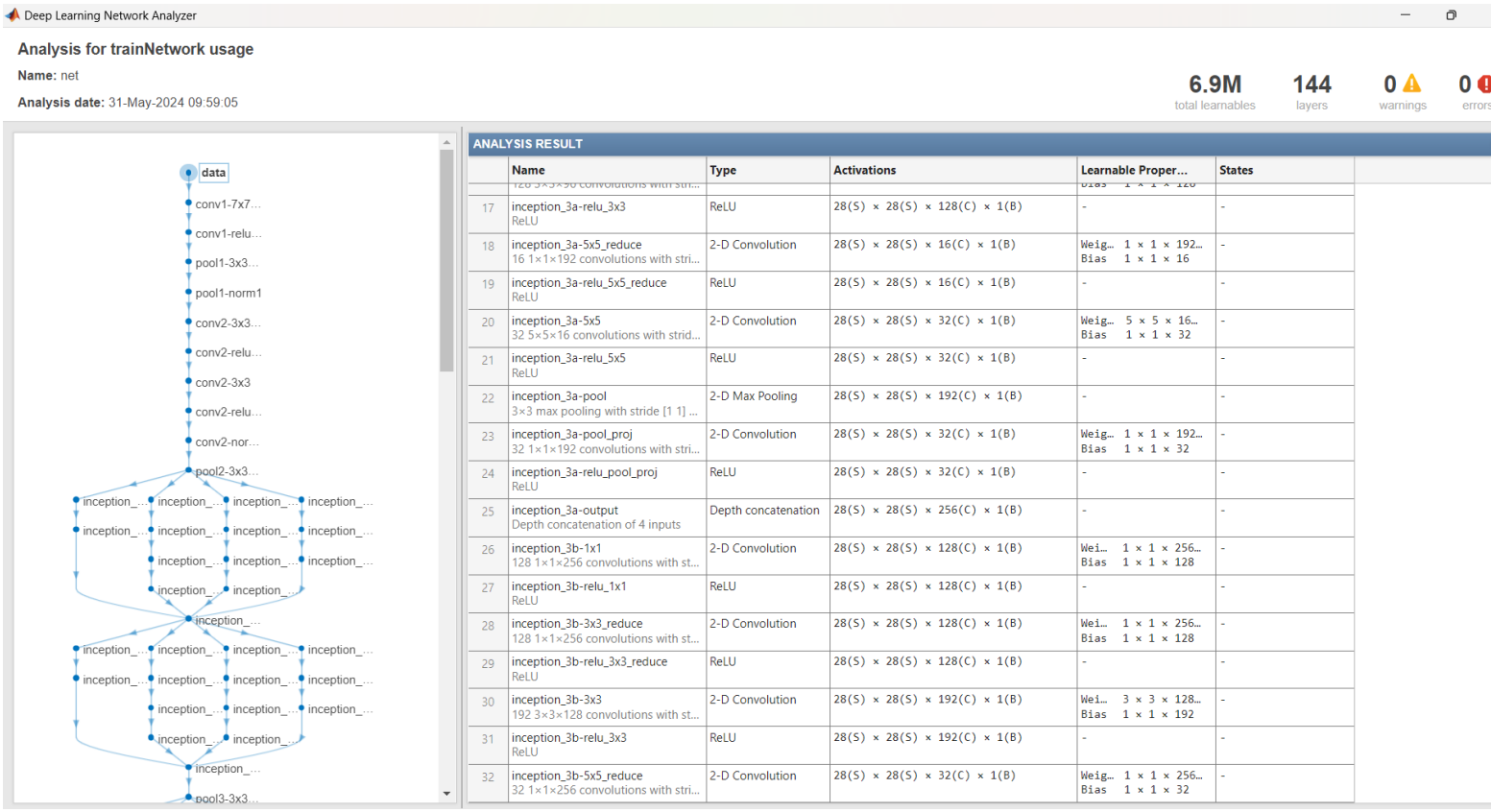
Analysis date: 31-May-2024 09:58:28

60.9M total learnables | 25 layers | 0 warnings | 0 errors



ANALYSIS RESULT

	Name	Type	Activations	Learnable Proper...	States
1	data 227×227×3 images with 'zerocent...	Image Input	227(S) × 227(S) × 3(C) × 1(B)	-	-
2	conv1 96 11×11×3 convolutions with stri...	2-D Convolution	55(S) × 55(S) × 96(C) × 1(B)	Weig... 11 × 11 × 3... Bias 1 × 1 × 96	-
3	relu1 ReLU	ReLU	55(S) × 55(S) × 96(C) × 1(B)	-	-
4	norm1 cross channel normalization with 5...	Cross Channel Norm...	55(S) × 55(S) × 96(C) × 1(B)	-	-
5	pool1 3×3 max pooling with stride [2 2] ...	2-D Max Pooling	27(S) × 27(S) × 96(C) × 1(B)	-	-
6	conv2 2 groups of 128 5×5×48 convoluti...	2-D Grouped Convo...	27(S) × 27(S) × 256(C) × 1(B)	Wei... 5 × 5 × 48 ... Bias 1 × 1 × 128...	-
7	relu2 ReLU	ReLU	27(S) × 27(S) × 256(C) × 1(B)	-	-
8	norm2 cross channel normalization with 5...	Cross Channel Norm...	27(S) × 27(S) × 256(C) × 1(B)	-	-
9	pool2 3×3 max pooling with stride [2 2] ...	2-D Max Pooling	13(S) × 13(S) × 256(C) × 1(B)	-	-
10	conv3 384 3×3×256 convolutions with st...	2-D Convolution	13(S) × 13(S) × 384(C) × 1(B)	Wei... 3 × 3 × 256... Bias 1 × 1 × 384	-
11	relu3 ReLU	ReLU	13(S) × 13(S) × 384(C) × 1(B)	-	-
12	conv4 2 groups of 192 3×3×192 convolu...	2-D Grouped Convo...	13(S) × 13(S) × 384(C) × 1(B)	Wei... 3 × 3 × 192 ... Bias 1 × 1 × 192 ...	-
13	relu4 ReLU	ReLU	13(S) × 13(S) × 384(C) × 1(B)	-	-
14	conv5 2 groups of 128 3×3×192 convolu...	2-D Grouped Convo...	13(S) × 13(S) × 256(C) × 1(B)	Wei... 3 × 3 × 192 ... Bias 1 × 1 × 128 ...	-
15	relu5 ReLU	ReLU	13(S) × 13(S) × 256(C) × 1(B)	-	-
16	pool5 3×3 max pooling with stride [2 2] ...	2-D Max Pooling	6(S) × 6(S) × 256(C) × 1(B)	-	-
17	fc6	Fully Connected	1(S) × 1(S) × 4096(C) × 1(B)	Weigh... 4096 × 92...	-



Exercise-3

导入预训练好的 AlexNet,并确定该网络输入图像的大小以及分类种类的名称

```
net = googlenet;                                  % 将 Alexnet 导入工作区
inputSize = net.Layers(1).InputSize;              % 获取 Alexnet 输入层中输入图像的大小
classNames = net.Layers(end).ClassNames;          % 获取 Alexnet 输出层中的分类
```

读入 MATLAB 自带的 RGB 图像，改变图像大小并添加噪声

```
I = imread('peppers.png');
figure
imshow(I)
```

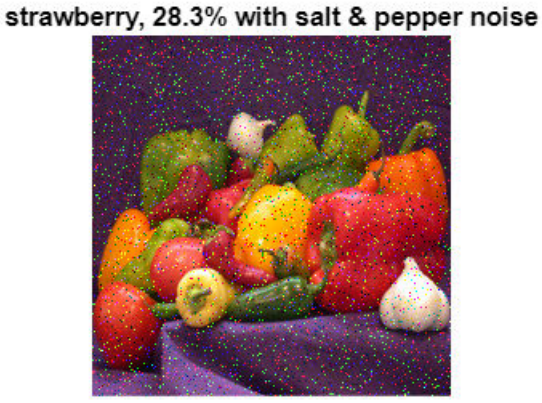
```
I = imresize(I,inputSize(1:2));
I1 = imnoise(I,'salt & pepper');    %添加椒盐噪声
I2 = imnoise(I, 'gaussian');
```

基于 Alexnet 对添加噪声后的图像进行分类

```
[label1,scores1] = classify(net,I1);
[label2,scores2] = classify(net,I2);
```

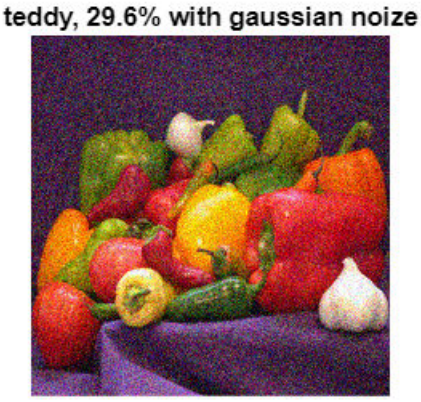
在图像上显示分类结果及概率

```
figure
imshow(I1)
title(string(label1) + ", " + num2str(100*scores1(classNames == label1),3) + "%
with salt & pepper noise");
```




```
figure
imshow(I2)
```

```
title(string(label2) + ", " + num2str(100*scores2(classNames == label2),3) + "%
with gaussian noize");
```



Exercise-4

```
fprintf('Demo of how to run the code for:\n');
```

```
Demo of how to run the code for:
```

```
fprintf('Generate Slective Seach boxes used in RCNN and Fast RCNN\n');
```

```
Generate Slective Seach boxes used in RCNN and Fast RCNN
```

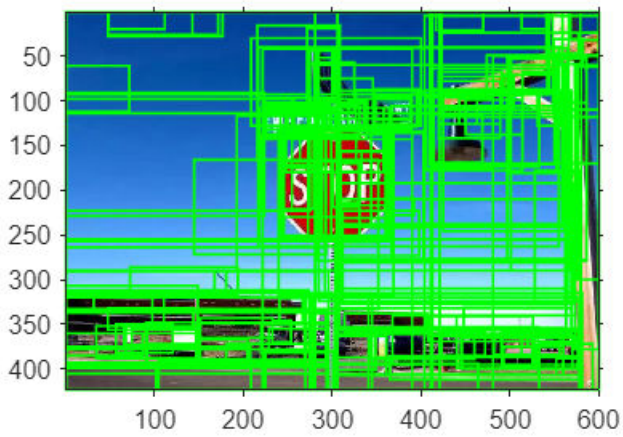
Complie dependencies

```
cd SelectiveSearchCodeIJCV

% Compile anisotropic gaussian filter
if(~exist('anigauss'))
    fprintf('Compiling the anisotropic gauss filtering of:\n');
    fprintf('   J. Geusebroek, A. Smeulders, and J. van de Weijer\n');
    fprintf('   Fast anisotropic gauss filtering\n');
    fprintf('   IEEE Transactions on Image Processing, 2003\n');
    fprintf('Source code/Project page:\n');
    fprintf('   http://staff.science.uva.nl/~mark/downloads.html#anigauss\n\n');
    mex Dependencies/anigaussm/anigauss_mex.c Dependencies/anigaussm/anigauss.c
-output anigauss
end

if(~exist('mexCountWordsIndex'))
    mex Dependencies/mexCountWordsIndex.cpp
end

% Compile the code of Felzenszwalb and Huttenlocher, IJCV 2004.
if(~exist('mexFelzenSegmentIndex'))
```

```
    fprintf('Compiling the segmentation algorithm of:\n');
    fprintf('   P. Felzenszwalb and D. Huttenlocher\n');
    fprintf('   Efficient Graph-Based Image Segmentation\n');
    fprintf('   International Journal of Computer Vision, 2004\n');
    fprintf('Source code/Project page:\n');
    fprintf('   http://www.cs.brown.edu/~pff/segment/\n');
    fprintf('Note: A small Matlab wrapper was made.\n');
    mex Dependencies/FelzenSegment/mexFelzenSegmentIndex.cpp -output
mexFelzenSegmentIndex;
end

cd ..
```

Generate Slective Seach boxes

```
addpath('./src/select_search/')
addpath(genpath('./SelectiveSearchCodeIJCV'));

fast_mode = true;
img = imread('./images/stoptest.jpg');

ss_boxes = selective_search_boxes(img, fast_mode);

% Draw boxes
imshow(img);
axis on;
hold on;
for n = 1: 10:length(ss_boxes)
    box = ss_boxes(n, :);
    % box co-ordinates: [ymin, xmin, ymax, xmax], 1-based index
    xmin = box(2);
    ymin = box(1);
    w = box(4) - box(2);
    h = box(3) - box(1);
    rectangle('Position', [xmin,ymin,w,h], 'EdgeColor','g','LineWidth',1)
end
```



Exercise-5

步骤 1：构建一个卷积神经网络

输入层（与训练集图像的大小相同）

```
% inputLayer = imageInputLayer([32 32 3]);
% % 卷积层
% filterSize = [5 5]; %卷积核大小
% numFilters = 32; %卷积核个数
% middleLayers = [
%     convolution2dLayer(filterSize, numFilters, 'Padding', 2)
%     batchNormalizationLayer
%     reluLayer()
%     maxPooling2dLayer(3, 'Stride', 2)
%     convolution2dLayer(filterSize, numFilters, 'Padding', 2)
%     batchNormalizationLayer
%     reluLayer()
%     maxPooling2dLayer(3, 'Stride',2)
%     convolution2dLayer(filterSize, 2 * numFilters, 'Padding', 2)
%     batchNormalizationLayer
%     reluLayer()
%     maxPooling2dLayer(3, 'Stride',2)
%     ];
% % 全连接层
% finalLayers = [
%     fullyConnectedLayer(64)
%     batchNormalizationLayer
%     reluLayer
%     fullyConnectedLayer(10)
%     softmaxLayer
%     classificationLayer
%     ];
% % 构建整个卷积神经网络
% layers = [
%     inputLayer
%     middleLayers
%     finalLayers
%     ];
```

步骤 2：采用 CIFAR-10 数据集，训练所构建的卷积神经网络；

导入 CIFAR-10 数据集，要求与步骤详见本书 4.7 节

```
% [trainingImages,trainingLabels,testImages,testLabels] =
helperCIFAR10Data.load('cifar10Data');
%
% % 显示其中的 100 幅
```

```
% figure
% thumbnails = trainingImages(:,:,:,1:100);
% montage(thumbnails)
%
% % 设置训练策略参数
% opts = trainingOptions('sgdm', ...
%     'Momentum', 0.9, ...
%     'InitialLearnRate', 0.001, ...
%     'LearnRateSchedule', 'piecewise', ...
%     'LearnRateDropFactor', 0.1, ...
%     'LearnRateDropPeriod', 8, ...
%     'MaxEpochs', 25, ...
%     'MiniBatchSize', 128, ...
%     'Verbose', true);
%
% % 训练网络，trainNetwork 函数的参数依次分别为：训练数据集，训练集标签，网络结构，训练策略。
% cifar10Net = trainNetwork(trainingImages, trainingLabels, layers, opts);
```

步骤 3：验证卷积神经网络的分类效果.

```
% YTest = classify(cifar10Net, testImages);
% % 计算正确率.
% accuracy = sum(YTest == testLabels)/numel(testLabels)
```

```
cifar10Net = load('./mat/cifar10Net.mat')
```

```
cifar10Net = struct with fields:
    cifar10Net: [1×1 SeriesNetwork]
```

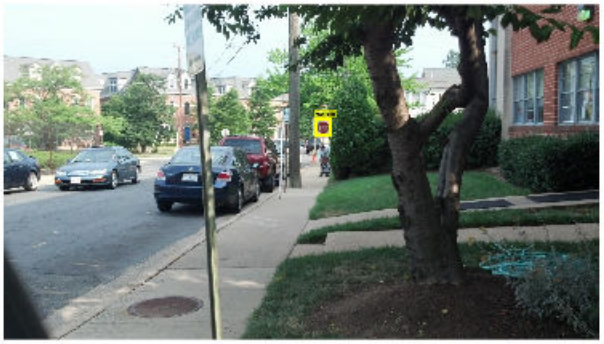
步骤 4：训练 RCNN 检测器

导入 41 张包括有“Stop sign”交通标志的图像

```
data = load('stopSignsAndCars.mat', 'stopSignsAndCars');
stopSignsAndCars = data.stopSignsAndCars;
% 设置图像路径参数
visiondata = fullfile(toolboxdir('vision'),'visiondata');
stopSignsAndCars.imageFilename = fullfile(visiondata,
stopSignsAndCars.imageFilename);
% 显示数据
summary(stopSignsAndCars)
```

```
Variables:

    imageFilename: 41×1 cell array of character vectors

    stopSign: 41×1 cell

    carRear: 41×1 cell

    carFront: 41×1 cell
```

```
% 只保留文件名及其所包含的“stop sign”区域
stopSigns = stopSignsAndCars(:, {'imageFilename','stopSign'});
% 显示一张照片及其所包含的真实“stop sign”区域
I = imread(stopSigns.imageFilename{1});
I = insertObjectAnnotation(I,'Rectangle',stopSigns.stopSign{1},'stop
sign','LineWidth',8);
figure
imshow(I)
```



```
% 设置训练策略
options = trainingOptions('sgdm', ...
    'MiniBatchSize', 128, ...
    'InitialLearnRate', 1e-3, ...
    'LearnRateSchedule', 'piecewise', ...
    'LearnRateDropFactor', 0.1, ...
    'LearnRateDropPeriod', 100, ...
    'MaxEpochs', 35, ...
    'Verbose', true);

% 训练 R-CNN 网络.
rcnn = trainRCNNObjectDetector(stopSigns, cifar10Net.cifar10Net, options, ...
    'NegativeOverlapRange', [0 0.3], 'PositiveOverlapRange',[0.5 1])
```

```
********************************************************************
Training an R-CNN Object Detector for the following object classes:

* stopSign

--> Extracting region proposals from 41 training images...done.

--> Training a neural network to classify objects in training data...

Training on single CPU.
Initializing input data normalization.
|=========================================================================================|
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Mini-batch  |  Base Learning  |
|         |             |   (hh:mm:ss)   |   Accuracy   |     Loss     |      Rate       |
|=========================================================================================|
|       1 |           1 |       00:00:01 |       29.69% |       0.7135 |          0.0010 |
|       6 |          50 |       00:00:31 |       98.44% |       0.0390 |          0.0010 |
|      12 |         100 |       00:01:02 |       99.22% |       0.0264 |          0.0010 |
```

```
|      17 |         150 |       00:01:31 |      100.00% |       0.0094 |          0.0010 |
|      23 |         200 |       00:02:05 |       99.22% |       0.0303 |          0.0010 |
|      28 |         250 |       00:02:33 |      100.00% |       0.0109 |          0.0010 |
|      34 |         300 |       00:03:00 |      100.00% |       0.0030 |          0.0010 |
|      35 |         315 |       00:03:09 |       99.22% |       0.0113 |          0.0010 |
|=========================================================================================|
Training finished: Max epochs completed.

Network training complete.

--> Training bounding box regression models for each object class...100.00%...done.

Detector training complete.
*********************************************************************
rcnn =
  rcnnObjectDetector with properties:

               Network: [1×1 SeriesNetwork]
     RegionProposalFcn: @rcnnObjectDetector.proposeRegions
            ClassNames: {'stopSign'  'Background'}
    BoxRegressionLayer: 'conv_3'
```

步骤 5：检验检测器的对“Stop sign”交通标志的图像的检测效果

检测“Stop sign“标志

```
% 载入测试图片
testImage = imread('./images/StopSign_1.jpg');

[bboxes,score,label] = detect(rcnn,testImage,'MiniBatchSize',128)
```

```
bboxes = 1×4
    -3    89   154   141
score = single

    0.9997
label = categorical
     stopSign
```

```
% 标注置信度
[score, idx] = max(score);
bbox = bboxes(idx, :);
annotation = sprintf('%s: (Confidence = %f)', label(idx), score);
outputImage = insertObjectAnnotation(testImage, 'rectangle', bbox, annotation);
figure
imshow(outputImage)
```


1st Ave NW
stopSign: (Confidence = 0.999674)
STOP