Assignment-13- [KNN] - ZOO

In [114]:

```
#KNN Classification
import pandas as pd
import numpy as np
from sklearn.model_selection import KFold
from sklearn.model_selection import cross_val_score
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import accuracy_score
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

In [115]:

```
zoo = pd.read_csv('Zoo.csv')
```

In [116]:

```
zoo
```

Out[116]:

	animal name	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	backbone	breathes	venomous	fins	legs	tail	domestic	catsize	type
0	aardvark	1	0	0	1	0	0	1	1	1	1	0	0	4	0	0	1	1
1	antelope	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0	1	1
2	bass	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0	0	4
3	bear	1	0	0	1	0	0	1	1	1	1	0	0	4	0	0	1	1
4	boar	1	0	0	1	0	0	1	1	1	1	0	0	4	1	0	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
96	wallaby	1	0	0	1	0	0	0	1	1	1	0	0	2	1	0	1	1
97	wasp	1	0	1	0	1	0	0	0	0	1	1	0	6	0	0	0	6
98	wolf	1	0	0	1	0	0	1	1	1	1	0	0	4	1	0	1	1
99	worm	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	7
100	wren	0	1	1	0	1	0	0	0	1	1	0	0	2	1	0	0	2

101 rows × 18 columns

In [117]:

```
zoo.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 101 entries, 0 to 100
Data columns (total 18 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   animal name  101 non-null    object
 1   hair         101 non-null    int64 
 2   feathers     101 non-null    int64 
 3   eggs         101 non-null    int64 
 4   milk         101 non-null    int64 
 5   airborne     101 non-null    int64 
 6   aquatic      101 non-null    int64 
 7   predator     101 non-null    int64 
 8   toothed      101 non-null    int64 
 9   backbone     101 non-null    int64 
 10  breathes     101 non-null    int64 
 11  venomous     101 non-null    int64 
 12  fins         101 non-null    int64 
 13  legs         101 non-null    int64 
 14  tail         101 non-null    int64 
 15  domestic     101 non-null    int64 
 16  catsize      101 non-null    int64 
 17  type         101 non-null    int64 
dtypes: int64(17), object(1)
memory usage: 14.3+ KB
```

In [118]:
```
zoo.describe()
```

Out[118]:

	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	backbone	breathes	venomous	fins	
count	101.000000	101.000000	101.000000	101.000000	101.000000	101.000000	101.000000	101.000000	101.000000	101.000000	101.000000	101.000000	101.00
mean	0.425743	0.198020	0.584158	0.405941	0.237624	0.356436	0.554455	0.603960	0.821782	0.792079	0.079208	0.168317	2.84
std	0.496921	0.400495	0.495325	0.493522	0.427750	0.481335	0.499505	0.491512	0.384605	0.407844	0.271410	0.376013	2.03
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.00
25%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	1.000000	0.000000	0.000000	2.00
50%	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	1.000000	1.000000	1.000000	1.000000	0.000000	0.000000	4.00
75%	1.000000	0.000000	1.000000	1.000000	0.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.000000	0.000000	4.00
max	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	8.00

In [119]:
```
zoo['animal name'].value_counts()
```

Out[119]:
```
frog        2
pony        1
sealion     1
seal        1
seahorse    1
           ..
gorilla     1
goat        1
gnat        1
girl        1
wren        1
Name: animal name, Length: 100, dtype: int64
```

In [120]:
```
#Check if there are duplicates in animal_name
duplicates = zoo['animal name'].value_counts()
duplicates[duplicates > 1]
```

Out[120]:
```
frog    2
Name: animal name, dtype: int64
```

In [121]:
```
frog = zoo[zoo['animal name'] == 'frog']
frog
```

Out[121]:

	animal name	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	backbone	breathes	venomous	fins	legs	tail	domestic	catsize	type
25	frog	0	0	1	0	0	1	1	1	1	1	0	0	4	0	0	0	5
26	frog	0	0	1	0	0	1	1	1	1	1	1	0	4	0	0	0	5

In [122]:
```
# Observation : find that one frog is venomous and another one is not
#change the venomous one into frog2 to separate 2kinds of frog
zoo['animal name'][(zoo['venomous'] == 1)& (zoo['animal name'] == 'frog')] = "frog2"
```

In [123]:
```
zoo['venomous'].value_counts()
```

Out[123]:
```
0    93
1     8
Name: venomous, dtype: int64
```

In [124]:
```
zoo.head(27)
```

Out[124]:

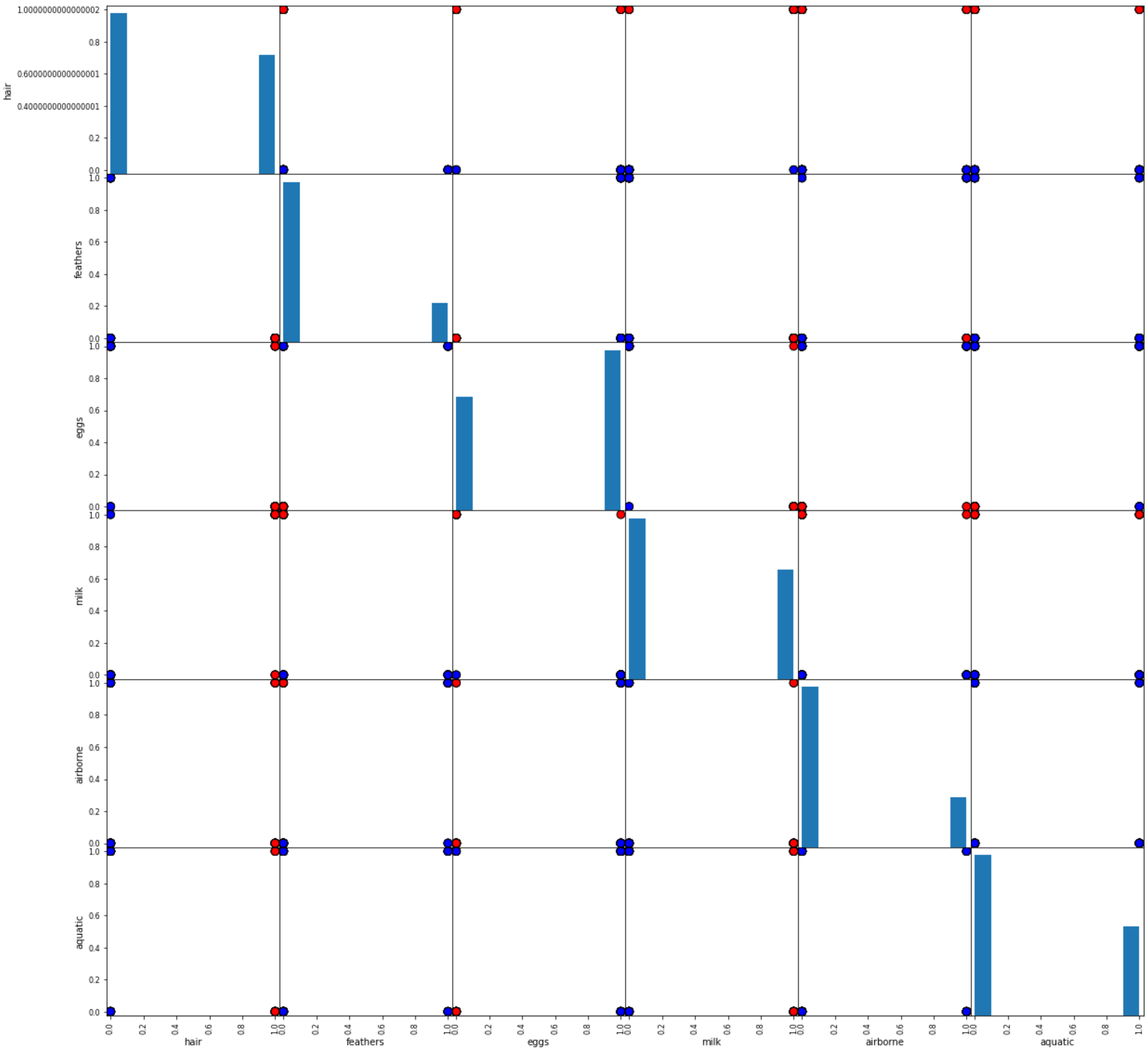
	animal name	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	backbone	breathes	venomous	fins	legs	tail	domestic	catsize	type
0	aardvark	1	0	0	1	0	0	1	1	1	1	0	0	4	0	0	1	1
1	antelope	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0	1	1
2	bass	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0	0	4
3	bear	1	0	0	1	0	0	1	1	1	1	0	0	4	0	0	1	1
4	boar	1	0	0	1	0	0	1	1	1	1	0	0	4	1	0	1	1
5	buffalo	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0	1	1
6	calf	1	0	0	1	0	0	0	1	1	1	0	0	4	1	1	1	1
7	carp	0	0	1	0	0	1	0	1	1	0	0	1	0	1	1	0	4
8	catfish	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0	0	4
9	cavy	1	0	0	1	0	0	0	1	1	1	0	0	4	0	1	0	1
10	cheetah	1	0	0	1	0	0	1	1	1	1	0	0	4	1	0	1	1
11	chicken	0	1	1	0	1	0	0	0	1	1	0	0	2	1	1	0	2
12	chub	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0	0	4
13	clam	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	7
14	crab	0	0	1	0	0	1	1	0	0	0	0	0	4	0	0	0	7
15	crayfish	0	0	1	0	0	1	1	0	0	0	0	0	6	0	0	0	7
16	crow	0	1	1	0	1	0	1	0	1	1	0	0	2	1	0	0	2
17	deer	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0	1	1
18	dogfish	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0	1	4
19	dolphin	0	0	0	1	0	1	1	1	1	1	0	1	0	1	0	1	1
20	dove	0	1	1	0	1	0	0	0	1	1	0	0	2	1	1	0	2
21	duck	0	1	1	0	1	1	0	0	1	1	0	0	2	1	0	0	2
22	elephant	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0	1	1
23	flamingo	0	1	1	0	1	0	0	0	1	1	0	0	2	1	0	1	2
24	flea	0	0	1	0	0	0	0	0	0	1	0	0	6	0	0	0	6
25	frog	0	0	1	0	0	1	1	1	1	1	0	0	4	0	0	0	5
26	frog2	0	0	1	0	0	1	1	1	1	1	1	0	4	0	0	0	5

In [125]:
```
#Finding unique value of hair
color_list = [("red" if i == 1 else "blue" if i == 0 else "yellow" ) for i in zoo.hair]
unique_color = list(set(color_list))
unique_color
```

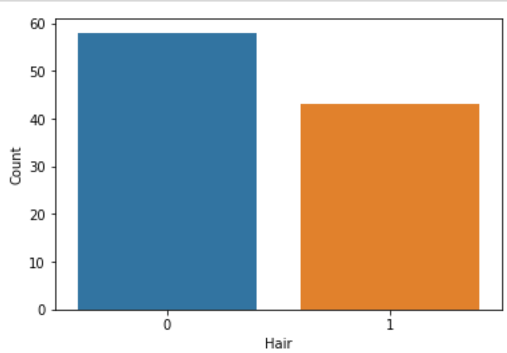
Out[125]: ['red', 'blue']

In [126]:
```
# Scatter matrix to observe relationship between every column attributes
pd.plotting.scatter_matrix(zoo.iloc[:,:7],
                                        c=color_list,
                                        figsize= [20,20],
                                        diagonal = 'hist',
                                        alpha=1,
                                        s = 300,
                                        marker = '.',
                                        edgecolor= 'black')
```

Out[126]:
```
array([[<AxesSubplot:xlabel='hair', ylabel='hair'>,
        <AxesSubplot:xlabel='feathers', ylabel='hair'>,
        <AxesSubplot:xlabel='eggs', ylabel='hair'>,
        <AxesSubplot:xlabel='milk', ylabel='hair'>,
        <AxesSubplot:xlabel='airborne', ylabel='hair'>,
        <AxesSubplot:xlabel='aquatic', ylabel='hair'>],
       [<AxesSubplot:xlabel='hair', ylabel='feathers'>,
        <AxesSubplot:xlabel='feathers', ylabel='feathers'>,
        <AxesSubplot:xlabel='eggs', ylabel='feathers'>,
        <AxesSubplot:xlabel='milk', ylabel='feathers'>,
        <AxesSubplot:xlabel='airborne', ylabel='feathers'>,
        <AxesSubplot:xlabel='aquatic', ylabel='feathers'>],
       [<AxesSubplot:xlabel='hair', ylabel='eggs'>,
        <AxesSubplot:xlabel='feathers', ylabel='eggs'>,
        <AxesSubplot:xlabel='eggs', ylabel='eggs'>,
        <AxesSubplot:xlabel='milk', ylabel='eggs'>,
        <AxesSubplot:xlabel='airborne', ylabel='eggs'>,
        <AxesSubplot:xlabel='aquatic', ylabel='eggs'>],
       [<AxesSubplot:xlabel='hair', ylabel='milk'>,
        <AxesSubplot:xlabel='feathers', ylabel='milk'>,
        <AxesSubplot:xlabel='eggs', ylabel='milk'>,
        <AxesSubplot:xlabel='milk', ylabel='milk'>,
        <AxesSubplot:xlabel='airborne', ylabel='milk'>,
        <AxesSubplot:xlabel='aquatic', ylabel='milk'>],
       [<AxesSubplot:xlabel='hair', ylabel='airborne'>,
        <AxesSubplot:xlabel='feathers', ylabel='airborne'>,
        <AxesSubplot:xlabel='eggs', ylabel='airborne'>,
        <AxesSubplot:xlabel='milk', ylabel='airborne'>,
        <AxesSubplot:xlabel='airborne', ylabel='airborne'>,
        <AxesSubplot:xlabel='aquatic', ylabel='airborne'>],
       [<AxesSubplot:xlabel='hair', ylabel='aquatic'>,
        <AxesSubplot:xlabel='feathers', ylabel='aquatic'>,
        <AxesSubplot:xlabel='eggs', ylabel='aquatic'>,
        <AxesSubplot:xlabel='milk', ylabel='aquatic'>,
        <AxesSubplot:xlabel='airborne', ylabel='aquatic'>,
        <AxesSubplot:xlabel='aquatic', ylabel='aquatic'>]], dtype=object)
```



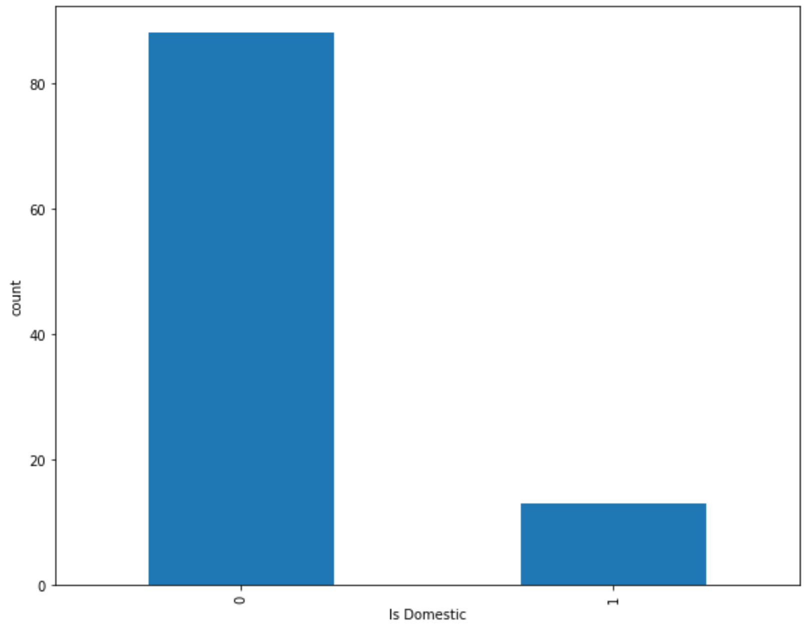
In [127]:
```
sns.countplot(x="hair", data=zoo)
plt.xlabel("Hair")
plt.ylabel("Count")
plt.show()
zoo.loc[:,'hair'].value_counts()
```



Out[127]:
```
0    58
1    43
Name: hair, dtype: int64
```

In [128]:
```
# Let plot how many animals are domestic or not
plt.figure(figsize=(10,8));
zoo['domestic'].value_counts().plot(kind="bar");
plt.xlabel('Is Domestic');
plt.ylabel("count"),
plt.plot()
```

Out[128]: []



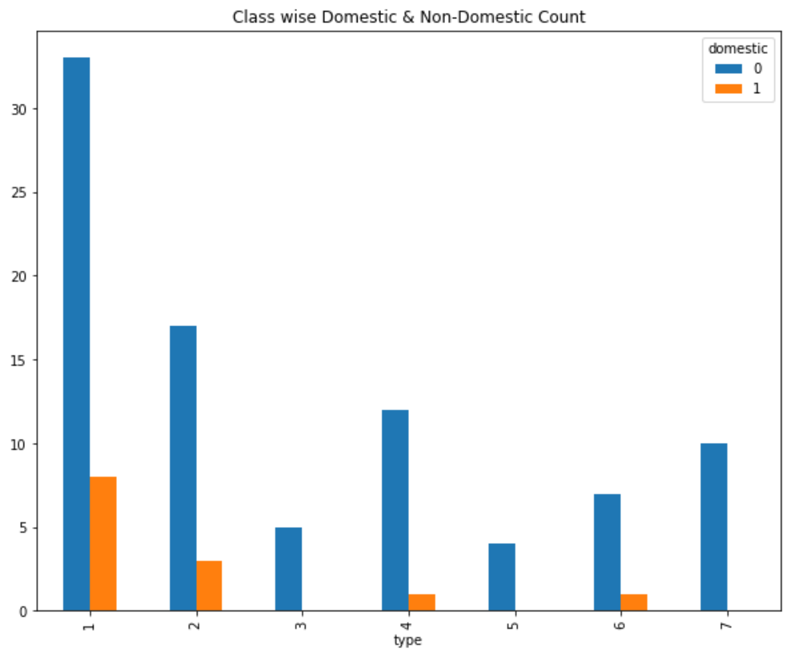
In [129]:
```
# So we can see mostly animals are not domestic
```

In [130]:
```
pd.crosstab(zoo['type'], zoo['domestic'])
```

Out[130]:

domestic	0	1
type		
1	33	8
2	17	3
3	5	0
4	12	1
5	4	0
6	7	1
7	10	0

In [131]:
```
# Lets see species wise domestic and non-domestic animals
pd.crosstab(zoo['type'], zoo['domestic']).plot(kind="bar", figsize=(10,8), title="Class wise Domestic & Non-Domestic Count")
plt.plot();
```



In [132]:
```
# lets see how many animals provides us milk
zoo['milk'].value_counts()
```

Out[132]:
```
0    60
1    41
Name: milk, dtype: int64
```

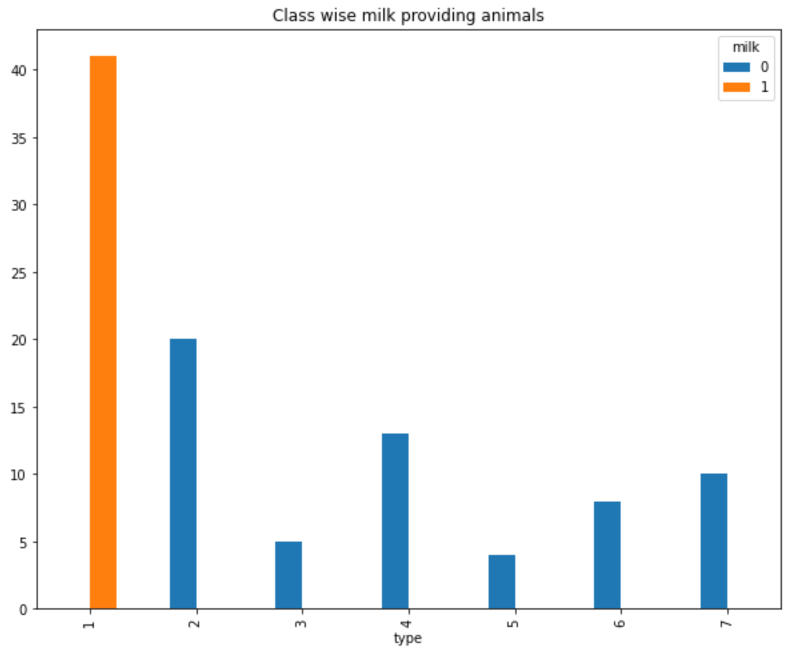
In [133]:
```
# So there are 41 animals in the list which provides us milk. Lets see to which category they belongs
```

In [134]:
```
pd.crosstab(zoo['type'], zoo['milk'])
```

Out[134]:

milk	0	1
type		
1	0	41
2	20	0
3	5	0
4	13	0
5	4	0
6	8	0
7	10	0

In [135]:
```
pd.crosstab(zoo['type'], zoo['milk']).plot(kind="bar", figsize=(10, 8), title="Class wise milk providing animals")
plt.plot();
```



In [136]:
```
# lets see how many animals live under water. i.e aquatic
# lets find out all aquatic animals.
zoo.aquatic.value_counts() #only 36 aquatic animals are there.
# lets see there class.
```

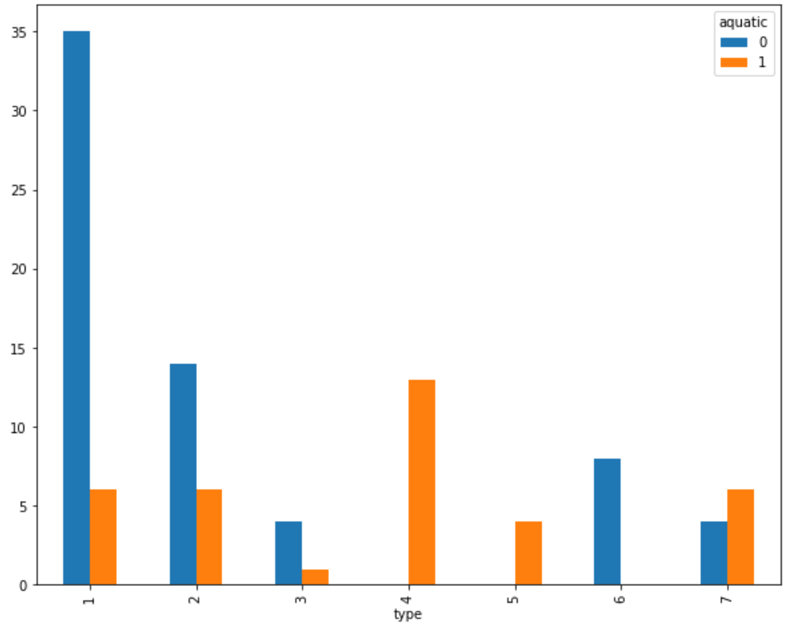
Out[136]:
```
0    65
1    36
Name: aquatic, dtype: int64
```

In [137]:
```
zoo[zoo['aquatic']==1].type.value_counts()
```

Out[137]:
```
4    13
7     6
1     6
2     6
5     4
3     1
Name: type, dtype: int64
```

In [138]:

```
pd.crosstab(zoo['type'], zoo['aquatic']).plot(kind="bar", figsize=(10,8));
```



In [139]:

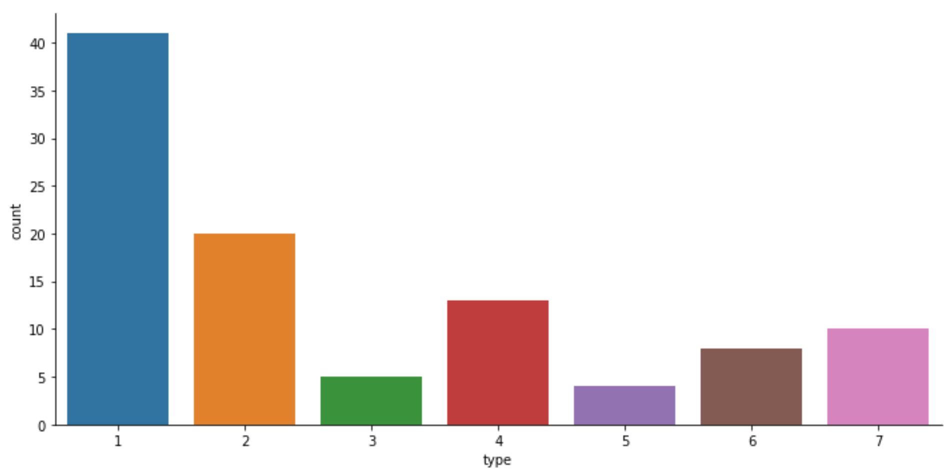
```
# finding unique value of class type
type_list = [i for i in zoo.type]
unique_type = list(set(type_list))
unique_type
```

Out[139]: [1, 2, 3, 4, 5, 6, 7]

In [140]:

```
# use seaborn to plot the count of each 7 class_type
sns.factorplot('type', data=zoo, kind="count",size = 5,aspect = 2)
```

Out[140]: <seaborn.axisgrid.FacetGrid at 0x1cbdee87340>



In [141]:
```
zoo
```

Out[141]:

	animal name	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	backbone	breathes	venomous	fins	legs	tail	domestic	catsize	type
0	aardvark	1	0	0	1	0	0	1	1	1	1	0	0	4	0	0	1	1
1	antelope	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0	1	1
2	bass	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0	0	4
3	bear	1	0	0	1	0	0	1	1	1	1	0	0	4	0	0	1	1
4	boar	1	0	0	1	0	0	1	1	1	1	0	0	4	1	0	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
96	wallaby	1	0	0	1	0	0	0	1	1	1	0	0	2	1	0	1	1
97	wasp	1	0	1	0	1	0	0	0	0	1	1	0	6	0	0	0	6
98	wolf	1	0	0	1	0	0	1	1	1	1	0	0	4	1	0	1	1
99	worm	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	7
100	wren	0	1	1	0	1	0	0	0	1	1	0	0	2	1	0	0	2

101 rows × 18 columns

In [142]:
```
from sklearn.model_selection import train_test_split
```

In [143]:
```
# split train test data into 70/30.
from sklearn.model_selection import train_test_split
X = zoo.iloc[:,1:16]
Y = zoo.iloc[:,16]
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.3, random_state=1, stratify=Y)
```

In [144]:
```
X_train
```

Out[144]:

	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	backbone	breathes	venomous	fins	legs	tail	domestic
33	0	1	1	0	1	1	1	0	1	1	0	0	2	1	0
58	0	1	1	0	0	1	1	0	1	1	0	0	2	1	0
62	0	0	1	0	0	0	1	1	1	1	1	0	0	1	0
25	0	0	1	0	0	1	1	1	1	1	0	0	4	0	0
82	0	0	1	0	0	1	0	1	1	0	0	1	0	1	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
35	1	0	0	1	0	0	0	1	1	1	0	0	4	1	1
83	0	1	1	0	1	0	0	0	1	1	0	0	2	1	0
59	0	1	1	0	1	0	0	0	1	1	0	0	2	1	0
65	1	0	0	1	0	0	0	1	1	1	0	0	4	1	1
77	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0

70 rows × 15 columns

In [145]:
```
1 X_test
```

Out[145]:

	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	backbone	breathes	venomous	fins	legs	tail	domestic
55	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0
0	1	0	0	1	0	0	1	1	1	1	0	0	4	0	0
16	0	1	1	0	1	0	1	0	1	1	0	0	2	1	0
12	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0
24	0	0	1	0	0	0	0	0	0	1	0	0	6	0	0
56	0	1	1	0	0	0	0	0	1	1	0	0	2	1	0
17	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0
18	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0
13	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
100	0	1	1	0	1	0	0	0	1	1	0	0	2	1	0
47	1	0	0	1	0	0	1	1	1	1	0	0	4	1	0
72	0	0	0	0	0	0	1	0	0	1	1	0	8	1	0
71	0	1	1	0	0	0	1	0	1	1	0	0	2	1	0
36	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0
32	1	0	0	1	0	0	0	1	1	1	0	0	2	0	0
5	1	0	0	1	0	0	0	1	1	1	0	0	4	1	0
2	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0
86	0	0	1	0	0	1	1	1	1	0	1	1	0	1	0
14	0	0	1	0	0	1	1	0	0	0	0	0	4	0	0
97	1	0	1	0	1	0	0	0	0	1	1	0	6	0	0
30	0	0	1	0	1	0	0	0	0	1	0	0	6	0	0
41	0	1	1	0	0	0	1	0	1	1	0	0	2	1	0
27	1	0	0	1	1	0	0	1	1	1	0	0	2	1	0
80	0	0	1	0	0	0	1	1	1	1	0	0	0	1	0
60	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0
44	1	0	0	1	0	0	1	1	1	1	0	0	4	1	0
7	0	0	1	0	0	1	0	1	1	0	0	1	0	1	1
21	0	1	1	0	1	1	0	0	1	1	0	0	2	1	0
95	0	1	1	0	1	0	1	0	1	1	0	0	2	1	0
63	1	0	1	1	0	1	1	0	1	1	0	0	4	1	0
15	0	0	1	0	0	1	1	0	0	0	0	0	6	0	0

In [146]:
```
1 Y_train
```

Out[146]:
```
33    0
58    1
62    0
25    0
82    0
     ..
35    0
83    0
59    0
65    1
77    0
Name: catsize, Length: 70, dtype: int64
```

In [147]:
```
Y_test
```

Out[147]:
```
55     1
0      1
16     0
12     0
24     0
56     1
17     1
18     1
13     0
100    0
47     1
72     0
71     1
36     0
32     1
5      1
2      0
86     1
14     0
97     0
30     0
41     0
27     0
80     0
60     1
44     1
7      0
21     0
95     1
63     1
15     0
Name: catsize, dtype: int64
```

In [148]:
```
num_folds = 10
KFold = KFold(n_splits=10)
```

In [149]:
```
model = KNeighborsClassifier(n_neighbors=3)
model.fit(X_train,Y_train)
```

Out[149]:
```
KNeighborsClassifier(n_neighbors=3)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [150]:
```
# Prediciting on test data
preds = model.predict(X_test)   # Prediciting on test data set
pd.Series(preds).value_counts() # getting the count of each category
```

Out[150]:
```
0    22
1     9
dtype: int64
```

In [151]:
```
pd.crosstab(Y_test,preds) #getting the 2 way table to understand the correct and wrong predictions
```

Out[151]:

col_0	0	1
catsize		
0	16	1
1	6	8

In [152]:
```
# Accuracy
np.mean(preds==Y_test)
```

Out[152]:
```
0.7741935483870968
```

In [153]:
```
model.score(X_train,Y_train)
```

Out[153]:
```
0.8285714285714286
```

In [154]:
```
print("Accuracy",accuracy_score(Y_test,preds)*100)
```

```
Accuracy 77.41935483870968
```

In [155]:
```
# Use cross validation score since this is a small size dataset
# Get cross validation score of K-Nearest Neighbors
```

In [156]:
```
result = cross_val_score(model, X, Y, cv=KFold)
```

In [157]:
```
print(result.mean()*100)
```

```
76.27272727272728
```

In [158]:
```
print(result.std()*100)
```

```
12.704199865197182
```

Grid Search for Algorithm Tuning

In [159]:
```
n_neighbors = np.array(range(1,40))
param_grid = dict(n_neighbors=n_neighbors)
```

In [160]:
```
model = KNeighborsClassifier()
grid = GridSearchCV(estimator=model, param_grid=param_grid)
grid.fit(X, Y)
```

Out[160]:
```
GridSearchCV(estimator=KNeighborsClassifier(),
             param_grid={'n_neighbors': array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16, 17,
       18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34,
       35, 36, 37, 38, 39])})
```

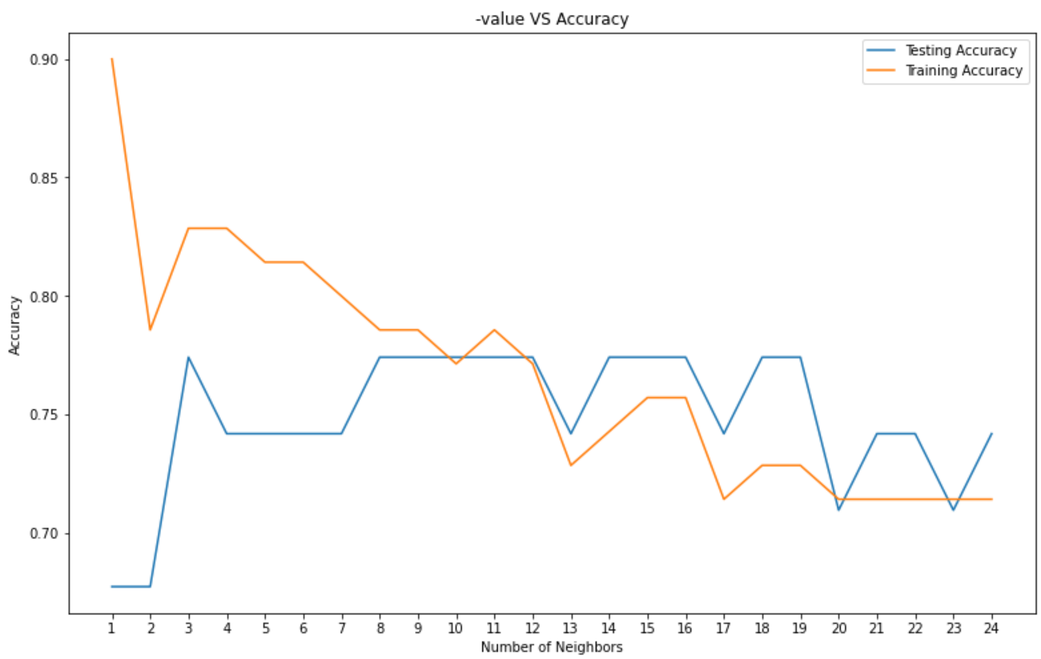
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [161]:
```
print(grid.best_score_)
print(grid.best_params_)
```

```
0.790952380952381
{'n_neighbors': 5}
```

In [162]:
```
k_values = np.arange(1,25)
train_accuracy = []
test_accuracy = []

for i, k in enumerate(k_values):
    # k from 1 to 25(exclude)
    knn = KNeighborsClassifier(n_neighbors=k)
    # Fit with knn
    knn.fit(X_train,Y_train)
    #train accuracy
    train_accuracy.append(knn.score(X_train,Y_train))
    # test accuracy
    test_accuracy.append(knn.score(X_test,Y_test))
# Plot
plt.figure(figsize=[13,8])
plt.plot(k_values, test_accuracy, label = 'Testing Accuracy')
plt.plot(k_values, train_accuracy, label = 'Training Accuracy')
plt.legend()
plt.title('-value VS Accuracy')
plt.xlabel('Number of Neighbors')
plt.ylabel('Accuracy')
plt.xticks(k_values)
plt.savefig('graph.png')
plt.show()
print("Best accuracy is {} with K = {}".format(np.max(test_accuracy),1+test_accuracy.index(np.max(test_accuracy))))
```




```
Best accuracy is 0.7741935483870968 with K = 3
```

In [ ]:
```

```

In [ ]:
```

```