CAB420 CAM

June 1, 2018

1 CAB420 Assignment 3 Class Activation Mappings

This notebook is an exploration in class activation mappings produced by a CNN which has been trained to classify images in three broad categories.

These categories are as follows: * air animals * land animals * water animals

The classifier is trained on a small subset of the Caltech256 dataset. The subset contains images from 27 classes in total (9 from each category).

By Christopher Ayling

Adapted from content from http://www.fast.ai/

```
In [10]: %reload_ext autoreload
         %autoreload 2
         %matplotlib inline

         from fastai.imports import *

         from fastai.transforms import *
         from fastai.conv_learner import *
         from fastai.model import *
         from fastai.dataset import *
         from fastai.sgdr import *
         from fastai.plots import *
```

2 Building Model

```
In [11]: PATH = "data/caltech256_A3/"
         sz = 224
         arch = resnet34
         bs = 64
         num_classes = 3
```

```
In [8]: m = arch(True)
```

```
In [12]: m
```

```
Out[12]: ResNet(
           (conv1): Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3), bias=False)
```

```
(bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
(relu): ReLU(inplace)
(maxpool): MaxPool2d(kernel_size=3, stride=2, padding=1, dilation=1, ceil_mode=False)
(layer1): Sequential(
  (0): BasicBlock(
    (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
    (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
    (relu): ReLU(inplace)
    (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
    (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
  )
  (1): BasicBlock(
    (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
    (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
    (relu): ReLU(inplace)
    (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
    (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
  )
  (2): BasicBlock(
    (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
    (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
    (relu): ReLU(inplace)
    (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
    (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
  )
)
(layer2): Sequential(
  (0): BasicBlock(
    (conv1): Conv2d(64, 128, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias=
    (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (downsample): Sequential(
      (0): Conv2d(64, 128, kernel_size=(1, 1), stride=(2, 2), bias=False)
      (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
  )
  (1): BasicBlock(
    (conv1): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (2): BasicBlock(
    (conv1): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
```

```
    (relu): ReLU(inplace)
    (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (3): BasicBlock(
    (conv1): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
)
(layer3): Sequential(
  (0): BasicBlock(
    (conv1): Conv2d(128, 256, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (downsample): Sequential(
      (0): Conv2d(128, 256, kernel_size=(1, 1), stride=(2, 2), bias=False)
      (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
  )
  (1): BasicBlock(
    (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (2): BasicBlock(
    (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (3): BasicBlock(
    (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (4): BasicBlock(
    (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
```

```
      (relu): ReLU(inplace)
      (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
    (5): BasicBlock(
      (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
  )
  (layer4): Sequential(
    (0): BasicBlock(
      (conv1): Conv2d(256, 512, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias
      (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (downsample): Sequential(
        (0): Conv2d(256, 512, kernel_size=(1, 1), stride=(2, 2), bias=False)
        (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      )
    )
    (1): BasicBlock(
      (conv1): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
    (2): BasicBlock(
      (conv1): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
  )
  (avgpool): AvgPool2d(kernel_size=7, stride=1, padding=0)
  (fc): Linear(in_features=512, out_features=1000, bias=True)
)
```

In [13]:
```
m = nn.Sequential(*children(m)[:-2],
                  nn.Conv2d(512, num_classes, 3, padding=1),
                  nn.AdaptiveAvgPool2d(1), Flatten(),
                  nn.LogSoftmax())
```

In [14]:
```
m
```

```
Out[14]: Sequential(
           (0): Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3), bias=False)
           (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
           (2): ReLU(inplace)
           (3): MaxPool2d(kernel_size=3, stride=2, padding=1, dilation=1, ceil_mode=False)
           (4): Sequential(
             (0): BasicBlock(
               (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
               (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
               (relu): ReLU(inplace)
               (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
               (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
             )
             (1): BasicBlock(
               (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
               (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
               (relu): ReLU(inplace)
               (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
               (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
             )
             (2): BasicBlock(
               (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
               (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
               (relu): ReLU(inplace)
               (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=F
               (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=
             )
           )
           (5): Sequential(
             (0): BasicBlock(
               (conv1): Conv2d(64, 128, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias=
               (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
               (relu): ReLU(inplace)
               (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
               (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
               (downsample): Sequential(
                 (0): Conv2d(64, 128, kernel_size=(1, 1), stride=(2, 2), bias=False)
                 (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
               )
             )
             (1): BasicBlock(
               (conv1): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
               (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
               (relu): ReLU(inplace)
               (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
               (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
             )
             (2): BasicBlock(
```

```
    (conv1): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (3): BasicBlock(
    (conv1): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
)
(6): Sequential(
  (0): BasicBlock(
    (conv1): Conv2d(128, 256, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (downsample): Sequential(
      (0): Conv2d(128, 256, kernel_size=(1, 1), stride=(2, 2), bias=False)
      (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
  )
  (1): BasicBlock(
    (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (2): BasicBlock(
    (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (3): BasicBlock(
    (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    (relu): ReLU(inplace)
    (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
    (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
  )
  (4): BasicBlock(
```

```
      (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
    (5): BasicBlock(
      (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
  )
  (7): Sequential(
    (0): BasicBlock(
      (conv1): Conv2d(256, 512, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias
      (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (downsample): Sequential(
        (0): Conv2d(256, 512, kernel_size=(1, 1), stride=(2, 2), bias=False)
        (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      )
    )
    (1): BasicBlock(
      (conv1): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
    (2): BasicBlock(
      (conv1): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
      (relu): ReLU(inplace)
      (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias
      (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats
    )
  )
  (8): Conv2d(512, 3, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (9): AdaptiveAvgPool2d(output_size=1)
  (10): Flatten()
  (11): LogSoftmax()
)
```

In [15]:
```
tfms = tfms_from_model(arch, sz, aug_tfms=transforms_side_on, max_zoom=1.1)
```

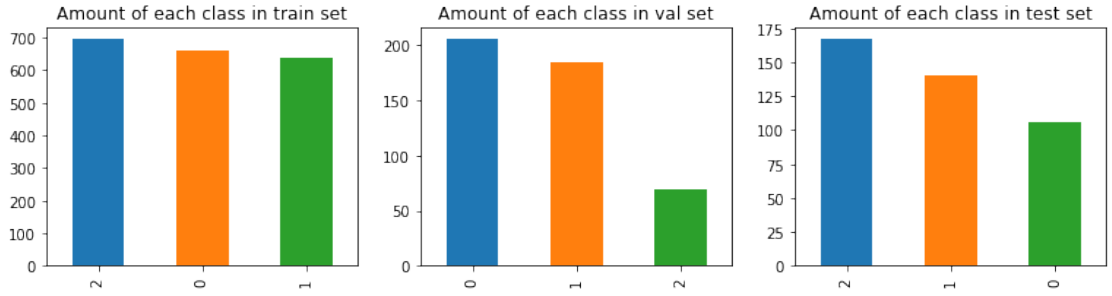
```
        data = ImageClassifierData.from_paths(PATH, tfms=tfms, bs=bs, test_name="test", test_wi
```

```
In [16]: print("train sz: {0}\nval sz: {1}\ntest sz: {2}".format(len(data.trn_ds), len(data.val_
```

```
train sz: 1991
val sz: 458
test sz: 413
```

```
In [17]: fig, axes = plt.subplots(nrows=1, ncols=3, figsize=(13, 3))
         pd.Series(data.trn_ds.y).value_counts().plot.bar(title="Amount of each class in train s
         pd.Series(data.val_ds.y).value_counts().plot.bar(title="Amount of each class in val set
         pd.Series(data.test_ds.y).value_counts().plot.bar(title="Amount of each class in test s
```

```
Out[17]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc25a223208>
```



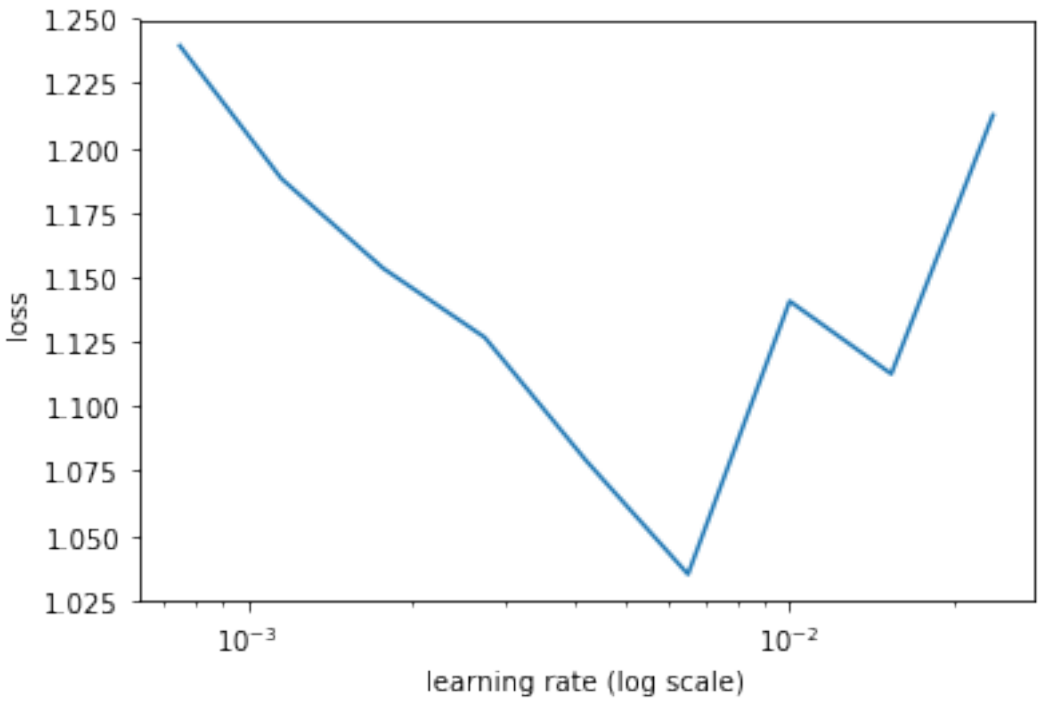

```
In [18]: learn = ConvLearner.from_model_data(m, data)
```

```
In [9]: learn.freeze_to(-4)
```

```
In [10]: learn.lr_find()
         learn.sched.plot()
```

```
HBox(children=(IntProgress(value=0, description='Epoch', max=1), HTML(value='')))
```

```
 78%|  | 25/32 [00:06<00:01,  3.58it/s, loss=6.7]
```




```
In [11]: learn.fit(1e-1, 2)
```

```
HBox(children=(IntProgress(value=0, description='Epoch', max=2), HTML(value='')))
```

```
epoch      trn_loss   val_loss   accuracy
    0      37.217134  11.480844  0.917031
    1      18.675371  10.801526  0.927948
```

```
Out[11]: [10.80152632367663, 0.9279475985135573]
```

```
In [12]: learn.fit(0.01, 1, cycle_len=1)
```

```
HBox(children=(IntProgress(value=0, description='Epoch', max=1), HTML(value='')))
```

```
epoch      trn_loss   val_loss   accuracy
    0      5.338181   7.552607   0.938865
```

```
Out[12]: [7.552606905391643, 0.9388646283003961]
```

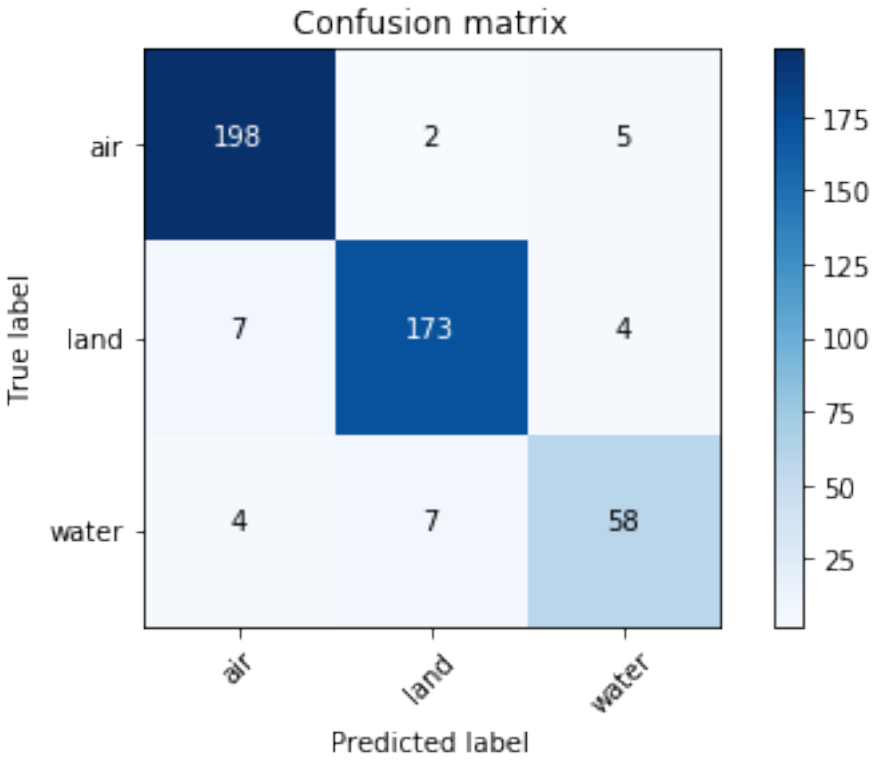
3 Model Evaluation

```
In [13]: log_preds,y = learn.TTA()
         probs = np.mean(np.exp(log_preds),0)
         print("accuracy", accuracy_np(probs, y))
```

```
accuracy 0.9366812227074236
```

```
In [14]: prds = np.argmax(probs, axis=1)
         prbs = probs[:,1]
         from sklearn.metrics import confusion_matrix
         cm = confusion_matrix(y, prds)
         plot_confusion_matrix(cm, data.classes)
```

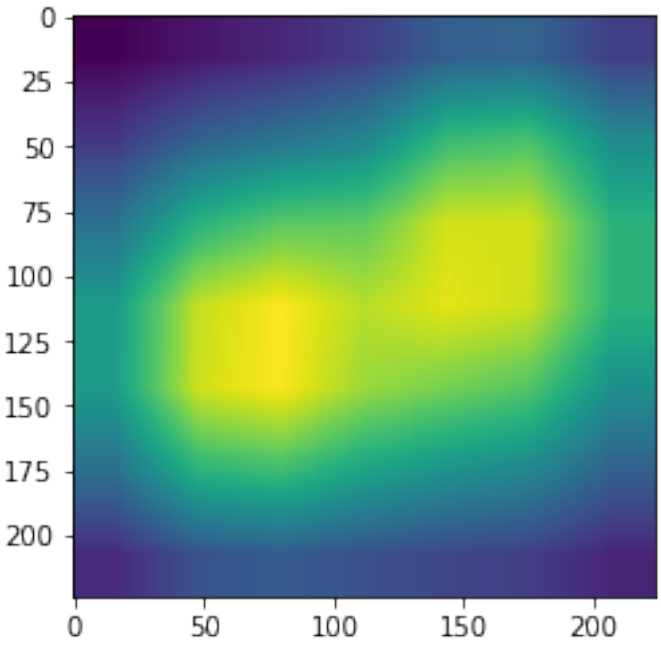
```
[[198   2   5]
 [  7 173   4]
 [  4   7  58]]
```



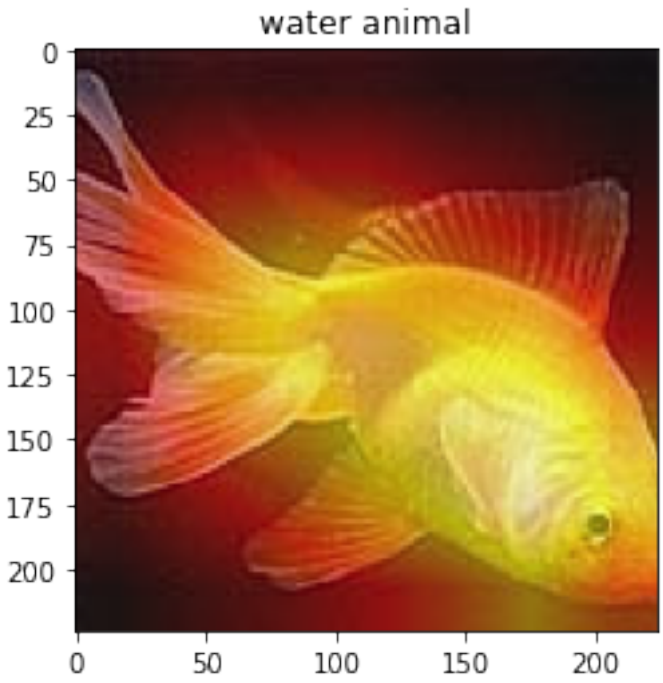
4 Class Actiation Mappings

Generate heatmaps of images representing what parts the CNN is interested in.

```
In [23]: def get_label(preds):
             return data.classes[np.argmax(preds)]

In [15]: # ignore scipy resize deprecation warnings
         import warnings
         warnings.filterwarnings('ignore')

In [16]: class SaveFeatures():
             features=None
             def __init__(self, m):
                 self.hook = m.register_forward_hook(self.hook_fn)
             def hook_fn(self, module, input, output):
                 self.features = output
             def remove(self):
                 self.hook.remove()

In [17]: trn_tfms, val_tfms = tfms_from_model(arch, sz)

In [90]: def get_cam_overlay(img):
             img = val_tfms(img)

             mo = learn.model
             sfs = [SaveFeatures(o) for o in [mo[-7], mo[-6], mo[-5], mo[-4]]]
             py = learn.predict_array(img[None])
             label = get_label(np.exp(py))
             for o in sfs: o.remove()

             img = scipy.misc.imresize(img, (sz, sz))
             py = np.exp(to_np(py)[0])
             feat = np.maximum(0, to_np(sfs[3].features[0]))
             f2 = np.dot(np.rollaxis(feat, 0, 3), py)
             f2 -= f2.min()
             f2 /= f2.max()
             return scipy.misc.imresize(f2, (sz, sz))

         def get_cam_overlay_from_path(path): return get_cam_overlay(open_image(path))

In [92]: plt.imshow(get_cam_overlay_from_path('test.jpg'))

Out[92]: <matplotlib.image.AxesImage at 0x7f0db4ff4eb8>
```




```
In [66]: def get_cam(img):
             img = val_tfms(img)

             mo = learn.model
             sfs = [SaveFeatures(o) for o in [mo[-7], mo[-6], mo[-5], mo[-4]]]
             py = learn.predict_array(img[None])
             label = get_label(np.exp(py))
             for o in sfs: o.remove()

             img = scipy.misc.imresize(img, (sz, sz))
             plt.imshow(img)

             py = np.exp(to_np(py)[0])
             feat = np.maximum(0, to_np(sfs[3].features[0]))
             f2 = np.dot(np.rollaxis(feat, 0, 3), py)
             f2 -= f2.min()
             f2 /= f2.max()

             plt.imshow(scipy.misc.imresize(f2, (sz, sz)), alpha=0.5, cmap='hot')
             plt.title(label + " animal")

         def get_cam_from_path(path): get_cam(open_image(path))

In [67]: get_cam_from_path(PATH+folder_source(PATH, 'test')[0][300])
```




```
In [47]: p = PATH + folder_source(PATH, 'test')[0][300]
         preds = learn.predict_array(val_tfms(open_image(p))[None])
         get_label(np.exp(preds)), p

Out[47]: ('water', 'data/caltech256_A3/test/water/087_0059.jpg')

In [117]: def get_label_from_path(path):
              preds = learn.predict_array(val_tfms(open_image(path))[None])
              return get_label(np.exp(preds))

In [80]: def get_examples(class_name, folder='test'):
             return list(map(lambda f: f"{PATH}{folder}/{class_name}/{f}", os.listdir(f"{PATH}{f

In [119]: exs = get_examples("air")[:5]

          f, axes = plt.subplots(nrows=1, ncols=5, figsize=(15, 3))

          for ax, ex in zip(axes, exs):
              ax.imshow(scipy.misc.imresize(open_image(ex), (sz, sz)))
              ax.imshow(get_cam_overlay_from_path(ex), alpha=0.5, cmap='hot')
              ax.set_yticklabels([])
              ax.set_xticklabels([])
              ax.set_title(get_label_from_path(ex) + " animal")
```


```
In [136]: f, axes = plt.subplots(nrows=3, ncols=5, figsize=(15, 10), dpi=300)
          f.suptitle("Test Set Inferences and CAM")

          for row, cls in zip(axes, data.classes):
              for col, img in zip(row, get_examples(cls)):
                  col.imshow(scipy.misc.imresize(open_image(img), (sz, sz)))
                  col.imshow(get_cam_overlay_from_path(img), alpha=0.5, cmap='hot')
                  col.set_yticklabels([])
                  col.set_xticklabels([])
                  col.set_title(get_label_from_path(img) + " animal")
```