Image Classification with Convolutional Neural Networks

Steps:

1. Explore the Data of bikes and no bikes
2. Build and Train a Neural Network to recognize the difference between the two
3. Evaluate the Training and Validation accuracy or F1-score

Preliminaries

In [1]:
```
gpu_info = !nvidia-smi
gpu_info = '\n'.join(gpu_info)
if gpu_info.find('failed') >= 0:
  print('Select the Runtime > "Change runtime type" menu to enable a GPU accelerator, ')
  print('and then re-execute this cell.')
else:
  print(gpu_info)
```

```
Tue Apr  6 19:01:44 2021
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 460.67       Driver Version: 460.32.03    CUDA Version: 11.2     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Tesla V100-SXM2...  Off  | 00000000:00:04.0 Off |                    0 |
| N/A   34C    P0    23W / 300W |      0MiB / 16160MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```

In [2]:
```
from psutil import virtual_memory
ram_gb = virtual_memory().total / 1e9
print('Your runtime has {:.1f} gigabytes of available RAM\n'.format(ram_gb))

if ram_gb < 20:
  print('To enable a high-RAM runtime, select the Runtime > "Change runtime type"')
  print('menu, and then select High-RAM in the Runtime shape dropdown. Then, ')
  print('re-execute this cell.')
else:
  print('You are using a high-RAM runtime!')
```

```
Your runtime has 27.4 gigabytes of available RAM

You are using a high-RAM runtime!
```

Libraries

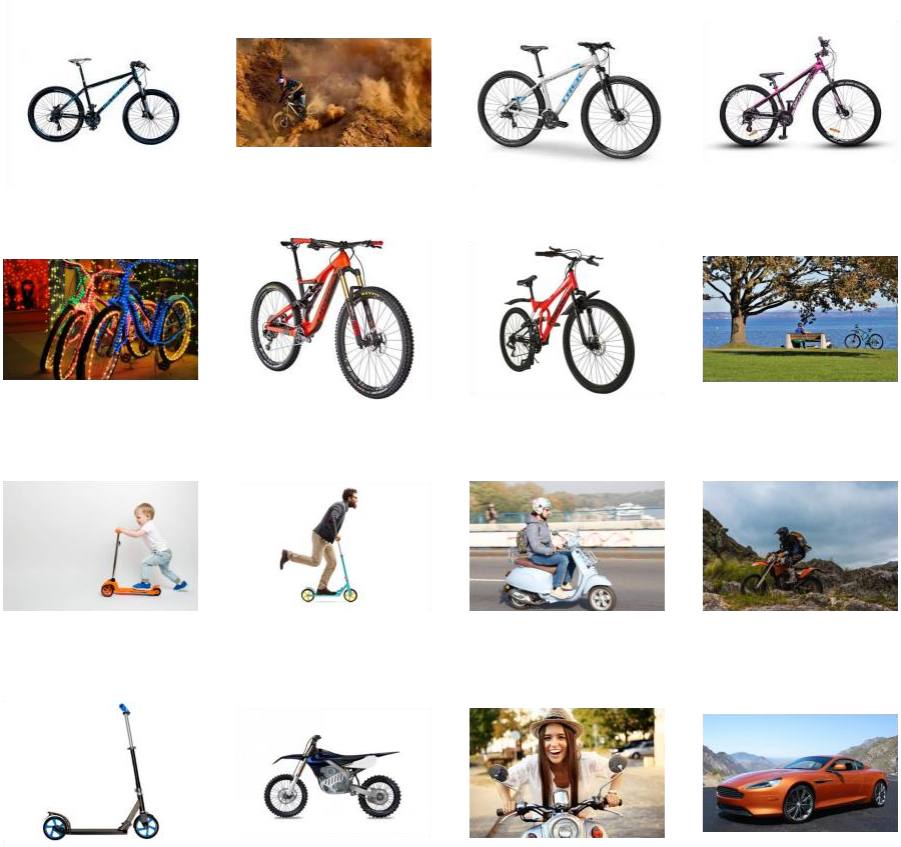
In [3]:
```
# Importing necessary libraries
import pathlib
import os
import random
import glob

import keras
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.layers import Input, Conv2D, Dense, Flatten, Dropout, GlobalMaxPooling2D, MaxPooling2D, BatchNormalization
from tensorflow.keras.models import Model
from tensorflow.keras.optimizers import RMSprop, Adam
from tensorflow.keras import optimizers
from tensorflow.keras.callbacks import *


from keras.callbacks import Callback
from sklearn.metrics import confusion_matrix, f1_score, precision_score, recall_score

from skimage import io
from skimage.morphology import binary_closing, binary_dilation, binary_erosion, binary_opening
from skimage.feature import canny
from skimage.morphology import selem
from skimage import transform


from PIL import Image

from sklearn.metrics import roc_auc_score
from sklearn.metrics import confusion_matrix

import itertools

import numpy as np
import pandas as pd
import cv2

%matplotlib inline
import matplotlib.image as mpimg
import matplotlib.pyplot as plt
```

Functions

Look at a few pictures.

In [10]:

```
nrows = 4
ncols = 4

pic_index = 0

fig = plt.gcf()
fig.set_size_inches(ncols*4, nrows*4)

pic_index+=8

next_bike_pix = [os.path.join(train_bikes_dir, fname)
                 for fname in train_bikes_fnames[ pic_index-8:pic_index]
                ]

next_nobike_pix = [os.path.join(train_nobikes_dir, fname)
                 for fname in train_nobikes_fnames[ pic_index-8:pic_index]
                ]

for i, img_path in enumerate(next_bike_pix + next_nobike_pix):
    sp = plt.subplot(nrows, ncols, i + 1)
    sp.axis('Off')

    img = mpimg.imread(img_path)
    plt.imshow(img)

plt.show()
```



In [23]:
```
for i in range(5):
  fig = plt.imshow(images[i], cmap='gray')
  fig.axes.get_xaxis().set_visible(False)
  fig.axes.get_yaxis().set_visible(False)
  print('\nEjemplo de imagen preprocesada:\n')
  plt.show()
```

```
Ejemplo de imagen preprocesada:
```

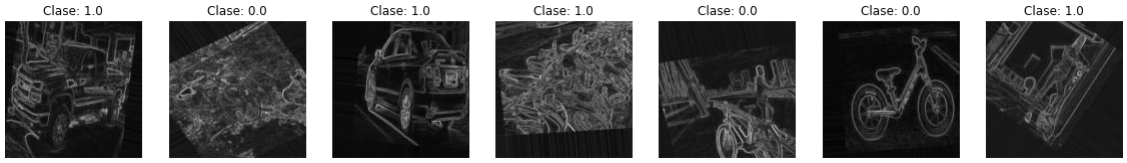
ImageDataGenerator

ImageDataGenerator for Train

```
Found 5759 images belonging to 2 classes.
```

In [35]:
```
plot_7_images(X_train,y_train)
```

```
Some Images:
```



ImageDataGenerator for Validation and Test

```
Found 1428 images belonging to 2 classes.
```

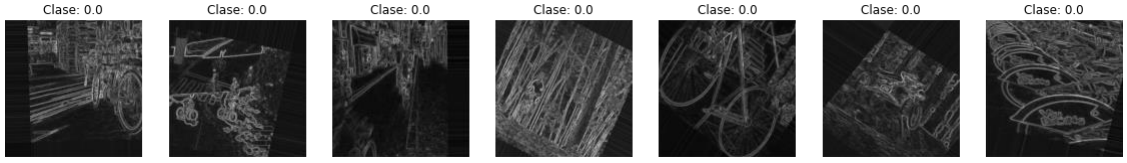
In [42]:
```
plot_7_images(X_val,y_val)
```

```
Some Images:
```

In [43]:
```
Found 894 images belonging to 2 classes.
```

In [44]:
```
plot_7_images(X_test, y_test)
```

```
Some Images:
```



Modelling ConvNet

Model Architecture

```
Total params: 648,354
Trainable params: 647,714
Non-trainable params: 640
_________________________________________________________________
```

Compile and Fit Model

Last Epochs

```
Epoch 288/300
359/359 - 52s - loss: 0.0571 - acc: 0.9758 - precision_1: 0.9758 - recall_1: 0.9758 - val_loss: 0.4388 - val_acc: 0.8764 - val_precision_1: 0.8764 - val_recall_1: 0.8764
Epoch 289/300
359/359 - 52s - loss: 0.0681 - acc: 0.9737 - precision_1: 0.9737 - recall_1: 0.9737 - val_loss: 0.3997 - val_acc: 0.8553 - val_precision_1: 0.8553 - val_recall_1: 0.8553
Epoch 290/300
359/359 - 52s - loss: 0.0592 - acc: 0.9770 - precision_1: 0.9770 - recall_1: 0.9770 - val_loss: 0.5144 - val_acc: 0.8617 - val_precision_1: 0.8617 - val_recall_1: 0.8617
Epoch 291/300
359/359 - 52s - loss: 0.0489 - acc: 0.9808 - precision_1: 0.9808 - recall_1: 0.9808 - val_loss: 0.6639 - val_acc: 0.8392 - val_precision_1: 0.8392 - val_recall_1: 0.8392

Reached 98.00% accuracy, so stopping training!!
```

In [105]:
```
model.save('bike_class_v5.h5')
```

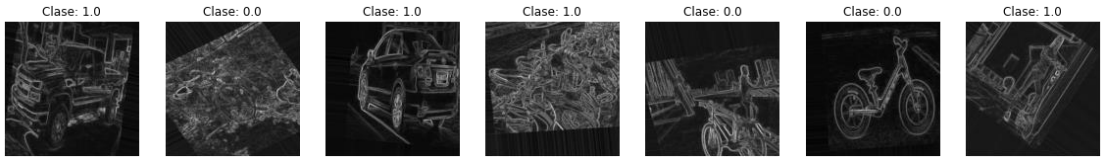
Evaluate Model

Performance Training

```
Found 5759 images belonging to 2 classes.
```

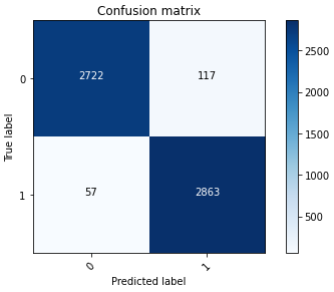
In [108]:
```
plot_7_images(images_train, images_class)
```

```
Some Images:
```



In [109]:

```
Confusion matrix, without normalization
[[2722  117]
 [  57 2863]]
```



In [110]:
```
print(classification_report(original_classes, predict_classes))
```

```
              precision    recall  f1-score   support

           0       0.98      0.96      0.97      2839
           1       0.96      0.98      0.97      2920

    accuracy                           0.97      5759
   macro avg       0.97      0.97      0.97      5759
weighted avg       0.97      0.97      0.97      5759
```

Performance en validacion

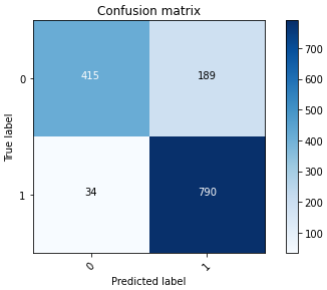
```
Found 1428 images belonging to 2 classes.
```

In [114]:
```
plot_7_images(images_train, images_class)
```

```
Some Images:
```

In [115]:

```
Confusion matrix, without normalization
[[415 189]
 [ 34 790]]
```



In [116]:
```
print(classification_report(original_classes, predict_classes))
```

```
              precision    recall  f1-score   support

           0       0.92      0.69      0.79       604
           1       0.81      0.96      0.88       824

    accuracy                           0.84      1428
   macro avg       0.87      0.82      0.83      1428
weighted avg       0.86      0.84      0.84      1428
```

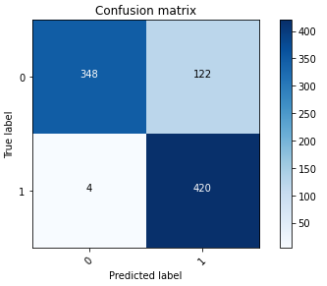
Performance en testing

In [117]:
```
images_train, images_class = next(test_generator)

plot_7_images(images_train, images_class)
```

```
Some Images:
```

In [118]:

```
Confusion matrix, without normalization
[[348 122]
 [  4 420]]
```



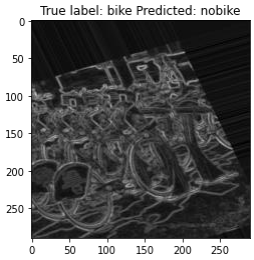
In [119]:
```
print(classification_report(original_classes, predict_classes))
```

```
              precision    recall  f1-score   support

           0       0.99      0.74      0.85       470
           1       0.77      0.99      0.87       424

    accuracy                           0.86       894
   macro avg       0.88      0.87      0.86       894
weighted avg       0.89      0.86      0.86       894
```

Concusiones

In [120]:
```
# Label mapping
labels = '''bike
nobike'''.split()
```

In [121]:
```
# Show some misclassified examples
misclassified_idx = np.where(predict_classes != original_classes)[0]
i = np.random.choice(misclassified_idx).astype(int)

if images_train[i].shape[2] == 1:
    image1 = images_train[i][:, :, 0]
plt.imshow(image1, cmap='gray')
plt.title("True label: %s Predicted: %s" % (labels[original_classes[i]], labels[predict_classes[i]]));
```



In [124]:
```
# Upload image
from google.colab import files
from shutil import copyfile
from keras.preprocessing import image
try:
  os.mkdir('/content/image/')
except:
  pass
uploaded = files.upload()
```

Elegir archivos No se ha seleccionado ningún archivo

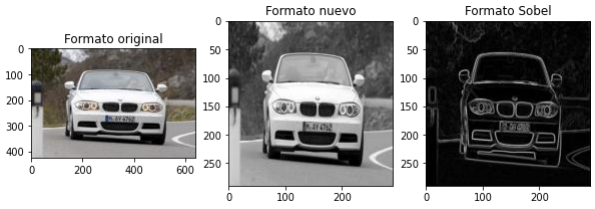
Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving 01622.jpg to 01622.jpg
Saving 01623.jpg to 01623.jpg
Saving 01624.jpg to 01624.jpg
Saving 01625.jpg to 01625.jpg
Saving 01626.jpg to 01626.jpg
Saving 5113823-1-11-f164ae9f40e8ac687015877172783544-640-0.jpg to 5113823-1-11-f164ae9f40e8ac687015877172783544-640-0 (1).jpg
Saving 828841001_1.jpg to 828841001_1.jpg
Saving bici 2.png to bici 2.png
Saving Bici.png to Bici (1).png
Saving bicicleta (1445).jpg to bicicleta (1445).jpg
Saving bicicleta (1468).jpg to bicicleta (1468).jpg
Saving bicicleta (1658).jpg to bicicleta (1658) (1).jpg
Saving bicicleta (1660).jpg to bicicleta (1660).jpg
Saving bicicleta (1662).jpg to bicicleta (1662) (1).jpg
Saving bicicleta (1664).jpg to bicicleta (1664) (2).jpg
Saving bike-at-sunrise-picture-id451266079.jpg to bike-at-sunrise-picture-id451266079 (1).jpg
Saving competitive-mood-picture-id186667614.jpg to competitive-mood-picture-id186667614 (1).jpg
Saving MicrosoftTeams-image (4).png to MicrosoftTeams-image (4) (3).png
Saving MicrosoftTeams-image.png to MicrosoftTeams-image (2).png
Saving Moto_Juancho (2).png to Moto_Juancho (2) (2).png
Saving Moto_Juancho 3.png to Moto_Juancho 3 (1).png
Saving Moto_juancho 4.png to Moto_juancho 4.png
Saving Moto_Juancho.png to Moto_Juancho.png
Saving row-of-ride-sharing-electric-scooters-parked-on-street-in-gaslamp-picture-id1263556504.jpg to row-of-ride-sharing-electric-scooters-parked-on-street-in-gaslamp-pictur
e-id1263556504.jpg
Saving sister-with-brother-riding-scooter-and-bike-on-driveway-at-home-picture-id904506354.jpg to sister-with-brother-riding-scooter-and-bike-on-driveway-at-home-picture-id9
04506354.jpg
Saving WhatsApp Image 2021-03-26 at 13.04.49.jpeg to WhatsApp Image 2021-03-26 at 13.04.49.jpeg
Saving WhatsApp Image 2021-03-26 at 13.05.02.jpeg to WhatsApp Image 2021-03-26 at 13.05.02 (1).jpeg
Saving WhatsApp Image 2021-03-26 at 13.05.15.jpeg to WhatsApp Image 2021-03-26 at 13.05.15.jpeg
Saving woman-on-scooter-on-parisian-street-picture-id1128757501.jpg to woman-on-scooter-on-parisian-street-picture-id1128757501 (1).jpg
```

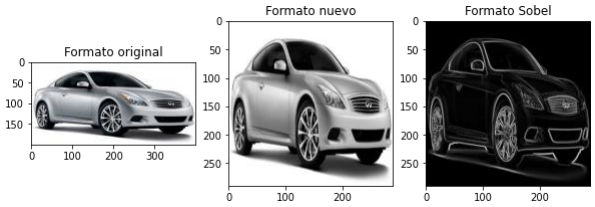
Testing model with new images.

In [125]:

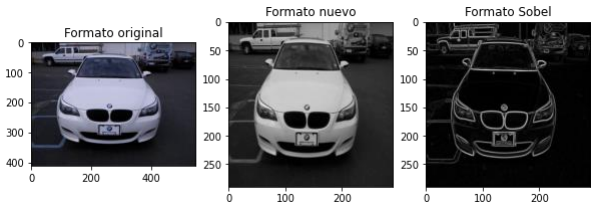
```
Nombre de la foto: 01622.jpg
(290, 290, 1)
0.1849121
```



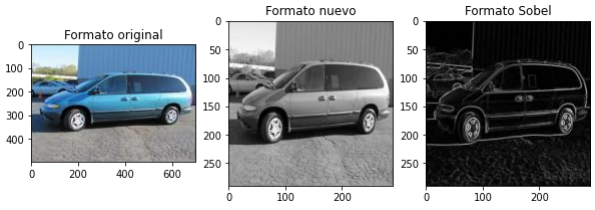

```
Prediction:  1
Probabilty: 1.4148395e-21
01622.jpg isn't a bike
.........................................

Nombre de la foto: 01623.jpg
(290, 290, 1)
0.18283488
```



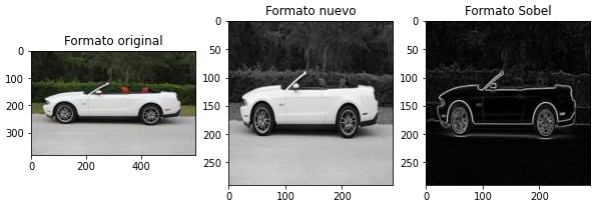

```
Prediction:  1
Probabilty: 2.991947e-30
01623.jpg isn't a bike
.........................................

Nombre de la foto: 01624.jpg
(290, 290, 1)
0.17213762
```




```
Prediction:  1
Probabilty: 1.7515737e-07
01624.jpg isn't a bike
.........................................

Nombre de la foto: 01625.jpg
(290, 290, 1)
0.18755648
```

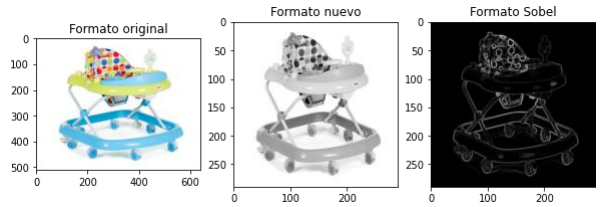



```
Prediction:  1
Probabilty: 9.787001e-38
01625.jpg isn't a bike
.........................................

Nombre de la foto: 01626.jpg
(290, 290, 1)
0.17469946
```

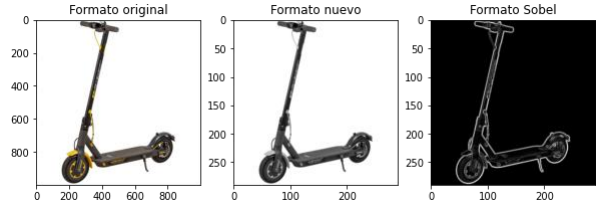



```
Prediction:  1
Probabilty: 2.08434e-28
01626.jpg isn't a bike
.........................................
```

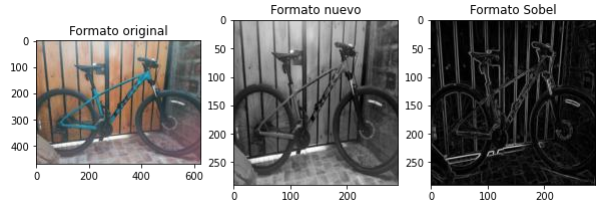
```
Nombre de la foto: 5113823-1-11-f164ae9f40e8ac687015877172783544-640-0.jpg
(290, 290, 1)
0.15261286
```



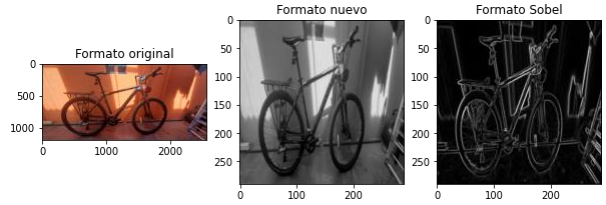

```
Prediction:  1
Probabilty:  2.729563e-10
5113823-1-11-f164ae9f40e8ac687015877172783544-640-0.jpg isn't a bike
.........................................

Nombre de la foto: 828841001_1.jpg
(290, 290, 1)
0.1435735
```



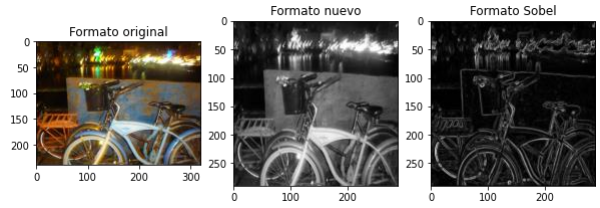

```
Prediction:  1
Probabilty:  9.12951e-18
828841001_1.jpg isn't a bike
.........................................

Nombre de la foto: bici 2.png
(290, 290, 1)
0.1936022
```



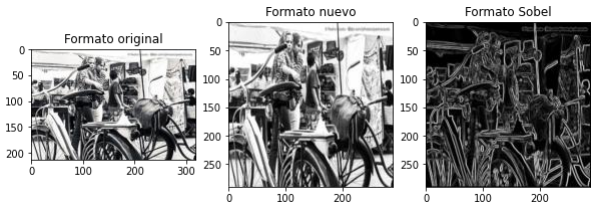

```
Prediction:  0
Probabilty:  1.0
bici 2.png is a bike
.........................................

Nombre de la foto: Bici.png
(290, 290, 1)
0.18890814
```



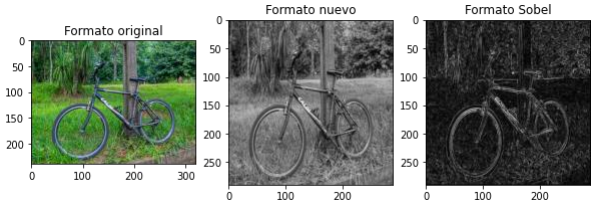

```
Prediction:  0
Probabilty:  1.0
Bici.png is a bike
.........................................

Nombre de la foto: bicicleta (1445).jpg
(290, 290, 1)
0.20211351
```



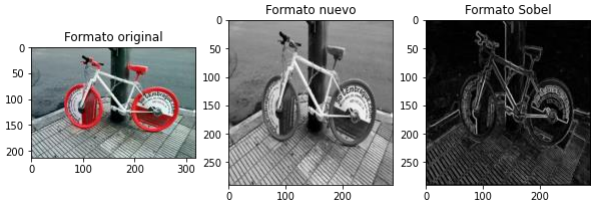

```
Prediction:  0
Probabilty:  0.9986072
bicicleta (1445).jpg is a bike
.........................................

Nombre de la foto: bicicleta (1468).jpg
(290, 290, 1)
0.25938335
```



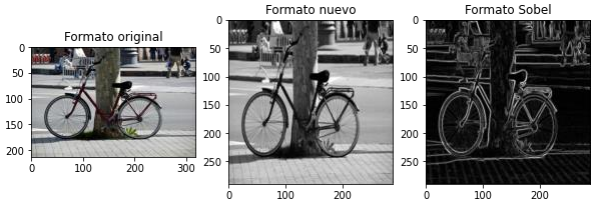

```
Prediction:  1
Probabilty:  0.1608455
bicicleta (1468).jpg isn't a bike
.........................................

Nombre de la foto: bicicleta (1658).jpg
(290, 290, 1)
0.24355316
```



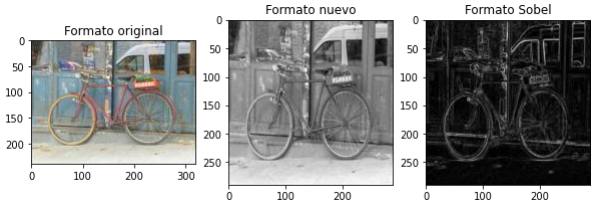

```
Prediction:  0
Probabilty:  1.0
bicicleta (1658).jpg is a bike
.........................................

Nombre de la foto: bicicleta (1660).jpg
(290, 290, 1)
0.2134772
```



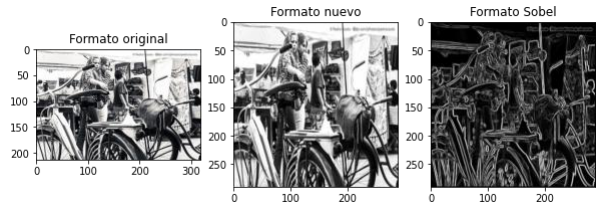

```
Prediction:  1
Probabilty:  0.05626133
bicicleta (1660).jpg isn't a bike
.........................................

Nombre de la foto: bicicleta (1662).jpg
(290, 290, 1)
0.21080095
```



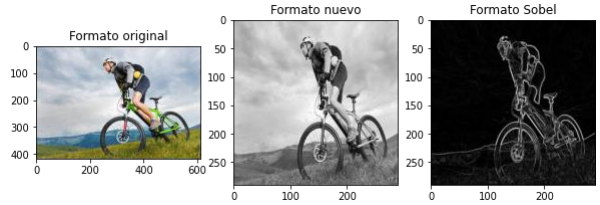

```
Prediction:  0
Probabilty:  1.0
bicicleta (1662).jpg is a bike
.........................................

Nombre de la foto: bicicleta (1664).jpg
(290, 290, 1)
0.20755534
```



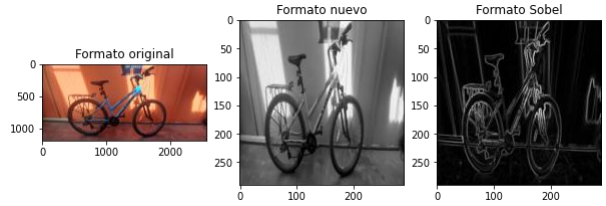

```
Prediction:  0
Probabilty:  1.0
bicicleta (1664).jpg is a bike
.........................................

Nombre de la foto: bike-at-sunrise-picture-id451266079.jpg
(290, 290, 1)
0.1471555
```



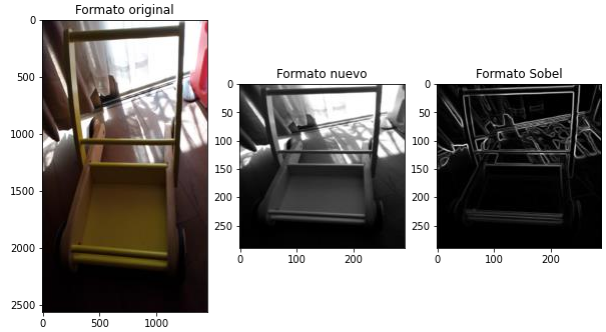

```
Prediction:  0
Probabilty:  0.9999964
bike-at-sunrise-picture-id451266079.jpg is a bike
..............................................

Nombre de la foto: competitive-mood-picture-id186667614.jpg
(290, 290, 1)
0.1763088
```



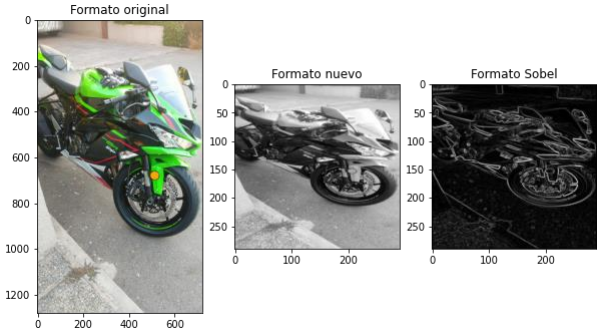

```
Prediction:  0
Probabilty:  1.0
competitive-mood-picture-id186667614.jpg is a bike
..............................................

Nombre de la foto: MicrosoftTeams-image (4).png
(290, 290, 1)
0.18261531
```



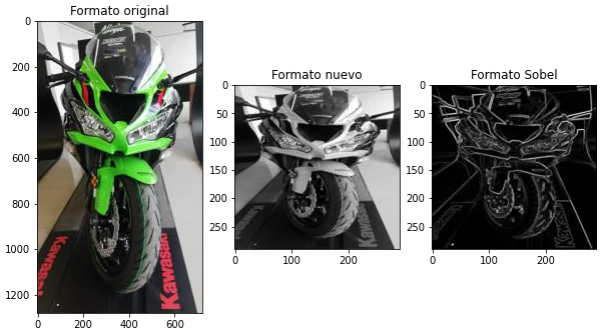

```
Prediction:  0
Probabilty:  0.999967
MicrosoftTeams-image (4).png is a bike
..............................................

Nombre de la foto: MicrosoftTeams-image.png
(290, 290, 1)
0.17185155
```



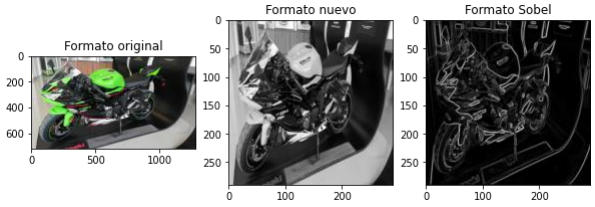

```
Prediction:  1
Probabilty:  1.7359398e-06
MicrosoftTeams-image.png isn't a bike
..............................................

Nombre de la foto: Moto_Juancho (2).png
(290, 290, 1)
0.20438586
```



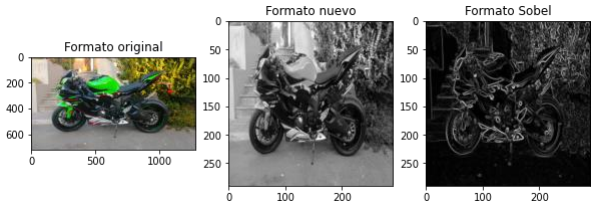

```
Prediction:  1
Probabilty:  1.583148e-08
Moto_Juancho (2).png isn't a bike
.........................................

Nombre de la foto: Moto_Juancho 3.png
(290, 290, 1)
0.19165553
```



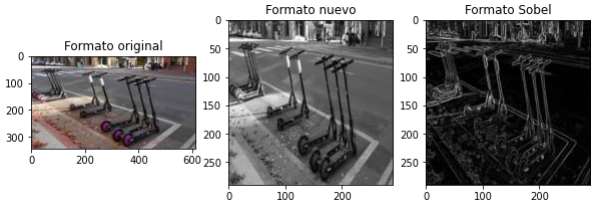

```
Prediction:  1
Probabilty:  0.00037665706
Moto_Juancho 3.png isn't a bike
.........................................

Nombre de la foto: Moto_juancho 4.png
(290, 290, 1)
0.19226515
```



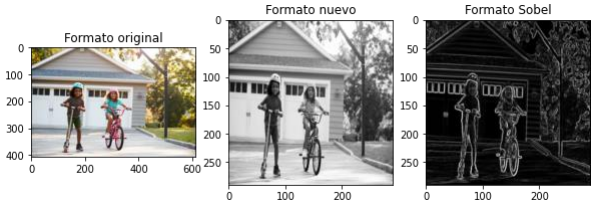

```
Prediction:  1
Probabilty:  2.1897949e-11
Moto_juancho 4.png isn't a bike
.........................................

Nombre de la foto: Moto_Juancho.png
(290, 290, 1)
0.21223935
```



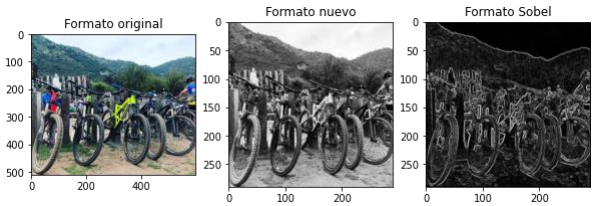

```
Prediction:  1
Probabilty:  8.620477e-15
Moto_Juancho.png isn't a bike
.........................................

Nombre de la foto: row-of-ride-sharing-electric-scooters-parked-on-street-in-gaslamp-picture-id1263556504.jpg
(290, 290, 1)
0.20459321
```



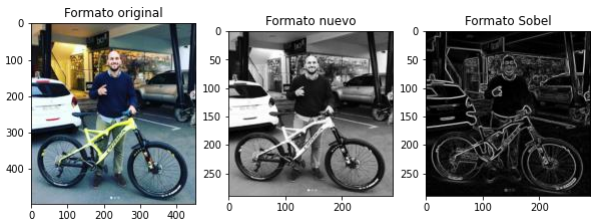

```
Prediction:  1
Probabilty:  1.5262219e-13
row-of-ride-sharing-electric-scooters-parked-on-street-in-gaslamp-picture-id1263556504.jpg isn't a bike
.........................................

Nombre de la foto: sister-with-brother-riding-scooter-and-bike-on-driveway-at-home-picture-id904506354.jpg
(290, 290, 1)
0.21292934
```



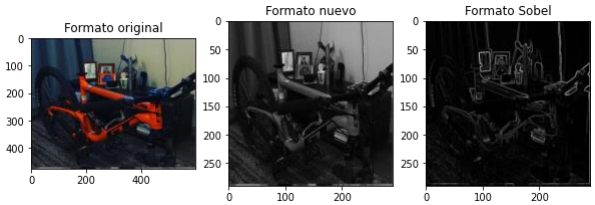

```
Prediction:  1
Probabilty:  2.0642844e-06
sister-with-brother-riding-scooter-and-bike-on-driveway-at-home-picture-id904506354.jpg isn't a bike
.........................................

Nombre de la foto: WhatsApp Image 2021-03-26 at 13.04.49.jpeg
(290, 290, 1)
0.23953933
```



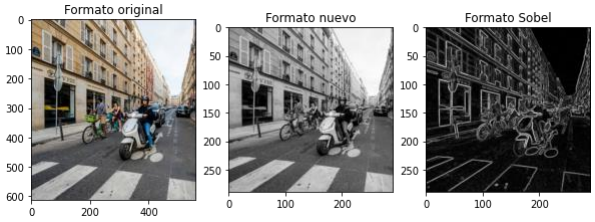

```
Prediction:  0
Probabilty:  0.9997954
WhatsApp Image 2021-03-26 at 13.04.49.jpeg is a bike
.........................................

Nombre de la foto: WhatsApp Image 2021-03-26 at 13.05.02.jpeg
(290, 290, 1)
0.20784639
```




```
Prediction:  0
Probabilty:  1.0
WhatsApp Image 2021-03-26 at 13.05.02.jpeg is a bike
.........................................

Nombre de la foto: WhatsApp Image 2021-03-26 at 13.05.15.jpeg
(290, 290, 1)
0.16290307
```




```
Prediction:  1
Probabilty:  3.192154e-05
WhatsApp Image 2021-03-26 at 13.05.15.jpeg isn't a bike
.........................................

Nombre de la foto: woman-on-scooter-on-parisian-street-picture-id1128757501.jpg
(290, 290, 1)
0.22714071
```




```
Prediction:  1
Probabilty:  1.9488583e-08
woman-on-scooter-on-parisian-street-picture-id1128757501.jpg isn't a bike
.........................................
```

In [ ]: