DAI_ASSIGNMENT_3_Q2.ipynb

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Question 2 (Explainability): [30 Marks]

Choose **any one** from the following:
Aim: Implementation of LIME model.
Dataset: 20newsgroups

1. Train an SVM/Regression Model on this data, visually explain predictions of the model on samples from test data using LIME.(one sample from each class)

Dataset: CIFAR10

2. Take any ImageNet Pretrained Model, generate a visual explanation of the model's predictions on 10 samples from CIFAR-10 test data using LIME. (One sample from each class)

Load Cifar 10 and then Pretrained Model

```
[1] from keras.datasets import cifar10
from keras.utils import to_categorical
from keras.models import Sequential
from keras.layers import Conv2D
from keras.layers import MaxPooling2D
from keras.layers import Dense
from keras.layers import Flatten
from keras.optimizers import SGD
from tensorflow.keras import datasets
import numpy as np
import matplotlib.pyplot as plt
import tensorflow as tf
from tensorflow.keras import layers, models
```

```
[2]
filtered_images=[]
(train_images, train_labels), (test_images, test_labels)= datasets.cifar10.load_data()
print('Images Shape: {}'.format(train_images.shape))
print('Labels Shape: {}'.format(train_labels.shape))
for i in range(0,10):
  idx = (train_labels == i).reshape(train_images.shape[0])
  # print('Index Shape: {}'.format(idx.shape))
  filtered_images.append(train_images[idx])
print('Filtered Images Shape: {}'.format(np.array(filtered_images).shape))

# Train Images
Xtrain_airplane = np.array(filtered_images[0])
Xtrain_automobile = np.array(filtered_images[1])
Xtrain_bird = np.array(filtered_images[2])
Xtrain_cat = np.array(filtered_images[3])
Xtrain_deer = np.array(filtered_images[4])
Xtrain_dog = np.array(filtered_images[5])
Xtrain_frog = np.array(filtered_images[6])
Xtrain_horse = np.array(filtered_images[7])
Xtrain_ship = np.array(filtered_images[8])
Xtrain_truck = np.array(filtered_images[9])
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170500096/170498071 [==============================] - 2s 0us/step
Images Shape: (50000, 32, 32, 3)
Labels Shape: (50000, 1)
Filtered Images Shape: (10, 5000, 32, 32, 3)
```

```
[3] filtered_labels = []
for i in range(0,10):
  idx = (train_labels == i).reshape(train_labels.shape[0])
  filtered_labels.append(train_labels[idx])
print('Filtered labels Shape: {}'.format(np.array(filtered_labels).shape))
# Train Labels
Ytrain_airplane = filtered_labels[0]
Ytrain_automobile = filtered_labels[1]
Ytrain_bird = filtered_labels[2]
Ytrain_cat = filtered_labels[3]
Ytrain_deer = filtered_labels[4]
Ytrain_dog = filtered_labels[5]
Ytrain_frog = filtered_labels[6]
Ytrain_horse = filtered_labels[7]
Ytrain_ship = filtered_labels[8]
Ytrain_truck = filtered_labels[9]
```

```
Filtered labels Shape: (10, 5000, 1)
```

```
[4] filtered_images_test = []
for i in range(0,10):
  idx = (test_labels == i).reshape(test_images.shape[0])
  # print('Index Shape: {}'.format(idx.shape))
  filtered_images_test.append(test_images[idx])
print('Filtered Images Shape: {}'.format(np.array(filtered_images_test).shape))
# Test Images
Xtest_airplane = np.array(filtered_images_test[0])
Xtest_automobile = np.array(filtered_images_test[1])
Xtest_bird = np.array(filtered_images_test[2])
Xtest_cat = np.array(filtered_images_test[3])
Xtest_deer = np.array(filtered_images_test[4])
Xtest_dog = np.array(filtered_images_test[5])
Xtest_frog = np.array(filtered_images_test[6])
Xtest_horse = np.array(filtered_images_test[7])
Xtest_ship = np.array(filtered_images_test[8])
Xtest_truck = np.array(filtered_images_test[9])

filtered_labels_test = []
for i in range(0,10):
  idx = (test_labels == i).reshape(test_labels.shape[0])
  filtered_labels_test.append(test_labels[idx])
print('Filtered labels Shape: {}'.format(np.array(filtered_labels_test).shape))

# Test Labels
Ytest_airplane = filtered_labels_test[0]
Ytest_automobile = filtered_labels_test[1]
Ytest_bird = filtered_labels_test[2]
Ytest_cat = filtered_labels_test[3]
Ytest_deer = filtered_labels_test[4]
Ytest_dog = filtered_labels_test[5]
Ytest_frog = filtered_labels_test[6]
Ytest_horse = filtered_labels_test[7]
Ytest_ship = filtered_labels_test[8]
Ytest_truck = filtered_labels_test[9]
```

```
Filtered Images Shape: (10, 1000, 32, 32, 3)
Filtered labels Shape: (10, 1000, 1)
```

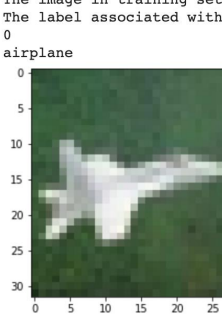
```
[5] X_train = np.concatenate((Xtrain_airplane,
                          Xtrain_automobile,
                          Xtrain_bird,
                          Xtrain_cat,
                          Xtrain_deer,
                          Xtrain_dog,
                          Xtrain_frog,
                          Xtrain_horse,
                          Xtrain_ship,
                          Xtrain_truck))

Y_train = np.concatenate((Ytrain_airplane,
                          Ytrain_automobile,
                          Ytrain_bird,
                          Ytrain_cat,
                          Ytrain_deer,
                          Ytrain_dog,
                          Ytrain_frog,
                          Ytrain_horse,
                          Ytrain_ship,
                          Ytrain_truck))

X_test = np.concatenate((Xtest_airplane,
                          Xtest_automobile,
                          Xtest_bird,
                          Xtest_cat,
                          Xtest_deer,
                          Xtest_dog,
                          Xtest_frog,
                          Xtest_horse,
                          Xtest_ship,
                          Xtest_truck))

Y_test = np.concatenate((Ytest_airplane,
                          Ytest_automobile,
                          Ytest_bird,
                          Ytest_cat,
                          Ytest_deer,
                          Ytest_dog,
                          Ytest_frog,
                          Ytest_horse,
                          Ytest_ship,
                          Ytest_truck))
print(X_train.shape)
print(Y_train.shape)
print(X_test.shape)
print(Y_test.shape)
```

```
(50000, 32, 32, 3)
(50000, 1)
(10000, 32, 32, 3)
(10000, 1)
```

```
[6] classes = ["airplane",#0
           "automobile",#1
           "bird",#2
           "cat",#3
           "deer",#4
           "dog",#5
           "frog",#6
           "horse",#7
           "ship",#8
           "truck"#9
           ]
```

```
[7]
def show_label_and_image(X,Y,index):
  print("The image in training set is desiplayed as:")
  plt.imshow(np.array(X[index]))
  print("The label associated with this image is in training set:")
  print(Y[index][0])
  print(classes[Y[index][0]])
show_label_and_image(X_train, Y_train, 4)
```

```
The image in training set is desiplayed as:
The label associated with this image is in training set:
0
airplane
```



Load Pretrained model

```
[8] resnet50 = tf.keras.applications.ResNet50(
    include_top=True,
    weights="imagenet",
    input_tensor=None,
    input_shape=None,
    pooling=None,
    classes=1000
)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/resnet/resnet50_weights_tf_dim_ordering_tf_kernels.h5
102973440/102967424 [==============================] - 0s 0us/step
```

```
[9] # examples:
airplane =                    Xtest_airplane[np.random.randint(1000)]
automobile =                 Xtest_automobile[np.random.randint(1000)]
bird =                       Xtest_bird[np.random.randint(1000)]
cat =                       Xtest_cat[np.random.randint(1000)]
deer =                       Xtest_deer[np.random.randint(1000)]
dog =                       Xtest_dog[np.random.randint(1000)]
frog =                       Xtest_frog[np.random.randint(1000)]
horse =                       Xtest_horse[np.random.randint(1000)]
ship =                       Xtest_ship[np.random.randint(1000)]
truck =                       Xtest_truck[np.random.randint(1000)]
```

[ ]

LIME (Local Interpretable Model agnostic Explanations)

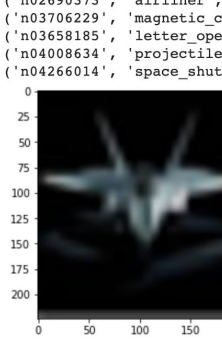
```
[10] # ref : https://youtu.be/vz_fkVkoGFM
# ref : https://nbviewer.jupyter.org/urls/arteagac.github.io/blog/lime.ipynb
# ref : https://github.com/marcotcr/lime/tree/master/doc/notebooks
# ref : https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20images.ipynb
```

LIME generates local explanations, in other words, explanations for individual instances in a dataset. LIME starts by generating a new dataset of perturbations around the instance to be explained. Then, the trained machine learning classifier is used to predict the class of each instance in the new generated dataset. Finally, a simpler model with intrinsic intepretability, for instance a linear regression model, is fitted and used to explain the prediction of the classifier. Before fitting a simpler model, the instances in the new generated dataset are weighed based on their distance to the original instance being explained. In this way, there is a higher certainty that the model is locally faithful around the explained instance.

FOR AIRPLANE

```
[11] import os
import keras
from keras.preprocessing import image
from keras.applications.imagenet_utils import decode_predictions
from skimage.io import imread
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import numpy as np
from PIL import Image
# Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
arr = airplane
img = Image.fromarray(arr)
img = img.resize((224, 224))
array_airplane = np.array(img)
print(array_airplane.shape)
# for airplane
plt.imshow(array_airplane)
preds = resnet50.predict(array_airplane.reshape((1,224,224,3)))
for x in decode_predictions(preds)[0]:
    print(x)
```

```
(224, 224, 3)
Downloading data from https://storage.googleapis.com/download.tensorflow.org/data/imagenet_class_index.json
40960/35363 [=================================] - 0s 0us/step
('n02690373', 'airliner', 0.750129)
('n03706229', 'magnetic_compass', 0.042152025)
('n03658185', 'letter_opener', 0.040669985)
('n04008634', 'projectile', 0.03277063)
('n04266014', 'space_shuttle', 0.01734258)
```



```
[12] !pip install lime
```

```
Collecting lime
  Downloading https://files.pythonhosted.org/packages/f5/86/91a13127d83d793ecb50eb75e716f76e6eda809b6803c5a4ff462339789e/lime-0.2.0.1.tar.gz (275kB)
     |████████████████████████████████| 276kB 15.8MB/s
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.6/dist-packages (from python-dateutil>=2.1->matplotlib->lime) (1.15.0)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
Building wheels for collected packages: lime
  Building wheel for lime (setup.py) ... done
  Created wheel for lime: filename=lime-0.2.0.1-cp36-none-any.whl size=283846 sha256=5e9c6e6659c6bc7e4adb8479a49e8d945b652afb74b49e2f7a56827ae25a5919
  Stored in directory: /root/.cache/pip/wheels/4c/4f/a5/0bc765457bd41378bf3ce8d17d7495369d6e7ca3b712c60c89
Successfully built lime
Installing collected packages: lime
Successfully installed lime-0.2.0.1
```

```
[13] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
from lime import lime_image
explainer = lime_image.LimeImageExplainer()

# Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
explanation = explainer.explain_instance(array_airplane, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

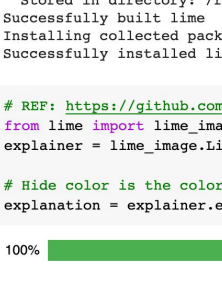
100% 1000/1000 [00:26<00:00, 37.23it/s]

```
[14] from skimage.segmentation import mark_boundaries
temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f0874a2dc50>
```

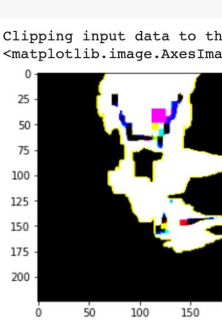
```
[15] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f08748d5fd0>
```



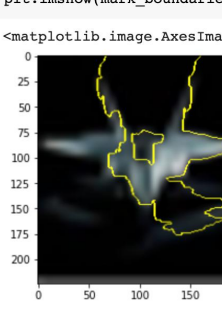
```
[16] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f0874aa4b00>
```



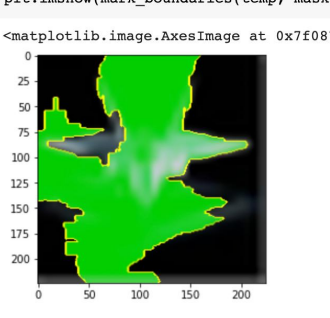
```
[17] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c78bac8>
```



```
[18] #Select the same class explained on the figures above.
ind =  explanation.top_labels[0]

#Map each explanation weight to the corresponding superpixel
dict_heatmap = dict(explanation.local_exp[ind])
heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

#Plot. The visualization makes more sense if a symmetrical colorbar is used.
plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f086c71ac50>
```

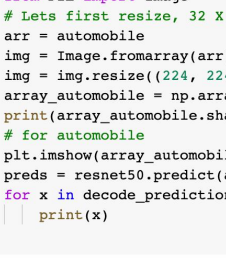


[ ]

FOR AUTOMOBILE

```
[19] import os
import keras
from keras.preprocessing import image
from keras.applications.imagenet_utils import decode_predictions
from skimage.io import imread
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import numpy as np
from PIL import Image
# Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
arr = automobile
img = Image.fromarray(arr)
img = img.resize((224, 224))
array_automobile = np.array(img)
print(array_automobile.shape)
# for automobile
plt.imshow(array_automobile)
preds = resnet50.predict(array_automobile.reshape((1,224,224,3)))
for x in decode_predictions(preds)[0]:
    print(x)
```

```
(224, 224, 3)
('n04127249', 'safety_pin', 0.22775148)
('n04153751', 'screw', 0.17388493)
('n03840681', 'ocarina', 0.11934535)
('n04579432', 'whistle', 0.08764689)
('n03804744', 'nail', 0.067204475)
```



```
[20] !pip install lime
```

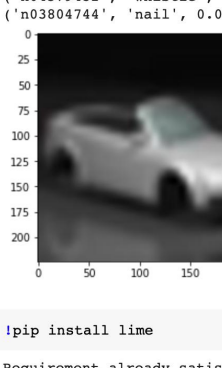
```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.6/dist-packages (from python-dateutil>=2.1->matplotlib->lime) (1.15.0)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
```

```
[21] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
from lime import lime_image
explainer = lime_image.LimeImageExplainer()

# Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
explanation = explainer.explain_instance(array_automobile, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

100% 1000/1000 [00:14<00:00, 69.69it/s]

```
[22] from skimage.segmentation import mark_boundaries
temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f086c4c2860>
```

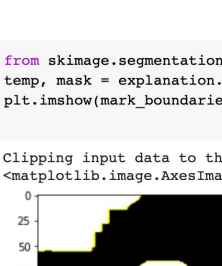


```
[23] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c66ab00>
```

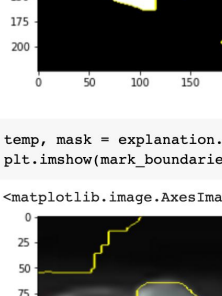
```
[24] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c4dc8d0>
```



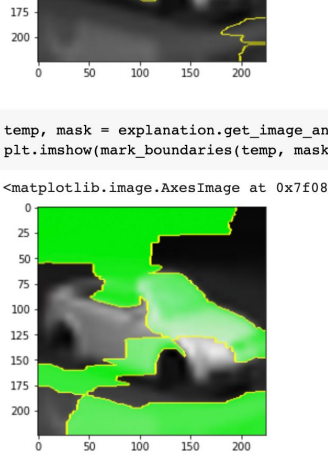
```
[25] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c33d630>
```



```
[26] #Select the same class explained on the figures above.
ind =  explanation.top_labels[0]

#Map each explanation weight to the corresponding superpixel
dict_heatmap = dict(explanation.local_exp[ind])
heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

#Plot. The visualization makes more sense if a symmetrical colorbar is used.
plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f086c2d6940>
```



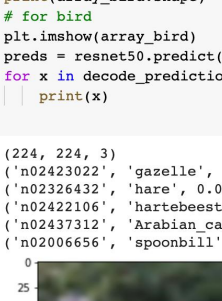
[ ]

[ ]

FOR BIRD

```
[27] import os
import keras
from keras.preprocessing import image
from keras.applications.imagenet_utils import decode_predictions
from skimage.io import imread
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import numpy as np
from PIL import Image
# Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
arr = bird
img = Image.fromarray(arr)
img = img.resize((224, 224))
array_bird = np.array(img)
print(array_bird.shape)
# for bird
plt.imshow(array_bird)
preds = resnet50.predict(array_bird.reshape((1,224,224,3)))
for x in decode_predictions(preds)[0]:
    print(x)
```

```
(224, 224, 3)
('n02423022', 'gazelle', 0.7805682)
('n02326432', 'hare', 0.06135845)
('n02422106', 'hartebeest', 0.034834128)
('n02437312', 'Arabian_camel', 0.029828925)
('n02006656', 'spoonbill', 0.023900127)
```



```
[28] !pip install lime
```

```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from cycler>=0.10->matplotlib->lime) (1.15.0)
```

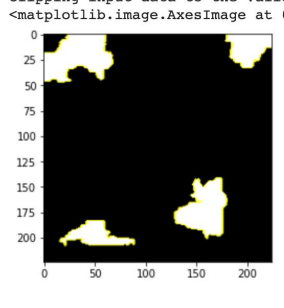
```
[29] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
from lime import lime_image
explainer = lime_image.LimeImageExplainer()

# Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
explanation = explainer.explain_instance(array_bird, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

100% 1000/1000 [00:36<00:00, 27.28it/s]

```
[30] from skimage.segmentation import mark_boundaries
```

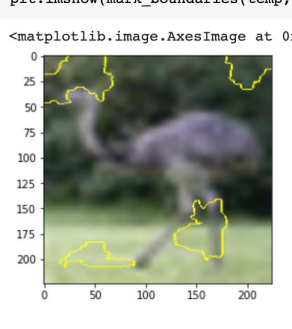
```
temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f087482eb38>
```



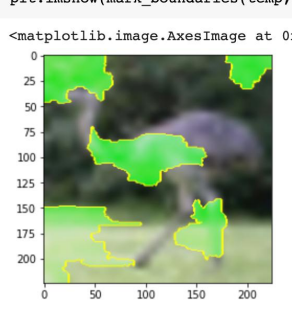
```
[31] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c21e2e8>
```



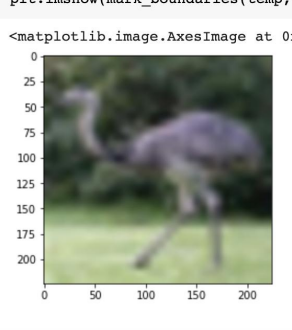
```
[32] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c63f1d0>
```



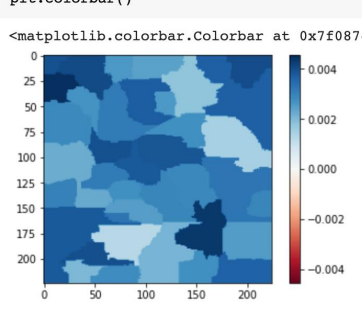
```
[33] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c449c88>
```



```
[34] #Select the same class explained on the figures above.
ind =  explanation.top_labels[0]

#Map each explanation weight to the corresponding superpixel
dict_heatmap = dict(explanation.local_exp[ind])
heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

#Plot. The visualization makes more sense if a symmetrical colorbar is used.
plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f087489bf98>
```

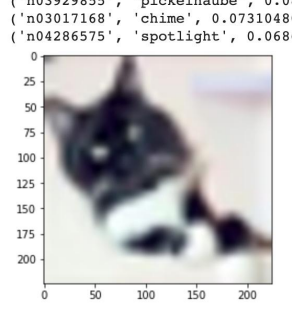


```
[ ]
```

FOR CAT

```
[35] import os
import keras
from keras.preprocessing import image
from keras.applications.imagenet_utils import decode_predictions
from skimage.io import imread
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import numpy as np
from PIL import Image
# Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
arr = cat
img = Image.fromarray(arr)
img = img.resize((224, 224))
array_cat = np.array(img)
print(array_cat.shape)
# for cat
plt.imshow(array_cat)
preds = resnet50.predict(array_cat.reshape((1,224,224,3)))
for x in decode_predictions(preds)[0]:
    print(x)
```

```
(224, 224, 3)
('n03720891', 'maraca', 0.14015383)
('n03838899', 'oboe', 0.08392137)
('n03929855', 'pickelhaube', 0.08309369)
('n03017168', 'chime', 0.073104806)
('n04286575', 'spotlight', 0.068617016)
```



```
[36] !pip install lime
```

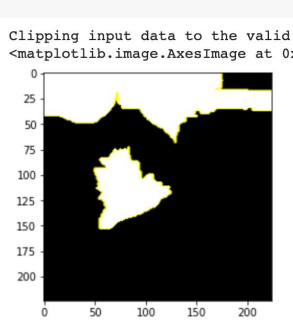
```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from cycler>=0.10->matplotlib->lime) (1.15.0)
```

```
[37] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
from lime import lime_image
explainer = lime_image.LimeImageExplainer()

# Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
explanation = explainer.explain_instance(array_cat, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

100% 1000/1000 [00:22<00:00, 43.49it/s]

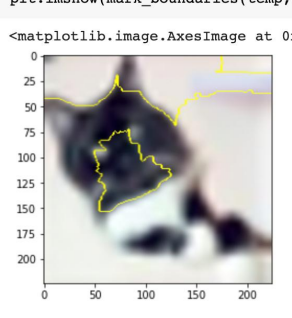
```
[38] from skimage.segmentation import mark_boundaries
temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f086b84f5c0>
```



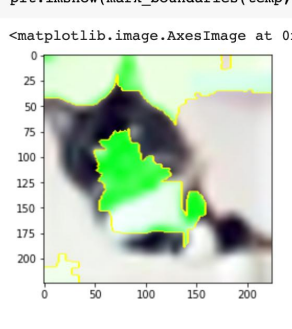
```
[39] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086a916ac8>
```



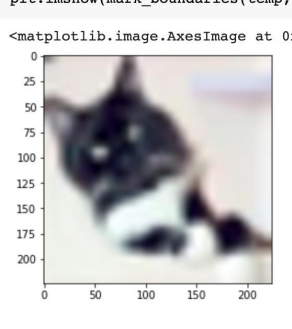
```
[40] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c1c85f8>
```



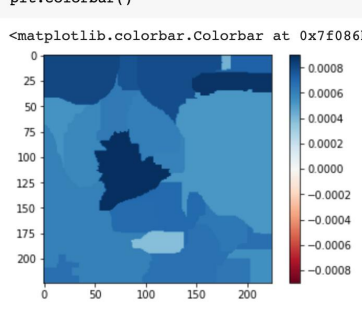
```
[41] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086b77ff98>
```



```
[42] #Select the same class explained on the figures above.
ind =  explanation.top_labels[0]

#Map each explanation weight to the corresponding superpixel
dict_heatmap = dict(explanation.local_exp[ind])
heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

#Plot. The visualization makes more sense if a symmetrical colorbar is used.
plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f086b7212e8>
```

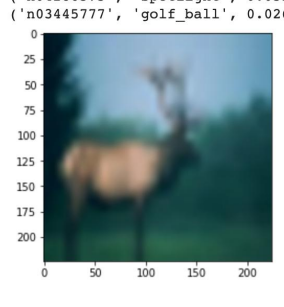


```
[ ]
```

FOR deer

```
[43] import os
import keras
from keras.preprocessing import image
from keras.applications.imagenet_utils import decode_predictions
from skimage.io import imread
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import numpy as np
from PIL import Image
# Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
arr = deer
img = Image.fromarray(arr)
img = img.resize((224, 224))
array_deer = np.array(img)
print(array_deer.shape)
# for deer
plt.imshow(array_deer)
preds = resnet50.predict(array_deer.reshape((1,224,224,3)))
for x in decode_predictions(preds)[0]:
    print(x)
```

```
(224, 224, 3)
('n04380533', 'table_lamp', 0.42434388)
('n03637318', 'lampshade', 0.16963987)
('n03544143', 'hourglass', 0.108071916)
('n04286575', 'spotlight', 0.052803192)
('n03445777', 'golf_ball', 0.026853792)
```



```
[44] !pip install lime
```

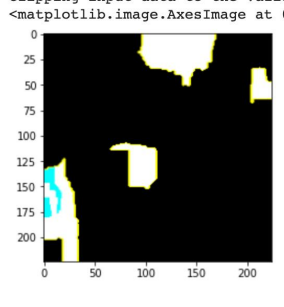
```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from cycler>=0.10->matplotlib->lime) (1.15.0)
```

```
[45] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
from lime import lime_image
explainer = lime_image.LimeImageExplainer()

# Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
explanation = explainer.explain_instance(array_deer, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

100% 1000/1000 [00:10<00:00, 98.05it/s]

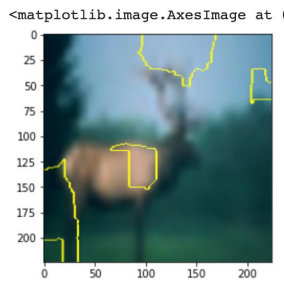
```
[46] from skimage.segmentation import mark_boundaries
temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f086b63b390>
```



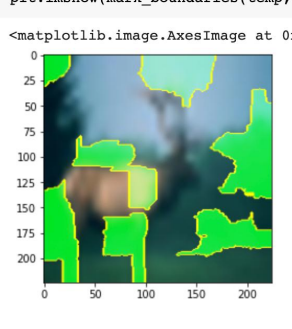
```
[47] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086b4a1860>
```



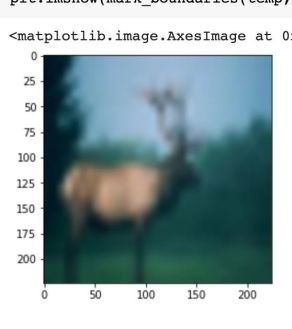
```
[48] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086b3eaf98>
```



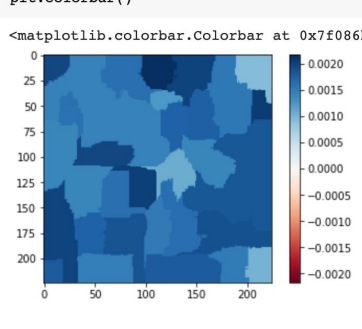
```
[49] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086b3406d8>
```



```
[50] #Select the same class explained on the figures above.
ind =  explanation.top_labels[0]

#Map each explanation weight to the corresponding superpixel
dict_heatmap = dict(explanation.local_exp[ind])
heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

#Plot. The visualization makes more sense if a symmetrical colorbar is used.
plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f086b2d99e8>
```

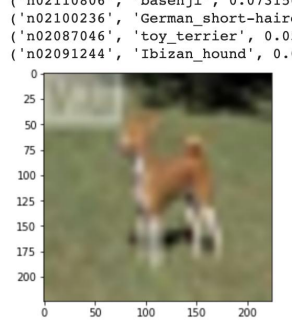


```
[ ]
```

FOR DOG

```
[51] import os
import keras
from keras.preprocessing import image
from keras.applications.imagenet_utils import decode_predictions
from skimage.io import imread
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import numpy as np
from PIL import Image
# Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
arr = dog
img = Image.fromarray(arr)
img = img.resize((224, 224))
array_dog = np.array(img)
print(array_dog.shape)
# for dog
plt.imshow(array_dog)
preds = resnet50.predict(array_dog.reshape((1,224,224,3)))
for x in decode_predictions(preds)[0]:
    print(x)
```

```
(224, 224, 3)
('n02093647', 'Bedlington_terrier', 0.36283636)
('n02110806', 'basenji', 0.073156856)
('n02100236', 'German_short-haired_pointer', 0.06064714)
('n02087046', 'toy_terrier', 0.059847422)
('n02091244', 'Ibizan_hound', 0.04943172)
```



```
[52] !pip install lime
```

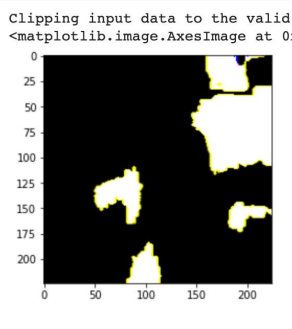
```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from cycler>=0.10->matplotlib->lime) (1.15.0)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
```

```
[53] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
from lime import lime_image
explainer = lime_image.LimeImageExplainer()

# Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
explanation = explainer.explain_instance(array_dog, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

100% 1000/1000 [00:40<00:00, 24.78it/s]

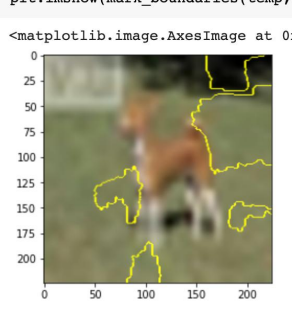
```
[54] from skimage.segmentation import mark_boundaries
temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f086b2935f8>
```



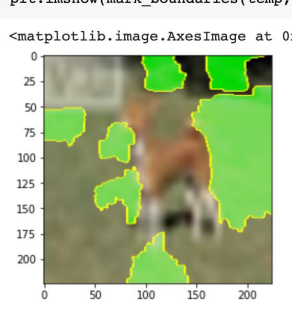
```
[55] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086b9a42b0>
```



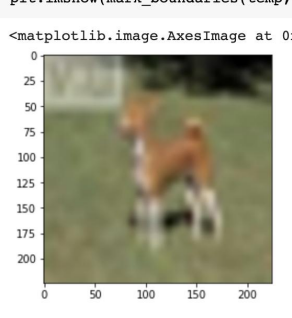
```
[56] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c204588>
```



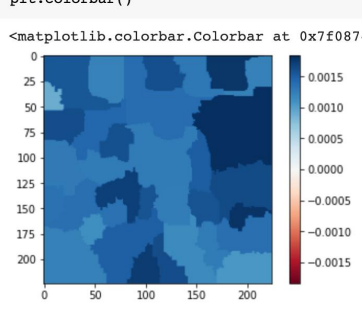
```
[57] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086c664320>
```



```
[58] #Select the same class explained on the figures above.
ind =  explanation.top_labels[0]

#Map each explanation weight to the corresponding superpixel
dict_heatmap = dict(explanation.local_exp[ind])
heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

#Plot. The visualization makes more sense if a symmetrical colorbar is used.
plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f0874a32160>
```

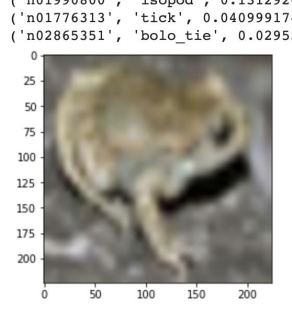


```
[ ]
```

FOR FROG

```
[59] import os
import keras
from keras.preprocessing import image
from keras.applications.imagenet_utils import decode_predictions
from skimage.io import imread
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import numpy as np
from PIL import Image
# Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
arr = frog
img = Image.fromarray(arr)
img = img.resize((224, 224))
array_frog = np.array(img)
print(array_frog.shape)
# for frog
plt.imshow(array_frog)
preds = resnet50.predict(array_frog.reshape((1,224,224,3)))
for x in decode_predictions(preds)[0]:
    print(x)
```

```
(224, 224, 3)
('n01930112', 'nematode', 0.36716795)
('n04286575', 'spotlight', 0.20037551)
('n01990800', 'isopod', 0.1312926)
('n01776313', 'tick', 0.040999174)
('n02865351', 'bolo_tie', 0.029531723)
```



```
[60] !pip install lime
```

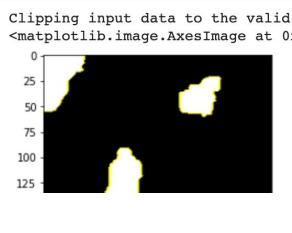
```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.6/dist-packages (from python-dateutil>=2.1->matplotlib->lime) (1.15.0)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
```

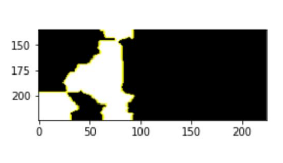
```
[61] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
from lime import lime_image
explainer = lime_image.LimeImageExplainer()

# Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
explanation = explainer.explain_instance(array_frog, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

100% 1000/1000 [00:27<00:00, 36.50it/s]

```
[62] from skimage.segmentation import mark_boundaries
temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
plt.imshow(mark_boundaries(temp, mask))
```

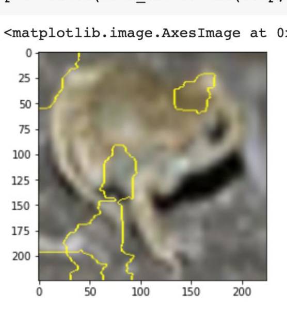
```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f0869fab5f8>
```





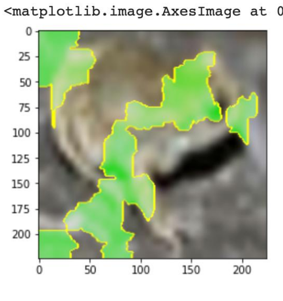
```
[63] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086b436940>
```



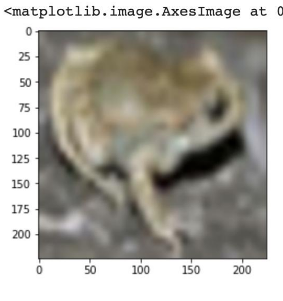
```
[64] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086b1c33c8>
```



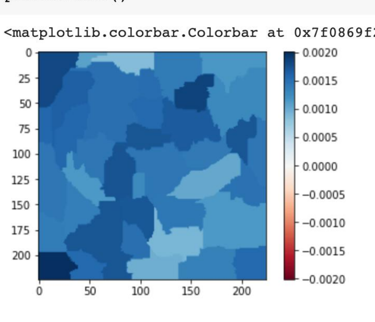
```
[65] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f0869f8dc18>
```



```
[66] #Select the same class explained on the figures above.
     ind =  explanation.top_labels[0]

     #Map each explanation weight to the corresponding superpixel
     dict_heatmap = dict(explanation.local_exp[ind])
     heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

     #Plot. The visualization makes more sense if a symmetrical colorbar is used.
     plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
     plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f0869f24f28>
```

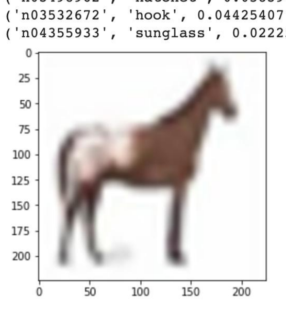


```
[ ]
```

FOR HORSE

```
[67] import os
     import keras
     from keras.preprocessing import image
     from keras.applications.imagenet_utils import decode_predictions
     from skimage.io import imread
     import matplotlib.pyplot as plt
     %matplotlib inline
     import numpy as np
     import numpy as np
     from PIL import Image
     # Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
     arr = horse
     img = Image.fromarray(arr)
     img = img.resize((224, 224))
     array_horse = np.array(img)
     print(array_horse.shape)
     # for horse
     plt.imshow(array_horse)
     preds = resnet50.predict(array_horse.reshape((1,224,224,3)))
     for x in decode_predictions(preds)[0]:
         print(x)
```

```
(224, 224, 3)
('n03804744', 'nail', 0.20845732)
('n04127249', 'safety_pin', 0.13645266)
('n03498962', 'hatchet', 0.058394317)
('n03532672', 'hook', 0.04425407)
('n04355933', 'sunglass', 0.022259263)
```



```
[68] !pip install lime
```

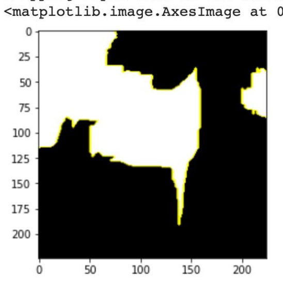
```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from cycler>=0.10->matplotlib->lime) (1.15.0)
```

```
[69] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
     from lime import lime_image
     explainer = lime_image.LimeImageExplainer()

     # Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
     explanation = explainer.explain_instance(array_horse, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

```
100% 1000/1000 [00:14<00:00, 69.86it/s]
```

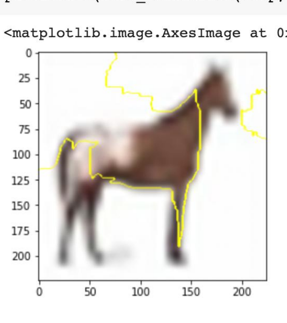
```
[70] from skimage.segmentation import mark_boundaries
     temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
     plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f086a6f6be0>
```



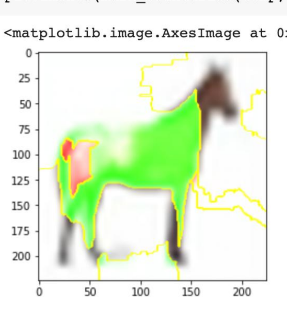
```
[71] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086a753898>
```



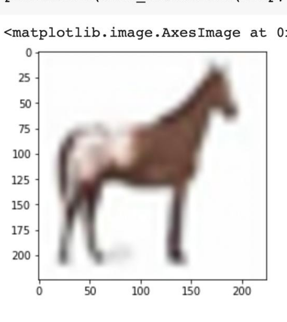
```
[72] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086a6e5c18>
```



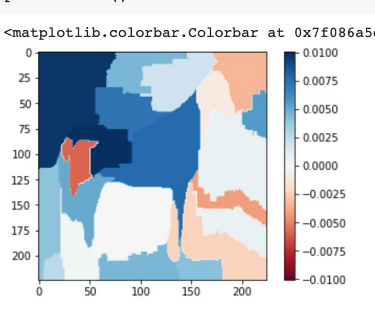
```
[73] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086a645358>
```



```
[74] #Select the same class explained on the figures above.
     ind =  explanation.top_labels[0]

     #Map each explanation weight to the corresponding superpixel
     dict_heatmap = dict(explanation.local_exp[ind])
     heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

     #Plot. The visualization makes more sense if a symmetrical colorbar is used.
     plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
     plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f086a5e0668>
```



```
[ ]
```

FOR SHIP

```
[75] import os
     import keras
     from keras.preprocessing import image
     from keras.applications.imagenet_utils import decode_predictions
     from skimage.io import imread
     import matplotlib.pyplot as plt
     %matplotlib inline
     import numpy as np
     import numpy as np
     from PIL import Image
     # Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
     arr = ship
     img = Image.fromarray(arr)
     img = img.resize((224, 224))
     array_ship = np.array(img)
     print(array_ship.shape)
     # for ship
     plt.imshow(array_ship)
     preds = resnet50.predict(array_ship.reshape((1,224,224,3)))
     for x in decode_predictions(preds)[0]:
         print(x)
```

```
(224, 224, 3)
('n03544143', 'hourglass', 0.1971248)
('n04111531', 'rotisserie', 0.1422272)
('n04357314', 'sunscreen', 0.083955914)
('n03062245', 'cocktail_shaker', 0.08059975)
('n04127249', 'safety_pin', 0.042410206)
```

```
[76] !pip install lime
```

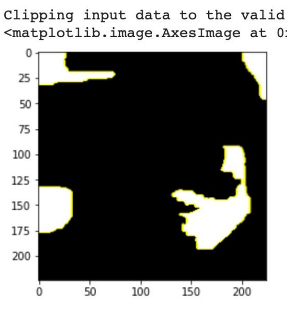
```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from cycler>=0.10->matplotlib->lime) (1.15.0)
```

```
[77] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
     from lime import lime_image
     explainer = lime_image.LimeImageExplainer()

     # Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
     explanation = explainer.explain_instance(array_ship, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

```
100% 1000/1000 [00:08<00:00, 118.05it/s]
```

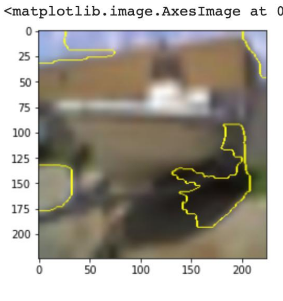
```
[78] from skimage.segmentation import mark_boundaries
     temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
     plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f086b234470>
```



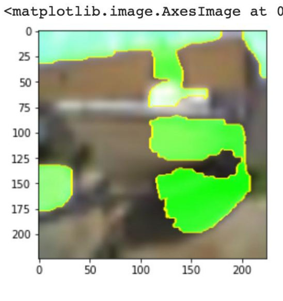
```
[79] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f08749fa240>
```



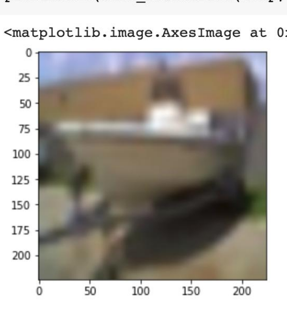
```
[80] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086b5b3d68>
```



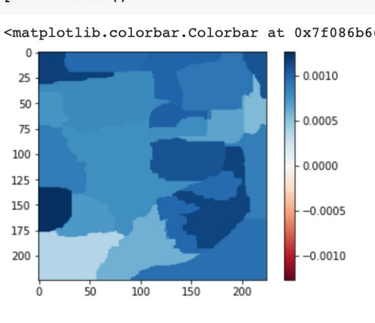
```
[81] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086a753400>
```



```
[82] #Select the same class explained on the figures above.
     ind =  explanation.top_labels[0]

     #Map each explanation weight to the corresponding superpixel
     dict_heatmap = dict(explanation.local_exp[ind])
     heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

     #Plot. The visualization makes more sense if a symmetrical colorbar is used.
     plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
     plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f086b669550>
```

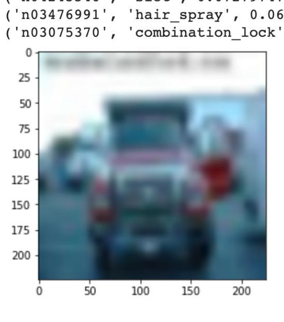


```
[ ]
```

FOR TRUCK

```
[83] import os
     import keras
     from keras.preprocessing import image
     from keras.applications.imagenet_utils import decode_predictions
     from skimage.io import imread
     import matplotlib.pyplot as plt
     %matplotlib inline
     import numpy as np
     import numpy as np
     from PIL import Image
     # Lets first resize, 32 X 32 X 3 to 224 X 224 X 3 for resnet or vice versa
     arr = truck
     img = Image.fromarray(arr)
     img = img.resize((224, 224))
     array_truck = np.array(img)
     print(array_truck.shape)
     # for truck
     plt.imshow(array_truck)
     preds = resnet50.predict(array_truck.reshape((1,224,224,3)))
     for x in decode_predictions(preds)[0]:
         print(x)
```

```
(224, 224, 3)
('n04357314', 'sunscreen', 0.09799741)
('n04127249', 'safety_pin', 0.07424616)
('n04243546', 'slot', 0.07279747)
('n03476991', 'hair_spray', 0.06999105)
('n03075370', 'combination_lock', 0.06572189)
```



```
[84] !pip install lime
```

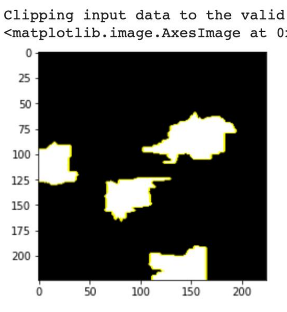
```
Requirement already satisfied: lime in /usr/local/lib/python3.6/dist-packages (0.2.0.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from lime) (1.19.5)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.6/dist-packages (from lime) (0.16.2)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from lime) (1.4.1)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.6/dist-packages (from lime) (0.22.2.post1)
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from lime) (4.41.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.6/dist-packages (from lime) (3.2.2)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.5)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (7.0.0)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image>=0.12->lime) (1.1.1)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-packages (from scikit-learn>=0.18->lime) (1.0.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.4.7)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (2.8.1)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib->lime) (0.10.0)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image>=0.12->lime) (4.4.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.6/dist-packages (from python-dateutil>=2.1->matplotlib->lime) (1.15.0)
```

```
[85] # REF: https://github.com/marcotcr/lime/blob/master/doc/notebooks/Tutorial%20-%20Image%20Classification%20Keras.ipynb
     from lime import lime_image
     explainer = lime_image.LimeImageExplainer()

     # Hide color is the color for a superpixel turned OFF. Alternatively, if it is NONE, the superpixel will be replaced by the average of its pixels
     explanation = explainer.explain_instance(array_truck, resnet50.predict, top_labels=5, hide_color=0, num_samples=1000)
```

```
100% 1000/1000 [00:08<00:00, 114.03it/s]
```

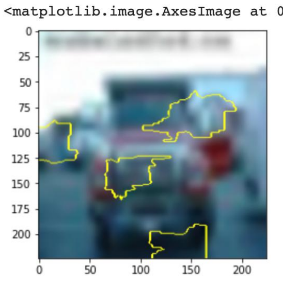
```
[86] from skimage.segmentation import mark_boundaries
     temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=True)
     plt.imshow(mark_boundaries(temp, mask))
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).
<matplotlib.image.AxesImage at 0x7f086a4bfe80>
```



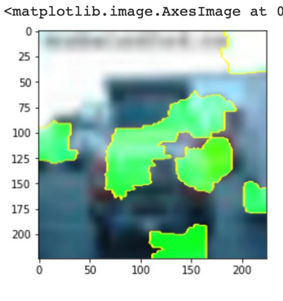
```
[87] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True, num_features=5, hide_rest=False)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086a096908>
```



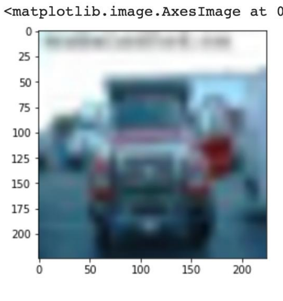
```
[88] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=10, hide_rest=False)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086a4e5cc0>
```



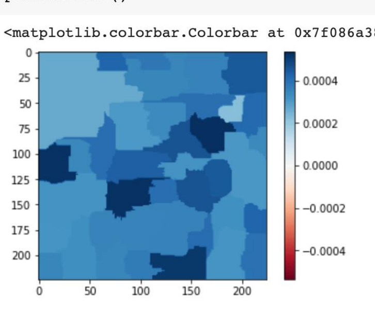
```
[89] temp, mask = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False, num_features=1000, hide_rest=False, min_weight=0.1)
     plt.imshow(mark_boundaries(temp, mask))
```

```
<matplotlib.image.AxesImage at 0x7f086a3e24a8>
```



```
[90] #Select the same class explained on the figures above.
     ind =  explanation.top_labels[0]

     #Map each explanation weight to the corresponding superpixel
     dict_heatmap = dict(explanation.local_exp[ind])
     heatmap = np.vectorize(dict_heatmap.get)(explanation.segments)

     #Plot. The visualization makes more sense if a symmetrical colorbar is used.
     plt.imshow(heatmap, cmap = 'RdBu', vmin  = -heatmap.max(), vmax = heatmap.max())
     plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f086a389710>
```



```
[ ]
```