

kernel (1)

November 30, 2018

Firstly we import the needed packages and libraries to run the python script. We then show the directories in which the data we need are in.

```
In [1]: import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

from IPython.core.interactiveshell import InteractiveShell
InteractiveShell.ast_node_interactivity = "all"
import datetime as dt
import matplotlib.pyplot as plt
import seaborn as sns
import ast
from datetime import date, timedelta

import pickle # Read/Write with Serialization
import requests # Makes HTTP requests
from io import BytesIO # Use When expecting bytes-like objects
start = dt.datetime.now()

import os
print(os.listdir("../input"))

# Any results you write to the current directory are saved as output.

['test_simplified.csv', 'sample_submission.csv', 'train_simplified', 'test_raw.csv']
```

The number of classes are easily found, looking at the amount of files in the *train_simplified* folder. Afterwards the amount of images in each class is found in a *for loop* by reading each csv file. The numbers are also used for counting the total amount of images.

```
In [2]: TRAIN_FILES_PATH = '../input/train_simplified/'
```

```

trainingFileNameArr = os.listdir(TRAIN_FILES_PATH)
totalClassesCount = len(trainingFileNameArr)
totalImagesCount = 0

print('classes:', totalClassesCount)

#for trainingFileName in trainingFileNameArr:
#    print(trainingFileName)
#    dataset = pd.read_csv(TRAIN_FILES_PATH + trainingFileName, header=0).values
#    print(dataset.shape[0])
#    totalImagesCount += dataset.shape[0]

print(trainingFileNameArr)
print('images: 49707579')
print('Average in each class: 146198.76')

```

classes: 340

['sleeping bag.csv', 'house plant.csv', 'bathtub.csv', 'key.csv', 'triangle.csv', 'grapes.csv',

images: 49707579

Average in each class: 146198.76

There are 340 classes and 49,707,579 images in total. The amount of images in each class is printed with the class name in the output above averaging at 146198.76 per class. ### Printing images from 8 classes. The first 8 classes has been selected for printing.

```

In [3]: for i in range(8):
        print(trainingFileNameArr[i]);
        path = os.path.join(TRAIN_FILES_PATH,trainingFileNameArr[i]);
        item = pd.read_csv(path);
        item['timestamp'] = pd.to_datetime(item.timestamp);
        item = item.sort_values(by='timestamp',ascending=False)[-20:]
        item['drawing'] = item['drawing'].apply(ast.literal_eval);

        item.head()

        n = 10
        fig, axs = plt.subplots(2, 10, figsize=(16, 3));
        for i, drawing in enumerate(item.drawing):
            ax = axs[i // n, i % n];
            for x, y in drawing:
                ax.plot(x, -np.array(y), lw=3);
            ax.axis('off');

        fig.savefig('item.jpg', dpi=200)
        fig = plt.show();

```

sleeping bag.csv

```

Out[3]:      countrycode      ...      word
          95303      US      ...      sleeping bag
          100359      US      ...      sleeping bag
          53606      JP      ...      sleeping bag
          38046      US      ...      sleeping bag
          69918      US      ...      sleeping bag

```

```
[5 rows x 6 columns]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d7a518>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d7aa58>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d7ae48>]
```

```
Out[3]: (-12.75, 267.75, -129.15, 6.15)
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f27555b2b00>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d7a9e8>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d92780>]
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```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d92a20>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d92e48>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d9a2e8>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d9a748>]
```

```
Out[3]: (-6.95, 167.95, -267.75, 12.75)
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8dad048>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d9aba8>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8dad860>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8dad9e8>]
```

```
Out[3]: (-12.75, 267.75, -121.8, 5.800000000000001)
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8db02e8>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8dade48>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8db0b00>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8db0c88>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d35128>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d35588>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d359e8>]
Out[3]: (-9.700000000000001, 203.7, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d3f2e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d35e48>]
Out[3]: (-12.75, 267.75, -71.4, 3.4000000000000004)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d3fb00>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d3fc88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d504e0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d50668>]
Out[3]: (-7.7, 161.7, -267.7, 11.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d50ac8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d50f28>]
Out[3]: (-10.65, 223.65, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d58be0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d58908>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d5e160>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d5e2e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d5e748>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d5eba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d69048>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d694a8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d69908>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d69d68>]
Out[3]: (-12.75, 267.75, -113.4, 5.4)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d70940>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d70668>]
```

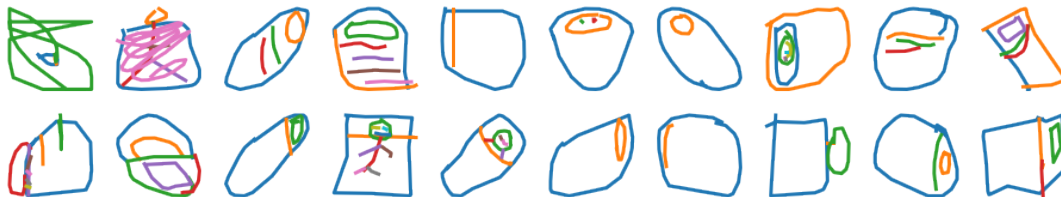
```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d70e80>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cfa048>]
Out[3]: (-5.050000000000001, 106.05, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cfabe0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cfa908>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d00160>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d002e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d00748>]
Out[3]: (-12.25, 257.25, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d02048>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d00ba8>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d029e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d02e48>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d122e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d12748>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d12ba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d1b048>]
Out[3]: (-12.75, 267.75, -69.3, 3.3000000000000003)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d1bbe0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d1b908>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d22160>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d222e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d22748>]
Out[3]: (-6.45, 135.45, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d25048>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d22ba8>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d25860>]
Out[3]: (-12.700000000000001, 266.7, -144.9, 6.9)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d259e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d25e48>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cb16a0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cb1828>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cb1c88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cbe128>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cbe588>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cbe9e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cbee48>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cc42e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ed15c0>]
Out[3]: (-6.25, 131.25, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cc4ba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cc4fd0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cce828>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cce9b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ccee10>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ccd2b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ccd710>]
Out[3]: (-12.75, 267.75, -227.85, 10.850000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ccdb70>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ccdfd0>]
Out[3]: (-12.75, 267.75, -63.0, 3.0)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cddc88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8cdd9b0>]
```

```

Out[3]: (-12.75, 267.75, -74.55, 3.5500000000000003)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ce7668>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ce7390>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ce7ba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ce7d30>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ce51d0>]
Out[3]: (-12.700000000000001, 266.7, -78.75, 3.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ce5d68>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ce5a90>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8c762e8>]
Out[3]: (-12.700000000000001, 266.7, -86.1, 4.1000000000000005)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8c76ba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8c768d0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8c7e128>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8c7e2b0>]
Out[3]: (-12.75, 267.75, -69.25, 2.25)

```



house plant.csv

```

Out[3]:
countrycode  ...  word
120777      US  ...  house plant
95668      US  ...  house plant
34037      US  ...  house plant
25792      GB  ...  house plant
60900      US  ...  house plant

```

[5 rows x 6 columns]

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a91ad828>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a91ad9b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9194278>]
Out[3]: (-10.0, 210.0, -267.7, 11.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8b6ecf8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f2706103f60>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9194f60>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57a37b8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a939a828>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a939acc0>]
Out[3]: (-7.4, 155.4, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a939afd0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a93852b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9385ba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a93857b8>]
Out[3]: (-5.7, 119.7, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a937c0b8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a937ca20>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a937cda0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a93ae320>]
Out[3]: (-5.7, 119.7, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a91adf60>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a93ae828>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9398160>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a93aecf8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9398a90>]
Out[3]: (-6.45, 135.45, -267.75, 12.75)
```



```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9398f98>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9398a20>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a93923c8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a93927f0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9392c88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9393470>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a93930f0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9393a58>]
Out[3]: (-12.75, 267.75, -227.85, 10.850000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e39438>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e39cf8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e52160>]
Out[3]: (-10.05, 211.05, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e52588>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e52da0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e52898>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e324a8>]
Out[3]: (-9.0, 189.0, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e32eb8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e328d0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e41208>]
Out[3]: (-9.35, 196.35, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e41c88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e41f28>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e40470>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e41630>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e409b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e652b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e40f28>]
Out[3]: (-7.45, 156.45, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e65cc0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e657f0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e35390>]
Out[3]: (-8.25, 173.25, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e35710>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e35e80>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e35e10>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e2d6a0>]
Out[3]: (-6.0, 126.0, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e2db70>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e2d400>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a25160>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a256d8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a25f60>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a16128>]
Out[3]: (-5.15, 130.15, -267.65, 10.65)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a16978>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a25f28>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a16c88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a1c240>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a1c518>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a1cb38>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a1c9e8>]
Out[3]: (-8.200000000000001, 172.2, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a26978>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a26358>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a26c88>]
Out[3]: (-8.700000000000001, 182.7, -267.7, 11.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a69f2198>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a69f2a58>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a69f24a8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a69f7438>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a69f7048>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a69f7908>]
Out[3]: (-6.6000000000000005, 138.6, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a69f7eb8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a12588>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a120b8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a12f98>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6a12ba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60e0908>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60e0d30>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60d6668>]
Out[3]: (-11.65, 266.65, -263.55, 12.55)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60d6c88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60d6198>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60e1390>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60e1780>]
```

```

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60e1c88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60e1c50>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60d6f60>]
Out[3]: (-9.200000000000001, 193.2, -267.75, 12.75)
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60dbc50>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60dbf28>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60c4668>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60c4240>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60c4b38>]
Out[3]: (-6.1000000000000005, 128.1, -267.75, 12.75)

```



bathtub.csv

```

Out[3]:
countrycode  ...  word
145115      US  ...  bathtub
51417       US  ...  bathtub
80684       US  ...  bathtub
75773       US  ...  bathtub
22887       US  ...  bathtub

```

[5 rows x 6 columns]

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a0dee128>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90d3d30>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90cc0b8>]
Out[3]: (-12.75, 267.75, -185.85, 8.85)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60c30f0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a0dee0f0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90ee390>]
Out[3]: (-12.200000000000001, 256.2, -100.75, 3.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90ee898>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90ee630>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b9320>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b9208>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b9b00>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b9e80>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b9710>]
Out[3]: (-12.700000000000001, 266.7, -168.0, 8.0)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b8358>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b8c50>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b8ba8>]
Out[3]: (-12.75, 267.75, -113.4, 5.4)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8eb0400>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8eb0940>]
Out[3]: (-12.75, 267.75, -139.65, 6.65)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90b8780>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ea10b8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ea15c0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ea1dd8>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8ea1ac8>]
Out[3]: (-12.75, 267.75, -128.1, 6.1000000000000005)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e78860>]
Out[3]: (-12.75, 267.75, -114.45, 5.45)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e78dd8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e789e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e787f0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e9f6d8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e9ffd0>]
Out[3]: (-12.700000000000001, 266.7, -143.85, 6.8500000000000005)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e78ba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8eaa828>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8eaa400>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8eaae48>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e7e2b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e7e6d8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e7ee80>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e931d0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e934a8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e938d0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f269a75eba8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e93cf8>]
Out[3]: (-12.75, 267.75, -260.4, 12.4)
Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b7fa58>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b7f630>]
Out[3]: (-12.75, 267.75, -240.45, 11.450000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b7ff28>]
```

```
Out[3]: (-12.75, 267.75, -73.5, 3.5)

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b6c908>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b6ccf8>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b6c128>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b62390>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b627b8>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b62be0>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b640f0>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b64550>]

Out[3]: (-12.75, 267.75, -233.1, 11.100000000000001)

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b64d68>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b64940>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b64f28>]

Out[3]: (-12.75, 267.75, -156.45, 7.45)

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b53da0>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b53710>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b57240>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b57908>]

Out[3]: (-12.75, 267.75, -104.95, 3.95)

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b57ef0>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b4b198>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b4b898>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b4bc50>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b57518>]

Out[3]: (-11.700000000000001, 267.7, -112.35, 5.3500000000000005)

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84e81d0>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84e84e0>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84e8f28>]
Out[3]: (-11.700000000000001, 267.7, -124.9, 4.9)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84c64e0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f2699b53d30>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84e8b70>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84c6ef0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84c7588>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84c6da0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84c7f60>]
Out[3]: (-11.15, 234.15, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84ea4a8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84ea828>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84ea8d0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84eaef0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84eada0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84c86a0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84c8f28>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84c8b00>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84d1780>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84d1470>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9967b8>]
Out[3]: (-12.75, 267.75, -184.8, 8.8)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84b95f8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84b99e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84b91d0>]
Out[3]: (-12.75, 267.75, -121.8, 5.800000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a84b9f28>]
```

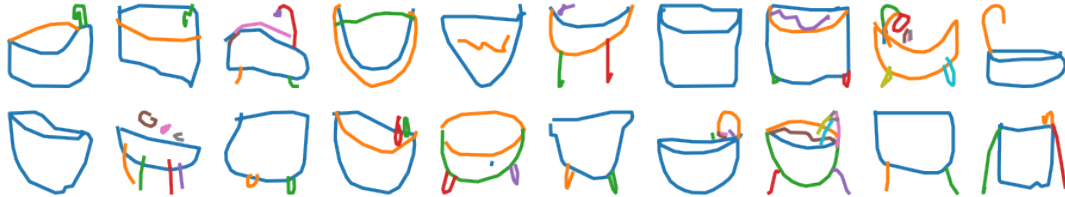


```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269981c780>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269981c438>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269981cd68>]
```

```
Out[3]: (-12.75, 267.75, -115.5, 5.5)
```



key.csv

```
Out[3]:      countrycode ... word
        37389          NL ...  key
        139408         US ...  key
        27493         US ...  key
        3925         US ...  key
        75394         DE ...  key
```

```
[5 rows x 6 columns]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e39f60>]
```

```
Out[3]: (-11.450000000000001, 240.45, -267.75, 12.75)
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e3f278>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269bc4e320>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f2699811908>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e3fdd8>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e3fc88>]
```

```
Out[3]: (-12.700000000000001, 266.7, -96.6, 4.6000000000000005)
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4ac88>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4a668>]
```

```
Out[3]: (-11.700000000000001, 267.7, -127.05, 6.050000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4e438>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4e3c8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4ec50>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4e908>]
Out[3]: (-6.550000000000001, 137.55, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4f710>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4f2e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4fda0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e4fbe0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e5e6d8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e5ed30>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5e5e588>]
Out[3]: (-12.75, 267.75, -81.9, 3.9000000000000004)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96cf438>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96cf908>]
Out[3]: (-11.05, 232.05, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96cf2e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96ca470>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96cff60>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96cadd8>]
Out[3]: (-12.75, 267.75, -82.95, 3.95)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96caac8>]
Out[3]: (-5.6000000000000005, 117.6, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96b3a58>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96b30f0>]
Out[3]: (-4.55, 95.55, -267.75, 12.75)
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96c62b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96b3ef0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96c6898>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96c6b70>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96ec400>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96ec0b8>]
Out[3]: (-11.700000000000001, 267.7, -81.9, 3.9000000000000004)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96ece10>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96bb208>]
Out[3]: (-12.700000000000001, 266.7, -82.95, 3.95)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96ece80>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96bbb00>]
Out[3]: (-12.75, 267.75, -95.55, 4.55)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96c93c8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96bbef0>]
Out[3]: (-10.75, 225.75, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96c9b38>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96c9208>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d4518>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d4080>]
Out[3]: (-12.700000000000001, 266.7, -233.05, 10.05)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d49e8>]
Out[3]: (-11.700000000000001, 267.7, -85.0, 3.0)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96bb898>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d4e10>]
Out[3]: (-6.800000000000001, 142.8, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d7dd8>]
```

```

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d4ef0>]
Out[3]: (-12.75, 267.75, -118.6, 4.6000000000000005)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d28d0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d79e8>]
Out[3]: (-6.25, 131.25, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57e4160>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57d2cf8>]
Out[3]: (-4.0, 84.0, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57e4080>]
Out[3]: (-5.7, 119.7, -267.75, 12.75)

```



triangle.csv

```

Out[3]:
countrycode  ...  word
104398      RU  ...  triangle
31368      US  ...  triangle
113292      US  ...  triangle
105446      US  ...  triangle
106496      VN  ...  triangle

```

[5 rows x 6 columns]

```

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a91ce048>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a91ce5f8>]
Out[3]: (-8.65, 181.65, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269bfa4f98>]

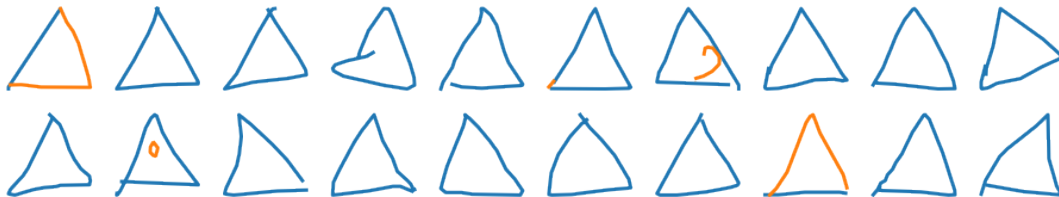
```

```
Out[3]: (-12.75, 267.75, -263.55, 12.55)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a91cedd8>]
Out[3]: (-11.700000000000001, 267.7, -263.55, 12.55)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269bfbf400>]
Out[3]: (-12.75, 267.75, -261.45, 12.450000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269bfbf240>]
Out[3]: (-12.75, 267.75, -213.1, 9.100000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269bfbf8d0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f269bfbfdd8>]
Out[3]: (-12.75, 267.75, -250.95, 11.950000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9d19b0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9d1ba8>]
Out[3]: (-7.6, 181.6, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9d1e48>]
Out[3]: (-11.450000000000001, 240.45, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9e7048>]
Out[3]: (-12.350000000000001, 259.35, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9e7e48>]
Out[3]: (-10.25, 215.25, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9e7f60>]
Out[3]: (-10.3, 216.3, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9cb048>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9cbb70>]
Out[3]: (-12.75, 267.75, -155.4, 7.4)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9cbf98>]
Out[3]: (-10.05, 211.05, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9c1198>]
```

```

Out[3]: (-12.75, 267.75, -213.15, 10.15)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9c1e80>]
Out[3]: (-10.5, 220.5, -267.7, 11.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9c1f60>]
Out[3]: (-8.65, 181.65, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9fa240>]
Out[3]: (-12.75, 267.75, -216.3, 10.3)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9fae80>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9c1518>]
Out[3]: (-10.4, 218.4, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9da7f0>]
Out[3]: (-10.850000000000001, 227.85, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9dae10>]
Out[3]: (-8.9, 186.9, -267.75, 12.75)

```



grapes.csv

```

Out[3]:
countrycode  ...  word
23112        US  ...  grapes
61144        US  ...  grapes
60593        US  ...  grapes
30364        US  ...  grapes
36352        US  ...  grapes

```

[5 rows x 6 columns]

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a61d0c88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8de8c18>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57fdda0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f269bc72cc0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57fd9e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a580d278>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57fd400>]
Out[3]: (-7.300000000000001, 153.3, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a580d860>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a580de80>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5826588>]
Out[3]: (-6.15, 129.15, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a61d0c18>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a58269e8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5827358>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5827048>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5827a90>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5827d68>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a58116d8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5811208>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5811f28>]
Out[3]: (-7.75, 162.75, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a58045c0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5804748>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5804e48>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5804fd0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a58048d0>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a5804e10>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8771f28>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8771b00>]
Out[3]: (-8.3, 174.3, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8797550>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8797c18>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8797eb8>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8797cc0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8773b00>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8773c88>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a87883c8>]
Out[3]: (-10.200000000000001, 214.2, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8773710>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a87885f8>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60cb240>]
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```



```
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60b4c50>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60bedd8>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a60e7ef0>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f2698d11390>]
```

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Out[3]: [<matplotlib.lines.Line2D at 0x7f2698d2dc50>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f2698d32518>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a67a3198>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a67a3160>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a677bef0>]
```

```
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6789588>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a679ab00>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6320390>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a6310358>]
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```

```
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Out[3]: [<matplotlib.lines.Line2D at 0x7f2699716f98>]
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```

```

Out[3]: [<matplotlib.lines.Line2D at 0x7f2699710908>]
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Out[3]: (-7.800000000000001, 163.8, -266.7, 12.700000000000001)

```



monkey.csv

```
Out[3]:      countrycode  ...      word
          22343      GB  ...  monkey
          68156      SE  ...  monkey
          35180      US  ...  monkey
          106105     GB  ...  monkey
          13416      US  ...  monkey
```

[5 rows x 6 columns]

```
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```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9e11d0>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9e1940>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a9398160>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9e1518>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9c7780>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9c7390>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9c7dd8>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9ed550>]
```

```
Out[3]: (-10.200000000000001, 214.2, -267.75, 12.75)
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9c8fd0>]
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b9edeb8>]
```

```
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```

```
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```

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```

```
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```

```
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```

```
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```

```
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```

```
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Out[3]: (-12.75, 267.75, -260.4, 12.4)
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```

```
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Out[3]: (-12.75, 267.75, -265.65, 12.65)
```



```
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a90e7390>]
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```
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Out[3]: (-12.700000000000001, 266.7, -219.45, 10.450000000000001)
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```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7f269bf9da90>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d2e908>]
Out[3]: (-12.75, 267.75, -242.55, 11.55)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8d2ed68>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a67c1048>]
```

```

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a67c1908>]
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Out[3]: (-6.4, 156.4, -267.75, 12.75)
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a67e24a8>]
Out[3]: (-10.200000000000001, 214.2, -266.7, 12.700000000000001)

```



television.csv

```
Out[3]:      countrycode      ...      word
          3022      US      ...      television
          1377      US      ...      television
          21348      US      ...      television
          75236      CA      ...      television
          74407      AR      ...      television
```

[5 rows x 6 columns]

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Out[3]: [<matplotlib.lines.Line2D at 0x7f269b99f898>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8fb0e10>]

Out[3]: (-12.75, 267.75, -199.5, 9.5)

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8f96828>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8e75d30>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8f96e10>]

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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8fab00>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8fabf28>]

Out[3]: (-12.75, 267.75, -212.1, 10.100000000000001)

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8f9e3c8>]

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a8f9e7f0>]

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Out[3]: (-12.3, 258.3, -267.75, 12.75)

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```
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26980f5400>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26980f5e80>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26980cd6a0>]
Out[3]: (-12.75, 267.75, -184.8, 8.8)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26980cdb70>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26980d3be0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26980cdf60>]
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Out[3]: (-12.75, 267.75, -227.85, 10.850000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f269b1e8ef0>]
```

```
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57f6d68>]
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Out[3]: (-10.75, 225.75, -266.7, 12.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57f3470>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57f5da0>]
```



```
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57f3780>]
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Out[3]: (-12.75, 267.75, -219.45, 10.450000000000001)
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Out[3]: (-12.75, 267.75, -201.6, 9.600000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57acb70>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57be7f0>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57be208>]
```

```

Out[3]: [<matplotlib.lines.Line2D at 0x7f26a57bee80>]
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Out[3]: (-9.850000000000001, 206.85, -267.75, 12.75)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96c54a8>]
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Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96c5ba8>]
Out[3]: (-9.950000000000001, 208.95, -267.7, 11.700000000000001)
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96d4550>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96d4278>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96d4d68>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96d4a58>]
Out[3]: [<matplotlib.lines.Line2D at 0x7f26a96d56d8>]
Out[3]: (-12.75, 267.75, -243.6, 11.600000000000001)

```



0.0.1 Preparing data for network

```
In [4]: %reset -f
```

```
In [5]: ### import
```

```
import os
from glob import glob
import re
import ast
import numpy as np
import pandas as pd
from PIL import Image, ImageDraw
from tqdm import tqdm
from dask import bag

import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Flatten
from tensorflow.keras.layers import Conv2D, MaxPooling2D
from tensorflow.keras.metrics import top_k_categorical_accuracy
from tensorflow.keras.callbacks import ModelCheckpoint, ReduceLROnPlateau, EarlyStopping
```

```
In [6]: ### set label dictionary and params
```

```
classfiles = os.listdir('../input/train_simplified/')
numstonames = {i: v[:-4].replace(" ", "_") for i, v in enumerate(classfiles)} #adds underscores

num_classes = 340 #340 max
imheight, imwidth = 32, 32
ims_per_class = 2000 #max?
```

```
In [7]: # faster conversion function
```

```
def draw_it(strokes):
    image = Image.new("P", (256,256), color=255)
    image_draw = ImageDraw.Draw(image)
    for stroke in ast.literal_eval(strokes):
        for i in range(len(stroke[0])-1):
            image_draw.line([stroke[0][i],
                             stroke[1][i],
                             stroke[0][i+1],
                             stroke[1][i+1]],
                             fill=0, width=5)
    image = image.resize((imheight, imwidth))
    return np.array(image)/255.
```

```
### get train arrays
```

```
train_grand = []
class_paths = glob('../input/train_simplified/*.csv')
for i,c in enumerate(tqdm(class_paths[0: num_classes])):
```

```

train = pd.read_csv(c, usecols=['drawing', 'recognized'], nrows=ims_per_class*5//4)
train = train[train.recognized == True].head(ims_per_class)
imagebag = bag.from_sequence(train.drawing.values).map(draw_it)
trainarray = np.array(imagebag.compute()) # PARALLELIZE
trainarray = np.reshape(trainarray, (ims_per_class, -1))
labelarray = np.full((train.shape[0], 1), i)
trainarray = np.concatenate((labelarray, trainarray), axis=1)
train_grand.append(trainarray)

train_grand = np.array([train_grand.pop() for i in np.arange(num_classes)]) #less memory
train_grand = train_grand.reshape((-1, (imheight*imwidth+1)))

del trainarray
del train

```

100%|| 340/340 [11:15<00:00, 2.14s/it]

```

In [8]: # memory-friendly alternative to train_test_split?
valfrac = 0.1
cutpt = int(valfrac * train_grand.shape[0])

np.random.shuffle(train_grand)
y_train, X_train = train_grand[cutpt: , 0], train_grand[cutpt: , 1:]
y_val, X_val = train_grand[0:cutpt, 0], train_grand[0:cutpt, 1:] #validation set is reco

del train_grand

y_train = keras.utils.to_categorical(y_train, num_classes)
X_train = X_train.reshape(X_train.shape[0], imheight, imwidth, 1)
y_val = keras.utils.to_categorical(y_val, num_classes)
X_val = X_val.reshape(X_val.shape[0], imheight, imwidth, 1)

print(y_train.shape, "\n",
      X_train.shape, "\n",
      y_val.shape, "\n",
      X_val.shape)

```

```

(612000, 340)
(612000, 32, 32, 1)
(68000, 340)
(68000, 32, 32, 1)

```

```

In [9]: model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3), padding='same', activation='relu', input_shape=
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(64, kernel_size=(3, 3), padding='same', activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))

```

```

model.add(Dropout(0.2))
model.add(Flatten())
model.add(Dense(680, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))
model.summary()

```

```

-----
Layer (type)                 Output Shape              Param #
=====
conv2d (Conv2D)              (None, 32, 32, 32)       320
-----
max_pooling2d (MaxPooling2D) (None, 16, 16, 32)       0
-----
conv2d_1 (Conv2D)            (None, 16, 16, 64)       18496
-----
max_pooling2d_1 (MaxPooling2 (None, 8, 8, 64)        0
-----
dropout (Dropout)            (None, 8, 8, 64)        0
-----
flatten (Flatten)            (None, 4096)             0
-----
dense (Dense)                (None, 680)              2785960
-----
dropout_1 (Dropout)          (None, 680)              0
-----
dense_1 (Dense)              (None, 340)              231540
=====
Total params: 3,036,316
Trainable params: 3,036,316
Non-trainable params: 0
-----

```

```

In [10]: def top_3_accuracy(x,y):
          t3 = top_k_categorical_accuracy(x,y, 3)
          return t3

reduceLRonPlat = ReduceLRonPlateau(monitor='val_loss', factor=0.5, patience=3,
                                   verbose=1, mode='auto', min_delta=0.005, cooldown=5,
earlystop = EarlyStopping(monitor='val_top_3_accuracy', mode='max', patience=5)
callbacks = [reduceLRonPlat, earlystop]

model.compile(loss='categorical_crossentropy',
              optimizer='adam',
              metrics=['accuracy', top_3_accuracy])

model.fit(x=X_train, y=y_train,

```

```

        batch_size = 32,
        epochs = 22,
        validation_data = (X_val, y_val),
        callbacks = callbacks,
        verbose = 1)

```

Train on 612000 samples, validate on 68000 samples

Epoch 1/22

612000/612000 [=====] - 190s 310us/step - loss: 3.0555 - acc: 0.3142 -

Epoch 2/22

612000/612000 [=====] - 189s 308us/step - loss: 2.4344 - acc: 0.4169 -

Epoch 3/22

612000/612000 [=====] - 189s 308us/step - loss: 2.2981 - acc: 0.4427 -

Epoch 4/22

612000/612000 [=====] - 188s 307us/step - loss: 2.2229 - acc: 0.4573 -

Epoch 5/22

612000/612000 [=====] - 187s 305us/step - loss: 2.1768 - acc: 0.4678 -

Epoch 6/22

612000/612000 [=====] - 187s 306us/step - loss: 2.1471 - acc: 0.4731 -

Epoch 7/22

612000/612000 [=====] - 188s 308us/step - loss: 2.1263 - acc: 0.4768 -

Epoch 8/22

612000/612000 [=====] - 188s 307us/step - loss: 2.1104 - acc: 0.4809 -

Epoch 9/22

612000/612000 [=====] - 187s 306us/step - loss: 2.1009 - acc: 0.4828 -

Epoch 10/22

612000/612000 [=====] - 186s 305us/step - loss: 2.0918 - acc: 0.4846 -

Epoch 11/22

611968/612000 [=====>.] - ETA: 0s - loss: 2.0864 - acc: 0.4858 - top_3_acc: 0.4858 -

Epoch 00011: ReduceLROnPlateau reducing learning rate to 0.00050000000237487257.

612000/612000 [=====] - 188s 307us/step - loss: 2.0864 - acc: 0.4858 -

Epoch 12/22

612000/612000 [=====] - 188s 307us/step - loss: 1.9707 - acc: 0.5080 -

Epoch 13/22

612000/612000 [=====] - 188s 307us/step - loss: 1.9391 - acc: 0.5150 -

Epoch 14/22

612000/612000 [=====] - 187s 306us/step - loss: 1.9250 - acc: 0.5175 -

Epoch 15/22

612000/612000 [=====] - 187s 305us/step - loss: 1.9133 - acc: 0.5191 -

Epoch 16/22

612000/612000 [=====] - 187s 305us/step - loss: 1.9051 - acc: 0.5205 -

Epoch 17/22

612000/612000 [=====] - 187s 306us/step - loss: 1.9016 - acc: 0.5223 -

Epoch 18/22

612000/612000 [=====] - 189s 308us/step - loss: 1.8924 - acc: 0.5238 -

Epoch 19/22

612000/612000 [=====] - 188s 307us/step - loss: 1.8888 - acc: 0.5247 -

Epoch 20/22

```

612000/612000 [=====] - 187s 305us/step - loss: 1.8822 - acc: 0.5253 -
Epoch 21/22
611872/612000 [=====>.] - ETA: 0s - loss: 1.8803 - acc: 0.5261 - top_3_ac
Epoch 00021: ReduceLROnPlateau reducing learning rate to 0.0002500000118743628.
612000/612000 [=====] - 186s 305us/step - loss: 1.8803 - acc: 0.5261 -
Epoch 22/22
612000/612000 [=====] - 187s 306us/step - loss: 1.8126 - acc: 0.5389 -

```

```
Out[10]: <tensorflow.python.keras.callbacks.History at 0x7f26a658ce80>
```

0.1 Predicting on the Test data

The CNN does OK on the validation data, even with a basic model and limited training data. Let's generate predictions on the test set and submit.

```

In [11]: ### get test set
         ttvlist = []
         reader = pd.read_csv('../input/test_simplified.csv', index_col=['key_id'],
                               chunksize=2048)
         for chunk in tqdm(reader, total=55):
             imagebag = bag.from_sequence(chunk.drawing.values).map(draw_it)
             testarray = np.array(imagebag.compute())
             testarray = np.reshape(testarray, (testarray.shape[0], imheight, imwidth, 1))
             testpreds = model.predict(testarray, verbose=0)
             ttvs = np.argsort(-testpreds)[: , 0:3] # top 3
             ttvlist.append(ttvs)

         ttvarray = np.concatenate(ttvlist)

100%|| 55/55 [02:14<00:00, 2.34s/it]

In [12]: preds_df = pd.DataFrame({'first': ttvarray[:,0], 'second': ttvarray[:,1], 'third': ttva
         preds_df = preds_df.replace(numstonames)
         preds_df['words'] = preds_df['first'] + " " + preds_df['second'] + " " + preds_df['thir

         sub = pd.read_csv('../input/sample_submission.csv', index_col=['key_id'])
         sub['word'] = preds_df.words.values
         sub.to_csv('subcnn_small.csv')
         sub.head()

```

```

Out[12]:
         key_id                                     word
0  9000003627287624                radio motorbike stereo
1  9000010688666847                hockey_puck pool sandwich
2  9000023642890129  The_Great_Wall_of_China camel castle
3  9000038588854897                mountain tent triangle
4  9000052667981386                campfire fireplace feather

```

```

In [13]: import sys

# These are the usual ipython objects, including this one you are creating
ipython_vars = ['In', 'Out', 'exit', 'quit', 'get_ipython', 'ipython_vars']

# Get a sorted list of the objects and their sizes
sorted([(x, sys.getsizeof(globals().get(x))) for x in dir() if not
        x.startswith('_') and x not in sys.modules and x
        not in ipython_vars], key=lambda x: x[1], reverse=True)

Out[13]: [('preds_df', 30572830),
          ('sub', 9900835),
          ('ttvarray', 2692888),
          ('testpreds', 2185632),
          ('chunk', 1053432),
          ('labelarray', 16112),
          ('numstonames', 9320),
          ('class_paths', 3104),
          ('Sequential', 3096),
          ('classfiles', 2896),
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          ('Flatten', 2000),
          ('MaxPooling2D', 2000),
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          ('Conv2D', 888),
          ('ttvlist', 528),
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          ('X_val', 144),
          ('testarray', 144),
          ('draw_it', 136),
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          ('top_k_categorical_accuracy', 136),
          ('ttvs', 112),
          ('y_train', 112),
          ('y_val', 112),
          ('c', 86),
          ('Image', 80),
          ('ImageDraw', 80),
          ('bag', 80),
          ('callbacks', 80),
          ('keras', 80),
          ('np', 80),
          ('pd', 80),
          ('tf', 80),
          ('earlystop', 56),

```



```
('imagebag', 56),  
( 'model', 56),  
( 'reader', 56),  
( 'reduceLR0nPlat', 56),  
( 'cutpt', 28),  
( 'i', 28),  
( 'imheight', 28),  
( 'ims_per_class', 28),  
( 'imwidth', 28),  
( 'num_classes', 28),  
( 'valfrac', 24)]
```