final_copy

December 7, 2021

1 Image Posterization using K-means Clustering Algorithm

[3]:
```
#import PIL as pil
from PIL import Image
from skimage import io
import numpy as np
import pandas as pd
import random
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
import sklearn
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from sklearn import metrics
from sklearn.cluster import AgglomerativeClustering
import joblib
import time
import os
```

[13]:
```
def smartPost(oldImage, percentage, fileName, elbowPoint, minK):
    image = oldImage
    pixels = image.load()

    random.seed(a=100)
    #k = 100   #we would have a loop and iterate k

    skip = int(1 / np.sqrt(percentage))
    count = 0
    size = np.ceil(image.size[0] / skip) * np.ceil(image.size[1] / skip)
    df_pixels = pd.DataFrame(columns=list('RGB'), index = np.arange(size))

    timeBeforeSample = time.time()
    for i in range(0, image.size[0], skip):
        for j in range(0, image.size[1], skip):
            i_ = i + random.randint(-3,3)
            if i_>=image.size[0]:
```

```
                i_ = image.size[0] - 1
            if i_<0:
                i_ = 0
            j_ = j + random.randint(-3,3)
            if j_>=image.size[1]:
                j_ = image.size[1] - 1
            if j_<0:
                j_ = 0

            df_pixels.iloc[[count]] = [[pixels[i_,j_][0], pixels[i_,j_][1],␣
↪pixels[i_,j_][2]]]
            count = count + 1
    timeAfterSample = time.time()
    sampleTime = timeAfterSample - timeBeforeSample
    distortions = []
    for k in range(minK,150):
        kmeans = KMeans(n_clusters=k, random_state=1, n_init=1) #k
        kmeans.fit(df_pixels) #run on df_pixels
        if k >=2:
            if kmeans.inertia_ / lastIntertia > elbowPoint:     ####### 0.98 is␣
↪the location on the elbow we select for the ideal k
                    break
            if kmeans.inertia_ < 100000:
                break
        lastIntertia = kmeans.inertia_
        distortions.append(lastIntertia)


    timeAfterKmeansFit = time.time()

    KMeansTime = timeAfterKmeansFit - timeAfterSample

    joblib.dump(kmeans, 'kmeans.pkl')
    kmeans_loaded = joblib.load('kmeans.pkl')
    kmeans_loaded

    timeAfterPickle = time.time()
    PickleTime = timeAfterPickle - timeAfterKmeansFit



    for i in range(0, image.size[0]):
        for j in range(0, image.size[1]):
            predicted = kmeans_loaded.predict([[pixels[i,j][0], pixels[i,j][1],␣
↪pixels[i,j][2]]])
```

```
            pixels[i,j] = (round(kmeans.cluster_centers_[predicted][0][0]),␣
↪round(kmeans.cluster_centers_[predicted][0][1]), round(kmeans.
↪cluster_centers_[predicted][0][2]))
            #pixels[i,j] = (0,0,0)

    timeAfterCompression = time.time()
    CompressionTime = timeAfterCompression - timeAfterPickle

    saveLocation = fileName.replace("Inputs","Outputs")

    image.save(saveLocation, format="png")

    timeAfterSave = time.time()
    SaveTime = timeAfterSave - timeAfterCompression
    return distortions, k
```

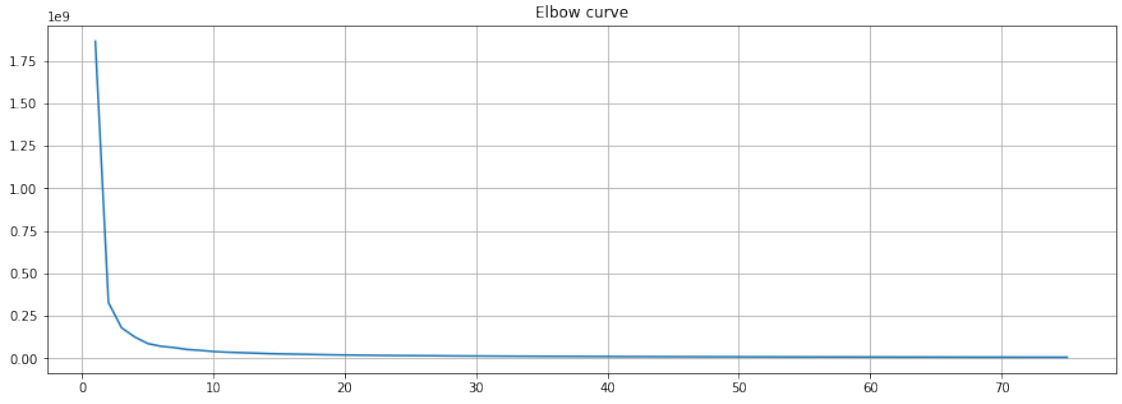
[14]:
```
def findBestK(oldImage, percentage, fileName, elbowPoint):
    image = oldImage
    pixels = image.load()

    random.seed(a=100)
    #k = 100   #we would have a loop and iterate k

    skip = int(1 / np.sqrt(percentage))
    count = 0
    size = np.ceil(image.size[0] / skip) * np.ceil(image.size[1] / skip)
    df_pixels = pd.DataFrame(columns=list('RGB'), index = np.arange(size))
    if percentage != 1:
        for i in range(0, image.size[0], skip):
            for j in range(0, image.size[1], skip):
                i_ = i + random.randint(-3,3)
                if i_>=image.size[0]:
                    i_ = image.size[0] - 1
                if i_<0:
                    i_ = 0
                j_ = j + random.randint(-3,3)
                if j_>=image.size[1]:
                    j_ = image.size[1] - 1
                if j_<0:
                    j_ = 0

                df_pixels.iloc[[count]] = [[pixels[i_,j_][0], pixels[i_,j_][1],␣
↪pixels[i_,j_][2]]]
                count = count + 1
    else:
        for i in range(0, image.size[0], skip):
            for j in range(0, image.size[1], skip):
```

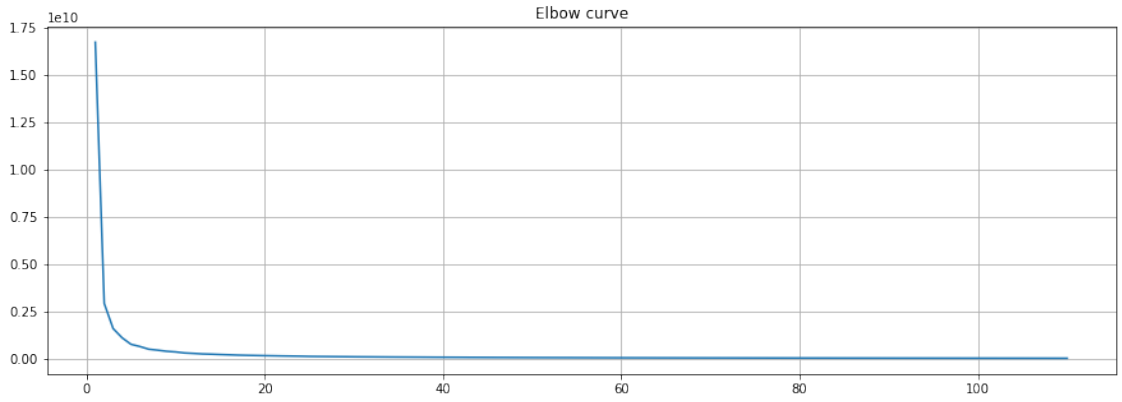
```
                df_pixels.iloc[[count]] = [[pixels[i,j][0], pixels[i,j][1],␣
 ↪pixels[i,j][2]]]
                count = count + 1
    distortions = []
    for k in range(1,150):
        kmeans = KMeans(n_clusters=k, random_state=1, n_init=1) #k
        kmeans.fit(df_pixels) #run on df_pixels
        if k >=2:
            if kmeans.inertia_ / lastIntertia > elbowPoint:     ####### 0.98 is␣
 ↪the location on the elbow we select for the ideal k
                break
        lastIntertia = kmeans.inertia_
        distortions.append(lastIntertia)


    return distortions, k
```

[11]:
```
percentage = 0.10
lowPercentageK = 0
highPercentageK = 0

currDir = 'Inputs/Explorations'
for filename in os.listdir(currDir):
    if filename.endswith(".png"):
        currImg = Image.open(str(currDir)+'/'+str(filename))
        distortions, lowPercentageK = findBestK(currImg, percentage,␣
 ↪str(currDir)+'/'+str(filename), 0.995)
        fig1 = plt.figure(figsize=(15, 5))
        plt.plot(range(1, lowPercentageK), distortions)
        plt.grid(True)
        fig1 = plt.title('Elbow curve')
print("lowPercentageK={0}\n".format(lowPercentageK))

percentage = 1

for filename in os.listdir(currDir):
    if filename.endswith(".png"):
        currImg = Image.open(str(currDir)+'/'+str(filename))
        distortions, highPercentageK = findBestK(currImg, percentage,␣
 ↪str(currDir)+'/'+str(filename), 0.995)
        fig1 = plt.figure(figsize=(15, 5))
        plt.plot(range(1, highPercentageK), distortions)
        plt.grid(True)
        fig1 = plt.title('Elbow curve')
print("highPercentageK={0}\n".format(highPercentageK))
```

```
lowPercentageK=76
```

highPercentageK=111





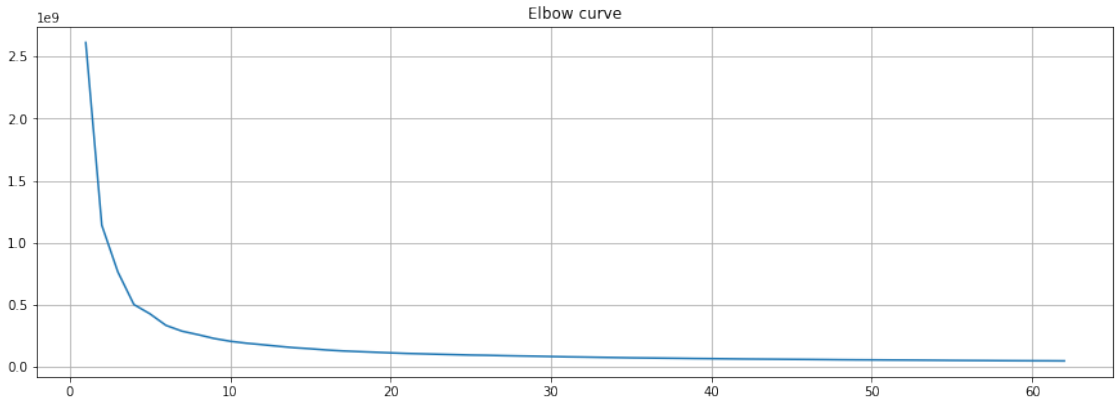
1 min 10 seconds to find lowPercentageK

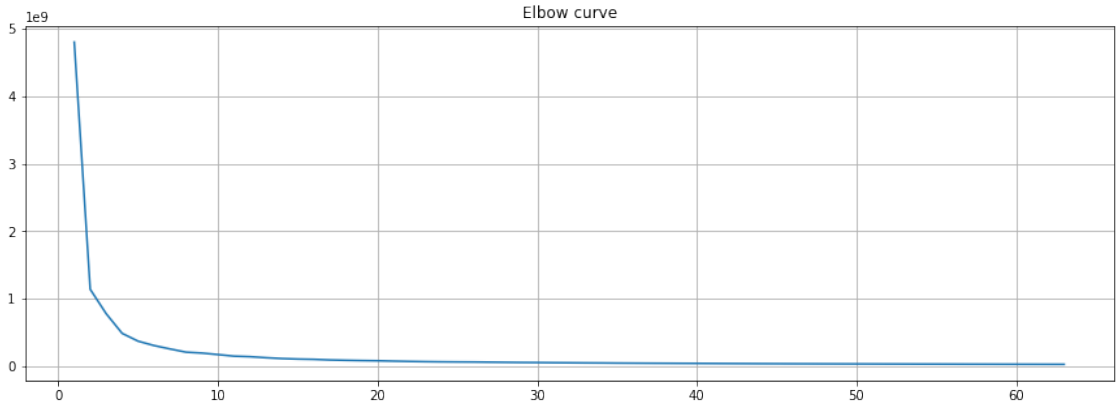
[12]:
```
percentage = 0.10
```

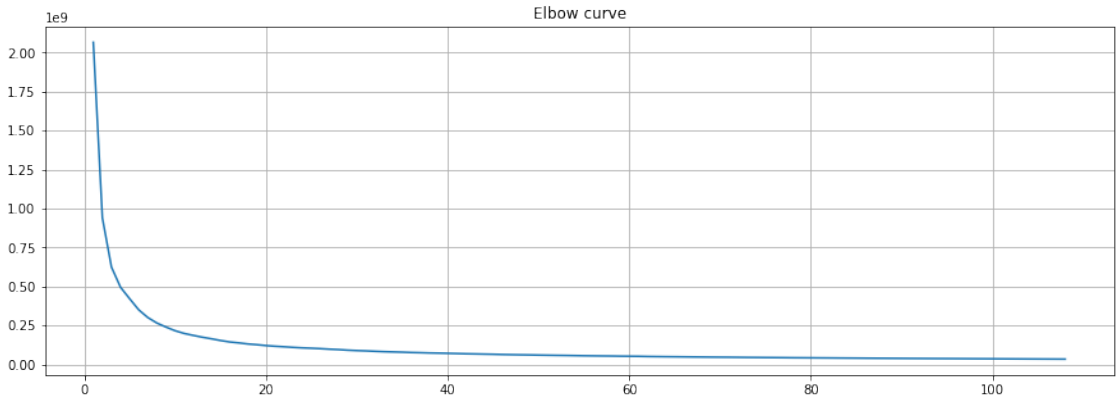
[13]:
```
currDir = 'Inputs/Landscapes'
kAvgLandscapes = 0
landscapeCount = 0
for filename in os.listdir(currDir):
   if filename.endswith(".png"):
        currImg = Image.open(str(currDir)+'/'+str(filename))
        distortions, k = smartPost(currImg, percentage, str(currDir)+'/
 ↪'+str(filename), 0.995, 1)
        landscapeCount = landscapeCount+1
        kAvgLandscapes = kAvgLandscapes+k
        fig1 = plt.figure(figsize=(15, 5))
```

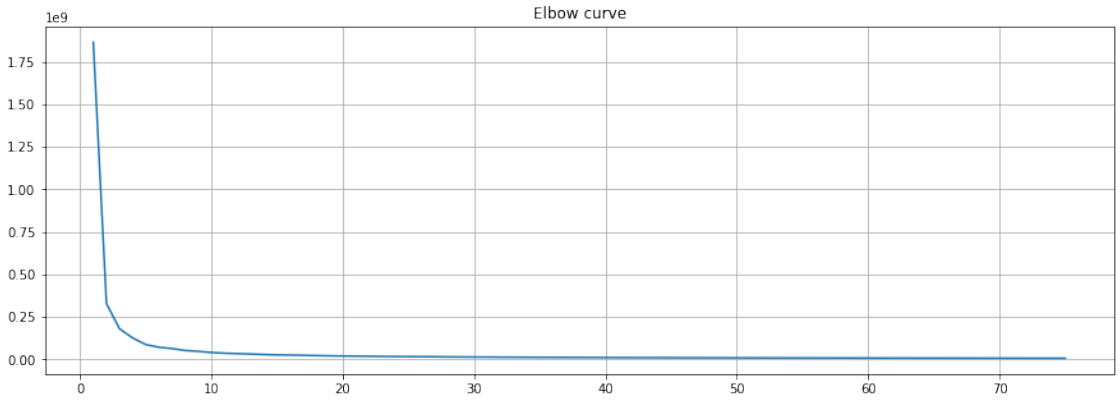
```
        plt.plot(range(1, k), distortions)
        plt.grid(True)
        fig1 = plt.title('Elbow curve')
kAvgLandscapes = kAvgLandscapes / landscapeCount
print("k={0}\n".format(kAvgLandscapes))
```

```
k=78.0
```



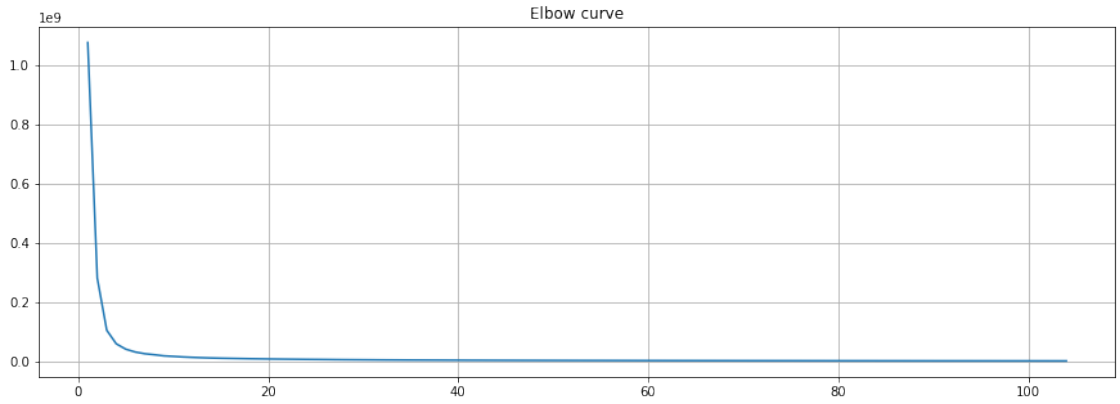


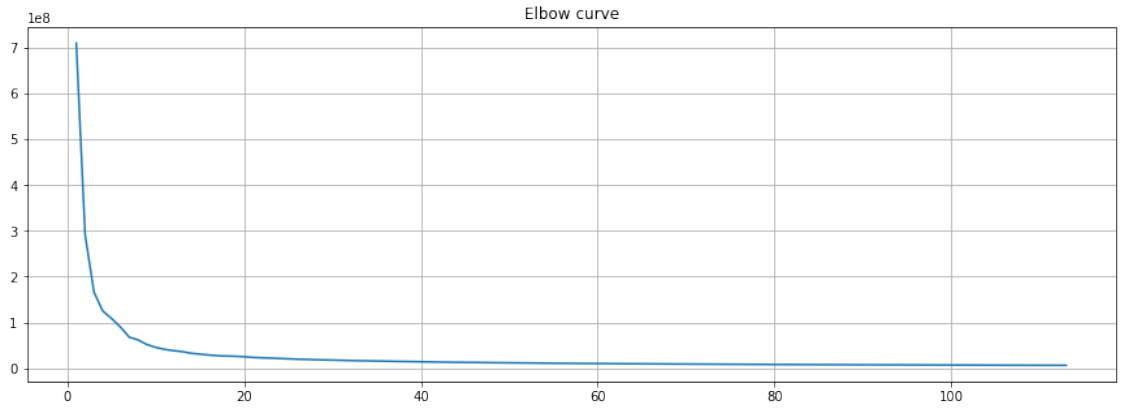


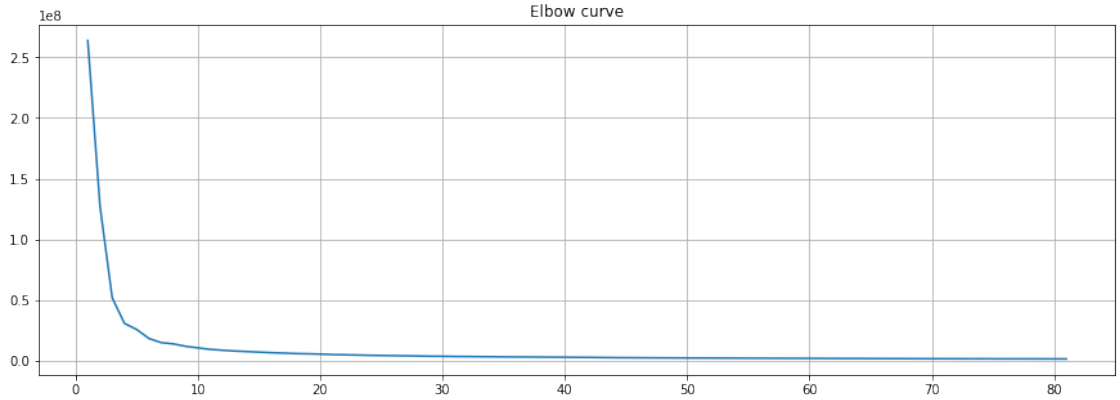


[14]:
```
currDir = 'Inputs/Animals'
kAvgAnimals = 0
animalCount = 0
for filename in os.listdir(currDir):
    if filename.endswith(".png"):
        currImg = Image.open(str(currDir)+'/'+str(filename))
        distortions, k = smartPost(currImg, percentage, str(currDir)+'/
 ↪'+str(filename), 0.995, 1)
        animalCount = animalCount+1
        kAvgAnimals = kAvgAnimals+k
        fig2 = plt.figure(figsize=(15, 5))
        plt.plot(range(1, k), distortions)
        plt.grid(True)
        fig2 = plt.title('Elbow curve')
kAvgAnimals = kAvgAnimals/animalCount
print("k={0}\n".format(kAvgAnimals))
```

```
k=100.33333333333333
```



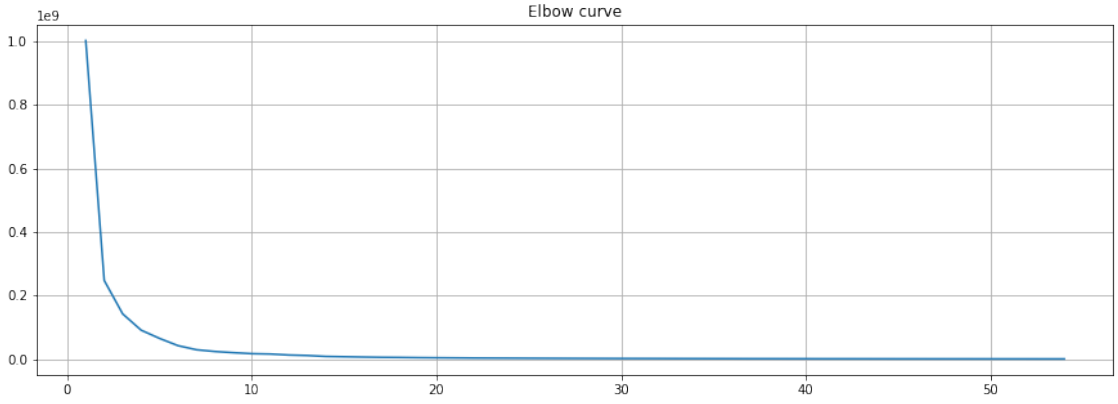


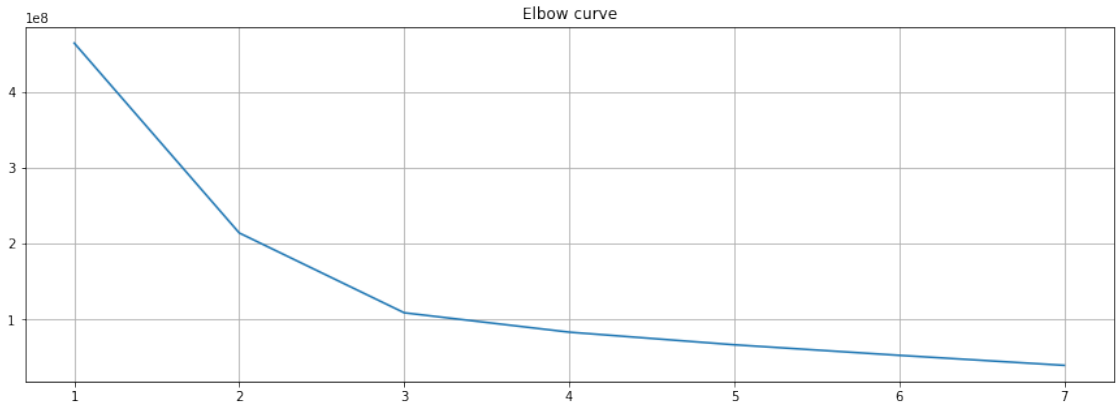


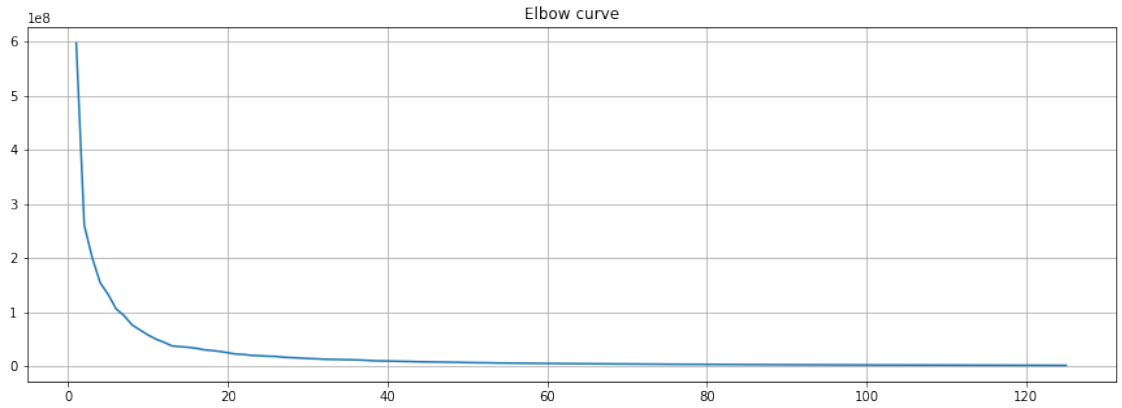
[15]:
```
currDir = 'Inputs/Gradients'
kAvgGradients = 0
gradientCount = 0
```

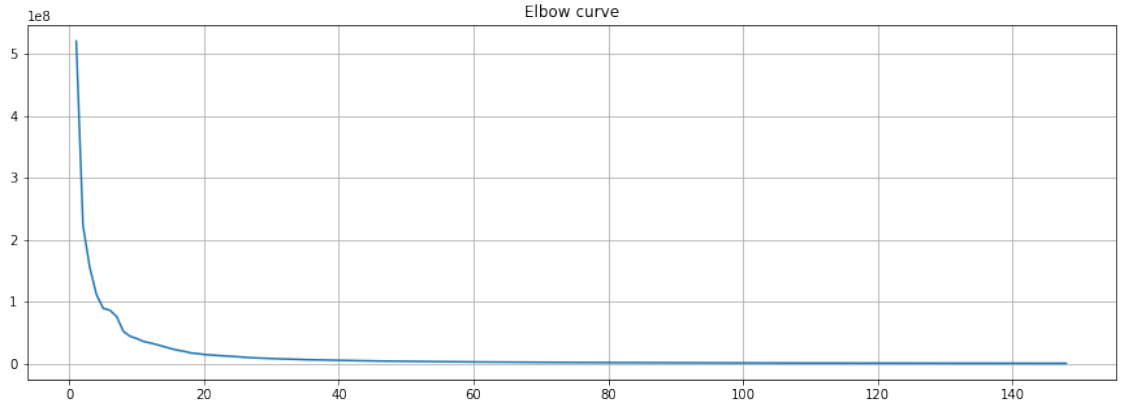
```
for filename in os.listdir(currDir):
    if filename.endswith(".png"):
        currImg = Image.open(str(currDir)+'/'+str(filename))
        distortions, k = smartPost(currImg, percentage, str(currDir)+'/
 ↪'+str(filename), 0.995, 1)
        gradientCount = gradientCount+1
        kAvgGradients = kAvgGradients+k
        fig3 = plt.figure(figsize=(15, 5))
        plt.plot(range(1, k), distortions)
        plt.grid(True)
        fig3 = plt.title('Elbow curve')

kAvgGradients = kAvgGradients/gradientCount
print("k={0}\n".format(kAvgGradients))
```

```
k=84.5
```



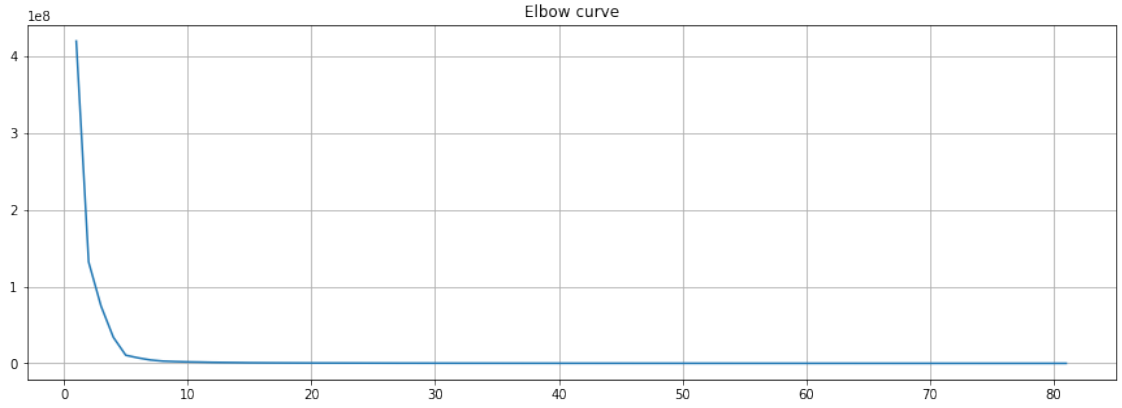


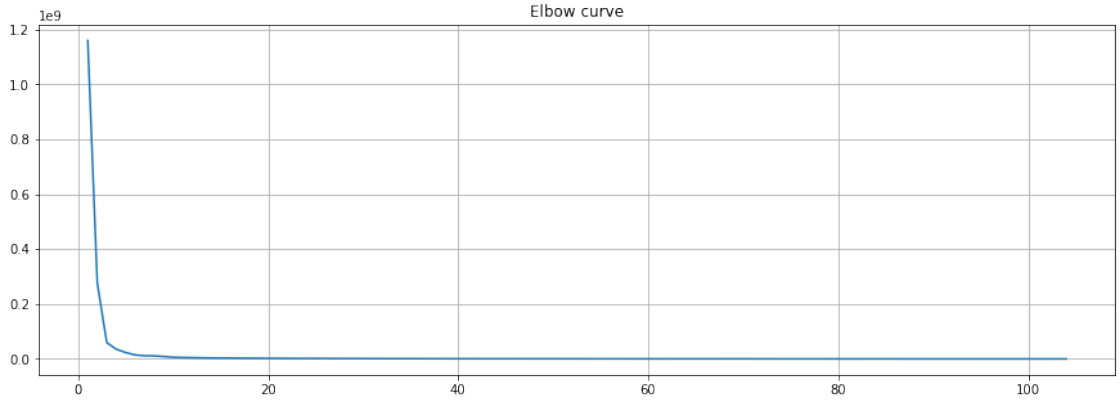


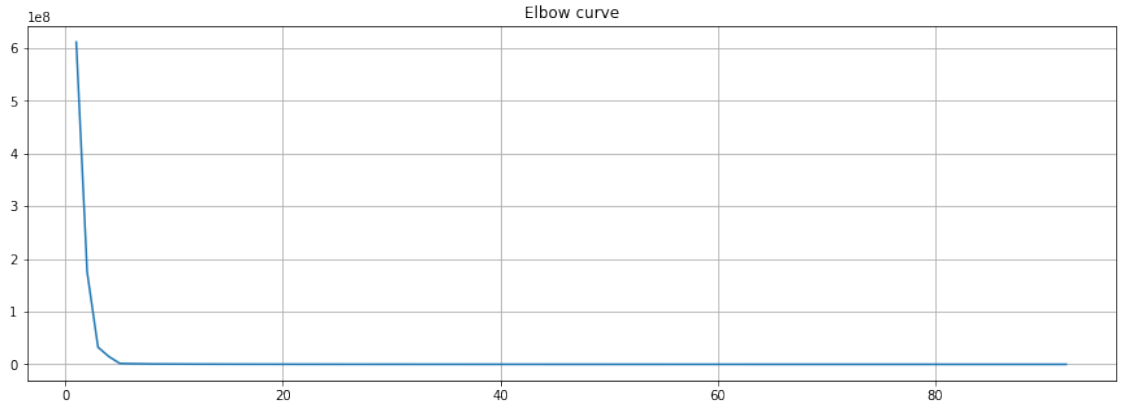


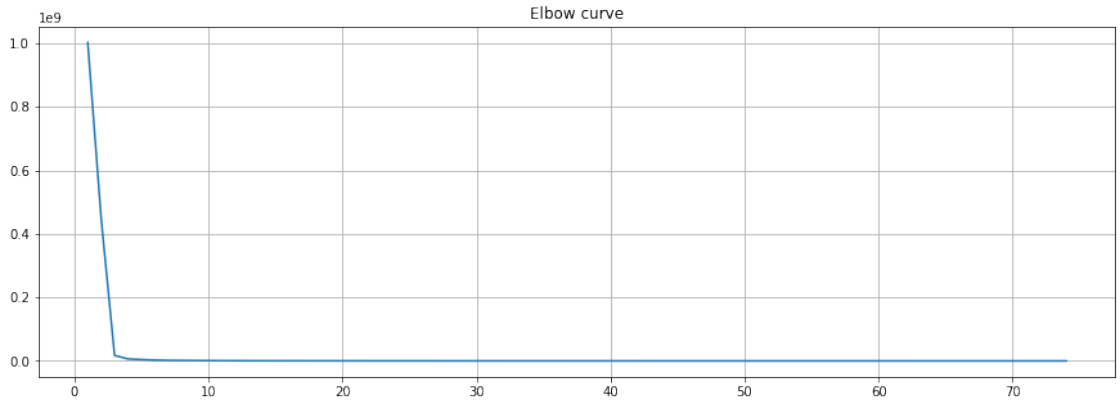
[31]:
```
currDir = 'Inputs/Simple'
kAvgSimple = 0
simpleCount = 0
for filename in os.listdir(currDir):
    if filename.endswith(".png"):
        currImg = Image.open(str(currDir)+'/'+str(filename))
        distorions = []
        distortions, k = smartPost(currImg, percentage, str(currDir)+'/
 ↪'+str(filename), 0.995, 1)
        simpleCount = simpleCount+1
        kAvgSimple = kAvgSimple+k
        fig3 = plt.figure(figsize=(15, 5))
        plt.plot(range(1, k), distortions)
        plt.grid(True)
        fig3 = plt.title('Elbow curve')
        currImg.close()
kAvgSimple = kAvgSimple/simpleCount
print("k={0}\n".format(kAvgSimple))
```

k=88.75


Elbow curve
1e8
4
3
2
1
0
0
10
20
30
40
50
60
70
80


Elbow curve
1e9
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100

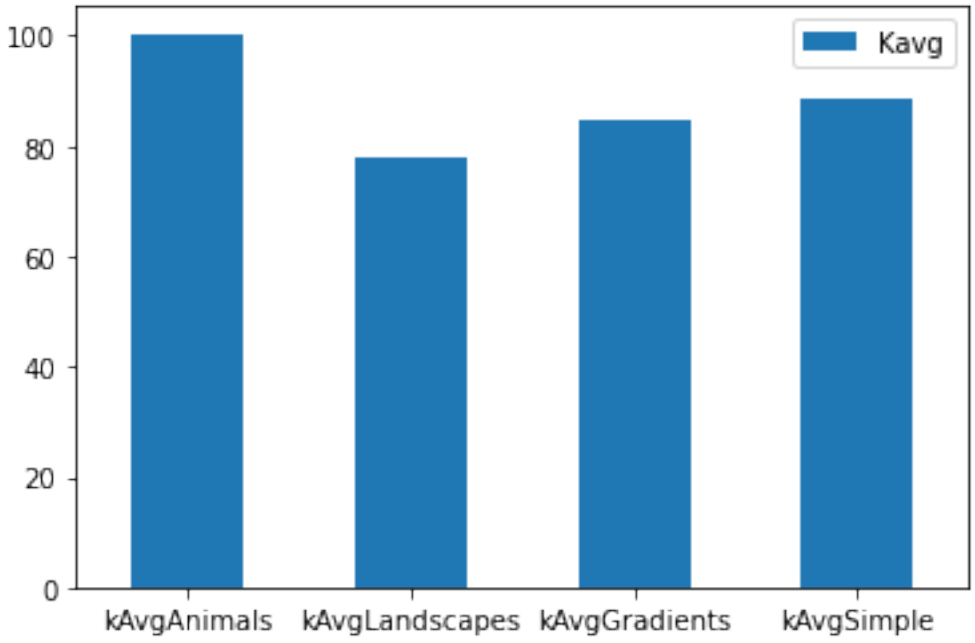

Elbow curve
1e8
6
5
4
3
2
1
0
0
20
40
60
80



[32]:
```
print("kAvgAnimals, kAvgLandscapes, kAvgGradients, kAvgSimple = {0}, {1}, {2},␣
↪{3}\n".format(kAvgAnimals, kAvgLandscapes, kAvgGradients, kAvgSimple))
```

```
kAvgAnimals, kAvgLandscapes, kAvgGradients, kAvgSimple = 100.33333333333333,
78.0, 84.5, 88.75
```

[4]:
```
kAvgAnimals = 100.3333333333
kAvgLandscapes = 78
kAvgGradients = 84.5
kAvgSimple = 88.75
Kavg = [kAvgAnimals, kAvgLandscapes, kAvgGradients, kAvgSimple]
types = ['kAvgAnimals', 'kAvgLandscapes', 'kAvgGradients', 'kAvgSimple']
df = pd.DataFrame({'Kavg': Kavg}, index=types)
ax = df.plot.bar(rot=0)
```


Kavg
100
80
60
40
20
0
kAvgAnimals
kAvgLandscapes
kAvgGradients
kAvgSimple