# 국민체육진흥원의 체력100에 따른 개인 맞춤형 건강등급 예측 알고리즘

by F-T AIsland from Tech-IT AI school 9th

## 문화빅데이터 플랫폼에 저장된 체력측정 및 운동처방 종합 데이터를 사용함

데이터 기간 : 2013.03 ~ 2022.12

데이터 출처 : https://www.bigdata-culture.kr/bigdata/user/data_market/detail.do?id=b3924850-aa65-11ec-8ee4-95f65f846b27

```
# 모듈 임포트

import glob
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

# 향후 버전 업에 대한 경고 메시지 출력 안하기
import warnings

warnings.filterwarnings(action='ignore')

from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error, r2_score

from scipy import stats
from statsmodels.formula.api import ols, glm

from prophet import Prophet

from sklearn.tree import DecisionTreeClassifier # 의사결정나무 알고리즘
from sklearn.ensemble import RandomForestClassifier # 랜덤포레스트 알고리즘
from sklearn.linear_model import LogisticRegression # 로지스틱 회귀분석 알고리즘
from sklearn.metrics import accuracy_score

from sklearn.datasets import make_classification
from joblib import dump, load
```

## 정제된 데이터 불러오기

```
# 데이터 불러오기
child = pd.read_csv(r"./data_child_final.csv", parse_dates=['MESURE_DE'])
teen = pd.read_csv(r"./data_teen_final.csv", parse_dates=['MESURE_DE'])
adult = pd.read_csv(r"./data_adult_final.csv", parse_dates=['MESURE_DE'])
elder = pd.read_csv(r"./data_elder_final.csv", parse_dates=['MESURE_DE'])

# 'Unnamed: 0' 제거하기
child.drop(['Unnamed: 0'], axis=1, inplace=True)
teen.drop(['Unnamed: 0'], axis=1, inplace=True)
adult.drop(['Unnamed: 0'], axis=1, inplace=True)
elder.drop(['Unnamed: 0'], axis=1, inplace=True)
```

## 1. 데이터 학습시키기

```
# 학습, 검정용 데이터 분리하기
# 유소년(child) 데이터
# X,Y분할하기
child_y = child['CRTFC_FLAG_NM']
child_x = child.drop(['CNTER_NM', 'AGRDE_FLAG_NM','MESURE_DE', 'CRTFC_FLAG_NM','MVM_PRSCRPTN_CN'], axis=1, inplace=False)
child_x_train, child_x_test, child_y_train, child_y_test = train_test_split(child_x, child_y, test_size=0.2, random_state=0)  # 훈련용, 테스트용 분할

# 청소년(teen) 데이터
# X,Y분할하기
teen_y = teen['CRTFC_FLAG_NM']
teen_x = teen.drop(['CNTER_NM', 'AGRDE_FLAG_NM','MESURE_DE', 'CRTFC_FLAG_NM','MVM_PRSCRPTN_CN'], axis=1, inplace=False)
teen_x_train, teen_x_test, teen_y_train, teen_y_test = train_test_split(teen_x, teen_y, test_size=0.2, random_state=0)  # 훈련용, 테스트용 분할

# 성인(adult) 데이터
# X,Y분할하기
adult_y = adult['CRTFC_FLAG_NM']
adult_x = adult.drop(['CNTER_NM', 'AGRDE_FLAG_NM','MESURE_DE', 'CRTFC_FLAG_NM','MVM_PRSCRPTN_CN'], axis=1, inplace=False)
adult_x_train, adult_x_test, adult_y_train, adult_y_test = train_test_split(adult_x, adult_y, test_size=0.2, random_state=0)  # 훈련용, 테스트용 분할

# 노인(elder) 데이터
elder_y = elder['CRTFC_FLAG_NM']
elder_x = elder.drop(['CNTER_NM', 'AGRDE_FLAG_NM','MESURE_DE', 'CRTFC_FLAG_NM','MVM_PRSCRPTN_CN'], axis=1, inplace=False)
elder_x_train, elder_x_test, elder_y_train, elder_y_test = train_test_split(elder_x, elder_y, test_size=0.2, random_state=0)  # 훈련용, 테스트용 분할


adult.head()
```

| | CNTER_NM | AGRDE_FLAG_NM | MESURE_AGE_CO | CRTFC_FLAG_NM | MESURE_DE | SEXDSTN_FLAG_CD | MESURE_IEM_001_VALUE | MESURE_IEM_002_VALUE |
|---|---|---|---|---|---|---|---|---|
| **0** | 남양주 | 성인 | 32.0 | 3 | 2013-03-05 | 1 | 170.0 | 80.0( |
| **1** | 원주 | 성인 | 44.0 | 4 | 2013-03-05 | 1 | 157.4 | 66.6( |
| **2** | 광산 | 성인 | 42.0 | 4 | 2013-03-05 | 1 | 161.9 | 76.4( |
| **3** | 광산 | 성인 | 27.0 | 4 | 2013-03-05 | 0 | 179.2 | 98.3( |
| **4** | 원주 | 성인 | 55.0 | 4 | 2013-03-05 | 1 | 155.8 | 58.2( |

## sklearn 모델링

- 유소년 데이터 sklearn 선형회귀학습

```
# 선형회귀분석 : 모델 생성
child_lr = LinearRegression()

# 선형회귀분석 : 모델 훈련
child_lr.fit(child_x_train, child_y_train)
```

LinearRegression
LinearRegression()

```
# 선형회귀분석 : 평가 데이터에 대한 예측 수행 -> 예측 결과 Y_predict 구하기
child_y_predict = child_lr.predict(child_x_test)

child_mse = mean_squared_error(child_y_test, child_y_predict)
child_rmse = np.sqrt(child_mse)

print('MSE : {0:.3f}, RMSE : {1:.3f}'.format(child_mse, child_rmse))
print('R^2(Variance score) : {0:.3f}'.format(r2_score(child_y_test, child_y_predict)))

print('Y 절편 값: ',  np.round(child_lr.intercept_, 2))
print('회귀 계수 값: ', np.round(child_lr.coef_, 2))

coef = pd.Series(data=np.round(child_lr.coef_, 2), index=child_x.columns)
coef.sort_values(ascending=False)
```

```
MSE : 0.308, RMSE : 0.555
R^2(Variance score) : 0.391
Y 절편 값:  3.13
회귀 계수 값:  [ 0.08 -0.11  0.   -0.01 -0.02  0.03 -0.01 -0.  ]
MESURE_AGE_CO           0.08
MESURE_IEM_018_VALUE    0.03
MESURE_IEM_001_VALUE    0.00
MESURE_IEM_022_VALUE   -0.00
MESURE_IEM_002_VALUE   -0.01
MESURE_IEM_020_VALUE   -0.01
MESURE_IEM_012_VALUE   -0.02
SEXDSTN_FLAG_CD        -0.11
dtype: float64
```

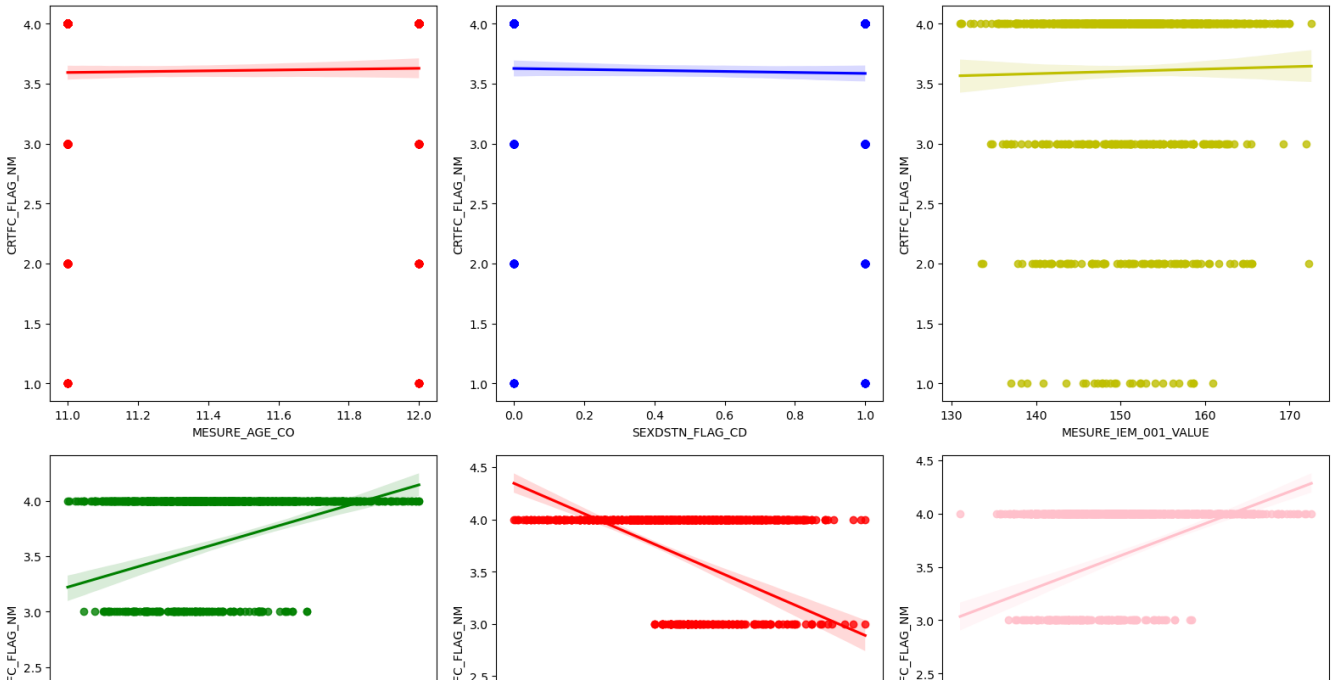
```
# 유소년 데이터에서 무작위로 1000개의 샘플 추출
child_sampled_data = child.sample(n=1000, random_state=42)  # 1000개의 샘플 추출, random_state는 재현성을 위한 시드값

# 선형회귀 그래프 그리기
fig, axs = plt.subplots(figsize=(16, 16), ncols=3, nrows=3)

x_features = ['MESURE_AGE_CO', 'SEXDSTN_FLAG_CD', 'MESURE_IEM_001_VALUE', 'MESURE_IEM_002_VALUE', 'MESURE_IEM_012_VALUE', 'MESURE_IEM_018_VALUE', 'ME
plot_color = ['r', 'b', 'y', 'g', 'r', 'pink', 'black','purple']

for i, feature in enumerate(x_features):
    row = int(i/3)
    col = i%3
    sns.regplot(x=feature, y='CRTFC_FLAG_NM', data=child_sampled_data, ax=axs[row][col], color=plot_color[i])

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




- 청소년 데이터 sklearn 학습

```
# 선형회귀분석 : 모델 생성
teen_lr = LinearRegression()

# 선형회귀분석 : 모델 훈련
teen_lr.fit(teen_x_train, teen_y_train)
```

```
▾ LinearRegression
LinearRegression()
```

```
# 선형회귀분석 : 평가 데이터에 대한 예측 수행 -> 예측 결과 Y_predict 구하기
teen_y_predict = teen_lr.predict(teen_x_test)

teen_mse = mean_squared_error(teen_y_test, teen_y_predict)
teen_rmse = np.sqrt(teen_mse)

print('MSE : {0:.3f}, RMSE : {1:.3f}'.format(teen_mse, teen_rmse))
print('R^2(Variance score) : {0:.3f}'.format(r2_score(teen_y_test, teen_y_predict)))

print('Y 절편 값: ',  np.round(teen_lr.intercept_, 2))
print('회귀 계수 값: ', np.round(teen_lr.coef_, 2))

coef = pd.Series(data=np.round(teen_lr.coef_, 2), index=teen_x.columns)
coef.sort_values(ascending=False)
```

```
MSE : 0.422, RMSE : 0.649
R^2(Variance score) : 0.432
Y 절편 값:  2.68
회귀 계수 값:  [ 0.04 -0.24  0.01 -0.   -0.03  0.04 -0.02 -0.  ]
MESURE_AGE_CO           0.04
MESURE_IEM_018_VALUE    0.04
MESURE_IEM_001_VALUE    0.01
MESURE_IEM_002_VALUE   -0.00
MESURE_IEM_022_VALUE   -0.00
MESURE_IEM_020_VALUE   -0.02
MESURE_IEM_012_VALUE   -0.03
SEXDSTN_FLAG_CD        -0.24
dtype: float64
```

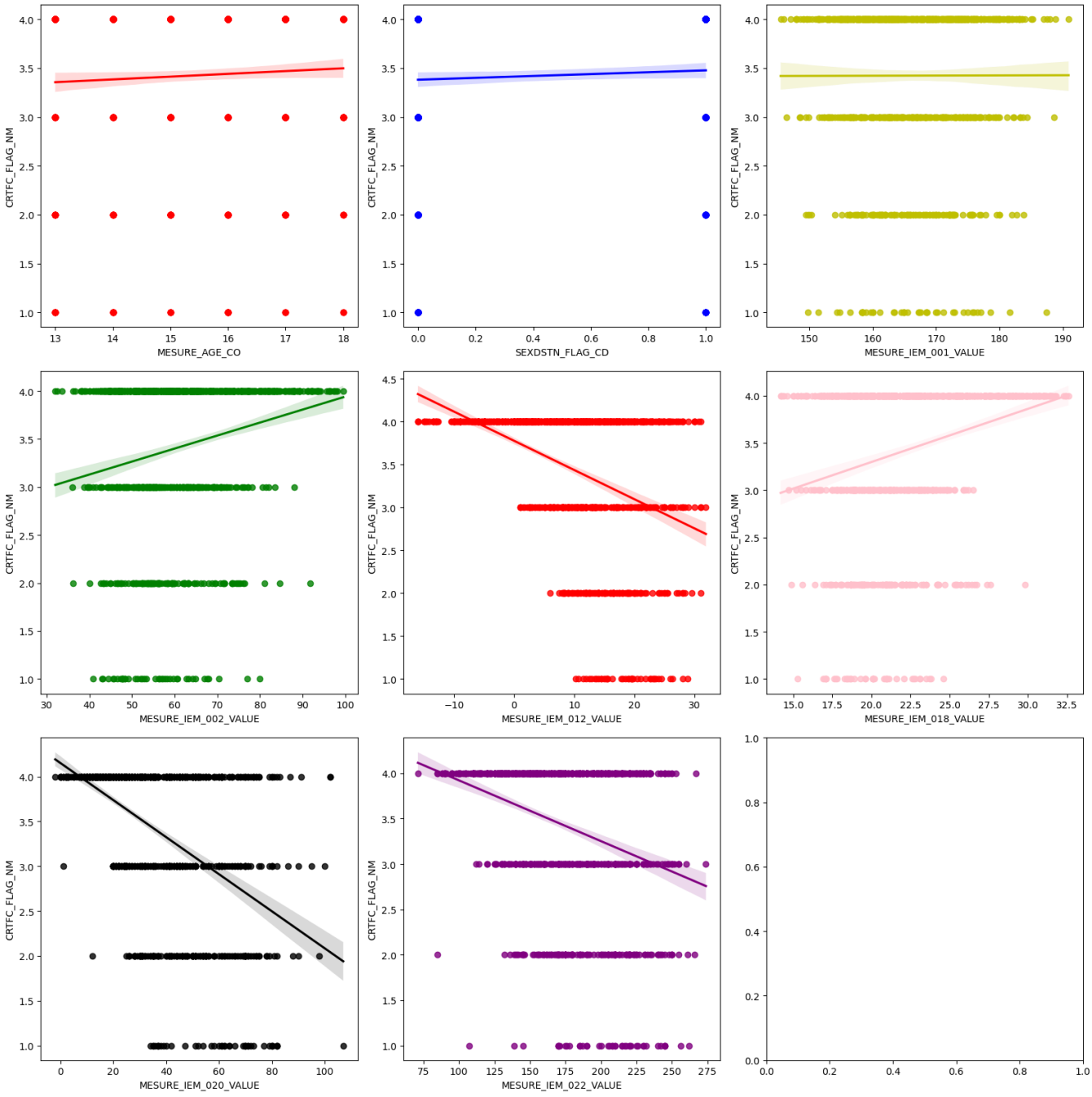
```
# 청소년 데이터에서 무작위로 1000개의 샘플 추출
teen_sampled_data = teen.sample(n=1000, random_state=42)  # 1000개의 샘플 추출, random_state는 재현성을 위한 시드값

# 선형회귀 그래프 그리기
fig, axs = plt.subplots(figsize=(16, 16), ncols=3, nrows=3)

x_features = ['MESURE_AGE_CO', 'SEXDSTN_FLAG_CD', 'MESURE_IEM_001_VALUE', 'MESURE_IEM_002_VALUE', 'MESURE_IEM_012_VALUE', 'MESURE_IEM_018_VALUE', 'ME
plot_color = ['r', 'b', 'y', 'g', 'r', 'pink', 'black','purple']

for i, feature in enumerate(x_features):
    row = int(i/3)
    col = i%3
    sns.regplot(x=feature, y='CRTFC_FLAG_NM', data=teen_sampled_data, ax=axs[row][col], color=plot_color[i])

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



- 성인 데이터 sklearn 학습

```
# 선형회귀분석 : 모델 생성
adult_lr = LinearRegression()

# 선형회귀분석 : 모델 훈련
adult_lr.fit(adult_x_train, adult_y_train)
```

```
▾ LinearRegression
LinearRegression()
```

```
# 선형회귀분석 : 평가 데이터에 대한 예측 수행 -> 예측 결과 Y_predict 구하기
adult_y_predict = adult_lr.predict(adult_x_test)

adult_mse = mean_squared_error(adult_y_test, adult_y_predict)
adult_rmse = np.sqrt(adult_mse)

print('MSE : {0:.3f}, RMSE : {1:.3f}'.format(adult_mse, adult_rmse))
print('R^2(Variance score) : {0:.3f}'.format(r2_score(adult_y_test, adult_y_predict)))

print('Y 절편 값: ',  np.round(adult_lr.intercept_, 2))
print('회귀 계수 값: ', np.round(adult_lr.coef_, 2))

coef = pd.Series(data=np.round(adult_lr.coef_, 2), index=adult_x.columns)
coef.sort_values(ascending=False)
```

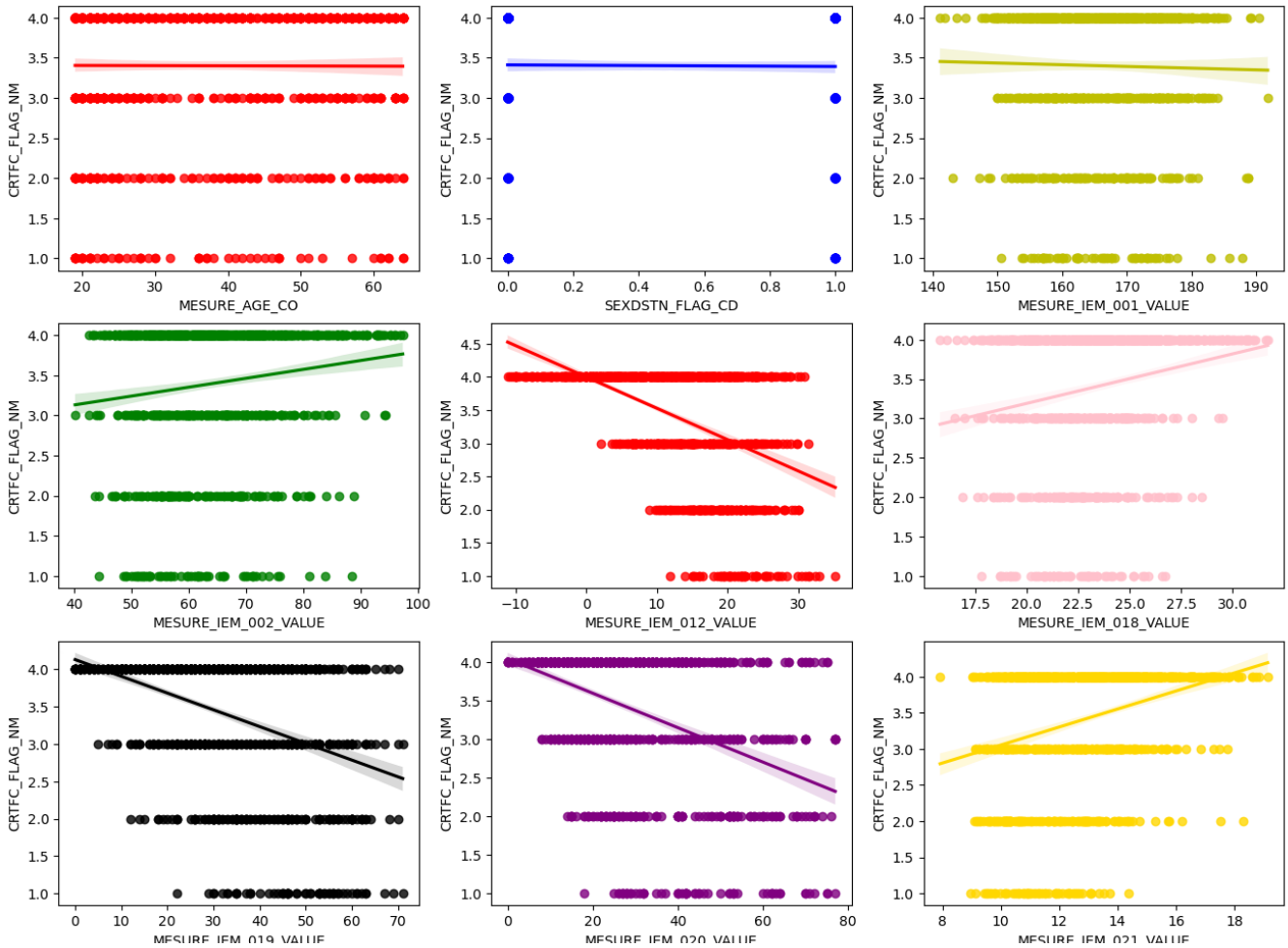
```
MSE : 0.414, RMSE : 0.643
R^2(Variance score) : 0.479
Y 절편 값:  0.35
회귀 계수 값:  [-0.02 -0.5   0.03 -0.03 -0.03  0.13 -0.02 -0.02  0.03 -0.  ]
MESURE_IEM_018_VALUE    0.13
MESURE_IEM_001_VALUE    0.03
MESURE_IEM_021_VALUE    0.03
MESURE_IEM_022_VALUE   -0.00
MESURE_AGE_CO          -0.02
MESURE_IEM_019_VALUE   -0.02
MESURE_IEM_020_VALUE   -0.02
MESURE_IEM_002_VALUE   -0.03
MESURE_IEM_012_VALUE   -0.03
SEXDSTN_FLAG_CD        -0.50
dtype: float64
```

```
# 성인 데이터에서 무작위로 1000개의 샘플 추출
adult_sampled_data = adult.sample(n=1000, random_state=42)  # 1000개의 샘플 추출, random_state는 재현성을 위한 시드값

# 선형회귀 그래프 그리기
fig, axs = plt.subplots(figsize=(16, 16), ncols=3, nrows=4)

x_features = ['MESURE_AGE_CO', 'SEXDSTN_FLAG_CD', 'MESURE_IEM_001_VALUE', 'MESURE_IEM_002_VALUE', 'MESURE_IEM_012_VALUE', 'MESURE_IEM_018_VALUE','MES
plot_color = ['r', 'b', 'y', 'g', 'r', 'pink', 'black','purple', 'gold', 'gray']

for i, feature in enumerate(x_features):
      row = int(i/3)
      col = i%3
      sns.regplot(x=feature, y='CRTFC_FLAG_NM', data=adult_sampled_data, ax=axs[row][col], color=plot_color[i])
```




- 노인데이터 sklearn학습

```
# 선형회귀분석 : 모델 생성
elder_lr = LinearRegression()

# 선형회귀분석 : 모델 훈련
elder_lr.fit(elder_x_train, elder_y_train)
```

```
LinearRegression()
```

```
# 선형회귀분석 : 평가 데이터에 대한 예측 수행 -> 예측 결과 Y_predict 구하기
elder_y_predict = elder_lr.predict(elder_x_test)

elder_mse = mean_squared_error(elder_y_test, elder_y_predict)
elder_rmse = np.sqrt(elder_mse)

print('MSE : {0:.3f}, RMSE : {1:.3f}'.format(elder_mse, elder_rmse))
print('R^2(Variance score) : {0:.3f}'.format(r2_score(elder_y_test, elder_y_predict)))

print('Y 절편 값: ',  np.round(elder_lr.intercept_, 2))
print('회귀 계수 값: ', np.round(elder_lr.coef_, 2))

coef = pd.Series(data=np.round(elder_lr.coef_, 2), index=elder_x.columns)
coef.sort_values(ascending=False)
```

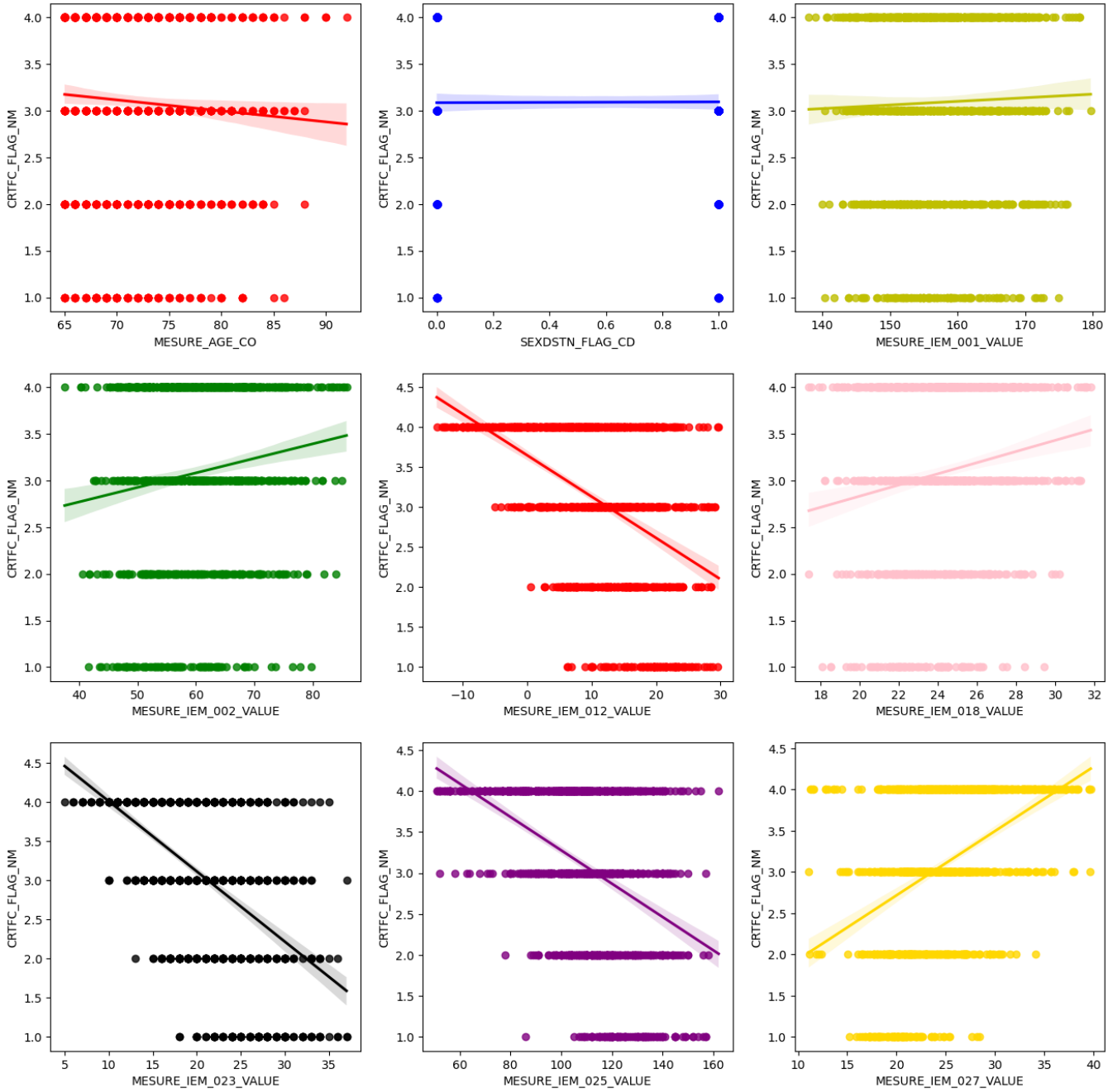
```
MSE : 0.411, RMSE : 0.641
R^2(Variance score) : 0.546
Y 절편 값:  8.54
회귀 계수 값:  [-0.   -0.06  0.21 -0.    0.   -0.05  0.03 -0.04 -0.01  0.04]
SEXDSTN_FLAG_CD          0.21
MESURE_IEM_027_VALUE     0.04
MESURE_IEM_018_VALUE     0.03
Unnamed: 0.1            -0.00
MESURE_IEM_001_VALUE    -0.00
MESURE_IEM_002_VALUE     0.00
MESURE_IEM_025_VALUE    -0.01
MESURE_IEM_023_VALUE    -0.04
MESURE_IEM_012_VALUE    -0.05
MESURE_AGE_CO           -0.06
dtype: float64
```

```
# 선형회귀 그래프 그리기
# 노인 데이터에서 무작위로 1000개의 샘플 추출
elder_sampled_data = elder.sample(n=1000, random_state=42)  # 1000개의 샘플 추출, random_state는 재현성을 위한 시드값


fig, axs = plt.subplots(figsize=(16, 16), ncols=3, nrows=3)

x_features = ['MESURE_AGE_CO', 'SEXDSTN_FLAG_CD', 'MESURE_IEM_001_VALUE', 'MESURE_IEM_002_VALUE', 'MESURE_IEM_012_VALUE', 'MESURE_IEM_018_VALUE', 'ME
plot_color = ['r', 'b', 'y', 'g', 'r', 'pink', 'black','purple', 'gold' ]

for i, feature in enumerate(x_features):
      row = int(i/3)
      col = i%3
      sns.regplot(x=feature, y='CRTFC_FLAG_NM', data=elder_sampled_data, ax=axs[row][col], color=plot_color[i])
```




## ols model 학습

```
# 유소년 데이터 학습
Rformula = 'CRTFC_FLAG_NM ~ MESURE_AGE_CO + SEXDSTN_FLAG_CD + MESURE_IEM_001_VALUE + ₩
            MESURE_IEM_002_VALUE + MESURE_IEM_012_VALUE + MESURE_IEM_018_VALUE + ₩
            MESURE_IEM_020_VALUE + MESURE_IEM_022_VALUE'

child_scipy_lr = ols(Rformula, data = child).fit()
child_scipy_lr.summary()
```

OLS Regression Results

| | | | |
|---|---|---|---|
| **Dep. Variable:** | CRTFC_FLAG_NM | **R-squared:** | 0.387 |
| **Model:** | OLS | **Adj. R-squared:** | 0.387 |
| **Method:** | Least Squares | **F-statistic:** | 2477. |
| **Date:** | Sun, 19 Nov 2023 | **Prob (F-statistic):** | 0.00 |
| **Time:** | 22:21:16 | **Log-Likelihood:** | -25919. |
| **No. Observations:** | 31378 | **AIC:** | 5.186e+04 |
| **Df Residuals:** | 31369 | **BIC:** | 5.193e+04 |
| **Df Model:** | 8 | | |
| **Covariance Type:** | nonrobust | | |

| | coef | std err | t | P>\|t\| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| **Intercept** | 3.0792 | 0.328 | 9.377 | 0.000 | 2.436 | 3.723 |
| **MESURE_AGE_CO** | 0.0804 | 0.007 | 11.056 | 0.000 | 0.066 | 0.095 |
| **SEXDSTN_FLAG_CD** | -0.1085 | 0.008 | -13.933 | 0.000 | -0.124 | -0.093 |
| **MESURE_IEM_001_VALUE** | 0.0044 | 0.002 | 2.050 | 0.040 | 0.000 | 0.009 |
| **MESURE_IEM_002_VALUE** | -0.0063 | 0.003 | -1.854 | 0.064 | -0.013 | 0.000 |
| **MESURE_IEM_012_VALUE** | -0.0231 | 0.000 | -54.492 | 0.000 | -0.024 | -0.022 |
| **MESURE_IEM_018_VALUE** | 0.0292 | 0.008 | 3.687 | 0.000 | 0.014 | 0.045 |
| **MESURE_IEM_020_VALUE** | -0.0123 | 0.000 | -78.681 | 0.000 | -0.013 | -0.012 |
| **MESURE_IEM_022_VALUE** | -0.0034 | 0.000 | -21.424 | 0.000 | -0.004 | -0.003 |

| | | | |
|---|---|---|---|
| **Omnibus:** | 4081.241 | **Durbin-Watson:** | 1.918 |
| **Prob(Omnibus):** | 0.000 | **Jarque-Bera (JB):** | 6761.092 |
| **Skew:** | -0.894 | **Prob(JB):** | 0.00 |
| **Kurtosis:** | 4.406 | **Cond. No.** | 2.35e+04 |

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 2.35e+04. This might indicate that there are
strong multicollinearity or other numerical problems.

```
# 청소년 데이터 학습
Rformula = 'CRTFC_FLAG_NM ~ MESURE_AGE_CO + SEXDSTN_FLAG_CD + MESURE_IEM_001_VALUE + ₩
            MESURE_IEM_002_VALUE + MESURE_IEM_012_VALUE + MESURE_IEM_018_VALUE + ₩
            MESURE_IEM_020_VALUE + MESURE_IEM_022_VALUE'

teen_scipy_lr = ols(Rformula, data = teen).fit()
teen_scipy_lr.summary()
```

OLS Regression Results

| | | | |
|---|---|---|---|
| **Dep. Variable:** | CRTFC_FLAG_NM | **R-squared:** | 0.428 |
| **Model:** | OLS | **Adj. R-squared:** | 0.428 |
| **Method:** | Least Squares | **F-statistic:** | 1.883e+04 |

```
print("R-squared:", teen_scipy_lr.rsquared)
print("Adjusted R-squared:", teen_scipy_lr.rsquared_adj)
print("F-statistic:", teen_scipy_lr.fvalue)
print("p-value:", teen_scipy_lr.f_pvalue)
```

```
R-squared: 0.42783908623708056
Adjusted R-squared: 0.4278163645328855
F-statistic: 18829.533320361694
p-value: 0.0
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **MESURE AGE CO** | 0.0409 | 0.001 | 40.879 | 0.000 | 0.039 | 0.043 |

```
# 성인 데이터 학습
Rformula = 'CRTFC_FLAG_NM ~ MESURE_AGE_CO + SEXDSTN_FLAG_CD + MESURE_IEM_001_VALUE + ₩
            MESURE_IEM_002_VALUE + MESURE_IEM_012_VALUE + MESURE_IEM_018_VALUE + ₩
            MESURE_IEM_019_VALUE + MESURE_IEM_020_VALUE + MESURE_IEM_021_VALUE + MESURE_IEM_022_VALUE'

adult_scipy_lr = ols(Rformula, data = adult).fit()
adult_scipy_lr.summary()
```

OLS Regression Results

| | | | |
|---|---|---|---|
| **Dep. Variable:** | CRTFC_FLAG_NM | **R-squared:** | 0.478 |
| **Model:** | OLS | **Adj. R-squared:** | 0.478 |
| **Method:** | Least Squares | **F-statistic:** | 3.452e+04 |
| **Date:** | Sun, 19 Nov 2023 | **Prob (F-statistic):** | 0.00 |
| **Time:** | 22:21:17 | **Log-Likelihood:** | -3.6929e+05 |
| **No. Observations:** | 377502 | **AIC:** | 7.386e+05 |
| **Df Residuals:** | 377491 | **BIC:** | 7.387e+05 |
| **Df Model:** | 10 | | |
| **Covariance Type:** | nonrobust | | |

| | coef | std err | t | P>\|t\| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| **Intercept** | 0.3526 | 0.162 | 2.174 | 0.030 | 0.035 | 0.671 |
| **MESURE_AGE_CO** | -0.0249 | 9.47e-05 | -262.819 | 0.000 | -0.025 | -0.025 |
| **SEXDSTN_FLAG_CD** | -0.4971 | 0.004 | -118.148 | 0.000 | -0.505 | -0.489 |
| **MESURE_IEM_001_VALUE** | 0.0285 | 0.001 | 29.253 | 0.000 | 0.027 | 0.030 |
| **MESURE_IEM_002_VALUE** | -0.0320 | 0.001 | -26.343 | 0.000 | -0.034 | -0.030 |
| **MESURE_IEM_012_VALUE** | -0.0310 | 0.000 | -223.892 | 0.000 | -0.031 | -0.031 |
| **MESURE_IEM_018_VALUE** | 0.1291 | 0.003 | 38.518 | 0.000 | 0.123 | 0.136 |
| **MESURE_IEM_019_VALUE** | -0.0212 | 0.000 | -180.831 | 0.000 | -0.021 | -0.021 |
| **MESURE_IEM_020_VALUE** | -0.0182 | 9.98e-05 | -182.824 | 0.000 | -0.018 | -0.018 |
| **MESURE_IEM_021_VALUE** | 0.0335 | 0.001 | 34.131 | 0.000 | 0.032 | 0.035 |
| **MESURE_IEM_022_VALUE** | -0.0016 | 5.65e-05 | -29.000 | 0.000 | -0.002 | -0.002 |

| | | | |
|---|---|---|---|
| **Omnibus:** | 10752.122 | **Durbin-Watson:** | 1.839 |
| **Prob(Omnibus):** | 0.000 | **Jarque-Bera (JB):** | 11691.877 |
| **Skew:** | -0.429 | **Prob(JB):** | 0.00 |
| **Kurtosis:** | 3.090 | **Cond. No.** | 3.94e+04 |

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 3.94e+04. This might indicate that there are
strong multicollinearity or other numerical problems.

```
# 노인 데이터 학습
Rformula = 'CRTFC_FLAG_NM ~ MESURE_AGE_CO + SEXDSTN_FLAG_CD + MESURE_IEM_001_VALUE + ₩
            MESURE_IEM_002_VALUE + MESURE_IEM_012_VALUE + MESURE_IEM_018_VALUE + ₩
            MESURE_IEM_023_VALUE + MESURE_IEM_025_VALUE + MESURE_IEM_027_VALUE'

elder_scipy_lr = ols(Rformula, data = elder).fit()
elder_scipy_lr.summary()
```

OLS Regression Results

| | | | |
|---|---|---|---|
| **Dep. Variable:** | CRTFC_FLAG_NM | **R-squared:** | 0.545 |
| **Model:** | OLS | **Adj. R-squared:** | 0.545 |
| **Method:** | Least Squares | **F-statistic:** | 2.630e+04 |
| **Date:** | Sun, 19 Nov 2023 | **Prob (F-statistic):** | 0.00 |
| **Time:** | 22:21:18 | **Log-Likelihood:** | -1.9216e+05 |
| **No. Observations:** | 197270 | **AIC:** | 3.843e+05 |
| **Df Residuals:** | 197260 | **BIC:** | 3.844e+05 |
| **Df Model:** | 9 | | |
| **Covariance Type:** | nonrobust | | |

| | coef | std err | t | P>\|t\| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| **Intercept** | 8.5999 | 0.266 | 32.384 | 0.000 | 8.079 | 9.120 |
| **MESURE_AGE_CO** | -0.0617 | 0.000 | -194.588 | 0.000 | -0.062 | -0.061 |
| **SEXDSTN_FLAG_CD** | 0.2100 | 0.005 | 42.133 | 0.000 | 0.200 | 0.220 |
| **MESURE_IEM_001_VALUE** | -0.0038 | 0.002 | -2.298 | 0.022 | -0.007 | -0.001 |
| **MESURE_IEM_002_VALUE** | 0.0029 | 0.002 | 1.335 | 0.182 | -0.001 | 0.007 |
| **MESURE_IEM_012_VALUE** | -0.0524 | 0.000 | -267.706 | 0.000 | -0.053 | -0.052 |
| **MESURE_IEM_018_VALUE** | 0.0259 | 0.005 | 4.885 | 0.000 | 0.016 | 0.036 |
| **MESURE_IEM_027_VALUE** | 0.0387 | 0.000 | 104.134 | 0.000 | 0.038 | 0.039 |

---

- 유소년 평가

```
child_dt_clf = DecisionTreeClassifier()
child_rf_clf = RandomForestClassifier()
child_lr_clf = LogisticRegression(solver='liblinear')

# sklearn 선형회귀 평가
print('sklearn MSE : {0:.3f}, RMSE : {1:.3f}'.format(child_mse, child_rmse))
print('sklearn R^2(Variance score) : {0:.3f}'.format(r2_score(child_y_test, child_y_predict)))

# spicy 선형회귀 평가
print("R-squared:", child_scipy_lr.rsquared)
print("Spicy Adjusted R-squared:", child_scipy_lr.rsquared_adj)


# DecisionTreeClassifier 학습/예측/평가
child_dt_clf.fit(child_x_train , child_y_train)
child_dt_pred = child_dt_clf.predict(child_x_test)
print('DecisionTreeClassifier 정확도: {0:.4f}'.format(accuracy_score(child_y_test, child_dt_pred)))

# RandomForestClassifier 학습/예측/평가
child_rf_clf.fit(child_x_train , child_y_train)
child_rf_pred = child_rf_clf.predict(child_x_test)
print('RandomForestClassifier 정확도:{0:.4f}'.format(accuracy_score(child_y_test, child_rf_pred)))

# LogisticRegression 학습/예측/평가
child_lr_clf.fit(child_x_train , child_y_train)
child_lr_pred = child_lr_clf.predict(child_x_test)
print('LogisticRegression 정확도: {0:.4f}'.format(accuracy_score(child_y_test, child_lr_pred)))
```

```
sklearn MSE : 0.308, RMSE : 0.555
sklearn R^2(Variance score) : 0.391
R-squared: 0.3871665038512283
Spicy Adjusted R-squared: 0.38701021362937904
DecisionTreeClassifier 정확도: 0.8107
RandomForestClassifier 정확도:0.8437
LogisticRegression 정확도: 0.7699
```

- 청소년 평가

```
teen_dt_clf = DecisionTreeClassifier()
teen_rf_clf = RandomForestClassifier()
teen_lr_clf = LogisticRegression(solver='liblinear')

# sklearn 선형회귀 평가
print('sklearn MSE : {0:.3f}, RMSE : {1:.3f}'.format(teen_mse, child_rmse))
print('sklearn R^2(Variance score) : {0:.3f}'.format(r2_score(teen_y_test, teen_y_predict)))

# spicy 선형회귀 평가
print("R-squared:", teen_scipy_lr.rsquared)
print("Spicy Adjusted R-squared:", teen_scipy_lr.rsquared_adj)


# DecisionTreeClassifier 학습/예측/평가
teen_dt_clf.fit(teen_x_train , teen_y_train)
teen_dt_pred = teen_dt_clf.predict(teen_x_test)
print('DecisionTreeClassifier 정확도: {0:.4f}'.format(accuracy_score(teen_y_test, teen_dt_pred)))

# RandomForestClassifier 학습/예측/평가
teen_rf_clf.fit(teen_x_train , teen_y_train)
teen_rf_pred = teen_rf_clf.predict(teen_x_test)
print('RandomForestClassifier 정확도:{0:.4f}'.format(accuracy_score(teen_y_test, teen_rf_pred)))

# LogisticRegression 학습/예측/평가
teen_lr_clf.fit(teen_x_train , teen_y_train)
teen_lr_pred = teen_lr_clf.predict(teen_x_test)
print('LogisticRegression 정확도: {0:.4f}'.format(accuracy_score(teen_y_test, teen_lr_pred)))
```

```
sklearn MSE : 0.422, RMSE : 0.555
sklearn R^2(Variance score) : 0.432
R-squared: 0.42783908623708056
Spicy Adjusted R-squared: 0.4278163645328855
DecisionTreeClassifier 정확도: 0.7769
RandomForestClassifier 정확도:0.8309
LogisticRegression 정확도: 0.6724
```

- 성인 평가

```
adult_dt_clf = DecisionTreeClassifier()
adult_rf_clf = RandomForestClassifier()
adult_lr_clf = LogisticRegression(solver='liblinear')

# sklearn 선형회귀 평가
print('sklearn MSE : {0:.3f}, RMSE : {1:.3f}'.format(adult_mse, adult_rmse))
print('sklearn R^2(Variance score) : {0:.3f}'.format(r2_score(adult_y_test, adult_y_predict)))

# spicy 선형회귀 평가
print("R-squared:", adult_scipy_lr.rsquared)
print("Spicy Adjusted R-squared:", adult_scipy_lr.rsquared_adj)

# DecisionTreeClassifier 학습/예측/평가
adult_dt_clf.fit(adult_x_train , adult_y_train)
adult_dt_pred = adult_dt_clf.predict(adult_x_test)
print('DecisionTreeClassifier 정확도: {0:.4f}'.format(accuracy_score(adult_y_test, adult_dt_pred)))

# RandomForestClassifier 학습/예측/평가
adult_rf_clf.fit(adult_x_train , adult_y_train)
adult_rf_pred = adult_rf_clf.predict(adult_x_test)
print('RandomForestClassifier 정확도:{0:.4f}'.format(accuracy_score(adult_y_test, adult_rf_pred)))

# LogisticRegression 학습/예측/평가
adult_lr_clf.fit(adult_x_train , adult_y_train)
adult_lr_pred = adult_lr_clf.predict(adult_x_test)
print('LogisticRegression 정확도: {0:.4f}'.format(accuracy_score(adult_y_test, adult_lr_pred)))
```

```
sklearn MSE : 0.414, RMSE : 0.643
sklearn R^2(Variance score) : 0.479
R-squared: 0.4776907501150436
Spicy Adjusted R-squared: 0.47767691377855126
DecisionTreeClassifier 정확도: 0.7861
RandomForestClassifier 정확도:0.8389
LogisticRegression 정확도: 0.6863
```

- 노인 평가

```
elder_dt_clf = DecisionTreeClassifier()
elder_rf_clf = RandomForestClassifier()
elder_lr_clf = LogisticRegression(solver='liblinear')

# sklearn 선형회귀 평가
print('sklearn MSE : {0:.3f}, RMSE : {1:.3f}'.format(elder_mse, elder_rmse))
print('sklearn R^2(Variance score) : {0:.3f}'.format(r2_score(elder_y_test, elder_y_predict)))

# spicy 선형회귀 평가
print("R-squared:", elder_scipy_lr.rsquared)
print("Spicy Adjusted R-squared:", elder_scipy_lr.rsquared_adj)

# DecisionTreeClassifier 학습/예측/평가
elder_dt_clf.fit(elder_x_train , elder_y_train)
elder_dt_pred = elder_dt_clf.predict(elder_x_test)
print('DecisionTreeClassifier 정확도: {0:.4f}'.format(accuracy_score(elder_y_test, elder_dt_pred)))

# RandomForestClassifier 학습/예측/평가
elder_rf_clf.fit(elder_x_train , elder_y_train)
elder_rf_pred = elder_rf_clf.predict(elder_x_test)
print('RandomForestClassifier 정확도:{0:.4f}'.format(accuracy_score(elder_y_test, elder_rf_pred)))

# LogisticRegression 학습/예측/평가
elder_lr_clf.fit(elder_x_train , elder_y_train)
elder_lr_pred = elder_lr_clf.predict(elder_x_test)
print('LogisticRegression 정확도: {0:.4f}'.format(accuracy_score(elder_y_test, elder_lr_pred)))
```

```
sklearn MSE : 0.411, RMSE : 0.641
sklearn R^2(Variance score) : 0.546
R-squared: 0.54540330248968
Spicy Adjusted R-squared: 0.5453825614865491
DecisionTreeClassifier 정확도: 0.7807
RandomForestClassifier 정확도:0.8397
LogisticRegression 정확도: 0.5627
```

---

```
# 모델 저장하기
dump(child_dt_clf, 'child_rf_model.joblib')
dump(teen_dt_clf, 'teen_rf_model.joblib')
dump(adult_dt_clf, 'adult_rf_model.joblib')
dump(elder_dt_clf, 'elder_rf_model.joblib')
```

```
['elder_rf_model.joblib']
```

```
# 모델 불러오기
# loaded_model = load('child_rf_model.joblib')
# loaded_model = load('teen_rf_model.joblib')
# loaded_model = load('adult_rf_model.joblib')
# loaded_model = load('elder_rf_model.joblib')
```

## 모델(랜덤포레스트) 적용하기

```
# # 유소년 사용자에게 데이터 입력받기

# print("유소년이신가요? 운동 등급을 예측하고 싶은 개인의 체력 정보를 입력해주세요.")

# age_1 = float(input("나이를 입력해주세요: "))
# sex_1 = float(input("성별을 숫자로 입력해주세요(남성:0, 여성:1): "))
# height_1 = float(input("키를 입력해주세요: "))
# weight_1 = float(input("몸무게를 입력해주세요: "))
# val12_1 = float(input("앉아윗몸앞으로굽히기(cm) : "))
# val18_1 = (weight_1 / (height_1/100)**2)
# val20_1 = float(input("왕복오래달리기(회): "))
# val22_1 = float(input("제자리 멀리뛰기(cm): "))

# grade_predict = child_rf_clf.predict([[age_1, sex_1, height_1, weight_1, val12_1, val18_1, val20_1, val22_1]])

# print(f"당신의 등급은 {grade_predict}등급입니다.")
```