In [1]:

```
import numpy as np
import pandas as pd
from sklearn.linear_model import Lasso, LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import r2_score
from sklearn.metrics import mean_squared_error
import matplotlib.pyplot as plt
import statsmodels.api as sm

df = pd.read_csv("housing.csv")
df
```

Out[1]:

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	population	households	media
0	-122.23	37.88	41.0	880.0	129.0	322.0	126.0	
1	-122.22	37.86	21.0	7099.0	1106.0	2401.0	1138.0	
2	-122.24	37.85	52.0	1467.0	190.0	496.0	177.0	
3	-122.25	37.85	52.0	1274.0	235.0	558.0	219.0	
4	-122.25	37.85	52.0	1627.0	280.0	565.0	259.0	
...	...	...	...	...	...	...	...	
20635	-121.09	39.48	25.0	1665.0	374.0	845.0	330.0	
20636	-121.21	39.49	18.0	697.0	150.0	356.0	114.0	
20637	-121.22	39.43	17.0	2254.0	485.0	1007.0	433.0	
20638	-121.32	39.43	18.0	1860.0	409.0	741.0	349.0	
20639	-121.24	39.37	16.0	2785.0	616.0	1387.0	530.0	

20640 rows × 10 columns

In [2]:

```
# Task 2
df.isnull().sum()
```

Out[2]:

```
longitude               0
latitude                0
housing_median_age      0
total_rooms             0
total_bedrooms        207
population              0
households              0
median_income           0
median_house_value      0
ocean_proximity         0
dtype: int64
```

In [3]:

```
# Task 2
rm_null = df['total_bedrooms'].mean()
```

In [4]:

```
# Task 2
df['total_bedrooms'] = df['total_bedrooms'].fillna(rm_null)
df.isnull().sum()
```

Out[4]:

```
longitude             0
latitude              0
housing_median_age    0
total_rooms           0
total_bedrooms        0
population            0
households            0
median_income         0
median_house_value    0
ocean_proximity       0
dtype: int64
```

In [5]:

```
# Task 3
df['ocean_proximity'] = pd.Categorical(df['ocean_proximity'])
df['ocean_proximity'].cat.categories.tolist()
```

Out[5]:

```
['<1H OCEAN', 'INLAND', 'ISLAND', 'NEAR BAY', 'NEAR OCEAN']
```

In [6]:

```
# Task 3
def char_to_int(x):
    if x == '<1H OCEAN':
        return 0
    elif x == 'INLAND':
        return 1
    elif x == 'ISLAND':
        return 2
    elif x == 'NEAR BAY':
        return 3
    else:
        return 4

df["ocean_condition"] = df["ocean_proximity"].apply(char_to_int)
df.drop("ocean_proximity", axis=1, inplace=True)
df["ocean_condition"]
```

Out[6]:

```
0         3
1         3
2         3
3         3
4         3
         ..
20635     1
20636     1
20637     1
20638     1
20639     1
Name: ocean_condition, Length: 20640, dtype: category
Categories (5, int64): [0, 1, 2, 3, 4]
```

In [7]:

```
# Task 3
df
```

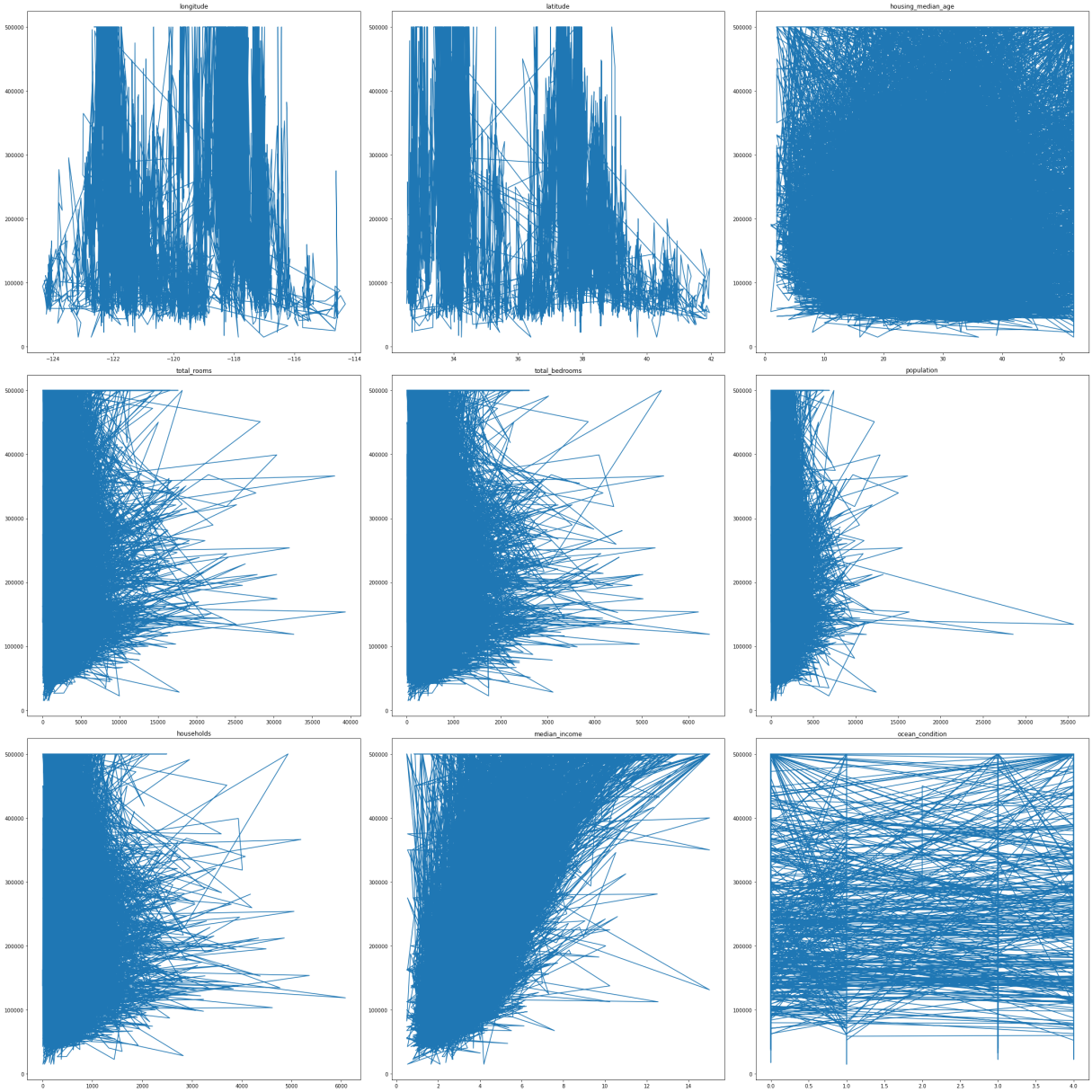
Out[7]:

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	population	households	media
0	-122.23	37.88	41.0	880.0	129.0	322.0	126.0	
1	-122.22	37.86	21.0	7099.0	1106.0	2401.0	1138.0	
2	-122.24	37.85	52.0	1467.0	190.0	496.0	177.0	
3	-122.25	37.85	52.0	1274.0	235.0	558.0	219.0	
4	-122.25	37.85	52.0	1627.0	280.0	565.0	259.0	
...	...	...	...	...	...	...	...	
20635	-121.09	39.48	25.0	1665.0	374.0	845.0	330.0	
20636	-121.21	39.49	18.0	697.0	150.0	356.0	114.0	
20637	-121.22	39.43	17.0	2254.0	485.0	1007.0	433.0	
20638	-121.32	39.43	18.0	1860.0	409.0	741.0	349.0	
20639	-121.24	39.37	16.0	2785.0	616.0	1387.0	530.0	

20640 rows × 10 columns

In [8]:

```
# Task 1
figure, axis = plt.subplots(3, 3, figsize=(30,30))

Y = df['median_house_value']

axis[0, 0].plot(df['longitude'], Y)
axis[0, 0].set_title("longitude")

axis[0, 1].plot(df['latitude'], Y)
axis[0, 1].set_title("latitude")

axis[0, 2].plot(df['housing_median_age'], Y)
axis[0, 2].set_title("housing_median_age")

axis[1, 0].plot(df['total_rooms'], Y)
axis[1, 0].set_title("total_rooms")

axis[1, 1].plot(df['total_bedrooms'], Y)
axis[1, 1].set_title("total_bedrooms")

axis[1, 2].plot(df['population'], Y)
axis[1, 2].set_title("population")

axis[2, 0].plot(df['households'], Y)
axis[2, 0].set_title("households")

axis[2, 1].plot(df['median_income'], Y)
axis[2, 1].set_title("median_income")

axis[2, 2].plot(df['ocean_condition'], Y)
axis[2, 2].set_title("ocean_condition")

figure.tight_layout()
plt.show()
```



In [9]:

```
# Task 4
column_to_move = df.pop("median_house_value")
df.insert(9, "median_house_value", column_to_move )

x = df.iloc[:, :-1].values
print(x)

y = df.iloc[:, -1].values
print(y)
```

```
[[-1.2223e+02  3.7880e+01  4.1000e+01 ...  1.2600e+02  8.3252e+00
   3.0000e+00]
 [-1.2222e+02  3.7860e+01  2.1000e+01 ...  1.1380e+03  8.3014e+00
   3.0000e+00]
 [-1.2224e+02  3.7850e+01  5.2000e+01 ...  1.7700e+02  7.2574e+00
   3.0000e+00]
 ...
 [-1.2122e+02  3.9430e+01  1.7000e+01 ...  4.3300e+02  1.7000e+00
   1.0000e+00]
 [-1.2132e+02  3.9430e+01  1.8000e+01 ...  3.4900e+02  1.8672e+00
   1.0000e+00]
 [-1.2124e+02  3.9370e+01  1.6000e+01 ...  5.3000e+02  2.3886e+00
   1.0000e+00]]
[452600. 358500. 352100. ...  92300.  84700.  89400.]
```

In [10]:

```
# Task 4
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.3, random_state = 10
```

In [11]:

```
# Task 5
model = LinearRegression()
model.fit(x_train,y_train)
predict = model.predict(x_test)
predict
```

Out[11]:

```
array([278779.09028801, 277664.03252104, 267153.05894305, ...,
       181574.14259931, 266283.93908029, 119540.63024601])
```

In [12]:

```
# Task 6
coeff = model.coef_
# print("coefficient of model is", coeff)
i = 0
for x in coeff:
    print("coefficient", i,"of model is", x)
    i += 1
```

```
coefficient 0 of model is -42903.6792985853
coefficient 1 of model is -42791.69978617312
coefficient 2 of model is 1160.981418881179
coefficient 3 of model is -6.922739869911311
coefficient 4 of model is 84.47518941048838
coefficient 5 of model is -35.263785800354526
coefficient 6 of model is 66.70379079420127
coefficient 7 of model is 39809.435186156654
coefficient 8 of model is 395.43931894582033
```

In [13]:

```
# Task 7
r2 = r2_score(y_test, predict)
mse = mean_squared_error(y_test, predict)
rmse = np.sqrt(mse)

print("R2 score is", r2)
print("mean squared error is", mse)
print("root mean squared error is", rmse)
```

```
R2 score is 0.6358657611751222
mean squared error is 4936354570.901405
root mean squared error is 70259.19563232563
```

Since R2 score is less than 80%, and mean squared error rate is too high, this model is not a good model.

In [14]:

```
# Task 8
lasso = Lasso(alpha=0.1)
lasso.fit(x_train, y_train)

feature_name = df.columns.values.tolist()
feature_name.pop(9)
print(feature_name)

def backward_elimination(X, y, significance_level):
    while True:
        X = sm.add_constant(X)
        model = sm.OLS(y, X).fit()
        p_values = model.pvalues
        max_p_value = p_values.max()
        if max_p_value > significance_level:
            feature_to_remove = p_values.idxmax()
            X = X.drop(feature_to_remove, axis=1)
        else:
            break
    return X.columns[1:]

X = pd.DataFrame(x_train, columns=feature_name)
y = pd.Series(y_train)

selected_variables = backward_elimination(X, y, 0.1)
selected_variables
```

```
['longitude', 'latitude', 'housing_median_age', 'total_rooms', 'total_bedroom
s', 'population', 'households', 'median_income', 'ocean_condition']
```

Out[14]:

```
Index(['longitude', 'latitude', 'housing_median_age', 'total_rooms',
       'total_bedrooms', 'population', 'households', 'median_income'],
      dtype='object')
```

ocean_condition is dropped

In [15]:

```
# Task 9
x_selected = df.iloc[:, :-2].values
print(x)

y = df.iloc[:, -1].values
print(y)

x_train_selected, x_test_selected, y_train_selected, y_test_selected \
= train_test_split(x_selected, y, test_size = 0.3, random_state = 10)

model_selected = LinearRegression()
model_selected.fit(x_train_selected,y_train_selected)
predict_selected = model_selected.predict(x_test_selected)
predict_selected
```

```
395.43931894582033
[452600. 358500. 352100. ...  92300.  84700.  89400.]
```

Out[15]:

```
array([277685.73651054, 276886.88404206, 267492.02865491, ...,
       181583.79186923, 265037.91243741, 119646.20961643])
```

In [16]:

```
# Task 10
r2_selected = r2_score(y_test_selected, predict_selected)
mse_selected = mean_squared_error(y_test_selected, predict_selected)
rmse_selected = np.sqrt(mse_selected)

print("R2 score with selected features is", r2_selected)
print("mean squared error with selected features is", mse_selected)
print("root mean squared error with selected features is", rmse_selected)
```

```
R2 score with selected features is 0.6359502658619735
mean squared error with selected features is 4935208990.36345
root mean squared error with selected features is 70251.04262830161
```

R2 score with selected features is little greater than original model's R2 score. In addition, mean squared error rate of new model is slightly smaller than original model's.

In [17]:

```
# Task 11
data=[[122.25*-1, 37.85, 40, 880, 129, 322, 126, 8.3]]

#df_new_house=pd.DataFrame(data,columns=['longitude', 'latitude', 'housing median age', \
#'total rooms', 'total bedrooms', 'population', 'households', 'median income'])

model_selected.predict(data)
```

Out[17]:

```
array([408351.2552891])
```

In [18]:

```
# Task 12
```