In [108…
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.stats import zscore
from category_encoders import OneHotEncoder
from sklearn.feature_selection import SelectKBest, f_regression
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error, mean_squared_error
from sklearn.compose import ColumnTransformer
from sklearn.preprocessing import OneHotEncoder
from sklearn.svm import SVR
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
```

In [109…
```
# Importing the insurance dataset
insurance = pd.read_csv('C:\\Users\\EagleCORS\OneDrive\\Desktop\\David_assignment 7-8\\ADS-Assignment-7-8\\insurance.csv')
```

In [110…
```
# Explore the data using pandas exploratory tools
print(insurance.head())
```

```
   age     sex     bmi  children smoker     region      charges
0   19  female  27.900         0    yes  southwest  16884.92400
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  21984.47061
4   32    male  28.880         0     no  northwest   3866.85520
```

In [111…
```
print(insurance.describe())
```

```
                age          bmi     children       charges
count  1338.000000  1338.000000  1338.000000   1338.000000
mean     39.207025    30.663397     1.094918  13270.422265
std      14.049960     6.098187     1.205493  12110.011237
min      18.000000    15.960000     0.000000   1121.873900
25%      27.000000    26.296250     0.000000   4740.287150
50%      39.000000    30.400000     1.000000   9382.033000
75%      51.000000    34.693750     2.000000  16639.912515
max      64.000000    53.130000     5.000000  63770.428010
```

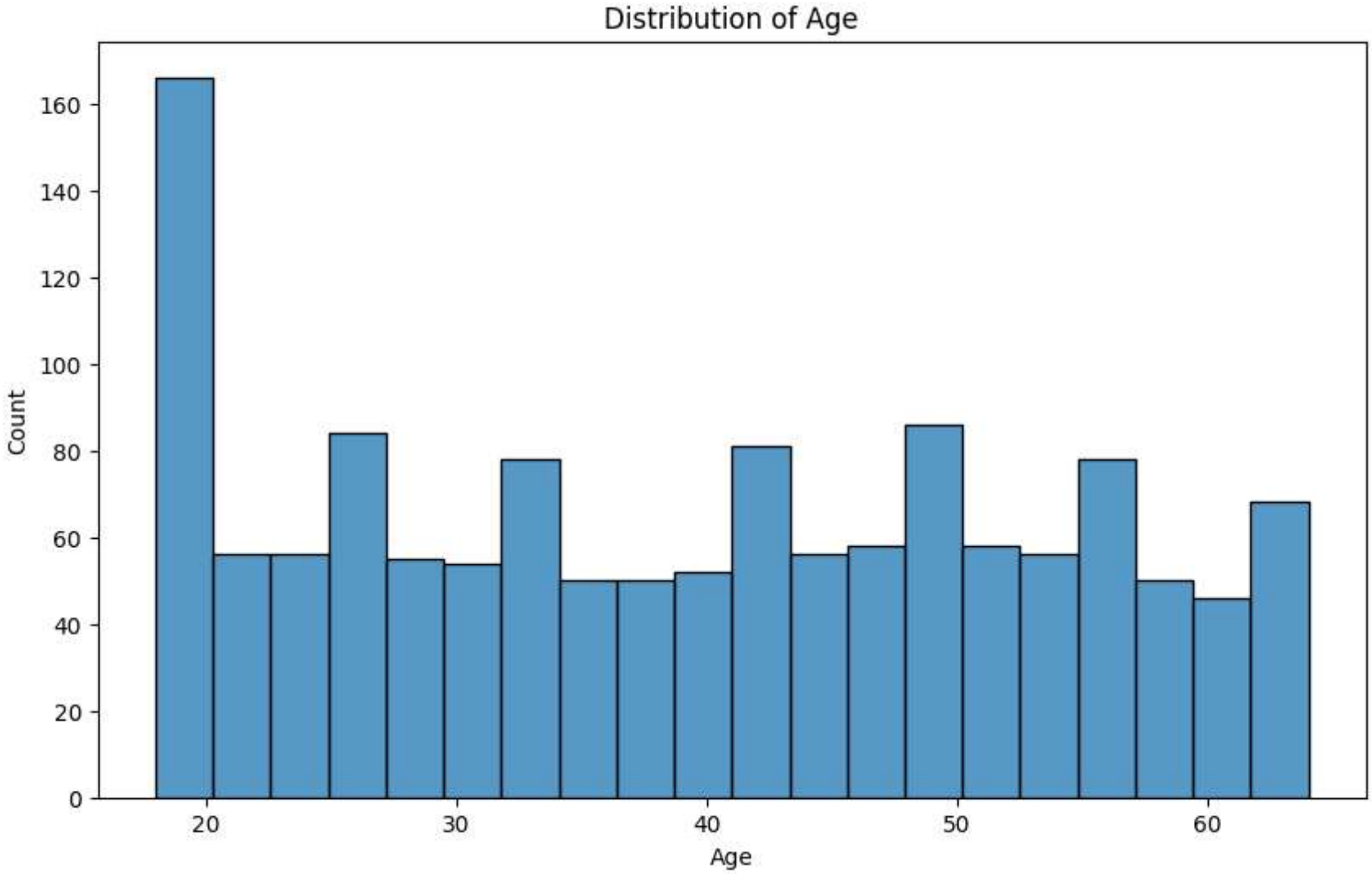
In [112…

```python
print(insurance.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1338 entries, 0 to 1337
Data columns (total 7 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   age       1338 non-null   int64  
 1   sex       1338 non-null   object 
 2   bmi       1338 non-null   float64
 3   children  1338 non-null   int64  
 4   smoker    1338 non-null   object 
 5   region    1338 non-null   object 
 6   charges   1338 non-null   float64
dtypes: float64(2), int64(2), object(3)
memory usage: 73.3+ KB
None
```

In [113…

```python
# Age distribution visualization
plt.figure(figsize=(10, 6))
sns.histplot(insurance['age'], bins=20)
plt.title('Distribution of Age')
plt.xlabel('Age')
plt.show()
```



In [114…

```
# Continuous and discrete features
numerical_continuous = ['age', 'bmi', 'charges']
numerical_discrete = ['children']
categorical = ['sex', 'smoker', 'region']
```

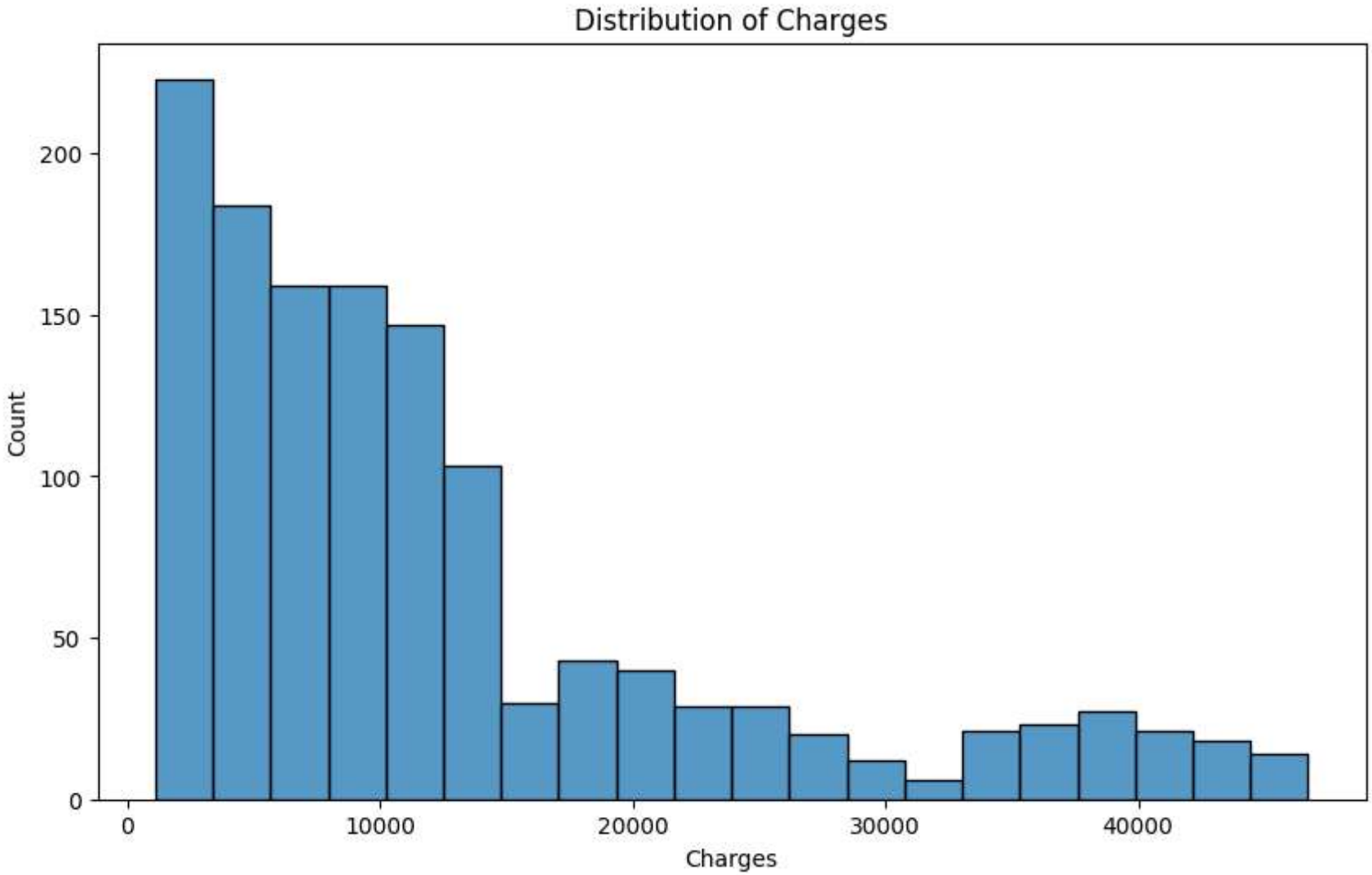
In [115…

```
# Check for outliers in numerical_continuous columns
for col in numerical_continuous:
    z_scores = zscore(insurance[numerical_continuous])
```

```
    abs_z_scores = np.abs(z_scores)
    filtered_entries = (abs_z_scores < 3).all(axis=1)
    insurance = insurance[filtered_entries]
```

In [116…

```
# Value distribution visualization
plt.figure(figsize=(10, 6))
sns.histplot(insurance['charges'], bins=20)
plt.title('Distribution of Charges')
plt.xlabel('Charges')
plt.show()
```



In [117…
```
# Outlier detection and removal for discrete and categorical features
for col in numerical_discrete + categorical:
    threshold = 0.05
    counts = insurance[col].value_counts(normalize=True)
    mask = insurance[col].isin(counts[counts < threshold].index)
    insurance[col][mask] = 'Other'
```

In [118…
```
insurance[numerical_discrete] = insurance[numerical_discrete].astype(str)
```

In [119…
```
# Encoding categorical and discrete features
encoder = OneHotEncoder(sparse=False, handle_unknown='ignore')
X_encoded = encoder.fit_transform(insurance[categorical + numerical_discrete])
X_encoded = pd.DataFrame(X_encoded, columns=encoder.get_feature_names(categorical + numerical_discrete), index=insurance.index)
X = pd.concat([X_encoded, insurance[numerical_continuous]], axis=1)
y = insurance['charges']
```

```
C:\Users\EagleCORS\anaconda3\lib\site-packages\sklearn\utils\deprecation.py:87: FutureWarning: Function get_feature_names is dep
recated; get_feature_names is deprecated in 1.0 and will be removed in 1.2. Please use get_feature_names_out instead.
  warnings.warn(msg, category=FutureWarning)
```

In [120…
```
# Feature selection
selector = SelectKBest(f_regression, k=5)
selector.fit(X, y)
X_new = selector.transform(X)
selected_features = X.columns[selector.get_support(indices=True)]
X = X[selected_features]
```

In [140…
```
# Train the model
model = LinearRegression()
model.fit(X_train, y_train)
```

Out[140]:
```
LinearRegression()
```

In [146…
```
# Replace NaN values with median
X_train = X_train.fillna(X_train.median())
X_test = X_test.fillna(X_train.median())
```

In [147…
```
# Replace infinite values with a large number
X_train[~np.isfinite(X_train)] = 1e16
X_test[~np.isfinite(X_test)] = 1e16
```

In [148…
```
# Convert labels back to their original scale
y_test = np.exp(y_test)
y_test_pred = np.exp(y_test_pred)
```

```
C:\Users\EagleCORS\AppData\Local\Temp\ipykernel_15304\2613626074.py:3: RuntimeWarning: overflow encountered in exp
  y_test_pred = np.exp(y_test_pred)
```

In [149…
```
# Calculate and print evaluation metrics
print('MAE:', mean_absolute_error(y_test, y_test_pred))
```

```
print('MSE:', mean_squared_error(y_test, y_test_pred))
print('RMSE:', np.sqrt(mean_squared_error(y_test, y_test_pred)))
print('R-squared:', r2_score(y_test, y_test_pred))
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
~\AppData\Local\Temp\ipykernel_15304\1025802231.py in <module>
      1 # Calculate and print evaluation metrics
----> 2 print('MAE:', mean_absolute_error(y_test, y_test_pred))
      3 print('MSE:', mean_squared_error(y_test, y_test_pred))
      4 print('RMSE:', np.sqrt(mean_squared_error(y_test, y_test_pred)))
      5 print('R-squared:', r2_score(y_test, y_test_pred))

~\anaconda3\lib\site-packages\sklearn\metrics\_regression.py in mean_absolute_error(y_true, y_pred, sample_weight, multioutput)
    189     0.85...
    190     """
--> 191     y_type, y_true, y_pred, multioutput = _check_reg_targets(
    192         y_true, y_pred, multioutput
    193     )

~\anaconda3\lib\site-packages\sklearn\metrics\_regression.py in _check_reg_targets(y_true, y_pred, multioutput, dtype)
     93     """
     94     check_consistent_length(y_true, y_pred)
---> 95     y_true = check_array(y_true, ensure_2d=False, dtype=dtype)
     96     y_pred = check_array(y_pred, ensure_2d=False, dtype=dtype)
     97

~\anaconda3\lib\site-packages\sklearn\utils\validation.py in check_array(array, accept_sparse, accept_large_sparse, dtype, orde
r, copy, force_all_finite, ensure_2d, allow_nd, ensure_min_samples, ensure_min_features, estimator)
    798
    799         if force_all_finite:
--> 800             _assert_all_finite(array, allow_nan=force_all_finite == "allow-nan")
    801
    802     if ensure_min_samples > 0:

~\anaconda3\lib\site-packages\sklearn\utils\validation.py in _assert_all_finite(X, allow_nan, msg_dtype)
    112         ):
    113             type_err = "infinity" if allow_nan else "NaN, infinity"
--> 114             raise ValueError(
    115                 msg_err.format(
    116                     type_err, msg_dtype if msg_dtype is not None else X.dtype

ValueError: Input contains NaN, infinity or a value too large for dtype('float64').
```

In [ ]:
```
# Convert target labels to log values
y = np.log(y)
```

In [ ]:
```
# Split the data into training and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

In [ ]:
```
# Normalize features using StandardScaler
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
```

In [ ]:
```
# Train and evaluate linear regression
linear_reg = LinearRegression()
linear_reg.fit(X_train_scaled, y_train)
linear_reg_train_score = linear_reg.score(X_train_scaled, y_train)
linear_reg_test_score = linear_reg.score(X_test_scaled, y_test)
```

In [ ]:
```
# Train and evaluate support vector regression
svr = SVR()
svr.fit(X_train_scaled, y_train)
svr_train_score = svr.score(X_train_scaled, y_train)
svr_test_score = svr.score(X_test_scaled, y_test)
```

In [ ]:
```
# Train and evaluate decision tree regression
decision_tree_reg = DecisionTreeRegressor()
decision_tree_reg.fit(X_train_scaled, y_train)
decision_tree_reg_train_score = decision_tree_reg.score(X_train_scaled, y_train)
decision_tree_reg_test_score = decision_tree_reg.score(X_test_scaled, y_test)
```

In [ ]:
```
# Train and evaluate random forest regression
random_forest_reg = RandomForestRegressor()
random_forest_reg.fit(X_train_scaled, y_train)
random_forest_reg_train_score = random_forest_reg.score(X_train_scaled, y_train)
random_forest_reg_test_score = random_forest_reg.score(X_test_scaled, y_test)
```

In [ ]:
```
# Train the best model (random forest regression) with training data
random_forest_reg.fit(X_train_scaled, y_train)

# Evaluate model performance using mean absolute error, mean squared error, and R-squared score
y_train_pred = np.exp(random_forest_reg.predict(X_train_scaled))
```

```
y_test_pred = np.exp(random_forest_reg.predict(X_test_scaled))
train_mae = mean_absolute_error(np.exp(y_train), y_train_pred)
test_mae = mean_absolute_error(np.exp(y_test), y_test_pred)
train_mse = mean_squared_error(np.exp(y_train), y_train_pred)
test_mse = mean_squared_error(np.exp(y_test), y_test_pred)
train_r2 = r2_score(np.exp(y_train), y_train_pred)
test_r2 = r2_score(np.exp(y_test), y_test_pred)

print('Training MAE:', train_mae)
print('Testing MAE:', test_mae)
print('Training MSE:', train_mse)
print('Testing MSE:', test_mse)
print('Training R-squared:', train_r2)
print('Testing R-squared:', test_r2)
```

In [ ]: