import libraries

In [145]:

```
import pandas as pd
import numpy as np
import sklearn
from sklearn.impute import SimpleImputer
from sklearn.compose import ColumnTransformer
from sklearn.ensemble import RandomForestRegressor
from sklearn.preprocessing import (
    OneHotEncoder,
    MinMaxScaler,
    PowerTransformer,
    FunctionTransformer,
    StandardScaler
)
from sklearn.pipeline import Pipeline,FeatureUnion
from feature_engine.encoding import (
    RareLabelEncoder,
    MeanEncoder,
    CountFrequencyEncoder,
    OrdinalEncoder
)
from feature_engine.selection import SelectBySingleFeaturePerformance
from sklearn.base import BaseEstimator, TransformerMixin
from sklearn.metrics.pairwise import rbf_kernel
from feature_engine.datetime import DatetimeFeatures
from feature_engine.outliers import Winsorizer
import warnings
import matplotlib.pyplot as plt
import os
import xgboost as xgb
```

Display Settings

In [2]:
```
pd.set_option('display.max_columns',None)
```

In [3]:
```
sklearn.set_config(transform_output='pandas')
```

In [4]:
```
warnings.filterwarnings('ignore')
```

Read Data

In [5]:
```
path = r"D:\Ml projects\car dekho\flights practice\data\train.csv"
```

In [6]:
```
train = pd.read_csv(path)
```

In [7]:
```
train.head()
```

Out[7]:

	airline	date_of_journey	source	destination	dep_time	arrival_time	duration	total_stops	additional_info	price
0	Jet Airways	2019-03-21	Banglore	New Delhi	08:55:00	19:10:00	615	1.0	In-flight meal not included	7832
1	Jet Airways	2019-03-27	Delhi	Cochin	17:30:00	04:25:00	655	1.0	In-flight meal not included	6540
2	Goair	2019-03-09	Banglore	New Delhi	11:40:00	14:35:00	175	0.0	No Info	7305
3	Air India	2019-06-12	Kolkata	Banglore	09:25:00	18:30:00	545	1.0	No Info	8366
4	Jet Airways	2019-03-12	Banglore	New Delhi	22:55:00	07:40:00	525	1.0	In-flight meal not included	11087

In [8]:
```
1 train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 6695 entries, 0 to 6694
Data columns (total 10 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   airline          6695 non-null   object 
 1   date_of_journey  6695 non-null   object 
 2   source           6695 non-null   object 
 3   destination      6695 non-null   object 
 4   dep_time         6695 non-null   object 
 5   arrival_time     6695 non-null   object 
 6   duration         6695 non-null   int64  
 7   total_stops      6694 non-null   float64
 8   additional_info  6695 non-null   object 
 9   price            6695 non-null   int64  
dtypes: float64(1), int64(2), object(7)
memory usage: 523.2+ KB
```

In [9]:
```
1 train.dropna(inplace=True)
```

In [10]:
```
1 train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 6694 entries, 0 to 6694
Data columns (total 10 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   airline          6694 non-null   object 
 1   date_of_journey  6694 non-null   object 
 2   source           6694 non-null   object 
 3   destination      6694 non-null   object 
 4   dep_time         6694 non-null   object 
 5   arrival_time     6694 non-null   object 
 6   duration         6694 non-null   int64  
 7   total_stops      6694 non-null   float64
 8   additional_info  6694 non-null   object 
 9   price            6694 non-null   int64  
dtypes: float64(1), int64(2), object(7)
memory usage: 575.3+ KB
```

In [11]:
```
x_train = train.drop(columns='price')
y_train = train.price.copy()
```

Transformation Operation

In [12]:
```
x_train.airline
```

Out[12]:
```
0       Jet Airways
1       Jet Airways
2             Goair
3         Air India
4       Jet Airways
           ...
6690    Jet Airways
6691      Air India
6692    Jet Airways
6693       Air Asia
6694      Air India
Name: airline, Length: 6694, dtype: object
```

In [13]:
```
air_transformer = Pipeline(steps=[
    ('imputer',SimpleImputer(strategy='most_frequent')),
    ('grouper',RareLabelEncoder(tol=0.1,replace_with ='Other',n_categories=2)),
    ('encoder',OneHotEncoder(sparse_output=False,handle_unknown='ignore'))
])

air_transformer.fit_transform(x_train.loc[:,['airline']])
```

Out[13]:

	airline_Air India	airline_Indigo	airline_Jet Airways	airline_Multiple Carriers	airline_Other
0	0.0	0.0	1.0	0.0	0.0
1	0.0	0.0	1.0	0.0	0.0
2	0.0	0.0	0.0	0.0	1.0
3	1.0	0.0	0.0	0.0	0.0
4	0.0	0.0	1.0	0.0	0.0
...	...	...	...	...	...
6690	0.0	0.0	1.0	0.0	0.0
6691	1.0	0.0	0.0	0.0	0.0
6692	0.0	0.0	1.0	0.0	0.0
6693	0.0	0.0	0.0	0.0	1.0
6694	1.0	0.0	0.0	0.0	0.0

6694 rows × 5 columns

date_of_journey

In [14]:
```
feature_to_extract = ['week','month','day_of_week','day_of_year']
```

In [15]:
```
doj_transformer = Pipeline(steps=[
    ('dt',DatetimeFeatures(features_to_extract=feature_to_extract,yearfirst=True, format='mixed')),
    ('scaler',MinMaxScaler())
])
doj_transformer.fit_transform(x_train.loc[:,['date_of_journey']])
```

Out[15]:

	date_of_journey_week	date_of_journey_month	date_of_journey_day_of_week	date_of_journey_day_of_year
0	0.176471	0.000000	0.500000	0.169492
1	0.235294	0.000000	0.333333	0.220339
2	0.058824	0.000000	0.833333	0.067797
3	0.882353	1.000000	0.333333	0.872881
4	0.117647	0.000000	0.166667	0.093220
...	...	...	...	...
6690	0.176471	0.000000	0.500000	0.169492
6691	0.529412	0.666667	0.333333	0.516949
6692	0.764706	1.000000	0.833333	0.779661
6693	1.000000	1.000000	0.000000	0.974576
6694	0.000000	0.000000	0.666667	0.000000

6694 rows × 4 columns

source and destination

In [16]:
```
1 x_train.source
```

Out[16]:
```
0       Banglore
1          Delhi
2       Banglore
3        Kolkata
4       Banglore
          ...
6690       Delhi
6691     Kolkata
6692       Delhi
6693       Delhi
6694    Banglore
Name: source, Length: 6694, dtype: object
```

In [17]:
```
1 x_train.destination
```

Out[17]:
```
0       New Delhi
1          Cochin
2       New Delhi
3        Banglore
4       New Delhi
          ...
6690       Cochin
6691     Banglore
6692       Cochin
6693       Cochin
6694    New Delhi
Name: destination, Length: 6694, dtype: object
```

In [18]:
```
location_subset = x_train.loc[:,['source','destination']]
location_subset
```

Out[18]:

	source	destination
0	Banglore	New Delhi
1	Delhi	Cochin
2	Banglore	New Delhi
3	Kolkata	Banglore
4	Banglore	New Delhi
...	...	...
6690	Delhi	Cochin
6691	Kolkata	Banglore
6692	Delhi	Cochin
6693	Delhi	Cochin
6694	Banglore	New Delhi

6694 rows × 2 columns

In [19]:
```
location_pipe1=Pipeline(steps=[
    ('grouper',RareLabelEncoder(tol=0.1,replace_with='Other',n_categories=2)),
    ('encoder',MeanEncoder()),
    ('transformer',PowerTransformer())
])
location_pipe1.fit_transform(location_subset,y_train)
```

Out[19]:

	source	destination
0	-0.857629	-0.736209
1	1.065619	1.061892
2	-0.857629	-0.736209
3	-0.203923	-0.224330
4	-0.857629	-0.736209
...	...	...
6690	1.065619	1.061892
6691	-0.203923	-0.224330
6692	1.065619	1.061892
6693	1.065619	1.061892
6694	-0.857629	-0.736209

6694 rows × 2 columns

In [20]:

```
def is_north(x):
    columns = x.columns.to_list()
    north_cities=['Delhi','Kolkata','Mumbai','New Delhi']
    return (
        x.
        assign(**{
            f'{col}_is_north':x.loc[:,col].isin(north_cities).astype(int)
            for col in columns
        })
        .drop(columns=columns)
)
FunctionTransformer(func=is_north).fit_transform(location_subset)
```

Out[20]:

	source_is_north	destination_is_north
0	0	1
1	1	0
2	0	1
3	1	0
4	0	1
...	...	...
6690	1	0
6691	1	0
6692	1	0
6693	1	0
6694	0	1

6694 rows × 2 columns

In [21]:
```
location_transformation = FeatureUnion(transformer_list=[
    ('part1',location_pipe1),
    ('part2',FunctionTransformer(func=is_north))
])
location_transformation.fit_transform(location_subset,y_train)
```

Out[21]:

	source	destination	source_is_north	destination_is_north
0	-0.857629	-0.736209	0	1
1	1.065619	1.061892	1	0
2	-0.857629	-0.736209	0	1
3	-0.203923	-0.224330	1	0
4	-0.857629	-0.736209	0	1
...	...	...	...	...
6690	1.065619	1.061892	1	0
6691	-0.203923	-0.224330	1	0
6692	1.065619	1.061892	1	0
6693	1.065619	1.061892	1	0
6694	-0.857629	-0.736209	0	1

6694 rows × 4 columns

dep_time and arrival_time

In [22]:
```
time_subset = x_train.loc[:,['dep_time','arrival_time']]
time_subset
```

Out[22]:

	dep_time	arrival_time
0	08:55:00	19:10:00
1	17:30:00	04:25:00
2	11:40:00	14:35:00
3	09:25:00	18:30:00
4	22:55:00	07:40:00
...	...	...
6690	10:45:00	18:50:00
6691	09:25:00	18:30:00
6692	14:00:00	19:00:00
6693	07:55:00	13:25:00
6694	11:50:00	08:55:00

6694 rows × 2 columns

In [23]:
```
time_pipe1 = Pipeline(steps=[
    ('dt',DatetimeFeatures(features_to_extract=['hour','minute'])),
    ('scaler',MinMaxScaler())
])
time_pipe1.fit_transform(time_subset)
```

Out[23]:

	dep_time_hour	dep_time_minute	arrival_time_hour	arrival_time_minute
0	0.347826	1.000000	0.826087	0.181818
1	0.739130	0.545455	0.173913	0.454545
2	0.478261	0.727273	0.608696	0.636364
3	0.391304	0.454545	0.782609	0.545455
4	0.956522	1.000000	0.304348	0.727273
...	...	...	...	...
6690	0.434783	0.818182	0.782609	0.909091
6691	0.391304	0.454545	0.782609	0.545455
6692	0.608696	0.000000	0.826087	0.000000
6693	0.304348	1.000000	0.565217	0.454545
6694	0.478261	0.909091	0.347826	1.000000

6694 rows × 4 columns

In [24]:

```
def part_of_day(x,morning=4,noon=12,eve=16,night=20):
    columns = x.columns.to_list()
    x_temp = x.assign(**{
        col:pd.to_datetime(x.loc[:,col]).dt.hour
        for col in columns
    })
    return (
        x_temp
        .assign(**{
            f'{col}_part_of_day': np.select(
                [x_temp.loc[:,col].between(morning,noon,inclusive='left'),
                x_temp.loc[:,col].between(noon,eve,inclusive='left'),
                 x_temp.loc[:,col].between(eve,night,inclusive='left')],
                ['morning','afternoon','evening'],
                default = 'night'
            )
            for col in columns
        })
        .drop(columns=columns)
    )
FunctionTransformer(func=part_of_day).fit_transform(time_subset)
```

Out[24]:

	dep_time_part_of_day	arrival_time_part_of_day
0	morning	evening
1	evening	morning
2	morning	afternoon
3	morning	evening
4	night	morning
...	...	...
6690	morning	evening
6691	morning	evening
6692	afternoon	evening
6693	morning	afternoon
6694	morning	morning

6694 rows × 2 columns

In [25]:
```
time_pipe2 = Pipeline(steps=[
    ('part1',FunctionTransformer(func=part_of_day)),
    ('encoder',CountFrequencyEncoder()),
    ('scaler',MinMaxScaler())
])
time_pipe2.fit_transform(time_subset)
```

Out[25]:

	dep_time_part_of_day	arrival_time_part_of_day
0	1.000000	0.667335
1	0.202773	0.951904
2	1.000000	0.000000
3	1.000000	0.667335
4	0.174177	0.951904
...	...	...
6690	1.000000	0.667335
6691	1.000000	0.667335
6692	0.000000	0.667335
6693	1.000000	0.000000
6694	1.000000	0.951904

6694 rows × 2 columns

In [26]:
```
time_transformer =FeatureUnion(transformer_list=[
    ('part1',time_pipe1),
    ('pipe2',time_pipe2)
])
time_transformer.fit_transform(time_subset)
```

Out[26]:

	dep_time_hour	dep_time_minute	arrival_time_hour	arrival_time_minute	dep_time_part_of_day	arrival_time_part_of_day
0	0.347826	1.000000	0.826087	0.181818	1.000000	0.667335
1	0.739130	0.545455	0.173913	0.454545	0.202773	0.951904
2	0.478261	0.727273	0.608696	0.636364	1.000000	0.000000
3	0.391304	0.454545	0.782609	0.545455	1.000000	0.667335
4	0.956522	1.000000	0.304348	0.727273	0.174177	0.951904
...	...	...	...	...	...	...
6690	0.434783	0.818182	0.782609	0.909091	1.000000	0.667335
6691	0.391304	0.454545	0.782609	0.545455	1.000000	0.667335
6692	0.608696	0.000000	0.826087	0.000000	0.000000	0.667335
6693	0.304348	1.000000	0.565217	0.454545	1.000000	0.000000
6694	0.478261	0.909091	0.347826	1.000000	1.000000	0.951904

6694 rows × 6 columns

duration

In [27]:
```
(
    x_train
    .duration
    .quantile([0.25,0.5,0.75])
    .values
    .reshape(-1,1)
    # .shape
)
```

Out[27]:
```
array([[170.],
       [510.],
       [920.]])
```

In [28]:

```python
class RBFpercentileSimilarity(BaseEstimator,TransformerMixin):
    def __init__(self,variables=None,percentiles=[0.25,0.50,0.75],gamma=0.1):
        self.variables = variables
        self.percentiles = percentiles
        self.gamma = gamma

    def fit(self,x,y=None):
        if not self.variables:
            self.variables = x.select_dtypes(include='number').columns.to_list()

        self.reference_values_ = {
            col:(
                x
                .loc[:,col]
                .quantile(self.percentiles)
                .values
                .reshape(-1,1)
            )
            for col in self.variables
        }

        return self

    def transform(self,x):
        objects=[]
        for col in self.variables:
            columns = [f'{col}_rbf_int{(percentile*100)}' for percentile in self.percentiles]
            obj = pd.DataFrame(
            data = rbf_kernel(x.loc[:,[col]],self.reference_values_[col],gamma=self.gamma),
                columns=columns
            )
            objects.append(obj)

        return pd.concat(objects,axis=1)
```

In [29]:
```
RBFpercentileSimilarity().fit_transform(x_train.loc[:,['duration']])
```

Out[29]:

	duration_rbf_int25.0	duration_rbf_int50.0	duration_rbf_int75.0
0	0.000000	0.000000e+00	0.0
1	0.000000	0.000000e+00	0.0
2	0.082085	0.000000e+00	0.0
3	0.000000	6.293989e-54	0.0
4	0.000000	1.691898e-10	0.0
...	...	...	...
6689	0.000000	0.000000e+00	0.0
6690	0.000000	6.293989e-54	0.0
6691	0.000000	0.000000e+00	0.0
6692	0.000000	0.000000e+00	0.0
6693	0.000000	0.000000e+00	0.0

6694 rows × 3 columns

In [30]:
```
def duration_category(X, short=180, med=400):
    return (
        X
        .assign(duration_cat=np.select([X.duration.lt(short),
                                        X.duration.between(short, med, inclusive="left")],
                                       ["short", "medium"],
                                       default="long"))
        .drop(columns="duration")
    )
```

In [31]:

```python
def is_over(X, value=1000):
    return (
        X
        .assign(**{
            f"duration_over_{value}": X.duration.ge(value).astype(int)
        })
        .drop(columns="duration")
    )
```

In [32]:

```
duration_pipe1 = Pipeline(steps=[
    # ('rbf',RBFpercentileSimilarity()),
    ('scaler',PowerTransformer())
])

duration_union = FeatureUnion(transformer_list=[
    ('part1',duration_pipe1),
    ('part2',StandardScaler())
])
duration_transformer = Pipeline(steps=[
    ('outlier',Winsorizer(capping_method='iqr',fold=1.5)),
    ('Imputer',SimpleImputer(strategy='median')),
    ('union', duration_union)
])
duration_transformer.fit_transform(x_train.loc[:,['duration']])
```

Out[32]:

	part1__duration	part2__duration
0	0.330340	-0.033600
1	0.403254	0.046768
2	-1.020908	-0.917646
3	0.191947	-0.174244
4	0.149506	-0.214428
...	...	...
6690	1.733333	2.598445
6691	0.191947	-0.174244
6692	-0.464892	-0.666496
6693	-0.362973	-0.606221
6694	1.196291	1.272376

6694 rows × 2 columns

In [33]:

```
(
    x_train
    .duration
    .loc[lambda ser: ser > 1000]
    .to_frame()
    .quantile([0.25,0.50,0.75])
)
```

Out[33]:

	duration
0.25	1220.0
0.50	1420.0
0.75	1590.0

total_stops

In [34]:

```
def is_direct(X):
    return X.assign(is_direct_flight=X.total_stops.eq(0).astype(int))


total_stops_transformer = Pipeline(steps=[
    ("imputer", SimpleImputer(strategy="most_frequent")),
    ("", FunctionTransformer(func=is_direct))
])

total_stops_transformer.fit_transform(x_train.loc[:, ["total_stops"]])
```

Out[34]:

	total_stops	is_direct_flight
0	1.0	0
1	1.0	0
2	0.0	1
3	1.0	0
4	1.0	0
...	...	...
6690	2.0	0
6691	1.0	0
6692	1.0	0
6693	1.0	0
6694	1.0	0

6694 rows × 2 columns

additional_info

In [35]:
```
info_pipe1 = Pipeline(steps=[
    ("group", RareLabelEncoder(tol=0.1, n_categories=2, replace_with="Other")),
    ("encoder", OneHotEncoder(handle_unknown="ignore", sparse_output=False))
])

info_pipe1.fit_transform(x_train.loc[:, ["additional_info"]])
```

Out[35]:

	additional_info_In-flight meal not included	additional_info_No Info	additional_info_Other
0	1.0	0.0	0.0
1	1.0	0.0	0.0
2	0.0	1.0	0.0
3	0.0	1.0	0.0
4	1.0	0.0	0.0
...	...	...	...
6690	0.0	1.0	0.0
6691	0.0	1.0	0.0
6692	1.0	0.0	0.0
6693	0.0	1.0	0.0
6694	0.0	0.0	1.0

6694 rows × 3 columns

In [36]:
```
def have_info(X):
    return X.assign(additional_info=X.additional_info.ne("No Info").astype(int))
info_union = FeatureUnion(transformer_list=[
    ("part1", info_pipe1),
    ("part2", FunctionTransformer(func=have_info))
])
info_transformer = Pipeline(steps=[
    ("imputer", SimpleImputer(strategy="constant", fill_value="unknown")),
    ("union", info_union)
])

info_transformer.fit_transform(x_train.loc[:, ["additional_info"]])
```

Out[36]:

	additional_info_In-flight meal not included	additional_info_No Info	additional_info_Other	additional_info
0	1.0	0.0	0.0	1
1	1.0	0.0	0.0	1
2	0.0	1.0	0.0	0
3	0.0	1.0	0.0	0
4	1.0	0.0	0.0	1
...	...	...	...	...
6690	0.0	1.0	0.0	0
6691	0.0	1.0	0.0	0
6692	1.0	0.0	0.0	1
6693	0.0	1.0	0.0	0
6694	0.0	0.0	1.0	1

6694 rows × 4 columns

In [ ]:
```

```

In [37]:
```
1 x_train.columns.to_list()
```

Out[37]:
```
['airline',
 'date_of_journey',
 'source',
 'destination',
 'dep_time',
 'arrival_time',
 'duration',
 'total_stops',
 'additional_info']
```

Column Transformer

In [38]:
```
column_transformer = ColumnTransformer(transformers=[
    ('air',air_transformer,['airline']),
    ('doj',doj_transformer,['date_of_journey']),
    ('location',location_transformation,['source','destination']),
    ('time',time_transformer,['dep_time','arrival_time']),
    ('dur',duration_transformer,['duration']),
    ("stops", total_stops_transformer, ["total_stops"]),
    ("info", info_transformer, ["additional_info"])
],remainder='passthrough')
column_transformer.fit_transform(x_train,y_train)
```

Out[38]:

	air__airline_Air India	air__airline_Indigo	air__airline_Jet Airways	air__airline_Multiple Carriers	air__airline_Other	doj__date_of_journey_week	doj__date_
0	0.0	0.0	1.0	0.0	0.0	0.176471	
1	0.0	0.0	1.0	0.0	0.0	0.235294	
2	0.0	0.0	0.0	0.0	1.0	0.058824	
3	1.0	0.0	0.0	0.0	0.0	0.882353	
4	0.0	0.0	1.0	0.0	0.0	0.117647	
...	...	...	...	...	...	...	
6690	0.0	0.0	1.0	0.0	0.0	0.176471	
6691	1.0	0.0	0.0	0.0	0.0	0.529412	
6692	0.0	0.0	1.0	0.0	0.0	0.764706	
6693	0.0	0.0	0.0	0.0	1.0	1.000000	
6694	1.0	0.0	0.0	0.0	0.0	0.000000	

6694 rows × 27 columns

Feature Selection

In [39]:
```
estimator = RandomForestRegressor(n_estimators=10, max_depth=3, random_state=42)

selector = SelectBySingleFeaturePerformance(
    estimator=estimator,
    scoring="r2",
    threshold=0.1
)
```

In [40]:
```
preprocessor = Pipeline(steps=[
    ("ct", column_transformer),
    ("selector", selector)
])

preprocessor.fit_transform(x_train, y_train)
```

Out[40]:

	air__airline_Indigo	air__airline_Jet Airways	air__airline_Other	doj__date_of_journey_week	doj__date_of_journey_day_of_year	location__sou
0	0.0	1.0	0.0	0.176471	0.169492	-0.857
1	0.0	1.0	0.0	0.235294	0.220339	1.065
2	0.0	0.0	1.0	0.058824	0.067797	-0.857
3	0.0	0.0	0.0	0.882353	0.872881	-0.203
4	0.0	1.0	0.0	0.117647	0.093220	-0.857
...	...	...	...	...	...	
6690	0.0	1.0	0.0	0.176471	0.169492	1.065
6691	0.0	0.0	0.0	0.529412	0.516949	-0.203
6692	0.0	1.0	0.0	0.764706	0.779661	1.065
6693	0.0	0.0	1.0	1.000000	0.974576	1.065
6694	0.0	0.0	0.0	0.000000	0.000000	-0.857

6694 rows × 11 columns

In [41]:
```
feature_performances = preprocessor.named_steps['selector'].feature_performance_
feature_performances
```

Out[41]:
```
{'air__airline_Air India': 0.00204748830602682,
 'air__airline_Indigo': 0.12836215285886088,
 'air__airline_Jet Airways': 0.19344947492438477,
 'air__airline_Multiple Carriers': 0.019061382721082227,
 'air__airline_Other': 0.11846058299683764,
 'doj__date_of_journey_week': 0.18545205813867202,
 'doj__date_of_journey_month': 0.0891930219053337,
 'doj__date_of_journey_day_of_week': 0.005234570009364818,
 'doj__date_of_journey_day_of_year': 0.2271022061742051,
 'location__source': 0.12699498762521164,
 'location__destination': 0.1311104993210662,
 'location__source_is_north': 0.02964117275449485,
 'location__destination_is_north': 0.02964117275449485,
 'time__dep_time_hour': 0.0074911375594401974,
 'time__dep_time_minute': 0.03794149357137192,
 'time__arrival_time_hour': 0.08068284546718978,
 'time__arrival_time_minute': 0.031190920907649595,
 'time__dep_time_part_of_day': -0.0011295681198565388,
 'time__arrival_time_part_of_day': 0.0314661311801779,
 'dur__part1__duration': 0.4247739678003379,
 'dur__part2__duration': 0.4248389453042105,
 'stops__total_stops': 0.4034522557365127,
 'stops__is_direct_flight': 0.37941238701968255,
 'info__additional_info_In-flight meal not included': 0.0017193556330226494,
 'info__additional_info_No Info': -0.0008149235823306326,
 'info__additional_info_Other': 0.01778001687368147,
 'info__additional_info': -0.0008149235823306326}
```

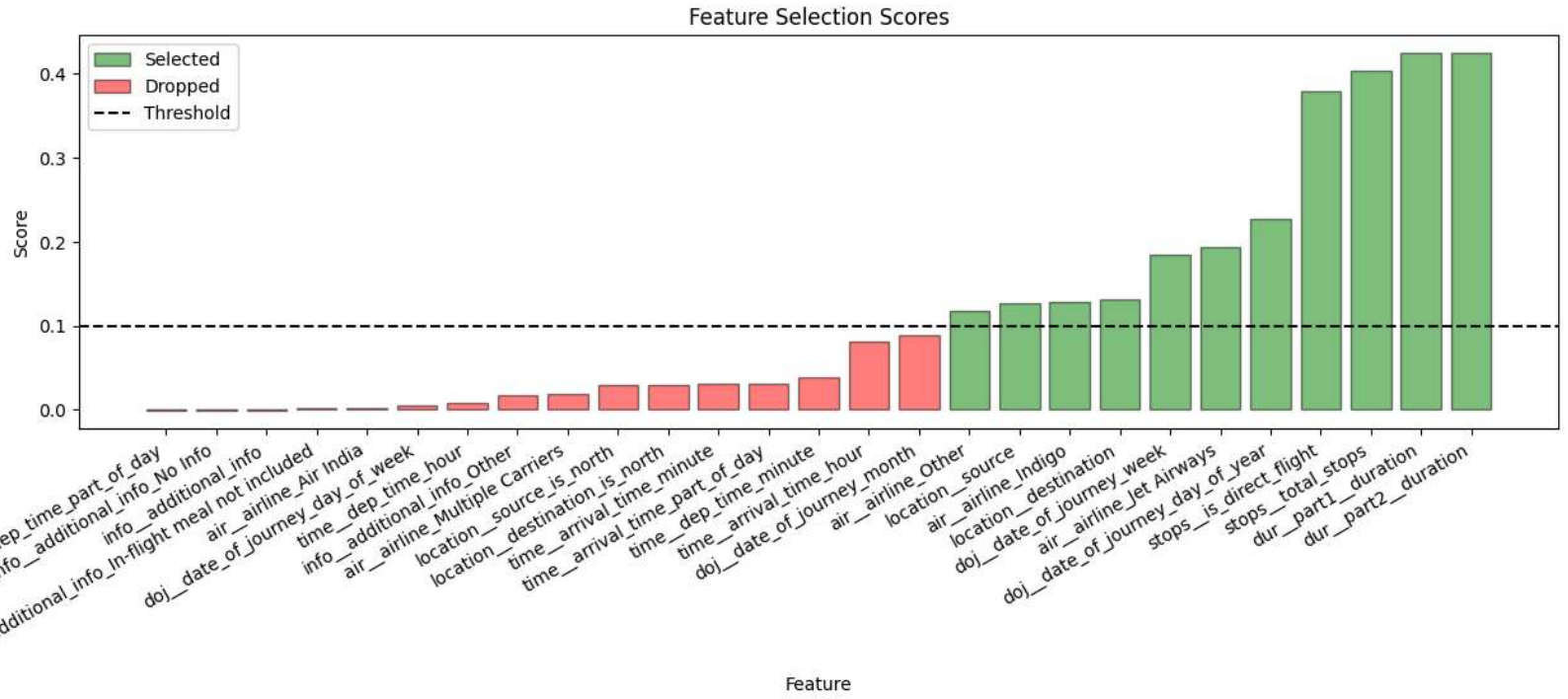
In [42]:
```
sorted_feat_imp = dict(sorted(feature_performances.items(), key=lambda val: val[1]))
sorted_feat_imp
```

Out[42]:
```
{'time__dep_time_part_of_day': -0.0011295681198565388,
 'info__additional_info_No Info': -0.0008149235823306326,
 'info__additional_info': -0.0008149235823306326,
 'info__additional_info_In-flight meal not included': 0.0017193556330226494,
 'air__airline_Air India': 0.00204748830602682,
 'doj__date_of_journey_day_of_week': 0.005234570009364818,
 'time__dep_time_hour': 0.0074911375594401974,
 'info__additional_info_Other': 0.01778001687368147,
 'air__airline_Multiple Carriers': 0.019061382721082227,
 'location__source_is_north': 0.02964117275449485,
 'location__destination_is_north': 0.02964117275449485,
 'time__arrival_time_minute': 0.031190920907649595,
 'time__arrival_time_part_of_day': 0.0314661311801779,
 'time__dep_time_minute': 0.03794149357137192,
 'time__arrival_time_hour': 0.08068284546718978,
 'doj__date_of_journey_month': 0.0891930219053337,
 'air__airline_Other': 0.11846058299683764,
 'location__source': 0.12699498762521164,
 'air__airline_Indigo': 0.12836215285886088,
 'location__destination': 0.1311104993210662,
 'doj__date_of_journey_week': 0.18545205813867202,
 'air__airline_Jet Airways': 0.19344947492438477,
 'doj__date_of_journey_day_of_year': 0.2271022061742051,
 'stops__is_direct_flight': 0.37941238701968255,
 'stops__total_stops': 0.4034522557365127,
 'dur__part1__duration': 0.4247739678003379,
 'dur__part2__duration': 0.4248389453042105}
```

In [43]:

```
THRESOLD = 0.1
selected_bar = None
dropped_bar = None
colors = ['red' if score < THRESOLD else 'green' for score in sorted_feat_imp.values()]

fig,ax = plt.subplots(figsize=(15,4))

for i,(feature,score) in enumerate(sorted_feat_imp.items()):
    params = dict(
        x=i,
        height = score,
        edgecolor='black',
        alpha=0.5
    )
    if score<THRESOLD:
        bar = ax.bar(
            color = 'red',
            **params
        )
        if not dropped_bar:
            dropped_bar=bar[0]
    else:
            bar = ax.bar(
                color='green',
                **params
            )
            if not selected_bar:
                selected_bar = bar[0]

thresh_line = ax.axhline(
    y=0.1,
    color="black",
    linestyle="--"
)

ax.set_xticks(
    ticks=range(len(sorted_feat_imp)),
    labels=list(sorted_feat_imp.keys()),
    rotation=30,
    ha="right"
)

ax.set(
```

```
    xlabel="Feature",
    ylabel="Score",
    title="Feature Selection Scores"
)

ax.legend(
    handles=[selected_bar, dropped_bar, thresh_line],
    labels=["Selected", "Dropped", "Threshold"],
    loc="upper left"
)

plt.show()
```



Preprocess Data

In [44]:
```
PATH_DIR = r'D:\Ml projects\car dekho\flights practice\data'
```

In [51]:
```
def get_data(data):
    file = f'{data}.csv'
    path = os.path.join(PATH_DIR,file)
    return pd.read_csv(path)
```

In [52]:
```
def export_data(data,name,pre):
    # split data into x and y subset
    x = data.drop(columns='price')
    y = data.price.copy()
    x_pre = pre.transform(x)
    file_name = f'{name}_pre.csv'
    file_path = os.path.join(PATH_DIR,file_name)
    x_pre.join(y).to_csv(file_path,index=False)
```

In [53]:
```
export_data(train,'train',preprocessor)
```

In [54]:
```
test = get_data('test')
export_data(test,'test',preprocessor)
```

In [55]:
```
val = get_data('val')
export_data(val,'val',preprocessor)
```

Data

In [69]:
```
train_pre = get_data('train_pre')
```

In [71]:
```
val_pre = get_data('val_pre')
```

In [72]:
```
pre_data = {
    'train':train_pre,
    'val':val_pre
}
```

Model

Train the Model

In [59]:
```
from xgboost import XGBRegressor
```

In [75]:
```
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV, train_test_split
from sklearn.metrics import mean_squared_error
```

In [146]:

```
train_pre = get_data('train_pre')
val_pre = get_data('val_pre')

# Combine train and validation data for cross-validation
full_data = pd.concat([train_pre, val_pre], axis=0)

# Split the data into features and target
X = full_data.drop(columns='price')
y = full_data['price']

# Convert the data to DMatrix format
dtrain = xgb.DMatrix(X, label=y)

# Define the hyperparameter grid
param_grid = {
    'eta': [0.05, 0.1, 0.15, 0.2],
    'max_depth': [3, 4, 5],
    'alpha': [0, 0.5, 1],
    'subsample': [0.6, 0.8, 1.0],
    'colsample_bytree': [0.6, 0.8, 1.0]
}

# Initialize the model
model = xgb.XGBRegressor(objective="reg:squarederror", random_state=42)

# Initialize GridSearchCV or RandomizedSearchCV
search = GridSearchCV(
    estimator=model,
    param_grid=param_grid,
    scoring='neg_mean_squared_error',
    cv=5,  # 5-fold cross-validation
    n_jobs=-1,  # Use all available cores
    verbose=1
)

# Fit the search object
search.fit(X, y)

# Print the best hyperparameters and the corresponding score
print("Best hyperparameters: ", search.best_params_)
print("Best RMSE: ", (-search.best_score_)**0.5)

# Evaluate the best model on the validation set
```

```
best_model = search.best_estimator_
X_val = val_pre.drop(columns='price')
y_val = val_pre['price']
dval = xgb.DMatrix(X_val, label=y_val)
y_pred = best_model.predict(X_val)
rmse = mean_squared_error(y_val, y_pred, squared=False)
print(f'Validation RMSE: {rmse}')

# Calculate accuracy (or another metric if needed)
accuracy = best_model.score(X_val, y_val)
print(f'Validation Accuracy: {accuracy}')

```

```
Fitting 5 folds for each of 324 candidates, totalling 1620 fits
Best hyperparameters:  {'alpha': 0, 'colsample_bytree': 0.8, 'eta': 0.2, 'max_depth': 4, 'subsample': 1.0}
Best RMSE:  2255.8550082337388
Validation RMSE: 1890.2229800805908
Validation Accuracy: 0.8395137786865234
```

Saving model and preprocessor

In [147]:

```
import pickle
model_path = 'best_model.pkl'
with open(model_path, 'wb') as f:
    pickle.dump(best_model, f)
print(f'Model saved to {model_path}')
```

```
Model saved to best_model.pkl
```

In [148]:

```
preprocessor_path = 'preprocess.pkl'
with open(preprocessor_path,'wb') as f:
    pickle.dump(preprocessor,f)
```

Prediction

In [149]:
```
import pandas as pd

# New data point
data = ['Jet Airways','2019-03-06','Banglore','New Delhi','08:00:00','08:15:00',1455,1.0,'No Info']
columns= ['airline','date_of_journey','source','destination','dep_time','arrival_time','duration','total_

# Create a DataFrame
new_data = pd.DataFrame([data], columns=columns)
new_data
```

Out[149]:

	airline	date_of_journey	source	destination	dep_time	arrival_time	duration	total_stops	additional_info
0	Jet Airways	2019-03-06	Banglore	New Delhi	08:00:00	08:15:00	1455	1.0	No Info

In [150]:
```
import pickle

# Load the model and preprocessor from disk
with open('best_model.pkl', 'rb') as f:
    loaded_model = pickle.load(f)

with open('preprocess.pkl','rb') as f:
    loaded_preprocessor = pickle.load(f)

```

In [151]:
```
# Preprocess the new data point
new_data_preprocessed = loaded_preprocessor.transform(new_data)

# Make prediction
predicted_price = loaded_model.predict(new_data_preprocessed)

print(f'Predicted Price: {predicted_price[0]}')

```

```
Predicted Price: 15125.7548828125
```

In [ ]:
```
1
```

In [ ]:
```
1
```