In [1]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.neighbors import KNeighborsRegressor
from statsmodels.stats.outliers_influence import variance_inflation_factor
from sklearn.metrics import r2_score, mean_squared_error
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import KFold
from sklearn.preprocessing import MinMaxScaler
from statistics import mean
```

In [2]:

```
with open("nba_2013.csv", 'r') as csvfile:
    nba = pd.read_csv(csvfile)
```

In [3]:

```
nba.shape
```

Out[3]:

```
(481, 31)
```

In [4]:
```
# Checking if columns have any null values
nba.isna().sum()
```

Out[4]:
```
player          0
pos             0
age             0
bref_team_id    0
g               0
gs              0
mp              0
fg              0
fga             0
fg.             2
x3p             0
x3pa            0
x3p.           67
x2p             0
x2pa            0
x2p.            3
efg.            2
ft              0
fta             0
ft.            20
orb             0
drb             0
trb             0
ast             0
stl             0
blk             0
tov             0
pf              0
pts             0
season          0
season_end      0
dtype: int64
```

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

Out[5]:

	age	g	gs	mp	fg	fga	fg.	
count	481.000000	481.000000	481.000000	481.000000	481.000000	481.000000	479.000000	4
mean	26.509356	53.253638	25.571726	1237.386694	192.881497	424.463617	0.436436	
std	4.198265	25.322711	29.658465	897.258840	171.832793	368.850833	0.098672	
min	19.000000	1.000000	0.000000	1.000000	0.000000	0.000000	0.000000	
25%	23.000000	32.000000	0.000000	388.000000	47.000000	110.000000	0.400500	
50%	26.000000	61.000000	10.000000	1141.000000	146.000000	332.000000	0.438000	
75%	29.000000	76.000000	54.000000	2016.000000	307.000000	672.000000	0.479500	
max	39.000000	83.000000	82.000000	3122.000000	849.000000	1688.000000	1.000000	2

8 rows × 27 columns

In [6]:

```
nba.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 481 entries, 0 to 480
Data columns (total 31 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   player        481 non-null    object 
 1   pos           481 non-null    object 
 2   age           481 non-null    int64  
 3   bref_team_id  481 non-null    object 
 4   g             481 non-null    int64  
 5   gs            481 non-null    int64  
 6   mp            481 non-null    int64  
 7   fg            481 non-null    int64  
 8   fga           481 non-null    int64  
 9   fg.           479 non-null    float64
 10  x3p           481 non-null    int64  
 11  x3pa          481 non-null    int64  
 12  x3p.          414 non-null    float64
 13  x2p           481 non-null    int64  
 14  x2pa          481 non-null    int64  
 15  x2p.          478 non-null    float64
 16  efg.          479 non-null    float64
 17  ft            481 non-null    int64  
 18  fta           481 non-null    int64  
 19  ft.           461 non-null    float64
 20  orb           481 non-null    int64  
 21  drb           481 non-null    int64  
 22  trb           481 non-null    int64  
 23  ast           481 non-null    int64  
 24  stl           481 non-null    int64  
 25  blk           481 non-null    int64  
 26  tov           481 non-null    int64  
 27  pf            481 non-null    int64  
 28  pts           481 non-null    int64  
 29  season        481 non-null    object 
 30  season_end    481 non-null    int64  
dtypes: float64(5), int64(22), object(4)
memory usage: 116.6+ KB
```

In [7]:

```
# As fg column is skewed, will replace the null value with median.
nba['fg.'].fillna(nba['fg.'].mean(), inplace=True)
# As x3p., x2p., efg., ft. column is almost normally distributed, replacing th
e missing values with mean
nba['x3p.'].fillna(nba['x3p.'].mean(), inplace=True)
nba['x2p.'].fillna(nba['x2p.'].mean(), inplace=True)
nba['efg.'].fillna(nba['efg.'].mean(), inplace=True)
nba['ft.'].fillna(nba['ft.'].mean(), inplace=True)
```

In [8]:

```
numerics = ['int16', 'int32', 'int64', 'float16', 'float32', 'float64']
nba_numerical = nba.select_dtypes(include=numerics)
nba_numerical.drop(columns=['season_end'], inplace=True)
```

```
C:\Users\Urvi\AppData\Roaming\Python\Python37\site-packages\pandas\core\fram
e.py:4174: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/s
table/user_guide/indexing.html#returning-a-view-versus-a-copy
  errors=errors,
```

In [9]:

```
# Checking if columns have any null values
nba.isna().sum()
```

Out[9]:

```
player          0
pos             0
age             0
bref_team_id    0
g               0
gs              0
mp              0
fg              0
fga             0
fg.             0
x3p             0
x3pa            0
x3p.            0
x2p             0
x2pa            0
x2p.            0
efg.            0
ft              0
fta             0
ft.             0
orb             0
drb             0
trb             0
ast             0
stl             0
blk             0
tov             0
pf              0
pts             0
season          0
season_end      0
dtype: int64
```

In [10]:

```python
# Checking the distribution of data
plt.figure(figsize=(25,35), facecolor='white')
plotnumber=1
for column in nba_numerical:
    if plotnumber <= 27:
        ax = plt.subplot(9, 3, plotnumber)
        sns.distplot(nba[column])
        plt.xlabel(column, fontsize=15)
    plotnumber+=1
plt.show()
```

```
C:\Users\Urvi\AppData\Roaming\Python\Python37\site-packages\seaborn\distribut
ions.py:2551: FutureWarning: `distplot` is a deprecated function and will be
removed in a future version. Please adapt your code to use either `displot`
(a figure-level function with similar flexibility) or `histplot` (an axes-lev
el function for histograms).
  warnings.warn(msg, FutureWarning)
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el function for histograms).
  warnings.warn(msg, FutureWarning)
```

```
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removed in a future version. Please adapt your code to use either `displot`
(a figure-level function with similar flexibility) or `histplot` (an axes-lev
el function for histograms).
  warnings.warn(msg, FutureWarning)
```
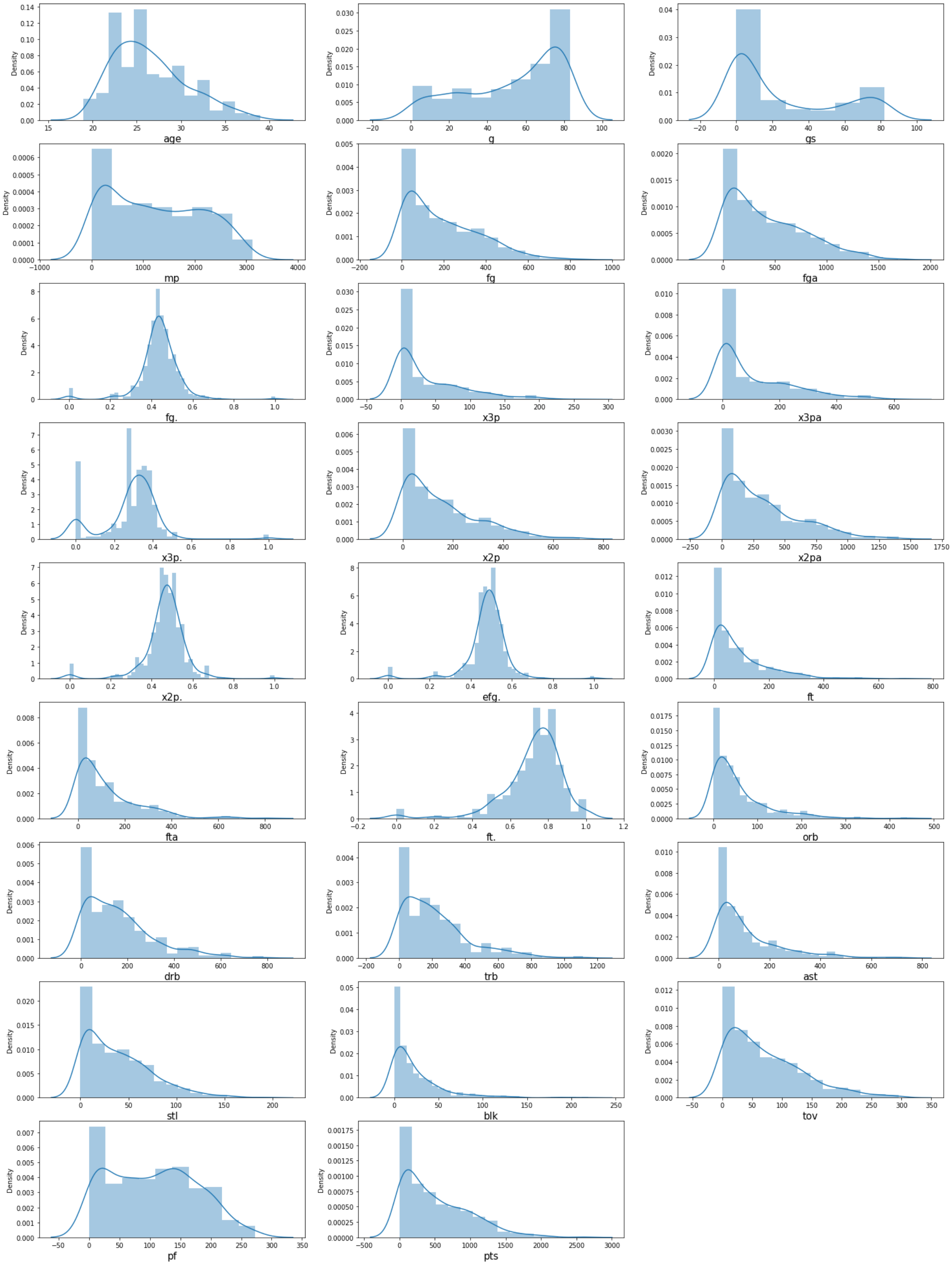
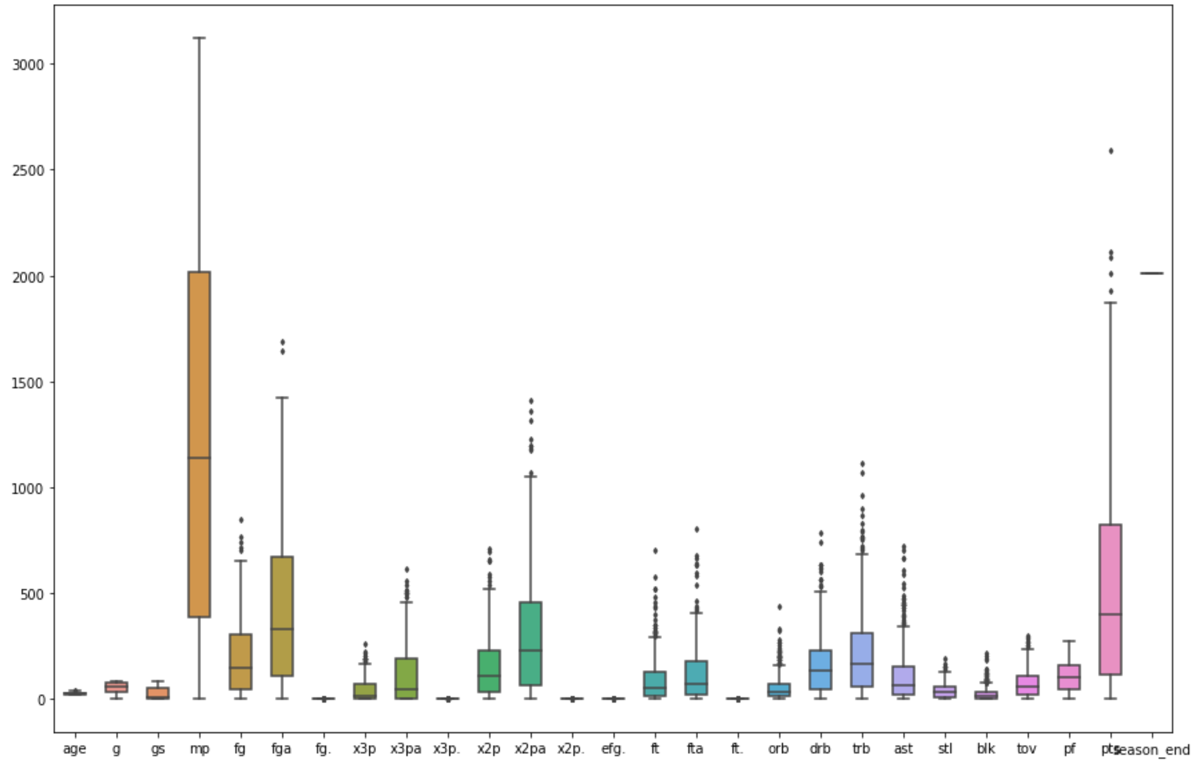


Density
age
g
gs
mp
fg
fga
fg.
x3p
x3pa
x3p.
x2p
x2pa
x2p.
efg.
ft
fta
ft.
orb
drb
trb
ast
stl
blk
tov
pf
pts

In [11]:

```
fig, ax = plt.subplots(figsize=(15,10))
sns.boxplot(data=nba, width= 0.5,ax=ax,  fliersize=3)
```

Out[11]:

```
<AxesSubplot:>
```



In [12]:

```
# Normalizing numerical columns
# nba_normalized = nba_numerical.apply(lambda x: (x - x.min()) / (x.max() - x.
min()))
nba_normalized = MinMaxScaler().fit_transform(nba_numerical.values)
```

In [13]:

```
nba_category = nba[['bref_team_id']]
```

In [14]:

```
number = LabelEncoder()
nba_category['bref_team_id'] = number.fit_transform(nba['bref_team_id'])
```

```
C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: SettingWi
thCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/s
table/user_guide/indexing.html#returning-a-view-versus-a-copy
```

In [15]:

```
nba = pd.concat([nba_category, pd.DataFrame(nba_normalized, columns=nba_numeri
cal.columns)], axis=1)
```

In [16]:

```
nba.head()
```

Out[16]:

	bref_team_id	age	g	gs	mp	fg	fga	fg.	x3p	x3
0	28	0.20	0.756098	0.000000	0.271067	0.077739	0.083531	0.468	0.015326	0.0243
1	20	0.05	0.975610	0.243902	0.383211	0.109541	0.109597	0.503	0.000000	0.0000
2	28	0.40	0.634146	0.146341	0.307594	0.168433	0.162915	0.520	0.000000	0.0000
3	21	0.45	0.878049	0.890244	0.817366	0.546525	0.598934	0.459	0.490421	0.4878
4	18	0.30	0.670732	0.365854	0.304390	0.160188	0.147512	0.546	0.000000	0.0016

5 rows × 27 columns

In [17]:

```
x_columns = nba.drop(columns=['pts'])
y_column = nba.pts

# x_columns = nba_normalized[['age', 'g', 'gs', 'mp', 'fg', 'fga', 'fg.', 'x3
p', 'x3pa', 'x3p.', 'x2p', 'x2pa', 'x2p.', 'efg.', 'ft', 'fta', 'ft.', 'orb',
 'drb', 'trb', 'ast', 'stl', 'blk', 'tov', 'pf']]

# # The column that we want to predict.
# y_column = nba_normalized["pts"]
x_train, x_test, y_train, y_test = train_test_split(x_columns, y_column, test_
size=0.2, random_state = 123)
```

In [18]:

```
for k in range(10):
    k_value = k + 1
    knn = KNeighborsRegressor(n_neighbors = k_value)
    knn.fit(x_train, y_train)
    y_pred = knn.predict(x_test)
    print ("Regression score is:",format(r2_score(y_test, y_pred),'.4f'), "for
k_value:", k_value)
```

```
Regression score is: 0.7980 for k_value: 1
Regression score is: 0.8117 for k_value: 2
Regression score is: 0.8185 for k_value: 3
Regression score is: 0.8276 for k_value: 4
Regression score is: 0.8130 for k_value: 5
Regression score is: 0.8143 for k_value: 6
Regression score is: 0.8106 for k_value: 7
Regression score is: 0.7993 for k_value: 8
Regression score is: 0.7968 for k_value: 9
Regression score is: 0.7856 for k_value: 10
```

K=4, as it gives us the highest prediction score.

```
In [19]: param_grid = {'algorithm' : ['ball_tree', 'kd_tree', 'brute'],
                       'leaf_size' : [18,20,25,27,30,32,34],
                       'n_neighbors' : [3,4, 5,7,9,10,11,12,13]
                      }
```

```
In [20]: gridsearch = GridSearchCV(knn, param_grid)
```

```
In [21]: gridsearch.fit(x_train, y_train)
```

```
Out[21]: GridSearchCV(cv=None, error_score=nan,
                      estimator=KNeighborsRegressor(algorithm='auto', leaf_size=30,
                                                    metric='minkowski',
                                                    metric_params=None, n_jobs=None,
                                                    n_neighbors=10, p=2,
                                                    weights='uniform'),
                      iid='deprecated', n_jobs=None,
                      param_grid={'algorithm': ['ball_tree', 'kd_tree', 'brute'],
                                  'leaf_size': [18, 20, 25, 27, 30, 32, 34],
                                  'n_neighbors': [3, 4, 5, 7, 9, 10, 11, 12, 13]},
                      pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
                      scoring=None, verbose=0)
```

```
In [22]: gridsearch.best_params_
```

```
Out[22]: {'algorithm': 'ball_tree', 'leaf_size': 18, 'n_neighbors': 4}
```

```
In [23]: # we will use the best parameters in our k-NN algorithm and check if accuracy
          is increasing.
         knn = KNeighborsRegressor(algorithm = 'ball_tree', leaf_size =18, n_neighbors
         =4)
```

```
In [24]: knn.fit(x_train,y_train)
```

```
Out[24]: KNeighborsRegressor(algorithm='ball_tree', leaf_size=18, metric='minkowski',
                             metric_params=None, n_jobs=None, n_neighbors=4, p=2,
                             weights='uniform')
```

```
In [25]: knn.score(x_train,y_train)
```

```
Out[25]: 0.8958999666709163
```

```
In [26]: knn.score(x_test,y_test)
```

```
Out[26]: 0.8275623229821877
```

As our dataset size is small, we will use k fold cross validation for training the model and to check that if model is not overfitted.

In [27]:

```
#k-fold cross validation
kfold = KFold(n_splits=12, random_state= 42)
kfold.get_n_splits(x_columns)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\model_selection\_split.py:
296: FutureWarning: Setting a random_state has no effect since shuffle is Fal
se. This will raise an error in 0.24. You should leave random_state to its de
fault (None), or set shuffle=True.
  FutureWarning
```

Out[27]:

```
12
```

In [28]:

```
knn = KNeighborsRegressor(algorithm = 'ball_tree', leaf_size = 18, n_neighbors
= 4)
cnt =0
count=[]
train_score =[]
test_score = []
x_scaled = x_columns.values
for train_index,test_index in kfold.split(x_scaled):
    X_train, X_test = x_scaled[train_index], x_scaled[test_index] # our scaled
data is an array so it can work on x[value]
    y_train, y_test = y_column.iloc[train_index], y_column.iloc[test_index] #
 y is a dataframe so we have to use "iloc" to retreive data
    knn.fit(X_train,y_train)
    train_score_ = knn.score(X_train,y_train)
    test_score_ =  knn.score(X_test,y_test)
    cnt+=1
    count.append(cnt)
    train_score.append(train_score_)
    test_score.append(test_score_)

    print("for k = ", cnt)
    print("train_score is :  ", train_score_, "and test score is :  ", test_sc
ore_)
print("************************************************")
print("************************************************")
print("Average train score is :  ", mean(train_score))
print("Average test score is :  ", mean(test_score))
```

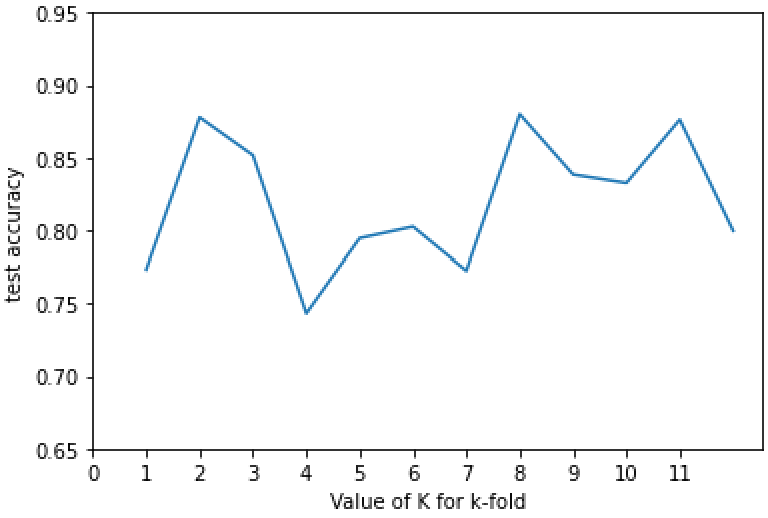
```
for k =  1
train_score is :   0.9054605273412101 and test score is :   0.773244096524539
2
for k =  2
train_score is :   0.900232549337864 and test score is :   0.877892709350229
for k =  3
train_score is :   0.8967781642691686 and test score is :   0.851701422828342
7
for k =  4
train_score is :   0.9001117217650348 and test score is :   0.743251430573702
6
for k =  5
train_score is :   0.9022604127819778 and test score is :   0.794669529127535
6
for k =  6
train_score is :   0.8995538373186219 and test score is :   0.802596894988889
for k =  7
train_score is :   0.9088002050256099 and test score is :   0.772416829747962
7
for k =  8
train_score is :   0.8995638521351774 and test score is :   0.880089693756378
for k =  9
train_score is :   0.9012828297786589 and test score is :   0.838442896834484
1
for k =  10
train_score is :   0.9063997525923092 and test score is :   0.832600018170349
9
for k =  11
train_score is :   0.8984811862538835 and test score is :   0.876275805542134
6
for k =  12
train_score is :   0.9060057936524925 and test score is :   0.799633256622849
************************************************
************************************************
Average train score is :   0.902077569354334
Average test score is :   0.8202345486722831
```

In [29]:

```
# let's plot the test_accuracy with the value of k in k-fold

plt.plot(count,test_score)
plt.xlabel('Value of K for k-fold')
plt.ylabel('test accuracy')
plt.xticks(np.arange(0, 12, 1))
plt.yticks(np.arange(0.65, 1, 0.05))
```

Out[29]:

```
([<matplotlib.axis.YTick at 0x19d243e7888>,
  <matplotlib.axis.YTick at 0x19d2ada5c08>,
  <matplotlib.axis.YTick at 0x19d2ada5cc8>,
  <matplotlib.axis.YTick at 0x19d2a7c6248>,
  <matplotlib.axis.YTick at 0x19d299e7308>,
  <matplotlib.axis.YTick at 0x19d2ad61888>,
  <matplotlib.axis.YTick at 0x19d29b31ec8>],
 [Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, ''),
  Text(0, 0, '')])
```



Our cross validation tells that on an avergae our model has a 82% accuracy on our test data. so, that's how we can use cross validation to compute how well our model is generalizing on our data.

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In [ ]: