EXPERIMENT- 5

AIM

Implementation of Multiple Regression on Housing Dataset.

SOFTWARE USED

Google Colab Platform - Python Programming Language

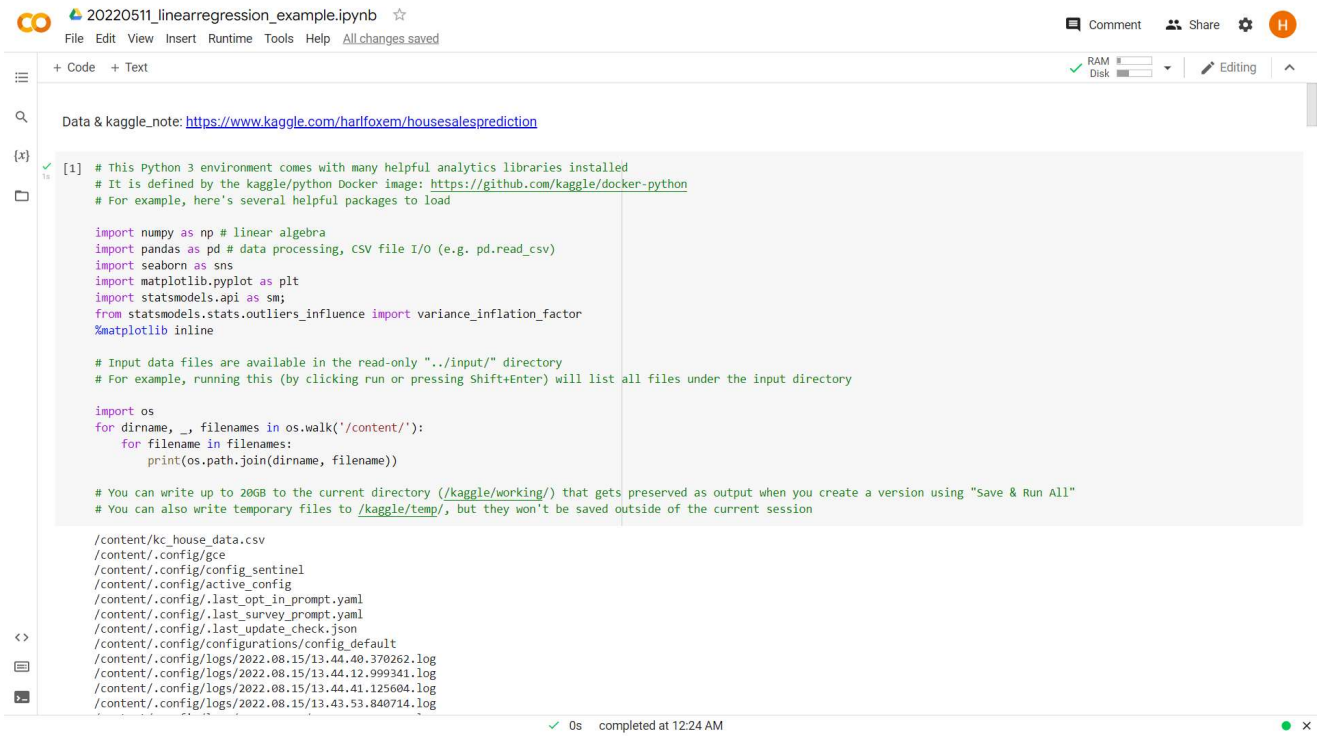
PROGRAM CODE

```
# This Python 3 environment comes with many helpful analytics libraries installed
# It is defined by the kaggle/python Docker image: https://github.com/kaggle/docker-python
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import seaborn as sns
import matplotlib.pyplot as plt
import statsmodels.api as sm;
from statsmodels.stats.outliers_influence import variance_inflation_factor
%matplotlib inline

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list all files under the input directory

import os
for dirname, _, filenames in os.walk('/content/'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that gets preserved as output when you create a version using "Save & Run All"
# You can also write temporary files to /kaggle/temp/, but they won't be saved outside of the current session

#Importing DataSet
dataset = pd.read_csv("kc_house_data.csv")
#Keggle note 우측 데이터 "kc_house_data.csv" click 후 path 복사


dataset.head()

dataset.shape

dataset.columns

dataset.dtypes

dataset.describe()
```

```
dataset.isnull().sum()

dataset['bedrooms'].value_counts()

fig,axes=plt.subplots(nrows=1,ncols=1,figsize=(15,10))
sns.countplot(dataset.bedrooms,order=dataset['bedrooms'].value_counts().index)

fig,axes=plt.subplots(nrows=1,ncols=1,figsize=(15,10))
sns.distplot(dataset['price'],hist=True,kde=True,rug=False,label='price',norm_hist=True)

variables = dataset[['bedrooms', 'bathrooms', 'sqft_living',
      'sqft_lot', 'floors', 'waterfront', 'view', 'condition', 'grade',
      'sqft_above', 'sqft_basement', 'yr_built', 'yr_renovated',
      'lat', 'long', 'sqft_living15', 'sqft_lot15']]

colormap = plt.cm.PuBu
plt.figure(figsize=(15, 10))
plt.title("Person Correlation of Features", y = 1.05, size = 15)
sns.heatmap(variables.astype(float).corr(), linecolor = "white", cmap = colormap, annot = True)
          #, linewidths = 0.1, vmax = 1.0, square = True, cmap = colormap,
        #   linecolor = "white", annot = True, annot_kws = {"size" : 16})


# 데이터 확인
dataset

# bedroom 이 종속변수인 price 에 영향을 미치는 관계를 구하기 위한 회귀분석 ( 다른 변수의 영향을
 받지 않았을 때)

dataset['intercept'] = 1
pm = sm.OLS(dataset['price'], dataset[['intercept','bedrooms']])
results_p = pm.fit()
results_p.summary()

'''
# 상관관계가 높은 변수를 제거하지 않고 모든 변수를 input 으로 사용했을 때( 다중공선성 고려 X)
dataset['intercept'] = 1
lm = sm.OLS(dataset['price'], dataset[['bedrooms', 'bathrooms', 'sqft_living',
      'sqft_lot', 'floors', 'waterfront', 'view', 'condition', 'grade',
      'sqft_above', 'sqft_basement', 'yr_built', 'yr_renovated',
      'lat', 'long', 'sqft_living15', 'sqft_lot15']])
results = lm.fit()
results.summary()
'''

from statsmodels.stats.outliers_influence import variance_inflation_factor

# 다중공선성을 고려하여 'bathrooms', 'sqft_living', 'sqft_lot', 'sqft_above', 'sqft_living15', 'sqft_lot15'
 변수 제거
dataset['intercept'] = 1
```

```
lm_re = sm.OLS(dataset['price'], dataset[['bedrooms', 'floors', 'waterfront', 'view', 'condition', 'grade',
      'sqft_basement', 'yr_built', 'yr_renovated', 'lat', 'long']])
results_re = lm_re.fit()
results_re.summary()

from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression

X = dataset[['bedrooms', 'floors', 'waterfront', 'view', 'condition', 'grade',
      'sqft_basement', 'yr_built', 'yr_renovated', 'lat', 'long']]
y = dataset['price']

# Train, Test set 80:20 분할
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=123)
#Random_state : 난수 값을 고정하는 역할

# 회귀모델 학습, 적합



# X_test set 에 대한 예측 결과


'''
pd.options.display.float_format = '{:.5f}'.format

# 실제 y 값과 예측 값 비교
y_compare={'y_test':y_test, 'y_predicted':y_pred}
pd.DataFrame(y_compare)
'''

from sklearn.metrics import mean_squared_error, mean_absolute_error
#print("mean_squared_error: ", mean_squared_error())
#print("root_mean_squared_error: ", mean_squared_error(,squared=False))
#print("mean_absolute_error: ", mean_absolute_error())

def MAPE(y_test, y_pred):
   return np.mean(np.abs((y_test - y_pred) / y_test)) * 100
```

OUTPUT



20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share

+ Code + Text

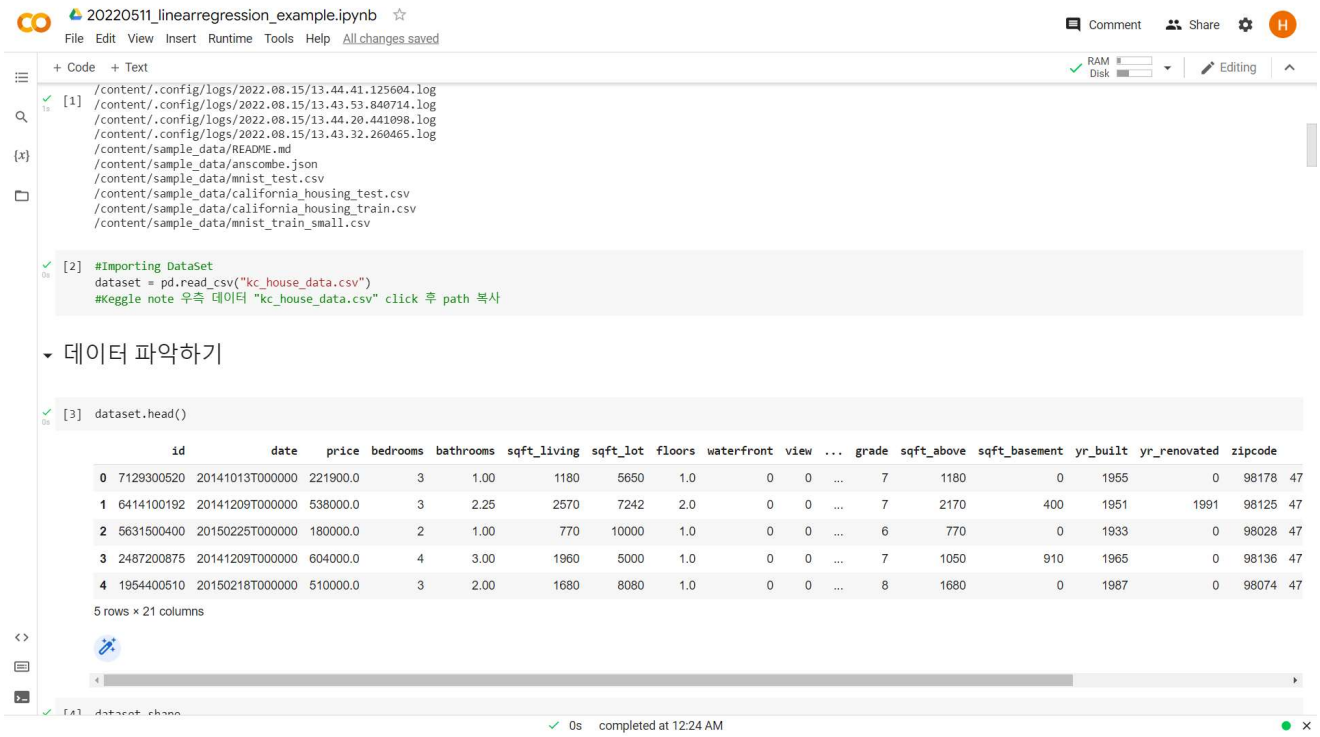
RAM Disk Editing

Data & kaggle_note: https://www.kaggle.com/harlfoxem/housesalesprediction

```
[1] # This Python 3 environment comes with many helpful analytics libraries installed
    # It is defined by the kaggle/python Docker image: https://github.com/kaggle/docker-python
    # For example, here's several helpful packages to load

    import numpy as np # linear algebra
    import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
    import seaborn as sns
    import matplotlib.pyplot as plt
    import statsmodels.api as sm;
    from statsmodels.stats.outliers_influence import variance_inflation_factor
    %matplotlib inline

    # Input data files are available in the read-only "../input/" directory
    # For example, running this (by clicking run or pressing Shift+Enter) will list all files under the input directory

    import os
    for dirname, _, filenames in os.walk('/content/'):
        for filename in filenames:
            print(os.path.join(dirname, filename))

    # You can write up to 20GB to the current directory (/kaggle/working/) that gets preserved as output when you create a version using "Save & Run All"
    # You can also write temporary files to /kaggle/temp/, but they won't be saved outside of the current session
```

```
/content/kc_house_data.csv
/content/.config/gce
/content/.config/config_sentinel
/content/.config/active_config
/content/.config/.last_opt_in_prompt.yaml
/content/.config/.last_survey_prompt.yaml
/content/.config/.last_update_check.json
/content/.config/configurations/config_default
/content/.config/logs/2022.08.15/13.44.40.370262.log
/content/.config/logs/2022.08.15/13.44.12.999341.log
/content/.config/logs/2022.08.15/13.44.41.125604.log
/content/.config/logs/2022.08.15/13.43.53.840714.log
```

0s completed at 12:24 AM



20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share

+ Code + Text

RAM Disk Editing

```
[1] /content/.config/logs/2022.08.15/13.44.41.125604.log
    /content/.config/logs/2022.08.15/13.43.53.840714.log
    /content/.config/logs/2022.08.15/13.44.20.441098.log
    /content/.config/logs/2022.08.15/13.43.32.260465.log
    /content/sample_data/README.md
    /content/sample_data/anscombe.json
    /content/sample_data/mnist_test.csv
    /content/sample_data/california_housing_test.csv
    /content/sample_data/california_housing_train.csv
    /content/sample_data/mnist_train_small.csv
```

```
[2] #Importing DataSet
    dataset = pd.read_csv("kc_house_data.csv")
    #Keggle note 우측 데이터 "kc_house_data.csv" click 후 path 복사
```

데이터 파악하기

```
[3] dataset.head()
```

	id	date	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	...	grade	sqft_above	sqft_basement	yr_built	yr_renovated	zipcode	
0	7129300520	20141013T000000	221900.0	3	1.00	1180	5650	1.0	0	0	...	7	1180	0	1955	0	98178	47
1	6414100192	20141209T000000	538000.0	3	2.25	2570	7242	2.0	0	0	...	7	2170	400	1951	1991	98125	47
2	5631500400	20150225T000000	180000.0	2	1.00	770	10000	1.0	0	0	...	6	770	0	1933	0	98028	47
3	2487200875	20141209T000000	604000.0	4	3.00	1960	5000	1.0	0	0	...	7	1050	910	1965	0	98136	47
4	1954400510	20150218T000000	510000.0	3	2.00	1680	8080	1.0	0	0	...	8	1680	0	1987	0	98074	47

5 rows × 21 columns

0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share H

+ Code + Text

RAM Disk Editing

```
[4] dataset.shape
```

```
(21613, 21)
```

```
[5] dataset.columns
```

```
Index(['id', 'date', 'price', 'bedrooms', 'bathrooms', 'sqft_living',
       'sqft_lot', 'floors', 'waterfront', 'view', 'condition', 'grade',
       'sqft_above', 'sqft_basement', 'yr_built', 'yr_renovated', 'zipcode',
       'lat', 'long', 'sqft_living15', 'sqft_lot15'],
      dtype='object')
```

```
[6] dataset.dtypes
```

```
id               int64
date            object
price          float64
bedrooms         int64
bathrooms      float64
sqft_living      int64
sqft_lot         int64
floors         float64
waterfront       int64
view             int64
condition        int64
grade            int64
sqft_above       int64
sqft_basement    int64
yr_built         int64
yr_renovated     int64
zipcode          int64
lat            float64
long           float64
sqft_living15    int64
sqft_lot15       int64
dtype: object
```

```
[7] dataset.describe()
```

0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share H

+ Code + Text

RAM Disk Editing

[7] dataset.describe()

	id	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	condition	grade	sqft_above	sqft_basement
count	2.161300e+04	2.161300e+04	21613.000000	21613.000000	21613.000000	2.161300e+04	21613.000000	21613.000000	21613.000000	21613.000000	21613.000000	21613.000000	21613.000000
mean	4.580302e+09	5.400881e+05	3.370842	2.114757	2079.899736	1.510697e+04	1.494309	0.007542	0.234303	3.409430	7.656873	1788.390691	291.509045
std	2.876566e+09	3.671272e+05	0.930062	0.770163	918.440897	4.142051e+04	0.539989	0.086517	0.766318	0.650743	1.175459	828.090978	442.575043
min	1.000102e+06	7.500000e+04	0.000000	0.000000	290.000000	5.200000e+02	1.000000	0.000000	0.000000	1.000000	1.000000	290.000000	0.000000
25%	2.123049e+09	3.219500e+05	3.000000	1.750000	1427.000000	5.040000e+03	1.000000	0.000000	0.000000	3.000000	7.000000	1190.000000	0.000000
50%	3.904930e+09	4.500000e+05	3.000000	2.250000	1910.000000	7.618000e+03	1.500000	0.000000	0.000000	3.000000	7.000000	1560.000000	0.000000
75%	7.308900e+09	6.450000e+05	4.000000	2.500000	2550.000000	1.068800e+04	2.000000	0.000000	0.000000	4.000000	8.000000	2210.000000	560.000000
max	9.900000e+09	7.700000e+06	33.000000	8.000000	13540.000000	1.651359e+06	3.500000	1.000000	4.000000	5.000000	13.000000	9410.000000	4820.000000

```
[8] dataset.isnull().sum()
```

```
id             0
date           0
price          0
bedrooms       0
bathrooms      0
sqft_living    0
sqft_lot       0
floors         0
waterfront     0
view           0
condition      0
grade          0
sqft_above     0
sqft_basement  0
yr_built       0
```

0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share H

+ Code + Text

RAM Disk Editing

```
[8] sqft_basement    0
    yr_built         0
    yr_renovated     0
    zipcode          0
    lat              0
    long             0
    sqft_living15    0
    sqft_lot15       0
    dtype: int64
```

```
[9] dataset['bedrooms'].value_counts()

    3     9824
    4     6882
    2     2760
    5     1601
    6      272
    1      199
    7       38
    0       13
    8       13
    9        6
    10       3
    11       1
    33       1
    Name: bedrooms, dtype: int64
```

EDA(Exploratory Data Analysis)

```
[10] fig,axes=plt.subplots(nrows=1,ncols=1,figsize=(15,10))
     sns.countplot(dataset.bedrooms,order=dataset['bedrooms'].value_counts().index)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7fa532a22e10>
```

0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

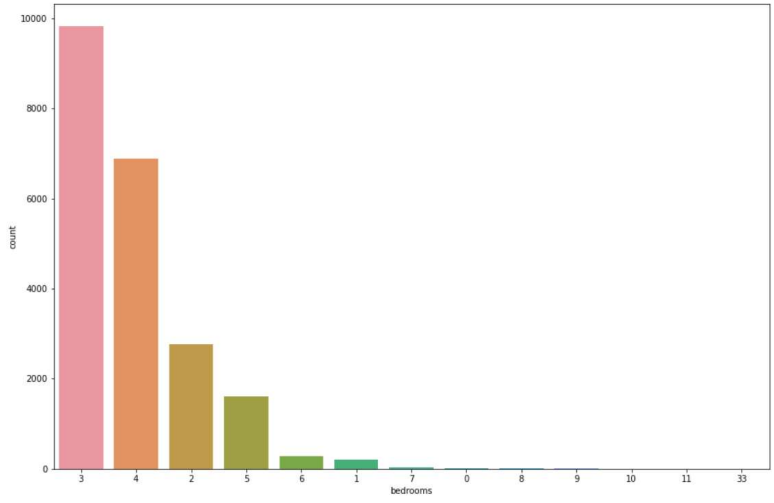
Comment Share H

+ Code + Text

RAM Disk Editing

```
sns.countplot(dataset.bedrooms,order=dataset['bedrooms'].value_counts().index)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument
  FutureWarning
<matplotlib.axes._subplots.AxesSubplot at 0x7fa532a22e10>
```



0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

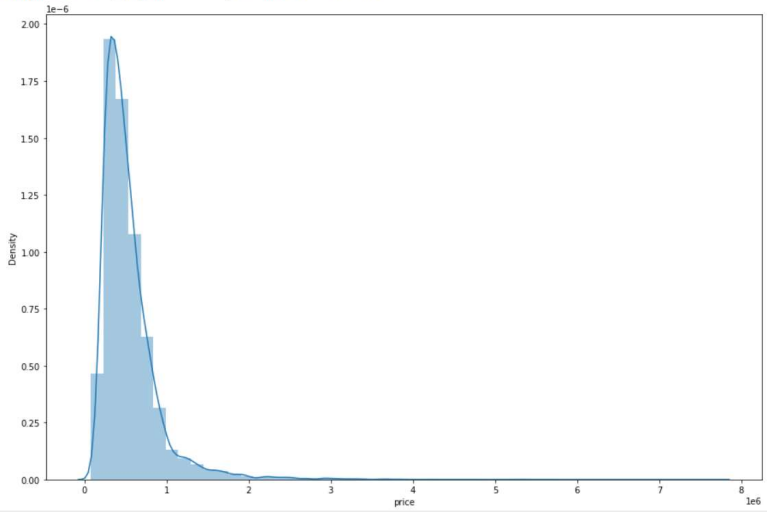
Comment Share H

+ Code + Text

RAM Disk Editing

```
fig,axes=plt.subplots(nrows=1,ncols=1,figsize=(15,10))
sns.distplot(dataset['price'],hist=True,kde=True,rug=False,label='price',norm_hist=True)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code
  warnings.warn(msg, FutureWarning)
<matplotlib.axes._subplots.AxesSubplot at 0x7fa5328d1790>
```



0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share H

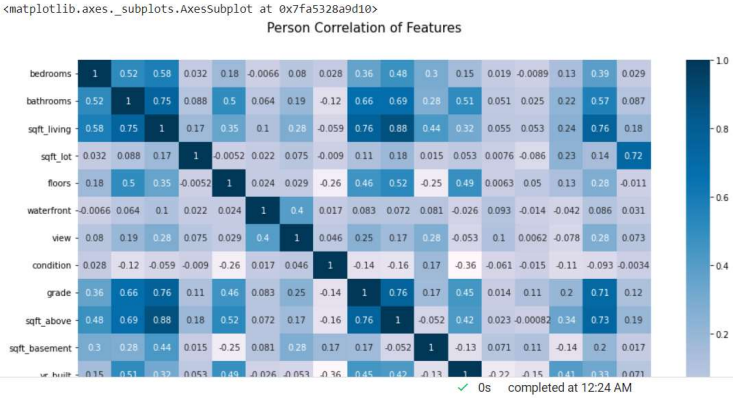
+ Code + Text

RAM Disk Editing

```
[12] variables = dataset[['bedrooms', 'bathrooms', 'sqft_living',
        'sqft_lot', 'floors', 'waterfront', 'view', 'condition', 'grade',
        'sqft_above', 'sqft_basement', 'yr_built', 'yr_renovated',
        'lat', 'long', 'sqft_living15', 'sqft_lot15']]
```

```
[13] colormap = plt.cm.PuBu
     plt.figure(figsize=(15, 10))
     plt.title("Person Correlation of Features", y = 1.05, size = 15)
     sns.heatmap(variables.astype(float).corr(), linecolor = "white", cmap = colormap, annot = True)
               #, linewidths = 0.1, vmax = 1.0, square = True, cmap = colormap,
          #   linecolor = "white", annot = True, annot_kws = {"size" : 16})
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fa5328a9d10>
```



0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

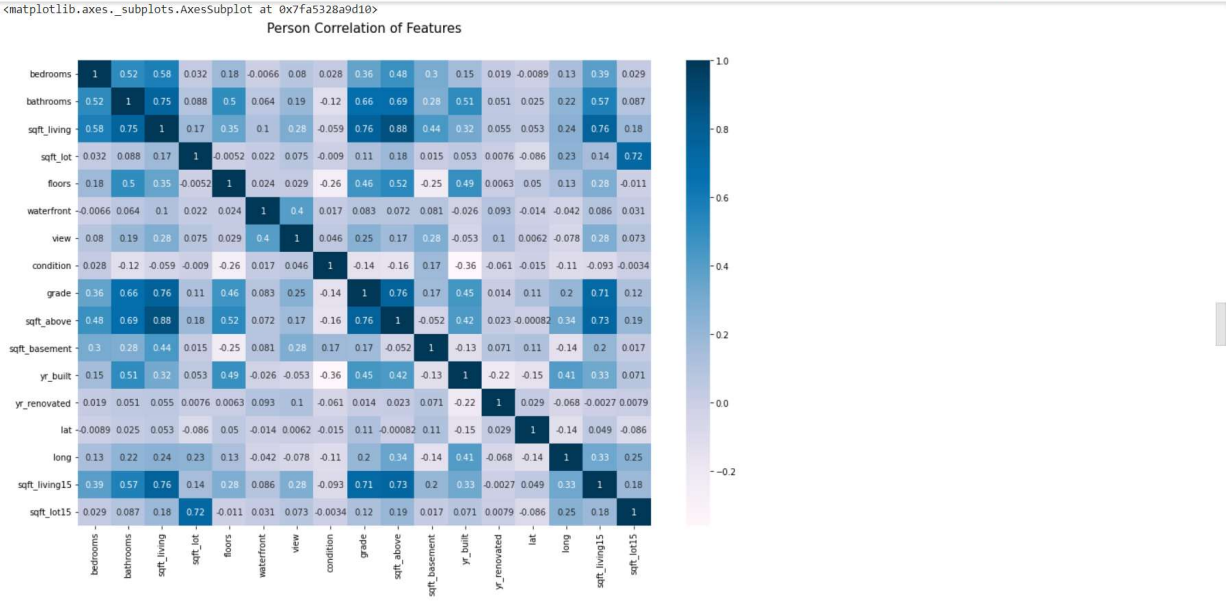
Comment Share H

+ Code + Text

RAM Disk Editing

[13]

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fa5328a9d10>
```



0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share H

+ Code + Text

RAM Disk Editing

- 독립 변수간 상관 관계를 보이는 것을 다중공선성(Multicollinearity)이라 하며, 다중공선성이 있으면 부정확한 회귀 결과가 도출됨
- X는 Y와 상관관계가 높아야 하고 독립변수끼리 상관관계가 없어야 비교적 정확한 결과를 얻을 수 있음
  - 계수 추정이 잘 되지 않거나 불안정해져서 데이터가 약간만 바뀌어도 추정치가 크게 달라질 수 있음
  - 계수가 통계적으로 유의미하지 않은 것처럼 나올 수 있음

다중공선성 변수 제거

[14]

```
#데이터 확인
dataset
```

	id	date	price	bedrooms	bathrooms	sqft_living	sqft_lot	floors	waterfront	view	...	grade	sqft_above	sqft_basement	yr_built	yr_renovated	zipcode
0	7129300520	20141013T000000	221900.0	3	1.00	1180	5650	1.0	0	0	...	7	1180	0	1955	0	98178
1	6414100192	20141209T000000	538000.0	3	2.25	2570	7242	2.0	0	0	...	7	2170	400	1951	1991	98125
2	5631500400	20150225T000000	180000.0	2	1.00	770	10000	1.0	0	0	...	6	770	0	1933	0	98028
3	2487200875	20141209T000000	604000.0	4	3.00	1960	5000	1.0	0	0	...	7	1050	910	1965	0	98136
4	1954400510	20150218T000000	510000.0	3	2.00	1680	8080	1.0	0	0	...	8	1680	0	1987	0	98074
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21608	263000018	20140521T000000	360000.0	3	2.50	1530	1131	3.0	0	0	...	8	1530	0	2009	0	98103
21609	6600060120	20150223T000000	400000.0	4	2.50	2310	5813	2.0	0	0	...	8	2310	0	2014	0	98146
21610	1523300141	20140623T000000	402101.0	2	0.75	1020	1350	2.0	0	0	...	7	1020	0	2009	0	98144
21611	291310100	20150116T000000	400000.0	3	2.50	1600	2388	2.0	0	0	...	8	1600	0	2004	0	98027
21612	1523300157	20141015T000000	325000.0	2	0.75	1020	1076	2.0	0	0	...	7	1020	0	2008	0	98144

21613 rows × 21 columns

0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share H

+ Code + Text

RAM Disk Editing

[15]
```
# bedroom이 종속변수인 price에 영향을 미치는 관계를 구하기 위한 회귀분석 (다른 변수의 영향을 받지 않았을 때)

dataset['intercept'] = 1
pm = sm.OLS(dataset['price'], dataset[['intercept','bedrooms']])
results_p = pm.fit()
results_p.summary()
```

OLS Regression Results

Dep. Variable:	price	**R-squared:**	0.095
Model:	OLS	**Adj. R-squared:**	0.095
Method:	Least Squares	**F-statistic:**	2271.
Date:	Tue, 30 Aug 2022	**Prob (F-statistic):**	0.00
Time:	18:54:36	**Log-Likelihood:**	-3.0652e+05
No. Observations:	21613	**AIC:**	6.131e+05
Df Residuals:	21611	**BIC:**	6.131e+05
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
intercept	1.298e+05	8931.866	14.533	0.000	1.12e+05	1.47e+05
bedrooms	1.217e+05	2554.304	47.651	0.000	1.17e+05	1.27e+05

Omnibus:	18859.406	**Durbin-Watson:**	1.961
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	1199044.960
Skew:	3.904	**Prob(JB):**	0.00
Kurtosis:	38.644	**Cond. No.**	14.2

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

- bedroom이 많을 수록 price가 비싸다는 양의 회귀계수가 도출 됨(다른 변수의 영향을 받지 않았을 때)

[16]
```
'''
#상관관계가 높은 변수를 제거하지 않고 모든 변수를 input으로 사용했을 때(다중공선성 고려 X)
dataset['intercept'] = 1
lm = sm.OLS(dataset['price'], dataset[['bedrooms', 'bathrooms', 'sqft_living',
```

0s completed at 12:24 AM

20220511_linearregression_example.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share H

+ Code + Text

RAM Disk Editing

[16]
```
dataset['intercept'] = 1
lm = sm.OLS(dataset['price'], dataset[['bedrooms', 'bathrooms', 'sqft_living',
       'sqft_lot', 'floors', 'waterfront', 'view', 'condition', 'grade',
       'sqft_above', 'sqft_basement', 'yr_built', 'yr_renovated',
       'lat', 'long', 'sqft_living15', 'sqft_lot15']])
results = lm.fit()
results.summary()
'''
```

```
'\n#상관관계가 높은 변수를 제거하지 않고 모든 변수를 input으로 사용했을 때(다중공선성 고려 X)\ndataset['intercept'] = 1\nlm = sm.OLS(dataset['price'], dataset[['bedrooms', 'bathrooms', 'sqft_living',\n       'sqft_lot', 'floors', 'waterfront', 'view', 'condition', 'grade',\n       'sqft_above', 'sqft_basement', 'yr_built', 'yr_renovated', \n       'lat', 'long', 'sqft_living15', 'sqft_lot15']])\nresults = lm.fit()\nresults.summary()\n'
```

- 변수가 많아질수록 다중공선성의 발생으로 회귀결과가 잘못 도출 될 수 있음
- bedrooms coef = -3.549e+04 : bedroom이 많을 수록 price가 떨어진다는 이상한 결과가 도출됨
- 이처럼 다중공선성이 있다면 회귀 결과를 왜곡하게 됨, 따라서 서로 상관관계가 높은 변수들 중 하나를 제거해야 함

[17]
```
from statsmodels.stats.outliers_influence import variance_inflation_factor
```

[18]
```
'''
pd.DataFrame({'column': column, 'VIF': variance_inflation_factor(lm.exog, i)}
              for i, column in enumerate(lm.exog_names)
              if column != 'Intercept')  # 절편의 VIF는 구하지 않는다.
'''
```

```
'\npd.DataFrame({'column': column, 'VIF': variance_inflation_factor(lm.exog, i)} \n              for i, column in enumerate(lm.exog_names)\n              if column != 'Intercept')  # 절편의 VIF는 구하지 않는다.\n'
```

[19]
```
# 다중공선성을 고려하여 'bathrooms', 'sqft_living', 'sqft_lot', 'sqft_above', 'sqft_living15', 'sqft_lot15'  변수 제거
dataset['intercept'] = 1
lm_re = sm.OLS(dataset['price'], dataset[['bedrooms', 'floors', 'waterfront', 'view', 'condition', 'grade',
       'sqft_basement', 'yr_built', 'yr_renovated', 'lat', 'long']])
results_re = lm_re.fit()
results_re.summary()
```

0s completed at 12:24 AM

```
[19] results_re.summary()
```

OLS Regression Results

Dep. Variable:	price	**R-squared (uncentered):**	0.884
Model:	OLS	**Adj. R-squared (uncentered):**	0.884
Method:	Least Squares	**F-statistic:**	1.495e+04
Date:	Tue, 30 Aug 2022	**Prob (F-statistic):**	0.00
Time:	18:54:43	**Log-Likelihood:**	-2.9678e+05
No. Observations:	21613	**AIC:**	5.936e+05
Df Residuals:	21602	**BIC:**	5.937e+05
Df Model:	11		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
bedrooms	1.995e+04	1833.847	10.879	0.000	1.64e+04	2.35e+04
floors	6.542e+04	3602.554	18.161	0.000	5.84e+04	7.25e+04
waterfront	6.266e+05	1.92e+04	32.683	0.000	5.89e+05	6.64e+05
view	6.134e+04	2321.914	26.416	0.000	5.68e+04	6.59e+04
condition	2.788e+04	2561.926	10.881	0.000	2.29e+04	3.29e+04
grade	1.906e+05	1730.662	110.107	0.000	1.87e+05	1.94e+05
sqft_basement	107.8957	4.056	26.599	0.000	99.945	115.846
yr_built	-2741.4062	66.010	-41.530	0.000	-2870.791	-2612.022
yr_renovated	29.3489	3.982	7.370	0.000	21.544	37.154
lat	4.959e+05	1.1e+04	45.213	0.000	4.74e+05	5.17e+05
long	1.588e+05	4471.649	35.523	0.000	1.5e+05	1.68e+05

Omnibus:	21287.185	**Durbin-Watson:**	1.979
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	3320421.877
Skew:	4.432	**Prob(JB):**	0.00
Kurtosis:	63.071	**Cond. No.**	2.54e+04

Notes:
[1] R^2 is computed without centering (uncentered) since the model does not contain a constant.
[2] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[3] The condition number is large, 2.54e+04. This might indicate that there are
strong multicollinearity or other numerical problems.


```
[19] Notes:
     [1] R² is computed without centering (uncentered) since the model does not contain a constant.
     [2] Standard Errors assume that the covariance matrix of the errors is correctly specified.
     [3] The condition number is large, 2.54e+04. This might indicate that there are
     strong multicollinearity or other numerical problems.
```

```
[20] from sklearn.model_selection import train_test_split
     from sklearn.linear_model import LinearRegression
```

```
[21] X = dataset[['bedrooms', 'floors', 'waterfront', 'view', 'condition', 'grade',
            'sqft_basement', 'yr_built', 'yr_renovated', 'lat', 'long']]
     y = dataset['price']
```

```
[22] # Train, Test set 80:20 분할
     X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=123)
     #Random_state :난수 값을 고정하는 역할
```

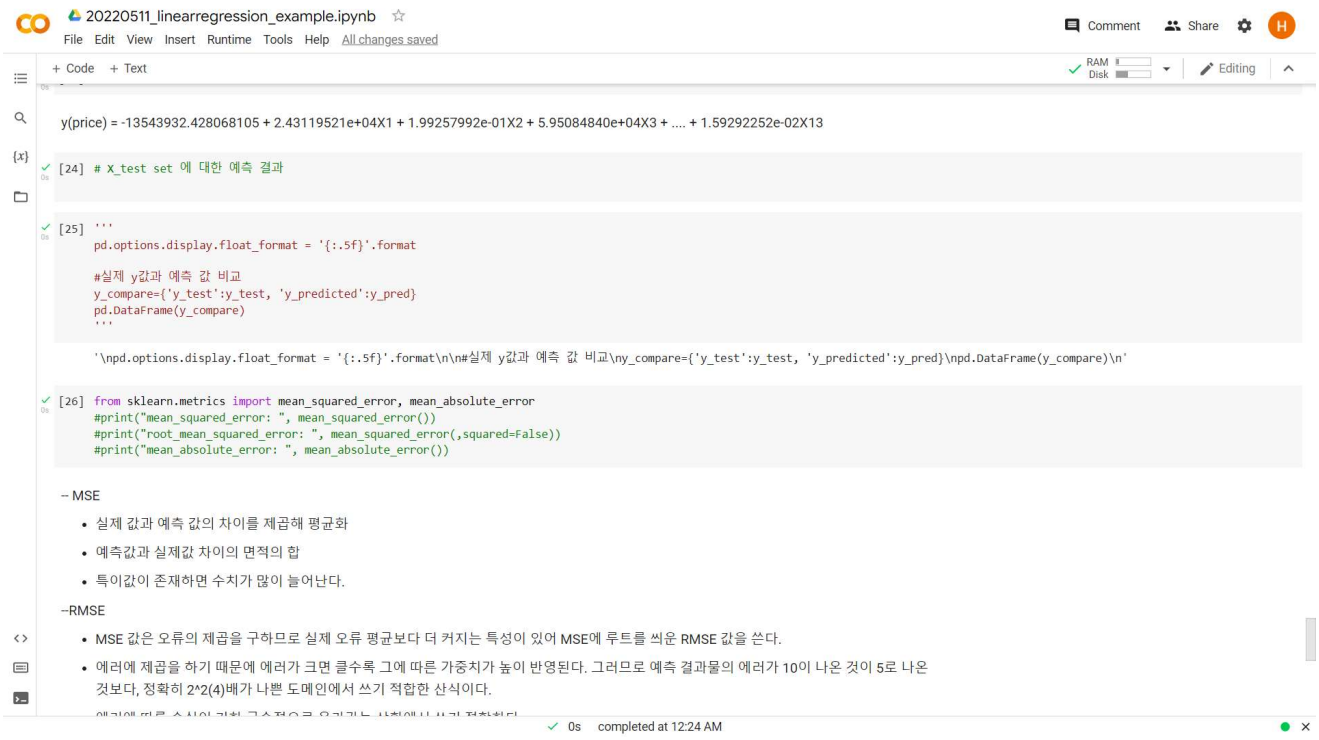
다중 선형회귀모델 학습 및 예측

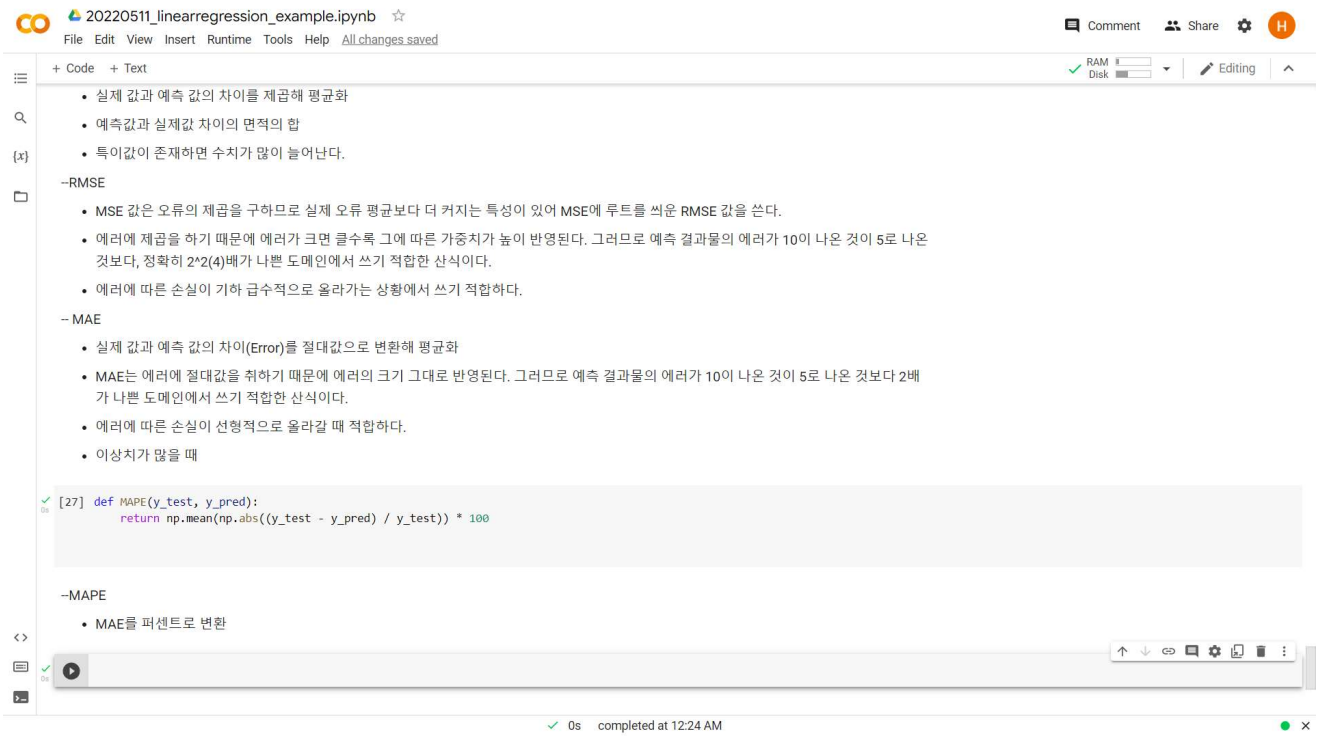
```
[23] # 회귀모델 학습, 적합
```

y(price) = -13543932.428068105 + 2.43119521e+04X1 + 1.99257992e-01X2 + 5.95084840e+04X3 + ... + 1.59292252e-02X13

```
[24] # X_test set 에 대한 예측 결과
```

```
[25] '''
     pd.options.display.float_format = '{:.5f}'.format

     #실제 y값과 예측 값 비교
```





DISCUSSION and CONCLUSION

The multiple regression model has been applied and executed successfully on housing data.

CRITERIA	TOTAL MARKS	MARKS OBTAINED	COMMENTS
Concept (A)	2		
Implementation (B)	2		
Performance (C)	2		
Total	6		