Homework 0

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Problem 1

In [1]:
```
# Required imports
from torchvision import models
import torch
from PIL import Image
from torchvision import transforms
```

In [2]:
```
# Generate the model, collect the labels, and initalize Resnet
resnet = models.resnet101(pretrained=True)
with open('../Data/Homework0/imagenet_classes.txt') as f:
    labels = [line.strip() for line in f.readlines()]
resnet.eval()
```

Out[2]:
```
ResNet(
  (conv1): Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3), b
ias=False)
  (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_
stats=True)
  (relu): ReLU(inplace=True)
  (maxpool): MaxPool2d(kernel_size=3, stride=2, padding=1, dilation=1, ceil_m
ode=False)
  (layer1): Sequential(
    (0): Bottleneck(
      (conv1): Conv2d(64, 64, kernel_size=(1, 1), stride=(1, 1), bias=False)
      (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_runn
ing_stats=True)
      (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1), bias=False)
      (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_runn
ing_stats=True)
      (conv3): Conv2d(64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False)
      (bn3): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_run
```

In [3]:
```
# Preprocess for images
preprocess = transforms.Compose([
        transforms.Resize(256),
        transforms.CenterCrop(224),
        transforms.ToTensor(),
        transforms.Normalize(
            mean=[0.485, 0.456, 0.406],
            std=[0.229, 0.224, 0.225]
        )])
preprocess2 = transforms.Compose([
        transforms.Resize(256),
        transforms.CenterCrop(224)
        ])
```

In [4]:
```
# Image for processing and evaluating
img = Image.open("../Data/Homework0/hedgehog.jpg")
img
```

Out[4]:

In [5]:
```
# Preprocess image
img_t = preprocess(img)
img_t2 = preprocess2(img)
# Preprocessed image
img_t2
```

Out[5]:

In [6]:
```
# Batch the image
batch_t = torch.unsqueeze(img_t, 0)
```

In [7]:
```
# Evaluate the image and find the index for the max label
out = resnet(batch_t)
_, index = torch.max(out, 1)
```

In [8]:
```
# Get the top result of the evaluated image
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[8]:
```
('porcupine, hedgehog', 99.72889709472656)
```

In [9]:
```
# Get the top 5 results of the evaluated image
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[9]:
```
[('porcupine, hedgehog', 99.72889709472656),
 ('echidna, spiny anteater, anteater', 0.08287858963012695),
 ('meerkat, mierkat', 0.022194799035787582),
 ('polecat, fitch, foulmart, foumart, Mustela putorius', 0.020525071769952774),
 ('weasel', 0.006436034105718136)]
```

In [10]:
```
# Image for processing and evaluating
img = Image.open("../Data/Homework0/chicken.jpg")
img
```

Out[10]:

In [11]:
```
# Preprocess image
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[11]:

In [12]:
```
# Batch the image
batch_t = torch.unsqueeze(img_t, 0)
```

In [13]:
```
# Evaluate the image and find the index for the max label
out = resnet(batch_t)
_, index = torch.max(out, 1)
```

In [14]:
```
# Get the top result of the evaluated image
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[14]:
```
('hen', 99.72811889648438)
```

In [15]:
```
# Get the top 5 results of the evaluated image
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[15]:
```
[('hen', 99.72811889648438),
 ('partridge', 0.08102461695671082),
 ('cock', 0.051276251673698425),
 ('flamingo', 0.023376919329166412),
 ('goose', 0.016361577436327934)]
```

In [16]:
```
img = Image.open("../Data/Homework0/fox.jpg")
img
```

Out[16]:

In [17]:
```
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[17]:

In [18]:
```
batch_t = torch.unsqueeze(img_t, 0)
```

In [19]:
```
out = resnet(batch_t)
_, index = torch.max(out, 1)
```

In [20]:
```
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[20]:
```
('red fox, Vulpes vulpes', 94.83055877685547)
```

In [21]:
```
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[21]:
```
[('red fox, Vulpes vulpes', 94.83055877685547),
 ('kit fox, Vulpes macrotis', 3.430546522140503),
 ('grey fox, gray fox, Urocyon cinereoargenteus', 0.7153975367546082),
 ('Arctic fox, white fox, Alopex lagopus', 0.5389819145202637),
 ('coyote, prairie wolf, brush wolf, Canis latrans', 0.10537964105606079)]
```

In [22]:
```
img = Image.open("../Data/Homework0/panda.jpg")
img
```

Out[22]:

In [23]:
```
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[23]:

In [24]:
```
batch_t = torch.unsqueeze(img_t, 0)
```

In [25]:
```
out = resnet(batch_t)
_, index = torch.max(out, 1)
```

In [26]:
```
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[26]:
```
('giant panda, panda, panda bear, coon bear, Ailuropoda melanoleuca',
 99.96420288085938)
```

In [27]:
```
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[27]:
```
[('giant panda, panda, panda bear, coon bear, Ailuropoda melanoleuca',
  99.96420288085938),
 ('lesser panda, red panda, panda, bear cat, cat bear, Ailurus fulgens',
  0.015233170241117477),
 ('indri, indris, Indri indri, Indri brevicaudatus', 0.007301695644855499),
 ('teddy, teddy bear', 0.0019585939589887857),
 ('cougar, puma, catamount, mountain lion, painter, panther, Felis concolor',
  0.0015386644518002868)]
```

In [28]:
```
img = Image.open("../Data/Homework0/caribbean-reef-shark.jpg")
img
```

Out[28]:

In [29]:
```
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[29]:

In [30]:
```
batch_t = torch.unsqueeze(img_t, 0)
```

In [31]:
```
out = resnet(batch_t)
_, index = torch.max(out, 1)
```

In [32]:
```
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[32]:
```
('hammerhead, hammerhead shark', 49.9366569519043)
```

In [33]:
```
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[33]:
```
[('hammerhead, hammerhead shark', 49.9366569519043),
 ('tiger shark, Galeocerdo cuvieri', 42.99036407470703),
 ('great white shark, white shark, man-eater, man-eating shark, Carcharodon car
charias',
  5.793252944946289),
 ('electric ray, crampfish, numbfish, torpedo', 0.6328141689300537),
 ('stingray', 0.15629637241363525)]
```

Problem 2

In [34]:
```
# Create the ResNetGenerator
import torch.nn as nn

class ResNetBlock(nn.Module): # <1>

    def __init__(self, dim):
        super(ResNetBlock, self).__init__()
        self.conv_block = self.build_conv_block(dim)

    def build_conv_block(self, dim):
        conv_block = []

        conv_block += [nn.ReflectionPad2d(1)]

        conv_block += [nn.Conv2d(dim, dim, kernel_size=3, padding=0, bias=True),
                       nn.InstanceNorm2d(dim),
                       nn.ReLU(True)]

        conv_block += [nn.ReflectionPad2d(1)]

        conv_block += [nn.Conv2d(dim, dim, kernel_size=3, padding=0, bias=True),
                       nn.InstanceNorm2d(dim)]

        return nn.Sequential(*conv_block)

    def forward(self, x):
        out = x + self.conv_block(x) # <2>
        return out


class ResNetGenerator(nn.Module):

    def __init__(self, input_nc=3, output_nc=3, ngf=64, n_blocks=9): # <3>

        assert(n_blocks >= 0)
        super(ResNetGenerator, self).__init__()

        self.input_nc = input_nc
        self.output_nc = output_nc
        self.ngf = ngf

        model = [nn.ReflectionPad2d(3),
                 nn.Conv2d(input_nc, ngf, kernel_size=7, padding=0, bias=True),
                 nn.InstanceNorm2d(ngf),
                 nn.ReLU(True)]

        n_downsampling = 2
        for i in range(n_downsampling):
            mult = 2**i
            model += [nn.Conv2d(ngf * mult, ngf * mult * 2, kernel_size=3,
                                stride=2, padding=1, bias=True),
                      nn.InstanceNorm2d(ngf * mult * 2),
                      nn.ReLU(True)]

        mult = 2**n_downsampling
        for i in range(n_blocks):
```

```
            model += [ResNetBlock(ngf * mult)]

        for i in range(n_downsampling):
            mult = 2**(n_downsampling - i)
            model += [nn.ConvTranspose2d(ngf * mult, int(ngf * mult / 2),
                                         kernel_size=3, stride=2,
                                         padding=1, output_padding=1,
                                         bias=True),
                      nn.InstanceNorm2d(int(ngf * mult / 2)),
                      nn.ReLU(True)]

        model += [nn.ReflectionPad2d(3)]
        model += [nn.Conv2d(ngf, output_nc, kernel_size=7, padding=0)]
        model += [nn.Tanh()]

        self.model = nn.Sequential(*model)

    def forward(self, input): # <3>
        return self.model(input)
```

In [35]:
```
# Load the model parameter values into the generator
netG = ResNetGenerator()
model_path = '../Data/Homework0/horse2zebra_0.4.0.pth'
model_data = torch.load(model_path)
netG.load_state_dict(model_data)
```

Out[35]:
```
<All keys matched successfully>
```

In [36]:
```
# Evaluate the generator
netG.eval()
```

Out[36]:
```
ResNetGenerator(
  (model): Sequential(
    (0): ReflectionPad2d((3, 3, 3, 3))
    (1): Conv2d(3, 64, kernel_size=(7, 7), stride=(1, 1))
    (2): InstanceNorm2d(64, eps=1e-05, momentum=0.1, affine=False, track_runn
ing_stats=False)
    (3): ReLU(inplace=True)
    (4): Conv2d(64, 128, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1))
    (5): InstanceNorm2d(128, eps=1e-05, momentum=0.1, affine=False, track_run
ning_stats=False)
    (6): ReLU(inplace=True)
    (7): Conv2d(128, 256, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1))
    (8): InstanceNorm2d(256, eps=1e-05, momentum=0.1, affine=False, track_run
ning_stats=False)
    (9): ReLU(inplace=True)
    (10): ResNetBlock(
      (conv_block): Sequential(
        (0): ReflectionPad2d((1, 1, 1, 1))
        (1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1))
```

In [37]:
```
# Preprocess for images
preprocess = transforms.Compose([transforms.Resize(256),
                                 transforms.ToTensor()])
```

In [38]:
```
# Image for processing
img = Image.open("../Data/Homework0/horse.jpg")
img
```

Out[38]:

In [39]:
```
# Preprocess image and send it through the generator
img_t = preprocess(img)
batch_t = torch.unsqueeze(img_t, 0)
batch_out = netG(batch_t)
```

In [40]:
```
# Generate and display the output image
out_t = (batch_out.data.squeeze() + 1.0) / 2.0
out_img = transforms.ToPILImage()(out_t)
# out_img.save('../data/p1ch2/zebra.jpg')
out_img
```

Out[40]:

In [41]:
```
img = Image.open("../Data/Homework0/horse2.jpg")
img
```

Out[41]:

In [42]:
```
img_t = preprocess(img)
batch_t = torch.unsqueeze(img_t, 0)
batch_out = netG(batch_t)
```

In [43]:
```
out_t = (batch_out.data.squeeze() + 1.0) / 2.0
out_img = transforms.ToPILImage()(out_t)
# out_img.save('../data/p1ch2/zebra.jpg')
out_img
```

Out[43]:

In [44]:
```
img = Image.open("../Data/Homework0/horse-in-snow.jpg")
img
```

Out[44]:

In [45]:
```
img_t = preprocess(img)
batch_t = torch.unsqueeze(img_t, 0)
batch_out = netG(batch_t)
```

In [46]:
```
out_t = (batch_out.data.squeeze() + 1.0) / 2.0
out_img = transforms.ToPILImage()(out_t)
# out_img.save('../data/p1ch2/zebra.jpg')
out_img
```

Out[46]:

In [47]:
```
img = Image.open("../Data/Homework0/spotted-horse.jpg")
img
```

Out[47]:

In [48]:
```
img_t = preprocess(img)
batch_t = torch.unsqueeze(img_t, 0)
batch_out = netG(batch_t)
```

In [49]:
```
out_t = (batch_out.data.squeeze() + 1.0) / 2.0
out_img = transforms.ToPILImage()(out_t)
# out_img.save('../data/p1ch2/zebra.jpg')
out_img
```

Out[49]:

In [50]:
```
img = Image.open("../Data/Homework0/three-horses.jpg")
img
```

Out[50]:

In [51]:
```
img_t = preprocess(img)
batch_t = torch.unsqueeze(img_t, 0)
batch_out = netG(batch_t)
```

In [52]:
```
out_t = (batch_out.data.squeeze() + 1.0) / 2.0
out_img = transforms.ToPILImage()(out_t)
# out_img.save('../data/p1ch2/zebra.jpg')
out_img
```

Out[52]:

Problem 3

In [53]:
```
# Import ptflops
from ptflops import get_model_complexity_info
```

In [54]:
```
# Calculate the MACs and size of the resnet model
macs, params = get_model_complexity_info(resnet, (3, 224, 224), as_strings=True,
                                         print_per_layer_stat=True, verbose=Tru
print('{:<30}  {:<8}'.format('Computational complexity: ', macs))
print('{:<30}  {:<8}'.format('Number of parameters: ', params))
```

```
512, kernel_size=(1, 1), stride=(1, 1), bias=False)
      (bn1): BatchNorm2d(0.001 M, 0.002% Params, 0.0 GMac, 0.001% MACs, 512,
eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (conv2): Conv2d(2.359 M, 5.296% Params, 0.116 GMac, 1.473% MACs, 512, 5
12, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
      (bn2): BatchNorm2d(0.001 M, 0.002% Params, 0.0 GMac, 0.001% MACs, 512,
eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (conv3): Conv2d(1.049 M, 2.354% Params, 0.051 GMac, 0.655% MACs, 512, 2

048, kernel_size=(1, 1), stride=(1, 1), bias=False)
      (bn3): BatchNorm2d(0.004 M, 0.009% Params, 0.0 GMac, 0.003% MACs, 2048,
eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (relu): ReLU(0.0 M, 0.000% Params, 0.0 GMac, 0.002% MACs, inplace=True)
    )
    (2): Bottleneck(
      4.463 M, 10.017% Params, 0.219 GMac, 2.788% MACs,
      (conv1): Conv2d(1.049 M, 2.354% Params, 0.051 GMac, 0.655% MACs, 2048,
512, kernel_size=(1, 1), stride=(1, 1), bias=False)
      (bn1): BatchNorm2d(0.001 M, 0.002% Params, 0.0 GMac, 0.001% MACs, 512,
eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
```

Computational complexity: 7.85 GMac

Number of parameters: 44.55 M

In [55]:
```
# Calculate the MACs and size of the resnetgenerator model
macs, params = get_model_complexity_info(netG, (3, 224, 224), as_strings=True,
                                         print_per_layer_stat=True, verbose=Tru
print('{:<30}  {:<8}'.format('Computational complexity: ', macs))
print('{:<30}  {:<8}'.format('Number of parameters: ', params))
```

```
kernel_size=(3, 3), stride=(1, 1))
        (2): InstanceNorm2d(0.0 M, 0.000% Params, 0.001 GMac, 0.002% MACs, 25
6, eps=1e-05, momentum=0.1, affine=False, track_running_stats=False)
        (3): ReLU(0.0 M, 0.000% Params, 0.001 GMac, 0.002% MACs, inplace=Tru
e)
        (4): ReflectionPad2d(0.0 M, 0.000% Params, 0.0 GMac, 0.000% MACs, (1,
1, 1, 1))
        (5): Conv2d(0.59 M, 5.186% Params, 1.85 GMac, 4.249% MACs, 256, 256,
kernel_size=(3, 3), stride=(1, 1))
        (6): InstanceNorm2d(0.0 M, 0.000% Params, 0.001 GMac, 0.002% MACs, 25
6, eps=1e-05, momentum=0.1, affine=False, track_running_stats=False)
      )
    )
    (17): ResNetBlock(
      1.18 M, 10.372% Params, 3.703 GMac, 8.503% MACs,
      (conv_block): Sequential(
        1.18 M, 10.372% Params, 3.703 GMac, 8.503% MACs,
        (0): ReflectionPad2d(0.0 M, 0.000% Params, 0.0 GMac, 0.000% MACs, (1,
1, 1, 1))
        (1): Conv2d(0.59 M, 5.186% Params, 1.85 GMac, 4.249% MACs, 256, 256,
```

```
Computational complexity:       43.55 GMac

Number of parameters:           11.38 M
```

Problem 4

In [56]:
```
# Generate a pretrained mobilenet model and evaluate it
mobnet = torch.hub.load('pytorch/vision:v0.10.0', 'mobilenet_v2', pretrained=True
mobnet.eval()
```

```
Using cache found in C:\Users\Grey/.cache\torch\hub\pytorch_vision_v0.10.0
```

In [57]:
```
# Use the same preprocess steps as used in problem 1
preprocess = transforms.Compose([
    transforms.Resize(256),
    transforms.CenterCrop(224),
    transforms.ToTensor(),
    transforms.Normalize(mean=[0.485, 0.456, 0.406], std=[0.229, 0.224, 0.225]),
])
```

In [58]:
```
# Evaluate each image in the same procress as problem 1
img = Image.open("../Data/Homework0/hedgehog.jpg")
img
```

Out[58]:

In [59]:
```
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[59]:

In [60]:
```
batch_t = torch.unsqueeze(img_t, 0)
```

In [61]:
```
out = mobnet(batch_t)
_, index = torch.max(out, 1)
```

In [62]:
```
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[62]:
```
('porcupine, hedgehog', 99.85497283935547)
```

In [63]:
```
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[63]:
```
[('porcupine, hedgehog', 99.85497283935547),
 ('polecat, fitch, foulmart, foumart, Mustela putorius', 0.05533171445131302),
 ('weasel', 0.026627708226442337),
 ('black-footed ferret, ferret, Mustela nigripes', 0.023999027907848358),
 ('meerkat, mierkat', 0.011314046569168568)]
```

In [64]:
```
img = Image.open("../Data/Homework0/chicken.jpg")
img
```

Out[64]:

In [65]:
```
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[65]:

In [66]:
```
batch_t = torch.unsqueeze(img_t, 0)
```

In [67]:
```
out = mobnet(batch_t)
_, index = torch.max(out, 1)
```

In [68]:
```
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[68]:
```
('hen', 99.78340148925781)
```

In [69]:
```
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[69]:
```
[('hen', 99.78340148925781),
 ('cock', 0.15116648375988007),
 ('flamingo', 0.012553366832435131),
 ('partridge', 0.008450346998870373),
 ('proboscis monkey, Nasalis larvatus', 0.006501121446490288)]
```

In [70]:
```
img = Image.open("../Data/Homework0/fox.jpg")
img
```

Out[70]:

In [71]:
```
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[71]:

In [72]:
```
batch_t = torch.unsqueeze(img_t, 0)
```

In [73]:
```
out = mobnet(batch_t)
_, index = torch.max(out, 1)
```

In [74]:
```
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[74]:
```
('red fox, Vulpes vulpes', 94.87842559814453)
```

In [75]:
```
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

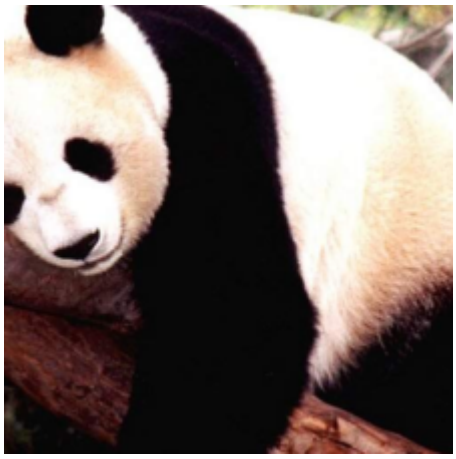
Out[75]:
```
[('red fox, Vulpes vulpes', 94.87842559814453),
 ('kit fox, Vulpes macrotis', 2.2196896076202393),
 ('grey fox, gray fox, Urocyon cinereoargenteus', 1.9752798080444336),
 ('Arctic fox, white fox, Alopex lagopus', 0.3061438202857971),
 ('Pomeranian', 0.1690659373998642)]
```

In [76]:
```
img = Image.open("../Data/Homework0/panda.jpg")
img
```

Out[76]:

In [77]:
```
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[77]:



In [78]:
```
batch_t = torch.unsqueeze(img_t, 0)
```

In [79]:
```
out = mobnet(batch_t)
_, index = torch.max(out, 1)
```

In [80]:
```
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[80]:
```
('giant panda, panda, panda bear, coon bear, Ailuropoda melanoleuca',
 99.48255920410156)
```

In [81]:
```
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[81]:
```
[('giant panda, panda, panda bear, coon bear, Ailuropoda melanoleuca',
  99.48255920410156),
 ('French bulldog', 0.1480681300163269),
 ('Boston bull, Boston terrier', 0.03717460483312607),
 ('capuchin, ringtail, Cebus capucinus', 0.031766995787620544),
 ('Siamese cat, Siamese', 0.031191986054182053)]
```

In [82]:
```
img = Image.open("../Data/Homework0/caribbean-reef-shark.jpg")
img
```

Out[82]:

In [83]:
```
img_t = preprocess(img)
img_t2 = preprocess2(img)
img_t2
```

Out[83]:

In [84]:
```
batch_t = torch.unsqueeze(img_t, 0)
```

In [85]:
```
out = mobnet(batch_t)
_, index = torch.max(out, 1)
```

In [86]:
```
percentage = torch.nn.functional.softmax(out, dim=1)[0] * 100
labels[index[0]], percentage[index[0]].item()
```

Out[86]:
```
('hammerhead, hammerhead shark', 79.31352233886719)
```

In [87]:
```
_, indices = torch.sort(out, descending=True)
[(labels[idx], percentage[idx].item()) for idx in indices[0][:5]]
```

Out[87]:
```
[('hammerhead, hammerhead shark', 79.31352233886719),
 ('tiger shark, Galeocerdo cuvieri', 15.26162052154541),
 ('great white shark, white shark, man-eater, man-eating shark, Carcharodon car
charias',
  5.320621490478516),
 ('electric ray, crampfish, numbfish, torpedo', 0.07180054485797882),
 ('killer whale, killer, orca, grampus, sea wolf, Orcinus orca',
  0.014228451997041702)]
```

In [88]:
```
# Calculate the MACs and size of the mobilenet
macs, params = get_model_complexity_info(mobnet, (3, 224, 224), as_strings=True,
                                         print_per_layer_stat=True, verbose=Tru
print('{:<30}  {:<8}'.format('Computational complexity: ', macs))
print('{:<30}  {:<8}'.format('Number of parameters: ', params))
```

```
          (0): Conv2d(0.005 M, 0.247% Params, 0.0 GMac, 0.132% MACs, 960, 96
0, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), groups=960, bias=False)
          (1): BatchNorm2d(0.002 M, 0.055% Params, 0.0 GMac, 0.029% MACs, 96
0, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
          (2): ReLU6(0.0 M, 0.000% Params, 0.0 GMac, 0.015% MACs, inplace=Tru
e)
        )
        (2): Conv2d(0.154 M, 4.382% Params, 0.008 GMac, 2.350% MACs, 960, 16
0, kernel_size=(1, 1), stride=(1, 1), bias=False)
        (3): BatchNorm2d(0.0 M, 0.009% Params, 0.0 GMac, 0.005% MACs, 160, ep
s=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      )
    )
    (16): InvertedResidual(
      0.32 M, 9.130% Params, 0.016 GMac, 4.926% MACs,
      (conv): Sequential(
        0.32 M, 9.130% Params, 0.016 GMac, 4.926% MACs,
        (0): ConvNormActivation(
          0.156 M, 4.437% Params, 0.008 GMac, 2.394% MACs,
          (0): Conv2d(0.154 M, 4.382% Params, 0.008 GMac, 2.350% MACs, 160, 9
```

Computational complexity: 0.32 GMac

Number of parameters: 3.5 M

In [ ]: