In [26]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

In [426]:

```
import seaborn as sns
from sklearn.preprocessing import scale
from sklearn.manifold import TSNE
```

In [28]:

```
data = pd.read_csv('final_dataset.csv')
```

In [29]:

```
len(data.columns)
```

Out[29]:

20

In [30]:

```
data.head()
```

Out[30]:

	Unnamed: 0	URL	embedded_domain_in_path	ip_address	number_of_dots	host_has_dash	dicti
0	0	https://locking-app-adverds.000webhostapp.com/...	1	-1	-1	1	
1	1	https://mxtoolbox.com/public/upgradev2.aspx?ps...	0	-1	-1	-1	
2	2	http://parolishop.com.br/questionreviews.htm	0	-1	-1	-1	
3	3	http://innovate.ieee.org/innovate/35675?lt=xpl...	1	-1	-1	-1	
4	4	http://ietbhaddal.edu.in/bb.mobile/mobile/inde...	0	-1	-1	-1	

In [ ]:

```

```

In [ ]:

```

```

DATA CLEANING

In [31]:

```
data.drop('Unnamed: 0', axis=1,inplace=True)
```

In [40]:

```
data[data['URL'] == "url"]
```

Out[40]:

	URL	embedded_domain_in_path	ip_address	number_of_dots	host_has_dash	dictionary_word	http_in_hostname	targeted_bran
1705	url	embedded_domain_in_path	ip_address	number_of_dots	host_has_dash	dictionary_word	http_in_hostname	targeted_bran

In [48]:

```
data.drop(1705,axis=0,inplace=True)
```

In [52]:

```
data.columns
```

Out[52]:

```
Index(['URL', 'embedded_domain_in_path', 'ip_address', 'number_of_dots',
       'host_has_dash', 'dictionary_word', 'http_in_hostname',
       'targeted_brand', 'redirecting url', 'ext url', 'Phishing',
       'Subdomains', 'Prefix-Suffix', 'Anchor Tag', 'Tags', 'Forms',
       'SSL Expiry Date', 'SSL Cert Check', 'Alexa Ranking'],
      dtype='object')
```

In [ ]:

```

```

Cleaning Anchor Tag feature

In [77]:

```
data[data['Anchor Tag'] == 'N-N']['Phishing'].value_counts()
```

Out[77]:

```
yes    875
no     179
Name: Phishing, dtype: int64
```

In [94]:

```
data['Anchor Tag'].replace('N-N',np.nan,inplace=True)
```

In [104]:

```
data['Anchor Tag'] = data['Anchor Tag'].astype(float)
```

In [106]:

```
data['Anchor Tag'] = round(data['Anchor Tag'],ndigits=0)
```

In [121]:

```
def impute_anchors_val(vals):
    anc = vals[0]
    phish = vals[1]
    if phish == 'yes' and pd.isnull(anc):
        return 300
    elif phish == 'no' and pd.isnull(anc):
        return 150
    else:
        return anc
```

In [124]:

```
data['Anchor Tag'] = data[['Anchor Tag', 'Phishing']].apply(impute_anchors_val,axis=1)
```

In [127]:

```
data[data['Anchor Tag'].isnull()]
```

Out[127]:

URL	embedded_domain_in_path	ip_address	number_of_dots	host_has_dash	dictionary_word	http_in_hostname	targeted_brand	re

In [129]:

```
data[data['Phishing'] == 'yes']['Anchor Tag'].mean()
```

Out[129]:

```
268.5291902071563
```

In [130]:

```
data[data['Phishing'] == 'no']['Anchor Tag'].mean()
```

Out[130]:

```
162.8074074074074
```

In [ ]:

```

```

Tags feature processing

In [141]:

```
data['Tags'].value_counts()
```

Out[141]:

```
N-N    1118
100    1024
Name: Tags, dtype: int64
```

OBSERVATION: It is better to exclude this feature as not much useful information can be extracted from it. Moreover, for more than half the data points the information is not available (exception case)

Forms feature processing

In [147]:

```
data[data['Phishing'] == 'no']['Forms'].value_counts()
```

Out[147]:

```
1      447
0      442
N-N    175
-1      16
Name: Forms, dtype: int64
```

In [148]:

```
data[data['Phishing'] == 'yes']['Forms'].value_counts()
```

Out[148]:

```
N-N    875
1      102
0       79
-1       6
Name: Forms, dtype: int64
```

In [151]:

```
data['Forms'].replace('N-N',np.nan, inplace=True)
```

In [159]:

```
# This function checks whether any information related to the form links is available or not
def form_info_available(form_val):
    val = form_val[0]
    if pd.isnull(val):
        return 0
    return 1
```

In [161]:

```
data['Forms'] = data[['Forms']].apply(form_info_available,axis=1)
```

In [ ]:

```

```

In [185]:

```
data[data['Phishing'] == "yes"]['SSL Expiry Date'].value_counts()
```

Out[185]:

```
-1       543
 253      59
 252      33
 39       19
 62       16
 55       16
 2501     10
 35        9
 22        8
 80        8
 85        8
 64        8
 36        8
 43        8
 12        8
 251       7
 42        7
 84        7
 76        7
 79        7
 54        6
 70        6
 243       6
 37        6
 61        6
 44        6
 2500      5
 11        5
 75        5
 41        5
        ...
 654       1
```

```
 676       1
 715       1
 731       1
 742       1
 9043      1
 857       1
 286       1
 282       1
 264       1
 175       1
 98        1
 99        1
 126       1
 2193      1
 148       1
 9157      1
 158       1
 167       1
 179       1
 235       1
 180       1
 182       1
 190       1
 204       1
 218       1
 227       1
 229       1
 6374      1
 154       1
Name: SSL Expiry Date, Length: 141, dtype: int64
```

Alexa Ranking Feature Processing

In [196]:

```
data[data['Phishing'] == "no"]['Alexa Ranking'].median()
```

Out[196]:

```
7538.0
```

In [197]:

```
data[data['Phishing'] == "yes"]['Alexa Ranking'].median()
```

Out[197]:

```
538085.0
```

In [198]:

```
def impute_alexa(vals):
    rank = vals[0]
    phis = vals[1]
    if pd.isnull(rank):
        if phis == "no":
            return 7500
        else:
            return 538000
    return rank
```

In [201]:

```
data['Alexa Ranking'] = data[['Alexa Ranking', 'Phishing']].apply(impute_alexa,axis=1)
```

In [203]:

```
data.columns
```

Out[203]:

```
Index(['URL', 'embedded_domain_in_path', 'ip_address', 'number_of_dots',
       'host_has_dash', 'dictionary_word', 'http_in_hostname',
       'targeted_brand', 'redirecting url', 'ext url', 'Phishing',
       'Subdomains', 'Prefix-Suffix', 'Anchor Tag', 'Tags', 'Forms',
       'SSL Expiry Date', 'SSL Cert Check', 'Alexa Ranking'],
      dtype='object')
```

In [ ]:

```
```

In [213]:

```
data['SSL Expiry Date'].groupby(data['Phishing']).mean()
```

Out[213]:

```
Phishing
no     223.114815
yes    149.979284
Name: SSL Expiry Date, dtype: float64
```

In [228]:

```
data[data['Phishing'] == "yes"]['SSL Expiry Date'].value_counts()
```

Out[228]:

```
-1       543
 253      59
 252      33
 39       19
 62       16
 55       16
 2501     10
 35        9
 22        8
 80        8
 85        8
 64        8
 36        8
 43        8
 12        8
 251       7
 42        7
 84        7
 76        7
 79        7
 54        6
 70        6
 243       6
 37        6
 61        6
 44        6
 2500      5
 11        5
 75        5
 41        5
        ...
 654       1
 676       1
 715       1
 731       1
 742       1
 9043      1
 857       1
 286       1
 282       1
 264       1
 175       1
 98        1
 99        1
```

```
 126       1
 2193      1
 148       1
 9157      1
 158       1
 167       1
 179       1
 235       1
 180       1
 182       1
 190       1
 204       1
 218       1
 227       1
 229       1
 6374      1
 154       1
Name: SSL Expiry Date, Length: 141, dtype: int64
```

In [219]:

```
data[data['Phishing'] == "no"]['SSL Expiry Date'].value_counts()
```

Out[219]:

```
-1      161
 69      78
 68      26
 163     14
 182     13
 219     12
 316     10
 380     10
 67      10
 151     10
 322      9
 626      9
 249      8
 77       8
 315      8
 74       7
 150      7
 434      7
 582      7
 93       7
 176      7
 49       7
 133      7
 34       7
 750      7
 147      6
 193      6
 66       6
 180      6
 175      6
       ...
 191      1
 294      1
 298      1
 423      1
 351      1
 409      1
 408      1
 406      1
 404      1
 391      1
 390      1
 389      1
 387      1
 382      1
 359      1
 358      1
 348      1
 303      1
 344      1
 341      1
```

```
 339      1
 337      1
 333      1
 325      1
 323      1
 317      1
 313      1
 311      1
 307      1
 287      1
Name: SSL Expiry Date, Length: 326, dtype: int64
```

In [ ]:

```
```

In [229]:

```
def impute_expiry(vals):
    days = vals[0]
    phis = vals[1]
    if days == -1:
        if phis == 'yes':
            return 69
        else:
            return 253
    return days
```

In [231]:

```
data["SSL Expiry Date"] = data[['SSL Expiry Date','Phishing']].apply(impute_expiry, axis=1)
```

In [232]:

```
data.head()
```

Out[232]:

	URL	embedded_domain_in_path	ip_address	number_of_dots	host_has_dash	dictionary_word
0	https://locking-app-adverds.000webhostapp.com/...	1	-1	-1	1	1
1	https://mxtoolbox.com/public/upgradev2.aspx?ps...	0	-1	-1	-1	-1
2	http://parolishop.com.br/questionreviews.htm	0	-1	-1	-1	-1
3	http://innovate.ieee.org/innovate/35675?lt=xpl...	1	-1	-1	-1	-1
4	http://ietbhaddal.edu.in/bb.mobile/mobile/inde...	0	-1	-1	-1	-1

In [235]:

```
data.to_csv("final_cleaned_dataset.csv",index=False)
```

In [ ]:

```
```

In [ ]:

```
```

In [ ]:

```
```

In [ ]:

```
```

In [ ]:

```
```

In [ ]:

```
```

In [288]:

```
data = pd.read_csv("final_cleaned_dataset.csv")
```

In [289]:

```
data.drop(['Tags'],axis=1, inplace=True)
```

In [290]:

```
data.head()
```

Out[290]:

	URL	embedded_domain_in_path	ip_address	dictionary_word	targeted_brand	ext url	Phishing	S
0	https://locking-app-adverds.000webhostapp.com/...	1	-1	1	-1	-1	yes	
1	https://mxtoolbox.com/public/upgradev2.aspx?ps...	0	-1	-1	-1	-1	no	
2	http://parolishop.com.br/questionreviews.htm	0	-1	-1	-1	-1	yes	
3	http://innovate.ieee.org/innovate/35675?lt=xpl...	1	-1	-1	-1	-1	no	
4	http://ietbhaddal.edu.in/bb.mobile/mobile/inde...	0	-1	-1	1	-1	yes	

In [291]:

```
data.columns
```

Out[291]:

```
Index(['URL', 'embedded_domain_in_path', 'ip_address', 'dictionary_word',
       'targeted_brand', 'ext url', 'Phishing', 'Subdomains', 'Prefix-Suffix',
       'Anchor Tag', 'Forms', 'SSL Expiry Date', 'SSL Cert Check',
       'Alexa Ranking', 'URL Length', 'URL Shortened', 'Redirects User',
       'URL has @ Symbol', 'URL has HTTPS'],
      dtype='object')
```

In [292]:

```
data.describe()
```

Out[292]:

	embedded_domain_in_path	ip_address	dictionary_word	targeted_brand	ext url	Subdomains	Prefix-Suffix	Anchor Tag
count	2142.000000	2142.000000	2142.000000	2142.000000	2142.000000	2142.000000	2142.000000	2142.000000
mean	0.351541	-0.992530	-0.433240	-0.478992	5.282913	2.776844	0.758170	215.224090
std	0.859676	0.122026	0.901489	0.878024	24.216451	0.784998	0.652209	90.402299

	embedded_domain_in_path	ip_address	dictionary_word	targeted_brand	ext url	Subdomains	Prefix-Suffix	Anchor Tag
min	-1.000000	-1.000000	-1.000000	-1.000000	-1.000000	1.000000	-1.000000	1.000000
25%	-1.000000	-1.000000	-1.000000	-1.000000	-1.000000	2.000000	1.000000	150.000000
50%	1.000000	-1.000000	-1.000000	-1.000000	-1.000000	3.000000	1.000000	209.000000
75%	1.000000	-1.000000	1.000000	1.000000	-1.000000	3.000000	1.000000	300.000000
max	1.000000	1.000000	1.000000	1.000000	99.000000	10.000000	1.000000	300.000000

In [293]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2142 entries, 0 to 2141
Data columns (total 19 columns):
URL                          2142 non-null object
embedded_domain_in_path      2142 non-null int64
ip_address                   2142 non-null int64
dictionary_word              2142 non-null int64
targeted_brand               2142 non-null int64
ext url                      2142 non-null int64
Phishing                     2142 non-null object
Subdomains                   2142 non-null int64
Prefix-Suffix                2142 non-null int64
Anchor Tag                   2142 non-null int64
Forms                        2142 non-null int64
SSL Expiry Date              2142 non-null int64
SSL Cert Check               2142 non-null int64
Alexa Ranking                2142 non-null int64
URL Length                   2142 non-null int64
URL Shortened                2142 non-null int64
Redirects User               2142 non-null int64
URL has @ Symbol             2142 non-null int64
URL has HTTPS                2142 non-null int64
dtypes: int64(17), object(2)
memory usage: 318.0+ KB
```

In [294]:

```
data['embedded_domain_in_path'].groupby(data['Phishing']).value_counts()
```

Out[294]:

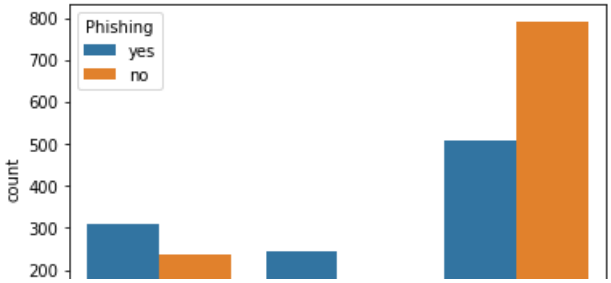
```
Phishing  embedded_domain_in_path
no         1                          793
          -1                          237
           0                           50
yes        1                          507
          -1                          310
           0                          245
Name: embedded_domain_in_path, dtype: int64
```

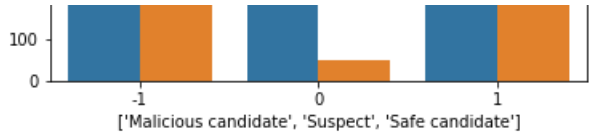
In [295]:

```
sns.countplot(x='embedded_domain_in_path',data= data, hue = 'Phishing')
plt.xlabel(['Malicious candidate', 'Suspect', 'Safe candidate'])
```

Out[295]:

```
Text(0.5,0,"['Malicious candidate', 'Suspect', 'Safe candidate']")
```





In [296]:

```
# Status: Included for model
```

In [ ]:

```

```

In [297]:

```
data['ip_address'].value_counts()
```

Out[297]:

```
-1    2134
 1       8
Name: ip_address, dtype: int64
```

In [298]:

```
# Status: Drop it (No useful information can be obtained from this feature)
```

In [299]:

```
# Note: Check for the source and validity of dictionary word and targeted blank and ext url
```

In [ ]:

```

```

In [300]:

```
data['targeted_brand'].groupby(data['Phishing']).value_counts()
```

Out[300]:

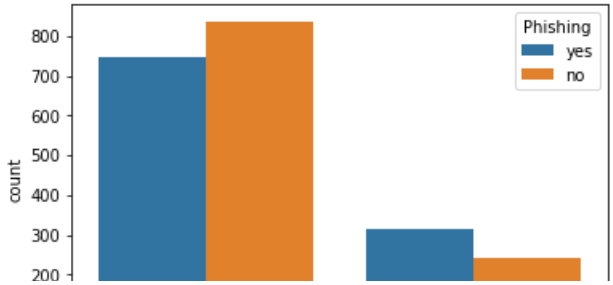
```
Phishing  targeted_brand
no        -1                837
           1                243
yes       -1                747
           1                315
Name: targeted_brand, dtype: int64
```

In [301]:

```
sns.countplot(x="targeted_brand",hue="Phishing",data= data)
```

Out[301]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x26e559462b0>
```



In [302]:

```
data[pd.isnull(data['Subdomains'])]
```

Out[302]:

	URL	embedded_domain_in_path	ip_address	dictionary_word	targeted_brand	ext url	Phishing	Subdomains	Prefix-Suffix	Anchor Tag	Forms

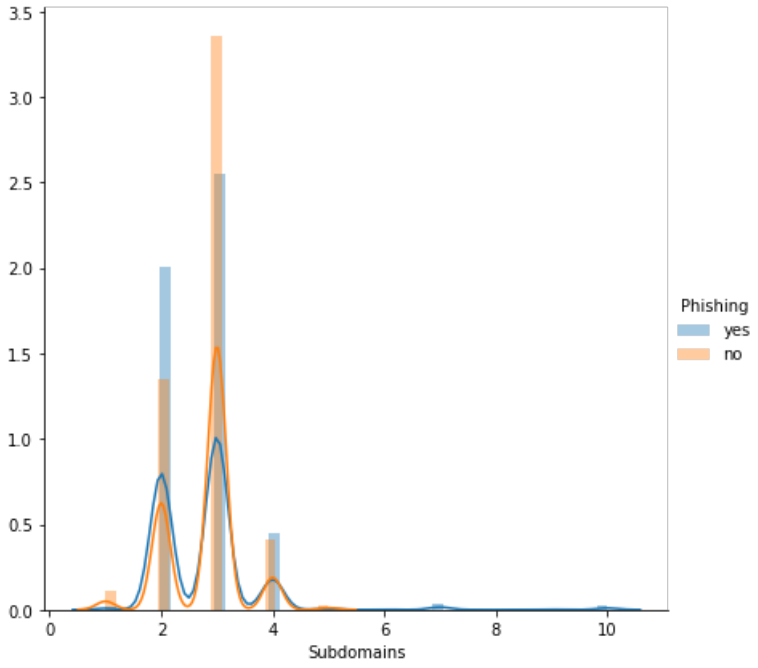
In [308]:

```
sns.FacetGrid(data, hue="Phishing", height=6).map(sns.distplot,"Subdomains").add_legend()
```

```
C:\Users\prabh\Anaconda3\lib\site-packages\scipy\stats\stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[308]:

```
<seaborn.axisgrid.FacetGrid at 0x26e51f20780>
```



Observations: When the number of subdomains are more than 5, it is highly likely the site is malicious

In [309]:

```
#Status: Include it
```

In [312]:

```
numerical_features = []
numerical_features.append('Subdomains')
```

In [ ]:

In [320]:

```
data['Prefix-Suffix'].groupby(data['Phishing']).value_counts()
```

Out[320]:

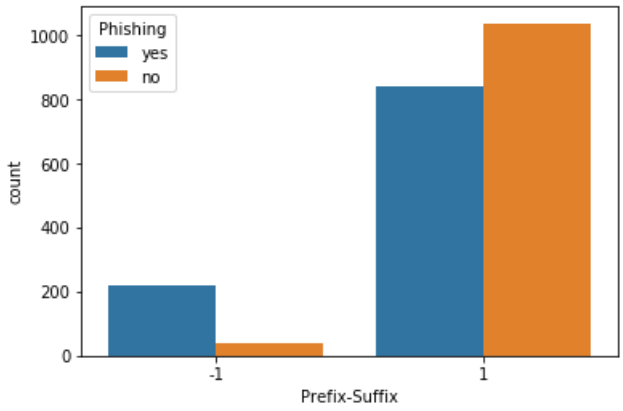
```
Phishing  Prefix-Suffix
no         1               1039
          -1                 41
yes        1                844
          -1                218
Name: Prefix-Suffix, dtype: int64
```

In [323]:

```
sns.countplot(x= 'Prefix-Suffix',data= data, hue='Phishing')
```

Out[323]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x26e51ab2b38>
```



In [325]:

```
#Status include it  (most of the malicious candidates are correctly attributes)
```

In [ ]:

```

```

In [332]:

```
data['Anchor Tag'].describe()
```

Out[332]:

```
count    2142.000000
mean      215.224090
std        90.402299
min         1.000000
25%       150.000000
50%       209.000000
75%       300.000000
max       300.000000
Name: Anchor Tag, dtype: float64
```

In [333]:

```
data['Anchor Tag'].groupby(data['Phishing']).describe()
```

Out[333]:

Phishing	count	mean	std	min	25%	50%	75%	max
no	1080.0	162.807407	65.450715	1.0	150.0	179.5	200.0	300.0
yes	1062.0	268.529190	80.586660	1.0	300.0	300.0	300.0	300.0

In [334]:

```
numerical_features.append('Anchor Tag')
```

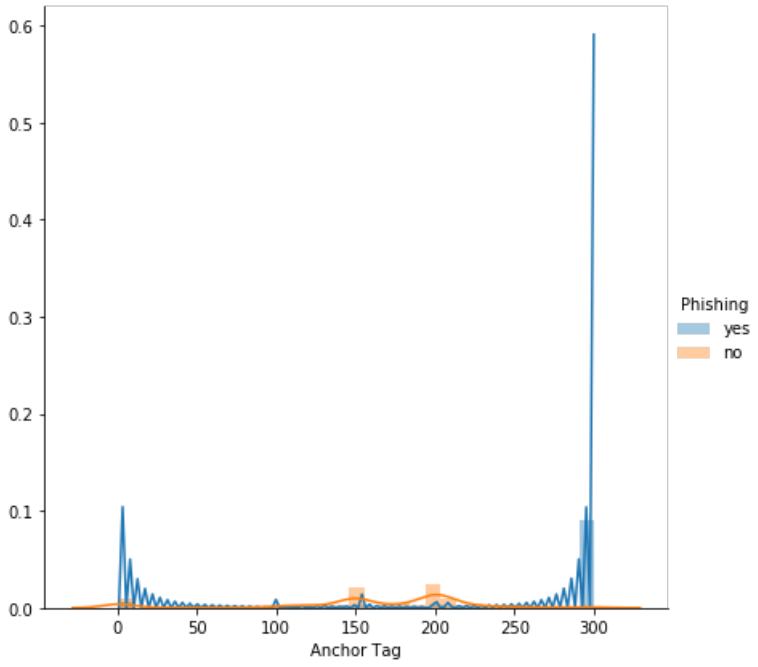
In [340]:

```
sns.FacetGrid(data, hue="Phishing", size=6).map(sns.distplot,'Anchor Tag').add_legend()
```

```
C:\Users\prabh\Anaconda3\lib\site-packages\seaborn\axisgrid.py:230: UserWarning: The `size`
paramter has been renamed to `height`; please update your code.
  warnings.warn(msg, UserWarning)
C:\Users\prabh\Anaconda3\lib\site-packages\scipy\stats\stats.py:1713: FutureWarning: Using a non-t
uple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[s
eq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will r
esult either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[340]:

```
<seaborn.axisgrid.FacetGrid at 0x26e51c0ea20>
```



Observation: As Anchor tag feature reach higher values the site tends to be Phishing

In [342]:

```
#Status:  Definitely Include (seams to be important feature upon initial analysis)
```

In [ ]:

```

```

In [346]:

```
data['Forms'].value_counts()
```

Out[346]:

```
1    1092
0    1050
Name: Forms, dtype: int64
```

In [347]:

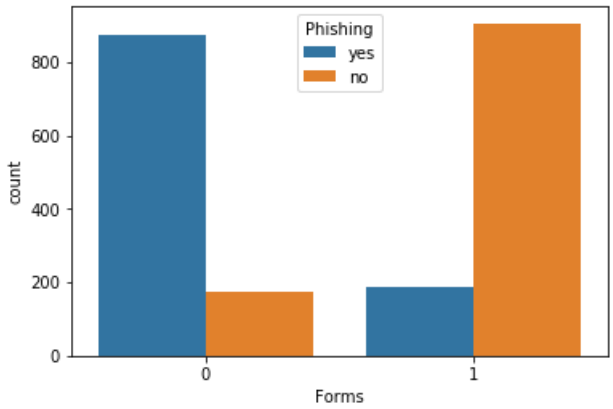
```
# 0: Data about forms not fetched
# 1: Data about forms fetched
```

In [349]:

```
sns.countplot(x="Forms", hue="Phishing", data=data)
```

Out[349]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x26e513106a0>
```



GREAT FEATURE! Most of the safe candidates and malicious candidates are classified correctly

In [350]:

```
# Status: Definitely Include (Important parameter)
```

In [ ]:

```

```

In [353]:

```
data['SSL Expiry Date'].groupby(data['Phishing']).describe()
```

Out[353]:

Phishing	count	mean	std	min	25%	50%	75%	max
no	1080.0	260.979630	209.460606	8.0	92.75	249.0	326.00	2501.0
yes	1062.0	185.770245	610.484474	11.0	69.00	69.0	84.75	9803.0

Mean Expiry Date for Phishing websites is slightly lower than that of safe websites. However, it would be too agressive to draw conclusions.

In [360]:

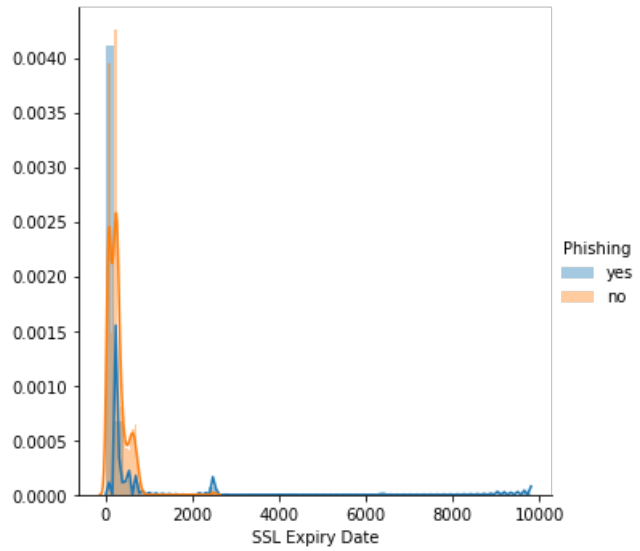
```
sns.FacetGrid(data=data, hue="Phishing", size=5).map(sns.distplot,'SSL Expiry Date').add_legend()
```

```
C:\Users\prabh\Anaconda3\lib\site-packages\seaborn\axisgrid.py:230: UserWarning: The `size`
paramter has been renamed to `height`; please update your code.
```

```
  warnings.warn(msg, UserWarning)
C:\Users\prabh\Anaconda3\lib\site-packages\scipy\stats\stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[360]:

```
<seaborn.axisgrid.FacetGrid at 0x26e516c2c18>
```



High Overlapping can be seen except the highly skewed values

In [361]:

```
# Status : Let's keep it
```

In [362]:

```
numerical_features.append('SSL Expiry Date')
```

In [ ]:

```

```

In [365]:

```
data['SSL Cert Check'].value_counts()
```

Out[365]:

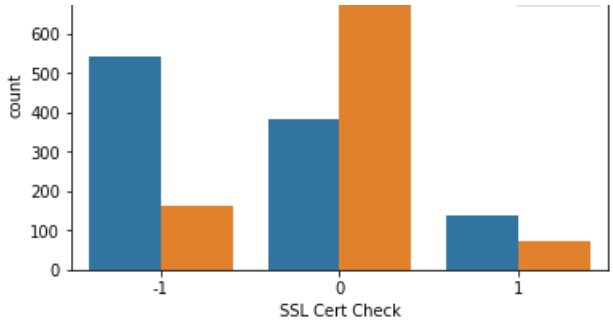
```
 0    1226
-1     704
 1     212
Name: SSL Cert Check, dtype: int64
```

In [366]:

```
sns.countplot(x='SSL Cert Check', hue='Phishing', data=data)
```

Out[366]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x26e516a3da0>
```



In [367]:

```
#Status : Keep it
```

In [ ]:

```

```

In [371]:

```
data['Alexa Ranking'].groupby(data['Phishing']).describe()
```

Out[371]:

Phishing	count	mean	std	min	25%	50%	75%	max
no	1080.0	6.350705e+05	2.290722e+06	1.0	599.5	7500.0	134548.0	19171314.0
yes	1062.0	1.526323e+06	3.687241e+06	1482.0	538000.0	538000.0	538000.0	19996840.0

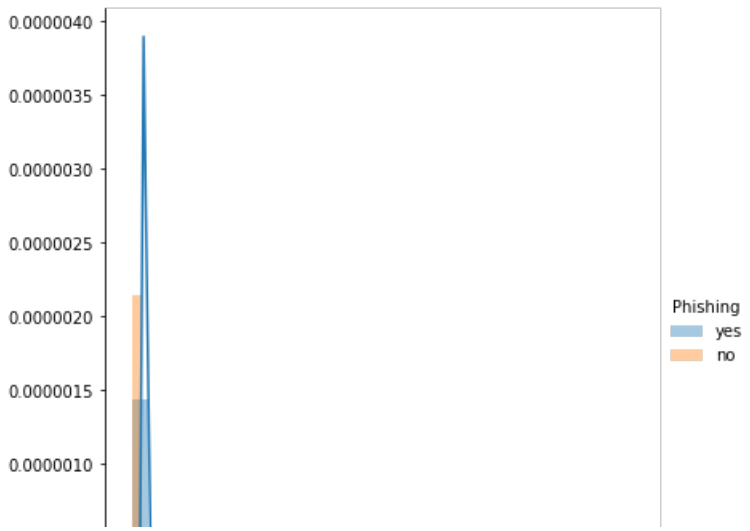
In [372]:

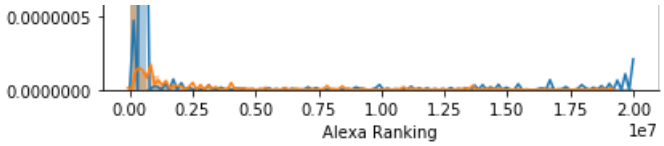
```
sns.FacetGrid(data, hue="Phishing", size=6).map(sns.distplot,'Alexa Ranking').add_legend()
```

```
C:\Users\prabh\Anaconda3\lib\site-packages\seaborn\axisgrid.py:230: UserWarning: The `size`
paramter has been renamed to `height`; please update your code.
  warnings.warn(msg, UserWarning)
C:\Users\prabh\Anaconda3\lib\site-packages\scipy\stats\stats.py:1713: FutureWarning: Using a non-t
uple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[s
eq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will r
esult either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[372]:

```
<seaborn.axisgrid.FacetGrid at 0x26e5168f198>
```





In [376]:

```
numerical_features.append('Alexa Ranking')
```

In [377]:

```
#Status: keep it
```

In [ ]:

```

```

In [381]:

```
numerical_features.append('URL Length')
```

In [384]:

```
data['URL Shortened'].value_counts()
```

Out[384]:

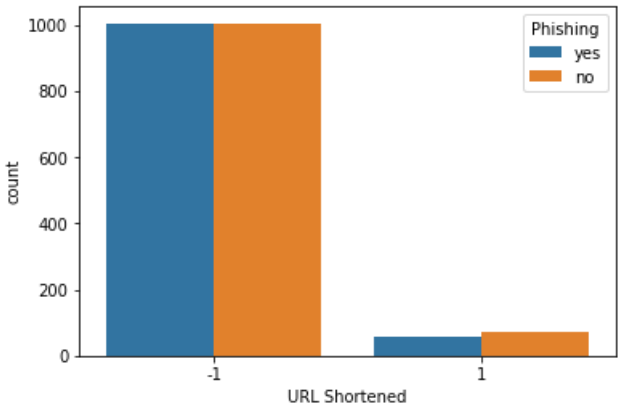
```
-1    2009
 1     133
Name: URL Shortened, dtype: int64
```

In [386]:

```
sns.countplot(x="URL Shortened", hue="Phishing", data= data)
```

Out[386]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x26e588abe80>
```



In [388]:

```
# Not much information ;
```

In [392]:

```
data['Redirects User'].value_counts()
```

Out[392]:

```
 1    2126
```

```
-1      16
Name: Redirects User, dtype: int64
```

In [396]:

```
# Not enough distinction
```

In [397]:

```
data['URL has @ Symbol'].value_counts()
```

Out[397]:

```
 1    2124
-1      18
Name: URL has @ Symbol, dtype: int64
```

In [398]:

```
# Not enough distinction
```

In [401]:

```
data['URL has HTTPS'].value_counts()
```

Out[401]:

```
-1    1560
 1     582
Name: URL has HTTPS, dtype: int64
```

In [ ]:

```

```

In [403]:

```
numerical_features
```

Out[403]:

```
['Subdomains', 'Anchor Tag', 'SSL Expiry Date', 'Alexa Ranking', 'URL Length']
```

In [408]:

```
pairs = numerical_features
```

In [409]:

```
pairs.append('Phishing')
```

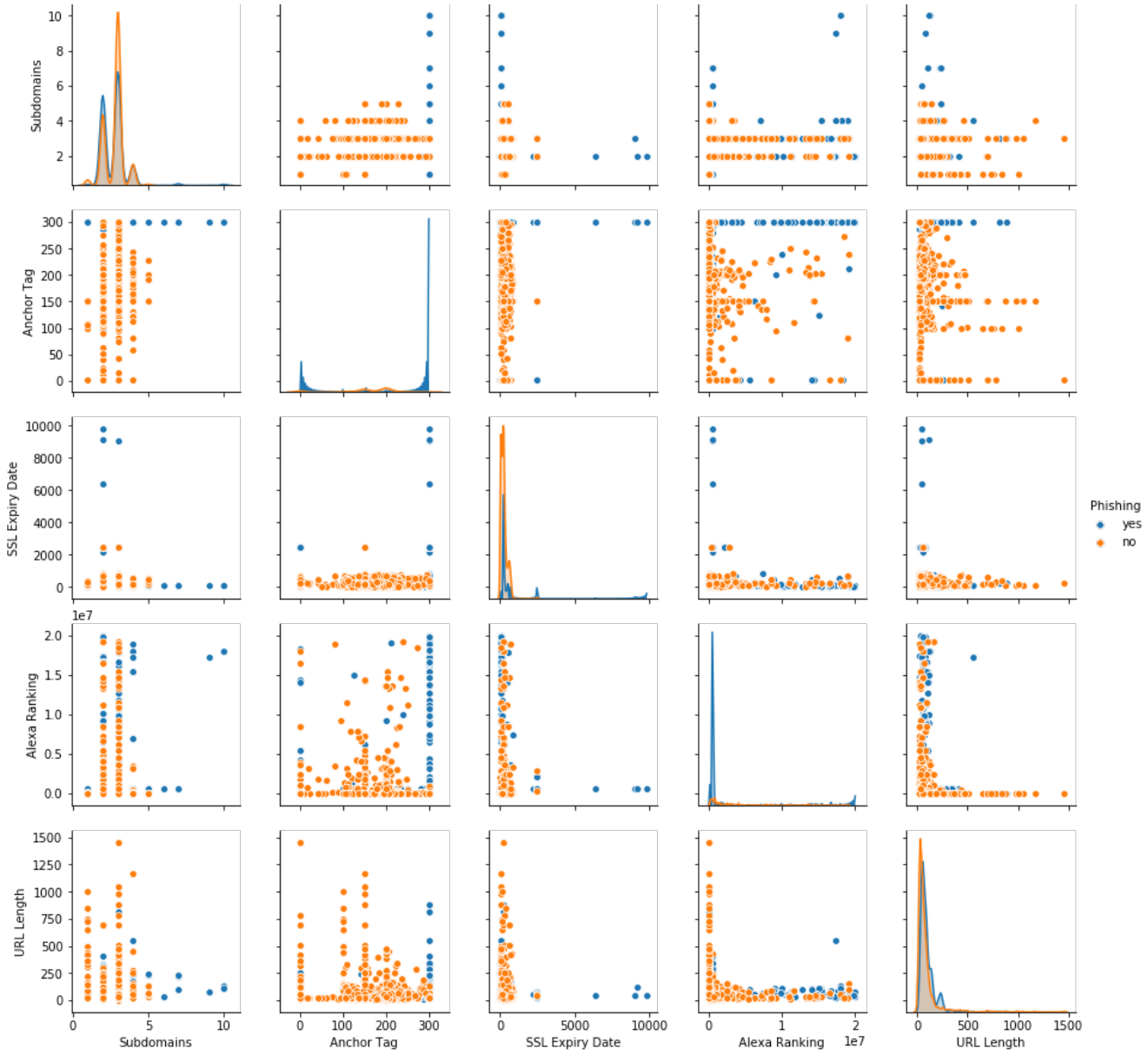
In [410]:

```
sns.pairplot(data[pairs],hue='Phishing')
```

```
C:\Users\prabh\Anaconda3\lib\site-packages\scipy\stats\stats.py:1713: FutureWarning: Using a non-t
uple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[s
eq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will r
esult either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[410]:

```
<seaborn.axisgrid.PairGrid at 0x26e6a94aac8>
```



In [ ]:

```
```

In [415]:

```
numerical_features.remove("Phishing")
```

In [ ]:

```
```

In [424]:

```
for col in numerical_features:
    data[col] = scale(data[col])
```

```
C:\Users\prabh\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:
Data with input dtype int64 was converted to float64 by the scale function.
  warnings.warn(msg, DataConversionWarning)
C:\Users\prabh\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:
Data with input dtype int64 was converted to float64 by the scale function.
  warnings.warn(msg, DataConversionWarning)
C:\Users\prabh\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:
Data with input dtype int64 was converted to float64 by the scale function.
  warnings.warn(msg, DataConversionWarning)
C:\Users\prabh\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:
```

```
Data with input dtype int64 was converted to float64 by the scale function.
  warnings.warn(msg, DataConversionWarning)
C:\Users\prabh\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:
Data with input dtype int64 was converted to float64 by the scale function.
  warnings.warn(msg, DataConversionWarning)
```

In [ ]:

```
```

In [ ]:

```
```

In [431]:

```
data.columns
```

Out[431]:

```
Index(['URL', 'embedded_domain_in_path', 'ip_address', 'dictionary_word',
       'targeted_brand', 'ext url', 'Phishing', 'Subdomains', 'Prefix-Suffix',
       'Anchor Tag', 'Forms', 'SSL Expiry Date', 'SSL Cert Check',
       'Alexa Ranking', 'URL Length', 'URL Shortened', 'Redirects User',
       'URL has @ Symbol', 'URL has HTTPS'],
      dtype='object')
```

In [428]:

```
model = TSNE(n_components=2, random_state=0)
```

In [432]:

```
X = data.drop(['Phishing','URL'],axis=1)
```

In [435]:

```
data['Phishing'].replace('yes','1',inplace=True)
```

In [437]:

```
data['Phishing'].replace('no','0',inplace=True)
```

In [438]:

```
y = data['Phishing']
```

In [439]:

```
tsne_data = model.fit_transform(X)
```

In [440]:

```
tsne_data = np.vstack((tsne_data.T, y)).T
```

In [441]:

```
tsne_data
```

Out[441]:

```
array([[-18.12958526611328, -27.14824676513672, '1'],
       [-45.64045715332031, -23.952043533325195, '0'],
       [22.156965255737305, 38.51922607421875, '1'],
       ...,
```

```
[36.30477905273375, 20.637802124023438, '0'],
[37.55514144897461, 21.1378173828125, '0'],
[70.81363677978516, -1.3471229076385498, '1']], dtype=object)
```

In [444]:

```
len(tsne_data)
```

Out[444]:

2142

In [445]:

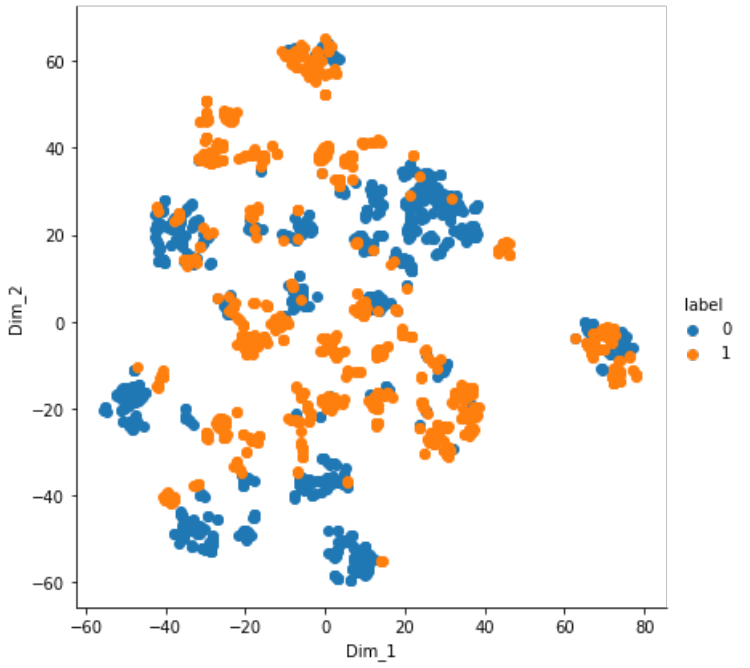
```
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))
tsne_df.head()
```

Out[445]:

	Dim_1	Dim_2	label
0	-18.1296	-27.1482	1
1	-45.6405	-23.952	0
2	22.157	38.5192	1
3	25.8022	19.3927	0
4	-14.8906	-4.23886	1

In [447]:

```
sns.FacetGrid(tsne_df, hue="label", height=6).map(plt.scatter, 'Dim_1', 'Dim_2').add_legend()
plt.show()
```



Observations

- T-SNE plot has made some well defined clusters
- Generally the central area is covered by label - 1 i.e. Phishing websites while, label-0 or safe website have some clusters around the edges
- Algorithms like K-NN might work wonders on this dataset ; Forest techniques and ensemble learning looks promising as well.
- Overfitting may ruin the model as this application of detecting malicious websites will observe so much unseen data once productionized

In [ ]:

```

```

In [ ]:

```

```

In [ ]:

```

```

In [ ]:

```

```

In [472]:

```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
from sklearn.metrics import accuracy_score
```

In [453]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=0)
```

In [455]:

```
X_train.shape
```

Out[455]:

```
(1499, 17)
```

In [ ]:

```

```

In [452]:

```
neighbors = list(range(1,50,2))
```

In [457]:

```
cv_scores=[]
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, X_train, y_train, scoring='accuracy', cv=10)
    cv_scores.append(scores.mean())
```

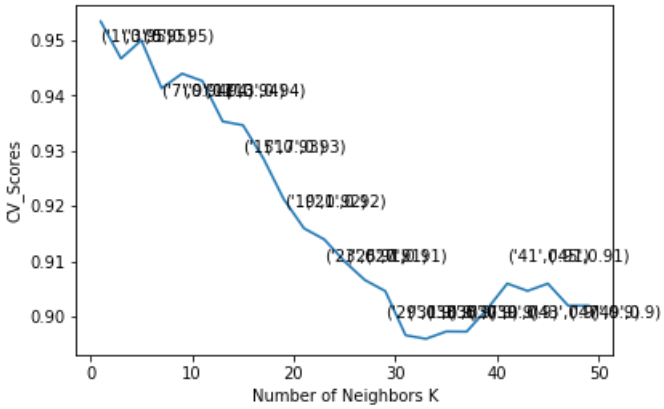
In [ ]:

```

```

In [469]:

```
plt.plot(neighbors, cv_scores)
for xy in zip(neighbors,np.round(cv_scores,2)):
    plt.annotate("('%s',%s)"% xy, xy=xy, textcoords='data')
plt.xlabel('Number of Neighbors K')
plt.ylabel('CV_Scores')
print("CV_SCORES: ",cv_scores)
```

```
CV_SCORES:  [0.9533670533505194, 0.9466601182274766, 0.9499713172437294, 0.9412776271537993,
0.9439310487873535, 0.9426066047379884, 0.9352818051172644, 0.9345973006207682,
0.9286015971080197, 0.9212412996133162, 0.9159299228113842, 0.9139254485384537, 0.909916381468806,
0.9065606767708194, 0.9045739218039319, 0.8965736254944664, 0.8959336266797043,
0.8972581299909625, 0.8972270471280204, 0.9012583077766421, 0.9059384565239936,
0.9046050639287673, 0.9059296265019187, 0.9019250337052018, 0.9019206186941642]
```



In [466]:

```
for xy in zip(neighbors,np.round(cv_scores,2)):
    print(xy)
```

```
(1, 0.95)
(3, 0.95)
(5, 0.95)
(7, 0.94)
(9, 0.94)
(11, 0.94)
(13, 0.94)
(15, 0.93)
(17, 0.93)
(19, 0.92)
(21, 0.92)
(23, 0.91)
(25, 0.91)
(27, 0.91)
(29, 0.9)
(31, 0.9)
(33, 0.9)
(35, 0.9)
(37, 0.9)
(39, 0.9)
(41, 0.91)
(43, 0.9)
(45, 0.91)
(47, 0.9)
(49, 0.9)
```

In [470]:

```
optimal_k = 5
```

In [473]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='kd_tree')

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
```

```
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 5 is 94.867807%
```

In [474]:

```
from sklearn.metrics import confusion_matrix
```

In [ ]:

```

```

In [475]:

```
confusion_matrix(y_test,pred)
```

Out[475]:

```
array([[321,  14],
       [ 19, 289]], dtype=int64)
```

In [ ]:

```

```

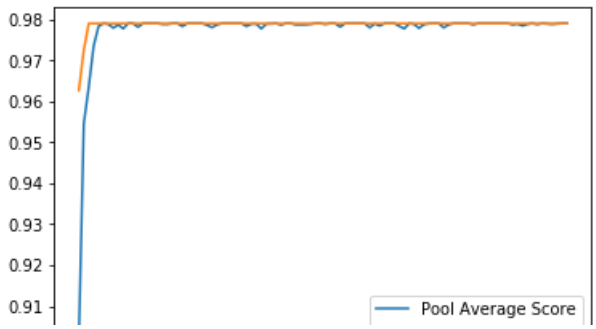
In [ ]:

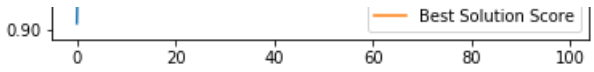
```

```

In [476]:

```
from geneticfs import GeneticFS

gen_model = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='kd_tree')
gfs = GeneticFS()

# fit the optimizer
gfs.fit(model=gen_model, _type='classification', X=X, y=y) # classification model

# get results output
binary_output_of_optimal_variables, indicies_of_optimal_variables = gfs.results()

# plot results of progress
gfs.plot_progress()
```

```
Iteration 10 Complete [Time Taken For Last Iteration: 3.76 Seconds]
Iteration 20 Complete [Time Taken For Last Iteration: 3.81 Seconds]
Iteration 30 Complete [Time Taken For Last Iteration: 3.78 Seconds]
Iteration 40 Complete [Time Taken For Last Iteration: 4.05 Seconds]
Iteration 50 Complete [Time Taken For Last Iteration: 4.0 Seconds]
Iteration 60 Complete [Time Taken For Last Iteration: 3.98 Seconds]
Iteration 70 Complete [Time Taken For Last Iteration: 3.97 Seconds]
Iteration 80 Complete [Time Taken For Last Iteration: 3.85 Seconds]
Iteration 90 Complete [Time Taken For Last Iteration: 4.05 Seconds]
Iteration 100 Complete [Time Taken For Last Iteration: 3.98 Seconds]
```





In [477]:

```
binary_output_of_optimal_variables
```

Out[477]:

```
array([0, 1, 1, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0])
```

In [478]:

```
indicies_of_optimal_variables
```

Out[478]:

```
[1, 2, 7, 8, 10, 11, 14]
```

In [496]:

```
X.columns[indicies_of_optimal_variables]
```

Out[496]:

```
Index(['ip_address', 'dictionary_word', 'Anchor Tag', 'Forms',
       'SSL Cert Check', 'Alexa Ranking', 'Redirects User'],
      dtype='object')
```

In [498]:

```
reduced_X = X[X.columns[indicies_of_optimal_variables]]
```

In [501]:

```
rX_train, rX_test, ry_train, ry_test = train_test_split(reduced_X, y, test_size=0.3, random_state=0
)
```

In [ ]:

```

```

In [510]:

```
cv_scores=[]
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, rX_train, ry_train, scoring='accuracy', cv=10)
    print("K : %d, Score : %f" % (k, scores.mean()))
    cv_scores.append(scores.mean())
```

```
K : 1, Score : 0.976639
K : 3, Score : 0.967297
K : 5, Score : 0.961972
K : 7, Score : 0.964661
K : 9, Score : 0.954647
K : 11, Score : 0.950620
K : 13, Score : 0.946598
K : 15, Score : 0.935922
K : 17, Score : 0.929935
K : 19, Score : 0.926633
K : 21, Score : 0.921290
K : 23, Score : 0.922624
K : 25, Score : 0.923957
K : 27, Score : 0.921281
K : 29, Score : 0.921281
K : 31, Score : 0.913294
K : 33, Score : 0.912623
```

```
K : 35, Score : 0.913957
K : 37, Score : 0.913290
K : 39, Score : 0.915952
K : 41, Score : 0.915952
K : 43, Score : 0.911952
K : 45, Score : 0.911281
K : 47, Score : 0.911961
K : 49, Score : 0.913299
```

In [511]:

```
optimal_k = 3
```

In [512]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='kd_tree')

# fitting the model
knn_optimal.fit(rX_train, ry_train)

# predict the response
pred = knn_optimal.predict(rX_test)

# evaluate accuracy
acc = accuracy_score(ry_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 3 is 96.889580%
```

In [513]:

```
confusion_matrix(ry_test,pred)
```

Out[513]:

```
array([[326,   9],
       [ 11, 297]], dtype=int64)
```

In [ ]:

```

```