

# Importing the needed libraries

```
In [1]: import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from datetime import date
from sklearn.metrics import accuracy_score
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler, OneHotEncoder,
LabelEncoder, StandardScaler, OrdinalEncoder
from sklearn.compose import ColumnTransformer

import numpy as np
from sklearn.model_selection import train_test_split
```

## Reading the data set

```
In [2]: df = pd.read_csv('insurance.csv')
```

```
In [3]: df.head()
```

Out[3]:		age	sex	bmi	children	smoker	region	charge
	0	19	female	27.900	0	yes	southwest	16884.9240
	1	18	male	33.770	1	no	southeast	1725.55230
	2	28	male	33.000	3	no	southeast	4449.46200
	3	33	male	22.705	0	no	northwest	21984.4706
	4	32	male	28.880	0	no	northwest	3866.85520

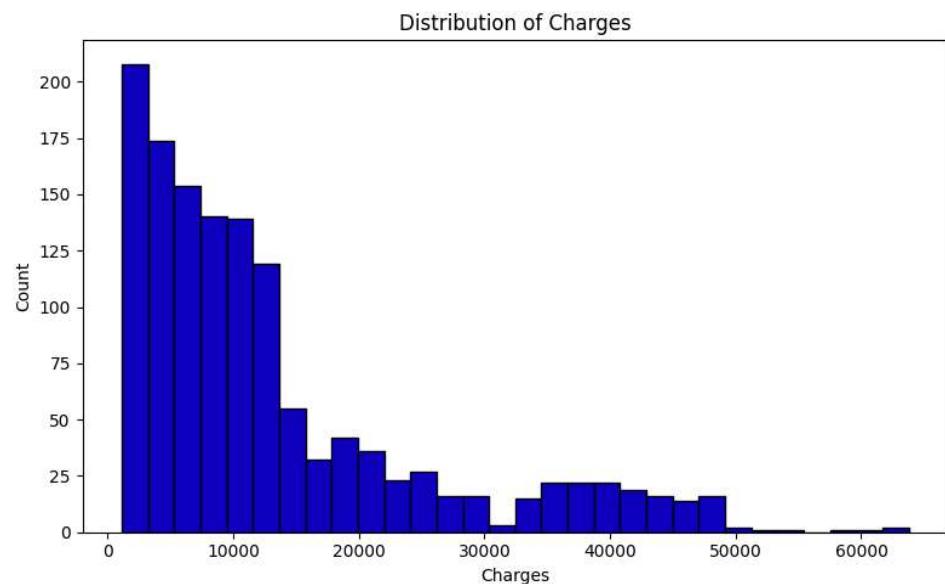
## Identifying missing values and dealing with them

```
In [4]: df.isnull().sum()
```

```
Out[4]: age      0  
         sex      0  
         bmi      0  
         children  0  
         smoker    0  
         region    0  
         charges   0  
         dtype: int64
```

## Distribution of the target column (charges)

```
In [5]: plt.figure(figsize=(8, 5))  
plt.hist(df["charges"], bins=30, edgecolor="black", color="#1000c2")  
plt.xlabel("Charges")  
plt.ylabel("Count")  
plt.title("Distribution of Charges")  
plt.tight_layout()  
plt.show()
```



# Removing unneeded features

```
In [6]: # Commented out features are the extracted ones
df = df.drop(columns=[
    # 'age',
    # 'sex',
    # 'bmi',
    # 'children',
    # 'smoker',
    'region',
    ])
```

# Encoding Categorical Data

```
In [7]: # Features and target
X = df.drop(columns=["charges"])
y = df["charges"]
# Split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,
random_state=42)

print(X_train)
```

	age	sex	bmi	children	smoker
560	46	female	19.950	2	no
1285	47	female	24.320	0	no
1142	52	female	24.860	0	no
969	39	female	34.320	5	no
486	54	female	21.470	3	no
...	...	...	...	...	...
1095	18	female	31.350	4	no
1130	39	female	23.870	5	no
1294	58	male	25.175	0	no
860	37	female	47.600	2	yes
1126	55	male	29.900	0	no

[1070 rows x 5 columns]

#### Encoding X

```
In [8]: # Identify columns
numeric_cols = [
    "age",
    "bmi",
    "children"
]

boolean_cols = [
    # "smoker"
]

categorical_cols = X.columns.drop(labels=numeric_cols +
boolean_cols).tolist()

# ColumnTransformer: correct encoding
ct = ColumnTransformer(
    transformers=[
        ("cat", OneHotEncoder(sparse_output=False,
handle_unknown="ignore"), categorical_cols),
        ("num", StandardScaler(), numeric_cols),
        ("bool", OrdinalEncoder(), boolean_cols)
    ]
)

# Fit/transform
X_train_processed = ct.fit_transform(X_train)
X_test_processed = ct.transform(X_test)
```

#### Encoding y

```
In [9]: # No encoding needed for y
```

# Training The Linear Regression Model

```
In [10]: from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score, root_mean_squared_error

lr = LinearRegression()
lr.fit(X_train_processed, y_train)

# Predict
y_pred = lr.predict(X_test_processed)

# Metrics
print("R2 Score:", r2_score(y_test, y_pred))
print("RMSE:", root_mean_squared_error(y_test, y_pred))
print("\n")

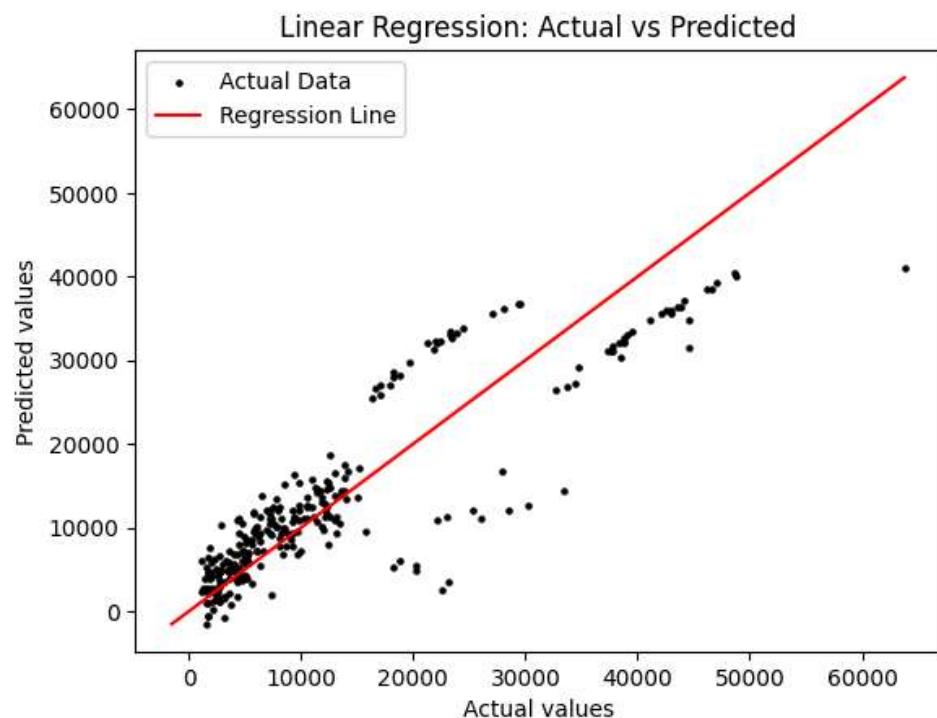
print("First 10 Actual vs Predicted Charges values:")
print("====")
for i in range(10):
    print(f"Actual: {y_test.iloc[i]} | Predicted: {y_pred[i]}")
```

R2 Score: 0.7811302113434097

RMSE: 5829.172930254189

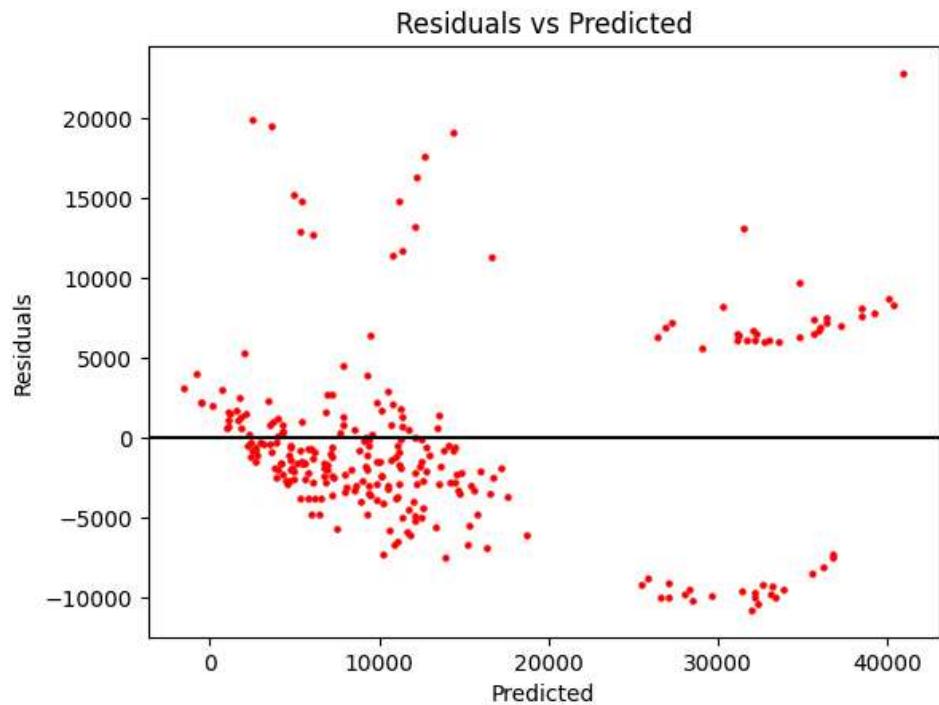
```
First 10 Actual vs Predicted Charges values:
=====
Actual: 9095.06825 | Predicted: 8554.817115888562
Actual: 5272.1758 | Predicted: 6973.587467448897
Actual: 29330.98315 | Predicted: 36798.60416104231
Actual: 9301.89355 | Predicted: 9417.882823025833
Actual: 33750.2918 | Predicted: 26871.680310814554
Actual: 4536.259 | Predicted: 11097.383839380904
Actual: 2117.33885 | Predicted: 145.27608963230523
Actual: 14210.53595 | Predicted: 16746.168377102887
Actual: 3732.6251 | Predicted: 747.534141909513
Actual: 10264.4421 | Predicted: 11153.675907223995
```

```
In [11]:  
plt.figure()  
plt.scatter(y_test, y_pred, s=5, label="Actual Data", color='black')  
plt.xlabel("Actual values")  
plt.ylabel("Predicted values")  
plt.title("Linear Regression: Actual vs Predicted")  
  
min_val = min(y_test.min(), y_pred.min())  
max_val = max(y_test.max(), y_pred.max())  
  
plt.plot([min_val, max_val], [min_val, max_val], label="Regression  
Line", color='red')  
  
plt.legend()  
plt.show()
```

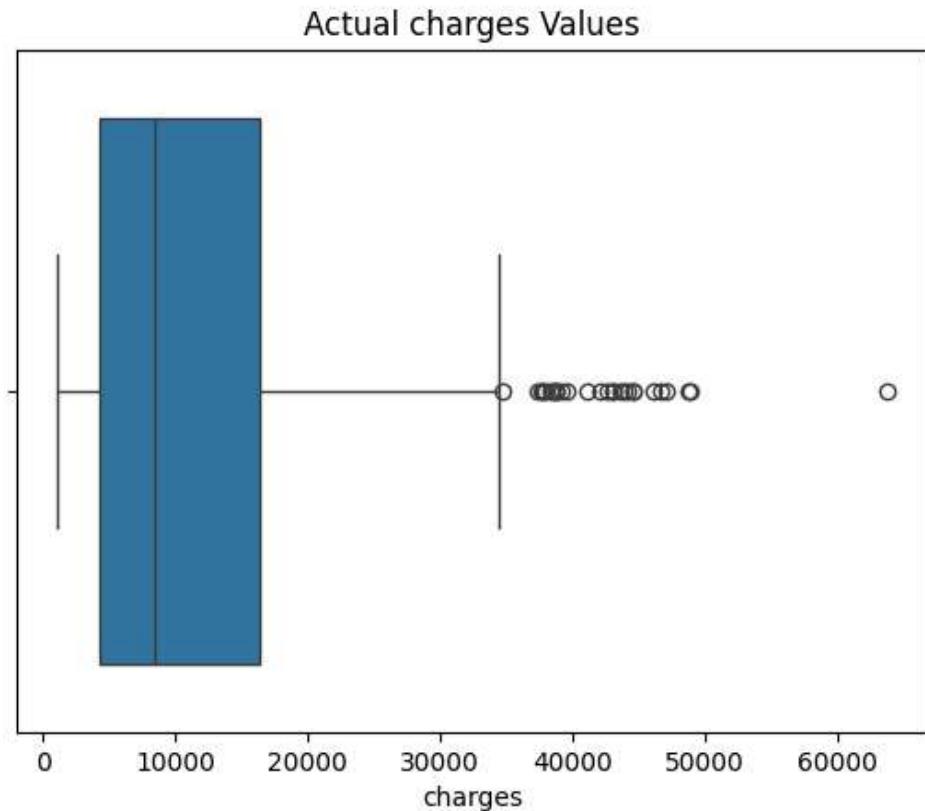


```
In [12]: residuals = y_test - y_pred

plt.figure()
plt.scatter(y_pred, residuals, s=5, color='red')
plt.axhline(0, color='black')
plt.xlabel("Predicted")
plt.ylabel("Residuals")
plt.title("Residuals vs Predicted")
plt.show()
```



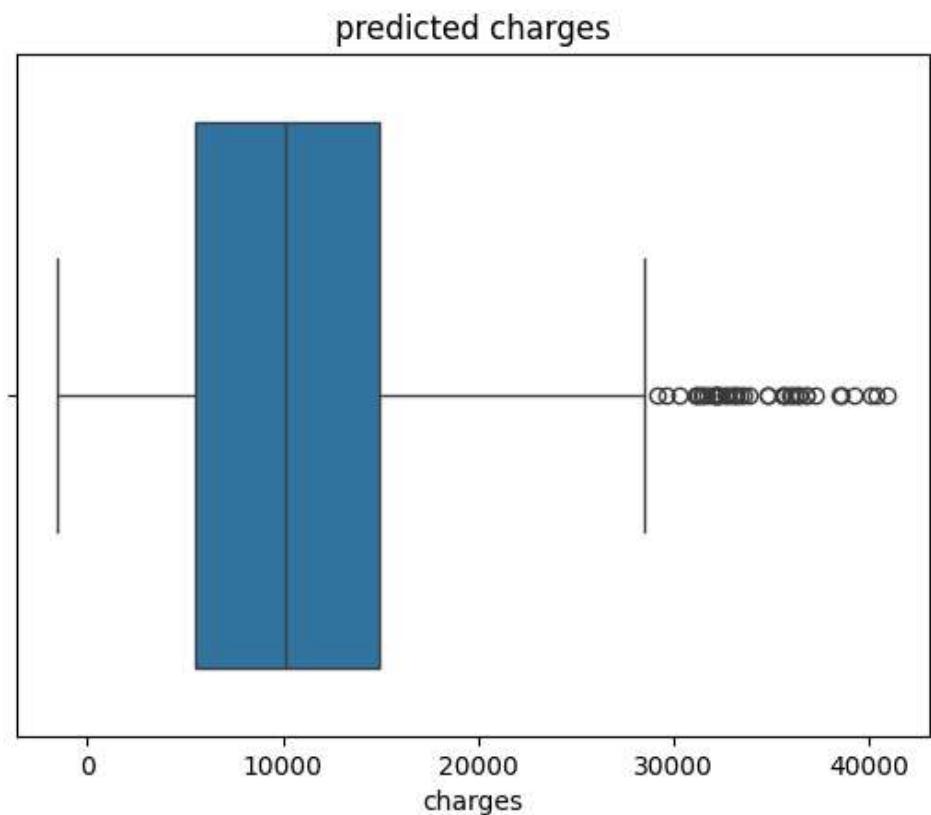
```
In [18]: df_test = pd.DataFrame(y_test, columns=["charges"])
df_pred = pd.DataFrame(y_pred, columns=["charges"])
import seaborn as sns
sns.boxplot(x= df_test["charges"])
plt.title('Actual charges Values')
plt.show()
```

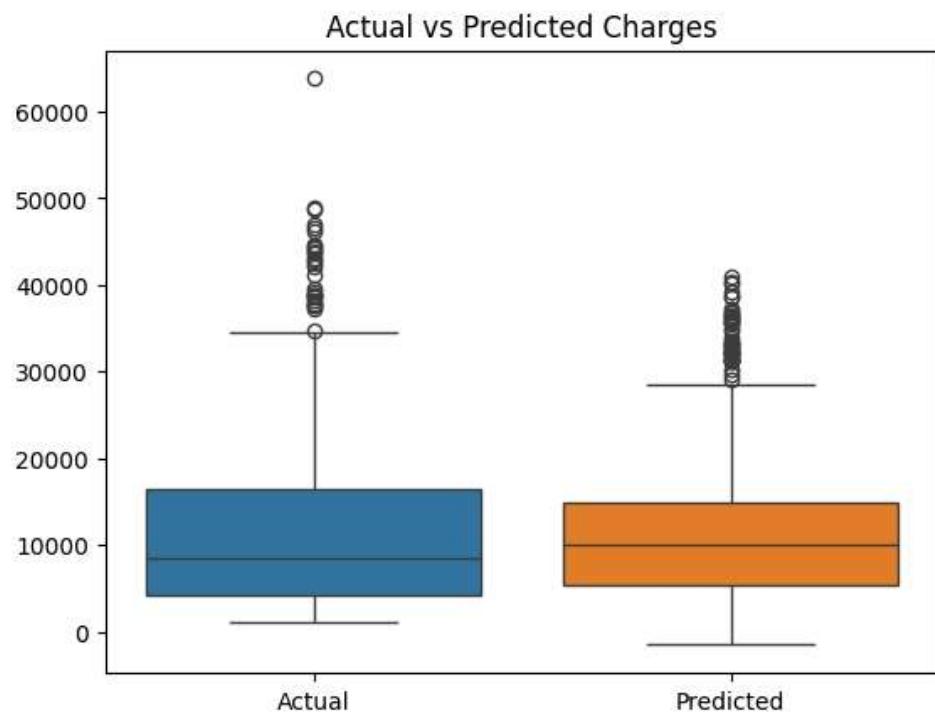


```
In [19]: df_selected = df_pred["charges"]
sns.boxplot(x=df_selected)
plt.title('predicted charges')
plt.show()

df_compare = pd.DataFrame({
    "Actual": y_test,
    "Predicted": y_pred
})

sns.boxplot(data=df_compare)
plt.title("Actual vs Predicted Charges")
plt.show()
```





# Training The KNN Regressor Model

```
In [21]: from sklearn.neighbors import KNeighborsRegressor
from sklearn.metrics import mean_squared_error, r2_score,
root_mean_squared_error

knr = KNeighborsRegressor(n_neighbors=11)
knr.fit(X_train_processed, y_train)

# Predict
y_pred = knr.predict(X_test_processed)

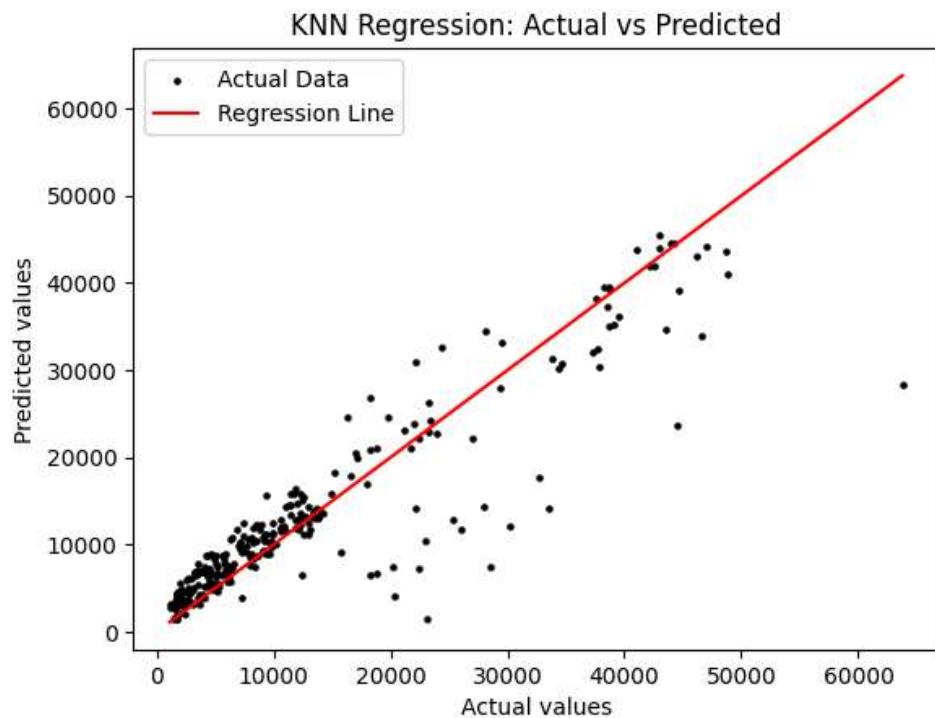
# Metrics for regression
print("R2 Score:", r2_score(y_test, y_pred))
print("RMSE: ", root_mean_squared_error(y_test, y_pred))
# print("MSE:", mean_squared_error(y_test, y_pred))
print("\n")

print("First 10 Actual vs Predicted Charges values:")
print("====")
for i in range(10):
    print(f"Actual: {y_test.iloc[i]} | Predicted: {y_pred[i]}")
```

```
R2 Score: 0.8249128499031824
RMSE:  5213.64152517611
```

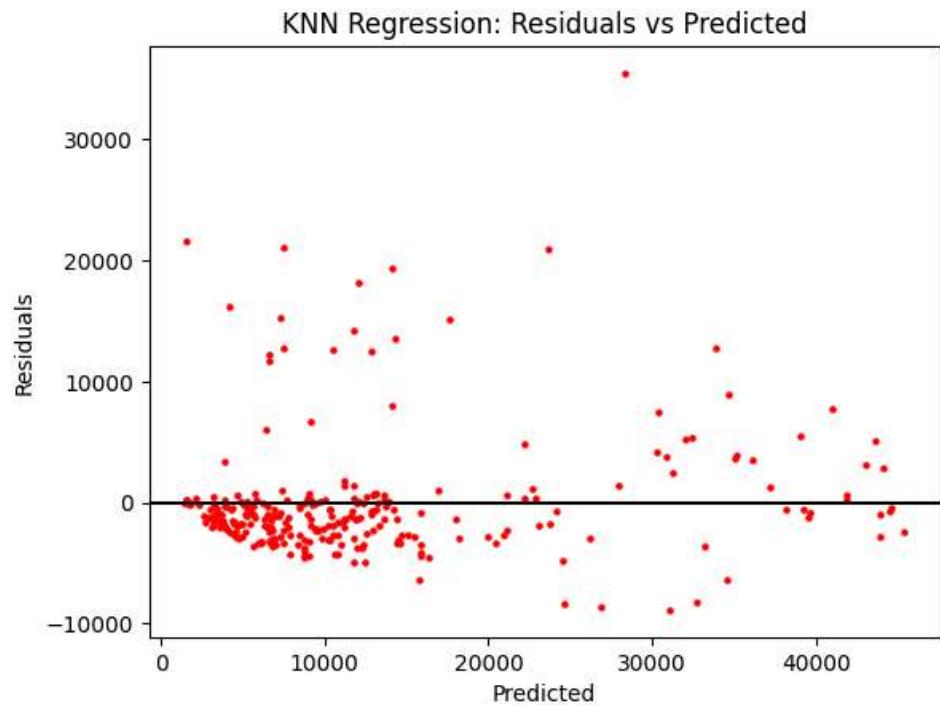
```
First 10 Actual vs Predicted Charges values:
=====
Actual: 9095.06825 | Predicted: 9235.773468181818
Actual: 5272.1758 | Predicted: 5212.744818181818
Actual: 29330.98315 | Predicted: 27903.093631818178
Actual: 9301.89355 | Predicted: 8908.697322727274
Actual: 33750.2918 | Predicted: 31299.684213636363
Actual: 4536.259 | Predicted: 6843.879458181818
Actual: 2117.33885 | Predicted: 4506.439585454545
Actual: 14210.53595 | Predicted: 13614.367945454544
Actual: 3732.6251 | Predicted: 3225.6531499999999996
Actual: 10264.4421 | Predicted: 9981.314518181818
```

```
In [22]:  
plt.figure()  
plt.scatter(y_test, y_pred, s=5, label="Actual Data", color='black')  
plt.xlabel("Actual values")  
plt.ylabel("Predicted values")  
plt.title("KNN Regression: Actual vs Predicted")  
  
min_val = min(y_test.min(), y_pred.min())  
max_val = max(y_test.max(), y_pred.max())  
  
plt.plot([min_val, max_val], [min_val, max_val], label="Regression  
Line", color='red')  
  
plt.legend()  
plt.show()
```

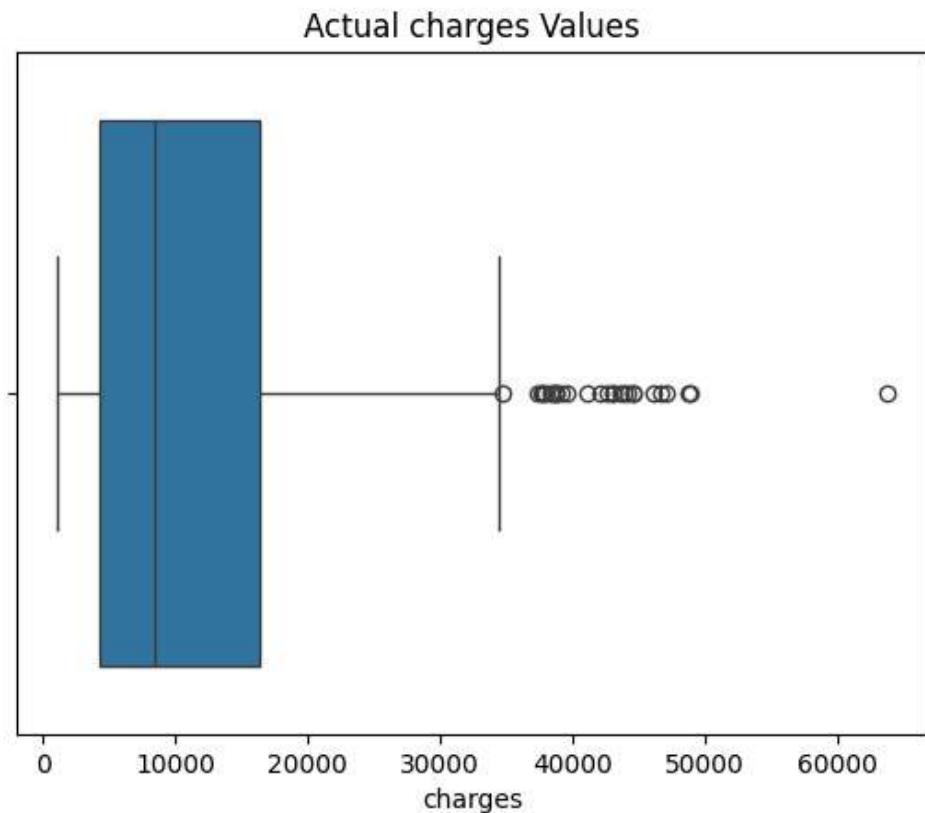


```
In [23]: residuals = y_test - y_pred

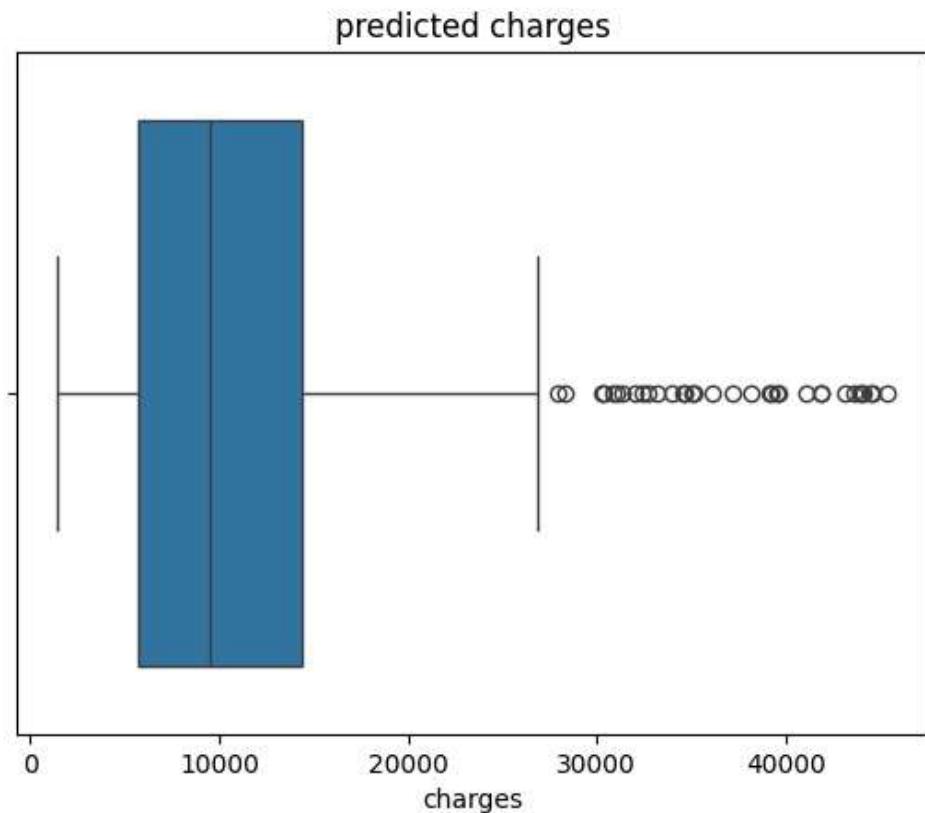
plt.figure()
plt.scatter(y_pred, residuals, s=5, color='red')
plt.axhline(0, color='black')
plt.xlabel("Predicted")
plt.ylabel("Residuals")
plt.title("KNN Regression: Residuals vs Predicted")
plt.show()
```

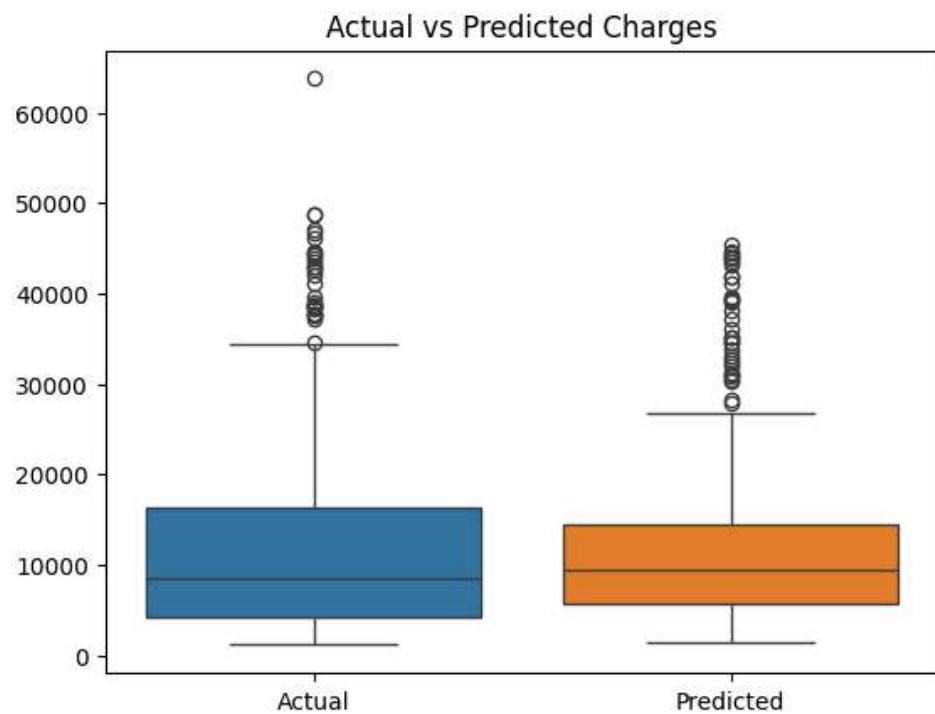


```
In [24]: df_test = pd.DataFrame(y_test, columns=["charges"])
df_pred = pd.DataFrame(y_pred, columns=["charges"])
import seaborn as sns
sns.boxplot(x= df_test["charges"])
plt.title('Actual charges Values')
plt.show()
```



```
In [25]:  
df_selected = df_pred["charges"]  
sns.boxplot(x=df_selected)  
plt.title('predicted charges')  
plt.show()  
  
df_compare = pd.DataFrame({  
    "Actual": y_test,  
    "Predicted": y_pred  
})  
  
sns.boxplot(data=df_compare)  
plt.title("Actual vs Predicted Charges")  
plt.show()
```





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