In [2]:
```
import pandas as pd
import matplotlib
import matplotlib.pyplot as plt
import numpy as np
import random
import seaborn as sns
import warnings
import time
from collections import Counter
from sklearn.preprocessing import StandardScaler, MinMaxScaler
from sklearn.decomposition import PCA
from scipy import stats
```

In [3]:
```
seed = 101
```

In [4]:
```
featureNames = ["word_freq_make", "word_freq_address", "word_freq_all", "word_freq_3d", "word_freq_our",
"word_freq_over", "word_freq_remove", "word_freq_internet", "word_freq_order", "word_freq_mail",
"word_freq_receive", "word_freq_will", "word_freq_people", "word_freq_report", "word_freq_addresses",
"word_freq_free", "word_freq_business", "word_freq_email", "word_freq_you", "word_freq_credit",
"word_freq_your", "word_freq_font", "word_freq_000", "word_freq_money", "word_freq_hp",
"word_freq_hpl", "word_freq_george", "word_freq_650", "word_freq_lab", "word_freq_labs",
"word_freq_telnet", "word_freq_857", "word_freq_data", "word_freq_415", "word_freq_85",
"word_freq_technology", "word_freq_1999", "word_freq_parts", "word_freq_pm", "word_freq_direct",
"word_freq_cs", "word_freq_meeting", "word_freq_original", "word_freq_project", "word_freq_re",
"word_freq_edu", "word_freq_table", "word_freq_conference", "char_freq_;", "char_freq_(",
"char_freq_[", "char_freq_!", "char_freq_$", "char_freq_#", "capital_run_length_average",
"capital_run_length_longest", "capital_run_length_total", "class"]
dt = pd.read_csv('dataset/spambase.csv', header=None, names=featureNames)
```

In [5]:
```
dt.describe()
```

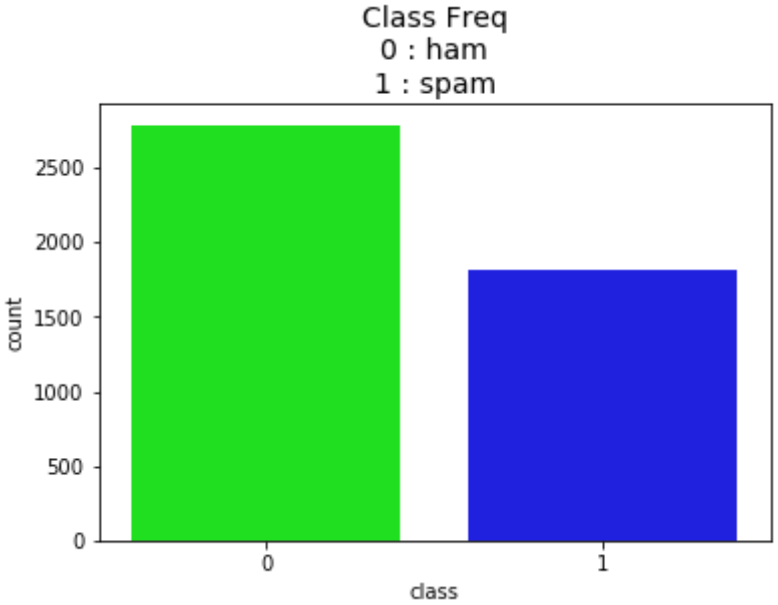
Out[5]:

	word_freq_make	word_freq_address	word_freq_all	word_freq_3d	word_freq_our	word_freq_over	word_freq_remove	word_freq_internet	v
count	4601.000000	4601.000000	4601.000000	4601.000000	4601.000000	4601.000000	4601.000000	4601.000000	
mean	0.104553	0.213015	0.280656	0.065425	0.312223	0.095901	0.114208	0.105295	
std	0.305358	1.290575	0.504143	1.395151	0.672513	0.273824	0.391441	0.401071	
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
50%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
75%	0.000000	0.000000	0.420000	0.000000	0.380000	0.000000	0.000000	0.000000	
max	4.540000	14.280000	5.100000	42.810000	10.000000	5.880000	7.270000	11.110000	

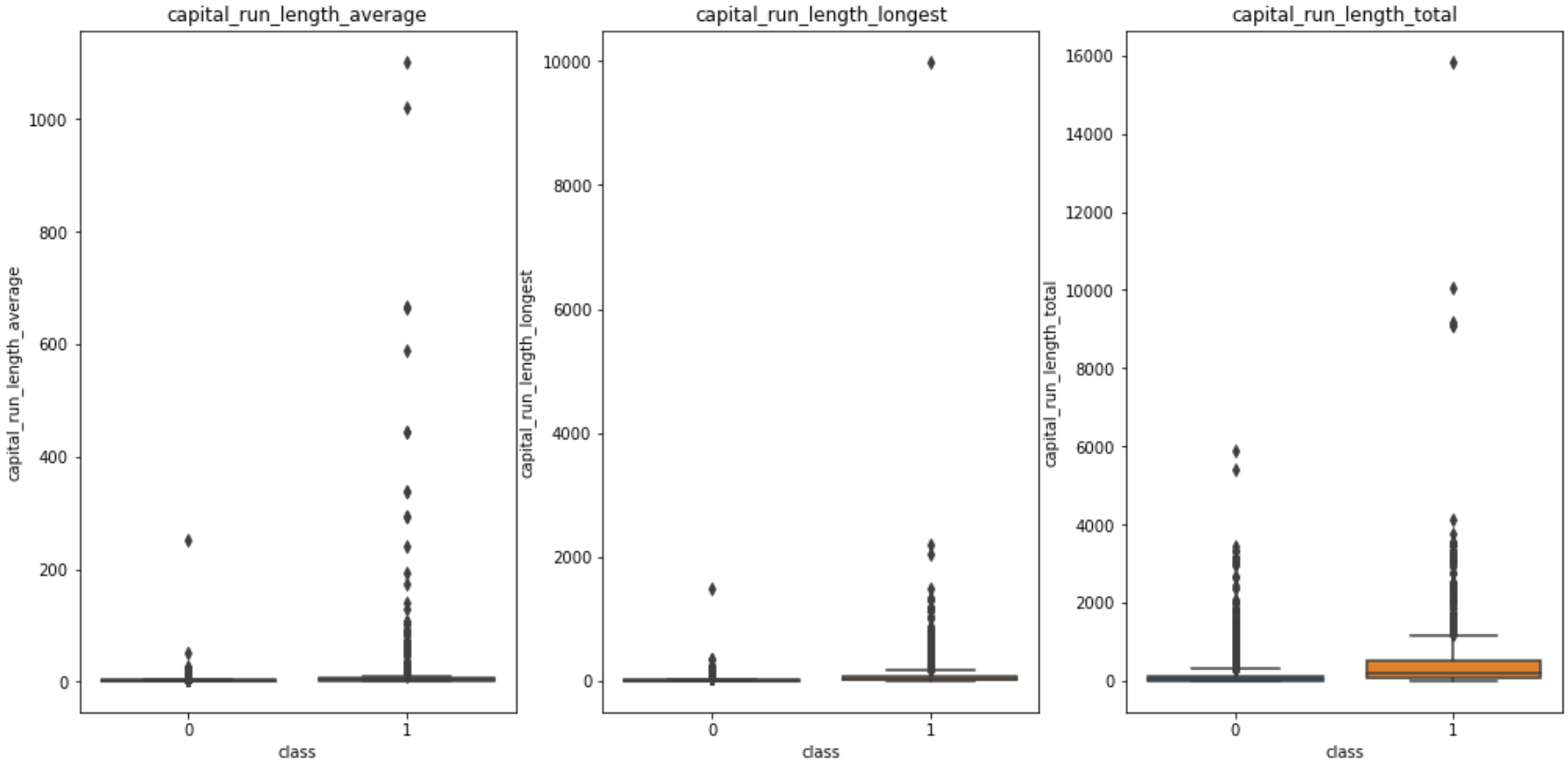
8 rows × 58 columns

In [6]:
```
colors = ["#00FF00","#0000FF"]
sns.countplot('class',data = dt, palette =  colors)
plt.title('Class Freq\n0 : ham\n1 : spam',fontsize=14)
```

Out[6]: Text(0.5, 1.0, 'Class Freq\n0 : ham\n1 : spam')



In [7]:
```
f, axes = plt.subplots(1, 3, figsize=(17,8))
sns.boxplot(x="class",y="capital_run_length_average",data = dt, ax=axes[0]).set_title('capital_run_length_average')
sns.boxplot(x="class",y="capital_run_length_longest",data = dt, ax=axes[1]).set_title('capital_run_length_longest')
sns.boxplot(x="class",y="capital_run_length_total",data = dt, ax=axes[2]).set_title('capital_run_length_total')
plt.show()
```



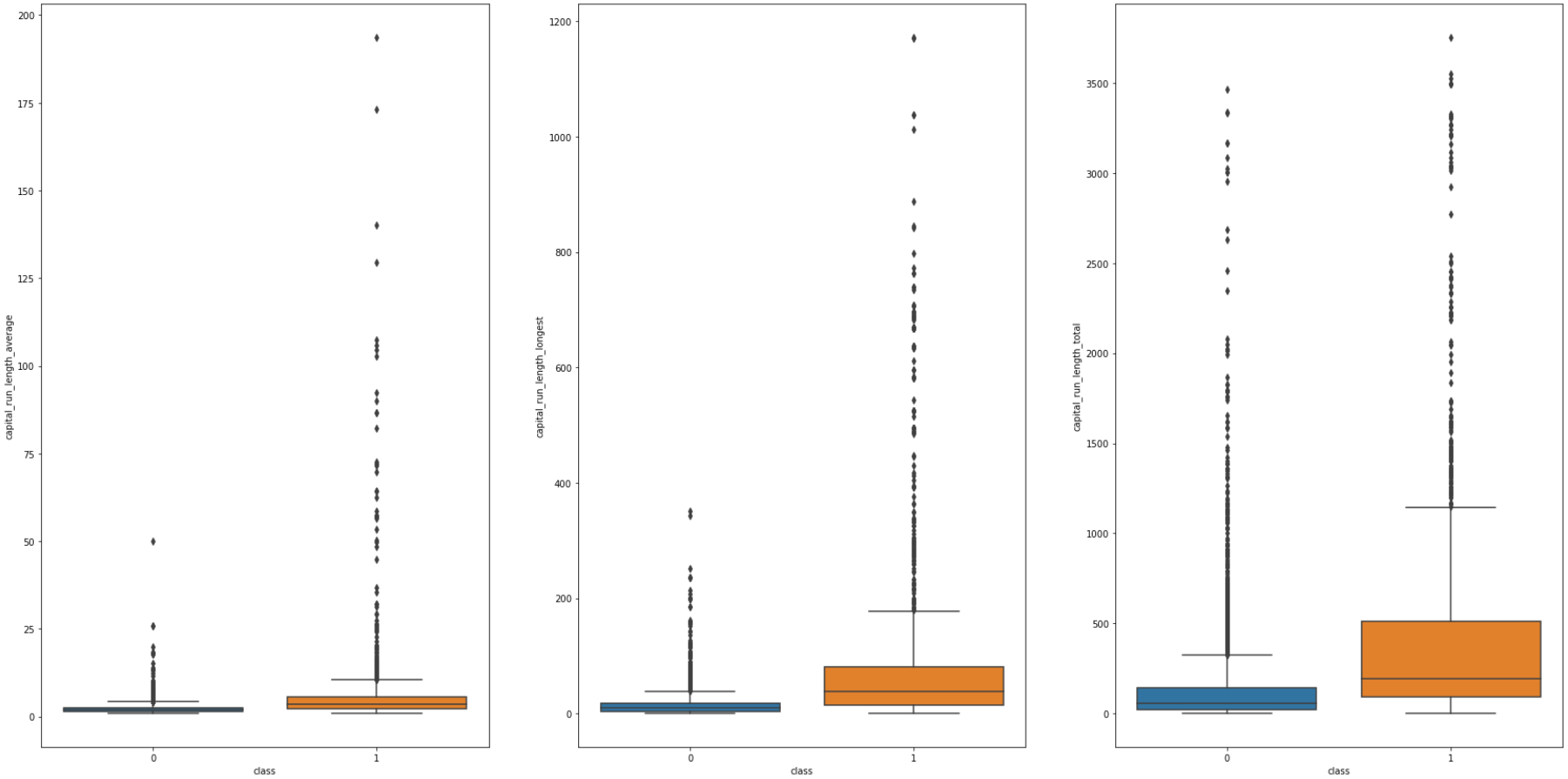
In [8]:
```
def removeOutlier(df, col_name, threshold, upper=True):
    if(upper==True):
        df = df.drop(df[(df[col_name] >= threshold)].index)
    else:
        df = df.drop(df[(df[col_name] < threshold)].index)
    return df

dt = removeOutlier(dt, 'capital_run_length_average',200)
dt = removeOutlier(dt, 'capital_run_length_longest', 1400)
dt = removeOutlier(dt, 'capital_run_length_total', 4000)
```

After Removing Outlier

In [9]:
```
f, axes = plt.subplots(1, 3, figsize=(30,15))
sns.boxplot(x='class', y='capital_run_length_average',data=dt,ax = axes[0])
sns.boxplot(x='class', y='capital_run_length_longest',data=dt,ax = axes[1])
sns.boxplot(x='class', y='capital_run_length_total',data=dt,ax = axes[2])
```

Out[9]: <matplotlib.axes._subplots.AxesSubplot at 0x7f67abd5db20>



In [10]:
```
mscaler = MinMaxScaler((0,100))

dt['capital_run_length_average'] = mscaler.fit_transform(np.array(dt['capital_run_length_average']).reshape(-1,1))
dt['capital_run_length_longest'] = mscaler.fit_transform(np.array(dt['capital_run_length_longest']).reshape(-1,1))
dt['capital_run_length_total'] = mscaler.fit_transform(np.array(dt['capital_run_length_total']).reshape(-1,1))
```

Visualization after Normalization

In [11]:
```
dt.describe()
```

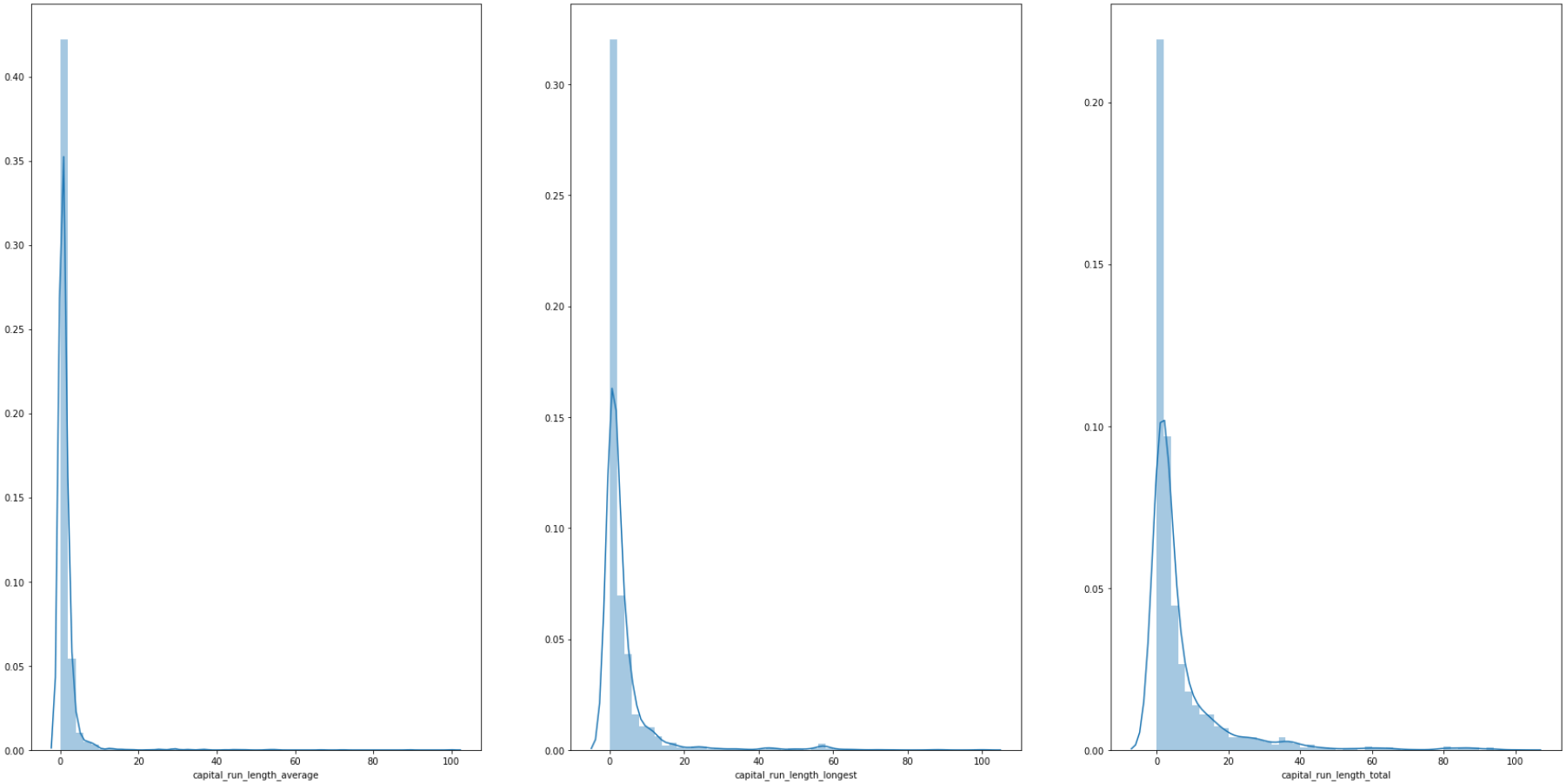
Out[11]:

	word_freq_make	word_freq_address	word_freq_all	word_freq_3d	word_freq_our	word_freq_over	word_freq_remove	word_freq_internet	w
count	4580.000000	4580.000000	4580.000000	4580.000000	4580.000000	4580.000000	4580.000000	4580.000000	
mean	0.104044	0.213707	0.277900	0.065675	0.311205	0.096162	0.114585	0.105603	
std	0.305758	1.293433	0.500914	1.398339	0.673004	0.274375	0.392245	0.401910	
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
50%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
75%	0.000000	0.000000	0.420000	0.000000	0.380000	0.000000	0.000000	0.000000	
max	4.540000	14.280000	5.100000	42.810000	10.000000	5.880000	7.270000	11.110000	

8 rows × 58 columns

In [12]:
```
f, axes = plt.subplots(1,3,figsize=(30,15))
sns.distplot(dt['capital_run_length_average'],ax=axes[0])
sns.distplot(dt['capital_run_length_longest'],ax=axes[1])
sns.distplot(dt['capital_run_length_total'],ax=axes[2])
```

Out[12]: <matplotlib.axes._subplots.AxesSubplot at 0x7f67ae2fd8e0>



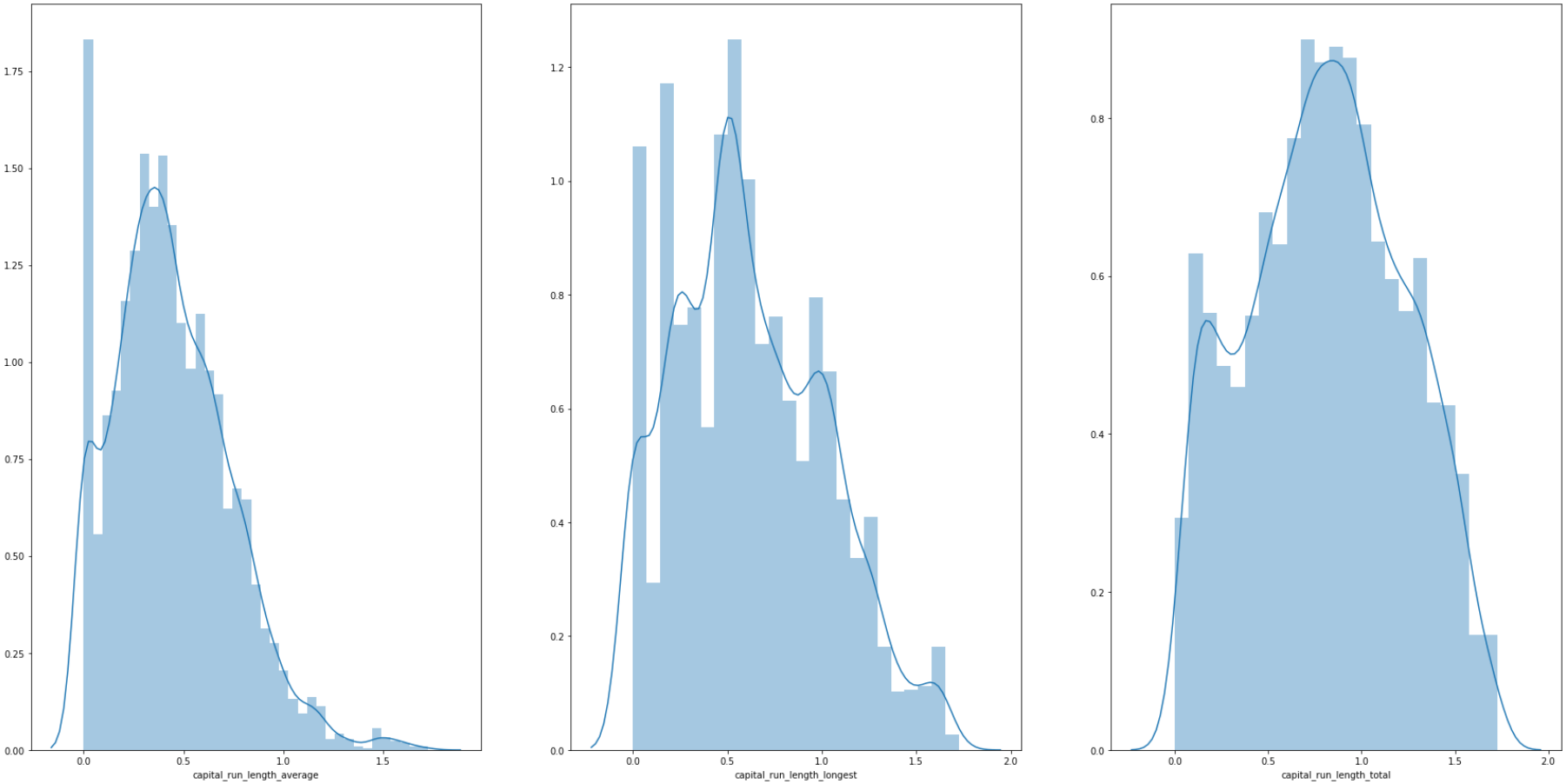
In [13]:
```
dt['capital_run_length_average'] = np.log(np.array(dt['capital_run_length_average']+1).reshape(-1,1))
dt['capital_run_length_longest'] = np.log(np.array(dt['capital_run_length_longest']+1).reshape(-1,1))
dt['capital_run_length_total'] = np.log(np.array(dt['capital_run_length_total']+1).reshape(-1,1))

dt['capital_run_length_average'] = np.log(np.array(dt['capital_run_length_average']+1).reshape(-1,1))
dt['capital_run_length_longest'] = np.log(np.array(dt['capital_run_length_longest']+1).reshape(-1,1))
dt['capital_run_length_total'] = np.log(np.array(dt['capital_run_length_total']+1).reshape(-1,1))
```

Transformation

In [14]:
```
f, axes = plt.subplots(1,3,figsize=(30,15))
sns.distplot(dt['capital_run_length_average'],ax=axes[0])
sns.distplot(dt['capital_run_length_longest'],ax=axes[1])
sns.distplot(dt['capital_run_length_total'],ax=axes[2])
```

Out[14]: <matplotlib.axes._subplots.AxesSubplot at 0x7f67abde4610>



In [15]:
```
dt = dt.reset_index()
X = dt
X = X.drop(columns='index')
y = X.pop('class')
```

Choose the best parameter

In [17]:
```
from sklearn.svm import SVC
from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import StratifiedKFold

skf = StratifiedKFold(5)
svm_par = {'C': [0.01, 0.1, 0.5, 1, 10, 100], 'kernel': ['rbf', 'poly', 'sigmoid', 'linear']}
clf = GridSearchCV(SVC(random_state=seed), svm_par).fit(X, y).best_estimator_
```

In [18]:
```
from sklearn.metrics import accuracy_score, precision_recall_fscore_support
def GetMetrics(estimator, X, y):
    y_pred = estimator.predict(X)
    acc = accuracy_score(y, y_pred)
    pre, rec, fs, sup = precision_recall_fscore_support(y, y_pred)
    return acc, pre, rec, fs
```

Training and Testing

In [19]:
```
pca = PCA(10)

scores = 0

for train_index, test_index in skf.split(X, y) :
    X_train, X_test = X.iloc[train_index], X.iloc[test_index]
    y_train, y_test = y[train_index], y[test_index]

    #pca.fit(X_train)
    #X_train = pca.transform(X_train)
    #X_test = pca.transform(X_test)

    classifier = clf.fit(X_train, y_train)
    scores = GetMetrics(classifier, X_test, y_test)
```

print the scores

In [20]:
```
names = ['Accuracy','Precision','Recall','f-score']

for i in range(len(scores)) :
    print(names[i],scores[i],sep=' = ',)
```

```
Accuracy = 0.8427947598253275
Precision = [0.90097087 0.7680798 ]
Recall = [0.83303411 0.85793872]
f-score = [0.86567164 0.81052632]
```

In [ ]:
```

```