# 2차원 데이터의 정리

## 두 데이터 사이의 관계를 나타내는 지표

In [1]:

```
import numpy as np
import pandas as pd

%precision 3
pd.set_option('display.float_format','{:,.3f}'.format)
```

In [2]:

```
df = pd.read_csv('scores_em.csv',
                 index_col='student number')
```

In [3]:

```
en_scores = np.array(df['english'])[:10]
ma_scores = np.array(df['mathematics'])[:10]

scores_df = pd.DataFrame({'english':en_scores,
                          'mathematics':ma_scores},
                         index=pd.Index(['A', 'B', 'C', 'D', 'E',
                                         'F', 'G', 'H', 'I', 'J'],
                                        name='student'))
scores_df
```

Out[3]:

| student | english | mathematics |
|---|---|---|
| A | 42 | 65 |
| B | 69 | 80 |
| C | 56 | 63 |
| D | 41 | 63 |
| E | 57 | 76 |
| F | 48 | 60 |
| G | 65 | 81 |
| H | 49 | 66 |
| I | 65 | 78 |
| J | 58 | 82 |

### 공분산

In [4]:

```
summary_df = scores_df.copy()
summary_df['english_deviation'] =₩
    summary_df['english'] - summary_df['english'].mean()
summary_df['mathematics_deviation'] =₩
    summary_df['mathematics'] - summary_df['mathematics'].mean()
summary_df['product of deviations'] =₩
    summary_df['english_deviation'] * summary_df['mathematics_deviation']
summary_df
```

Out[4]:

| student | english | mathematics | english_deviation | mathematics_deviation | product of deviations |
|---|---|---|---|---|---|
| **A** | 42 | 65 | -13.000 | -6.400 | 83.200 |
| **B** | 69 | 80 | 14.000 | 8.600 | 120.400 |
| **C** | 56 | 63 | 1.000 | -8.400 | -8.400 |
| **D** | 41 | 63 | -14.000 | -8.400 | 117.600 |
| **E** | 57 | 76 | 2.000 | 4.600 | 9.200 |
| **F** | 48 | 60 | -7.000 | -11.400 | 79.800 |
| **G** | 65 | 81 | 10.000 | 9.600 | 96.000 |
| **H** | 49 | 66 | -6.000 | -5.400 | 32.400 |
| **I** | 65 | 78 | 10.000 | 6.600 | 66.000 |
| **J** | 58 | 82 | 3.000 | 10.600 | 31.800 |

In [5]:

```
summary_df['product of deviations'].mean()
```

Out[5]:

62.800

In [6]:

```
cov_mat = np.cov(en_scores, ma_scores, ddof=0)
cov_mat
```

Out[6]:

```
array([[86.  , 62.8 ],
       [62.8 , 68.44]])
```

In [7]:

```
cov_mat[0, 1], cov_mat[1, 0]
```

Out[7]:

(62.800, 62.800)

In [8]:

```
cov_mat[0, 0], cov_mat[1, 1]
```

Out[8]:

```
(86.000, 68.440)
```

In [9]:

```
np.var(en_scores, ddof=0), np.var(ma_scores, ddof=0)
```

Out[9]:

```
(86.000, 68.440)
```

### 상관계수

In [10]:

```
np.cov(en_scores, ma_scores, ddof=0)[0, 1] /₩
    (np.std(en_scores) * np.std(ma_scores))
```

Out[10]:

```
0.819
```

In [11]:

```
np.corrcoef(en_scores, ma_scores)
```

Out[11]:

```
array([[1.   , 0.819],
       [0.819, 1.   ]])
```

In [12]:

```
scores_df.corr()
```

Out[12]:

| | english | mathematics |
|---|---|---|
| **english** | 1.000 | 0.819 |
| **mathematics** | 0.819 | 1.000 |

## 2차원 데이터의 시각화

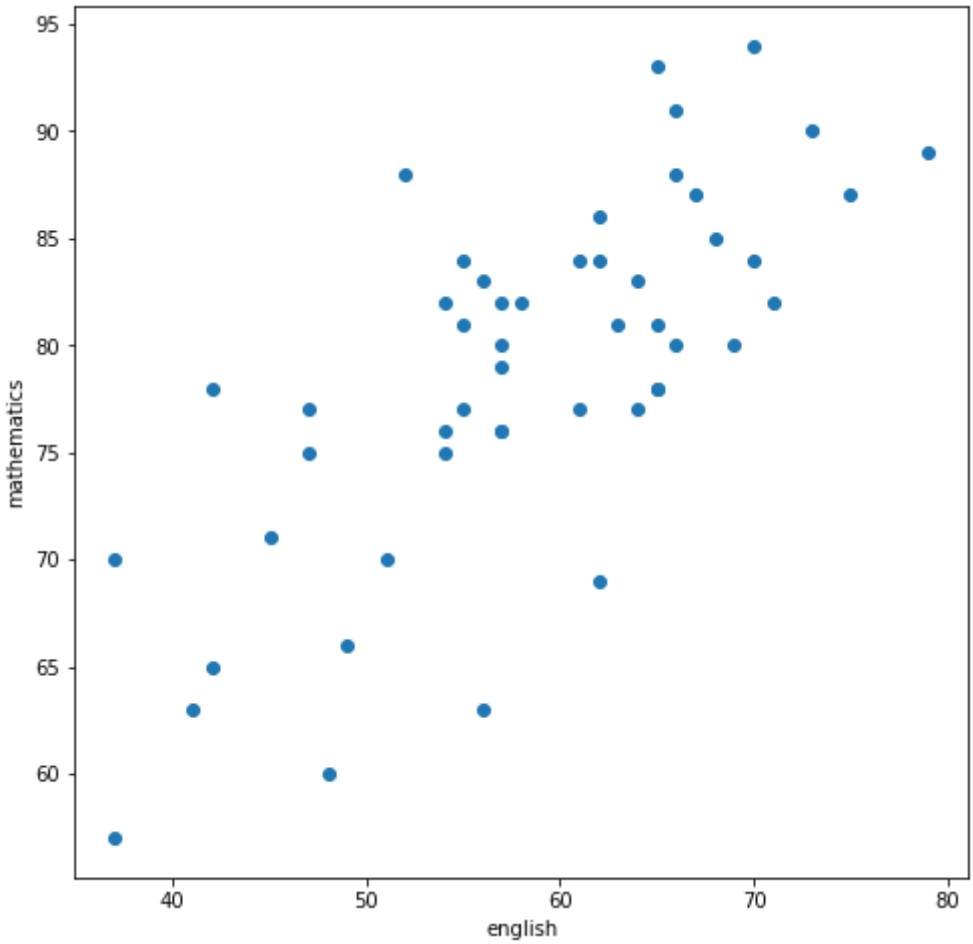
### 산점도

In [13]:

```
import matplotlib.pyplot as plt

%matplotlib inline
```

In [14]:

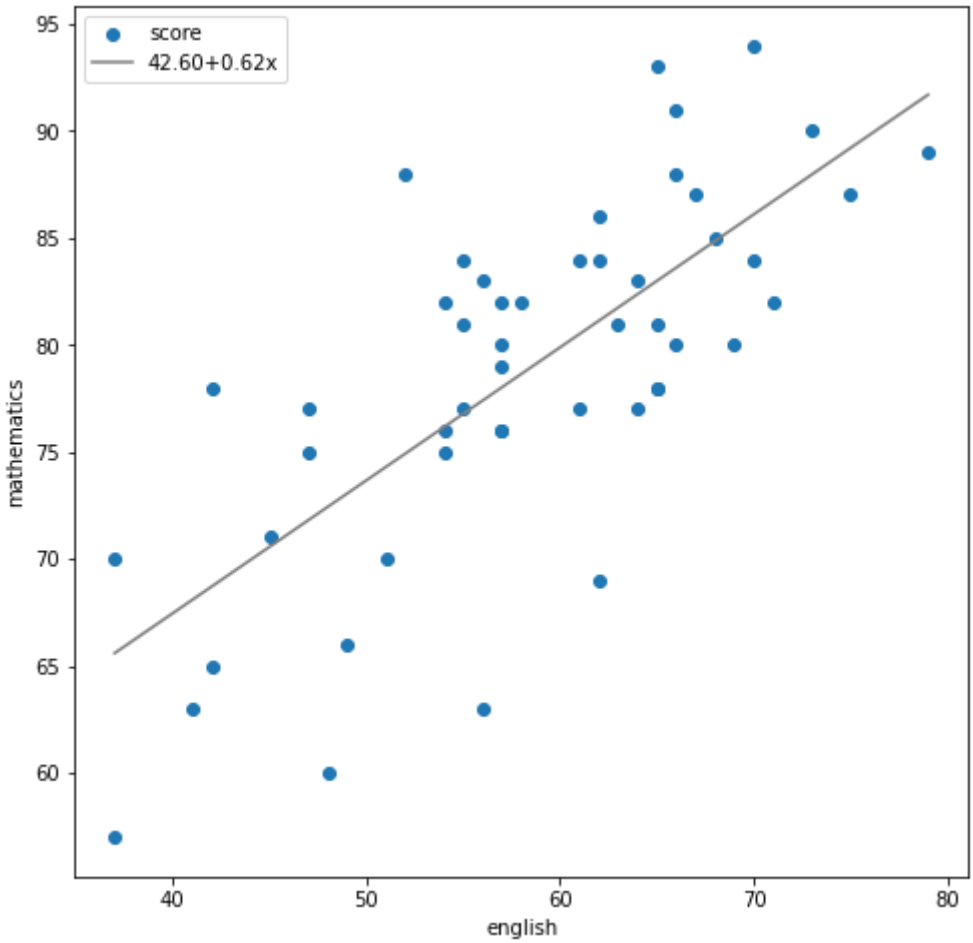
```
english_scores = np.array(df['english'])
math_scores = np.array(df['mathematics'])

fig = plt.figure(figsize=(8, 8))
ax = fig.add_subplot(111)
# 산점도
ax.scatter(english_scores, math_scores)
ax.set_xlabel('english')
ax.set_ylabel('mathematics')

plt.show()
```




## 회귀직선

In [15]:

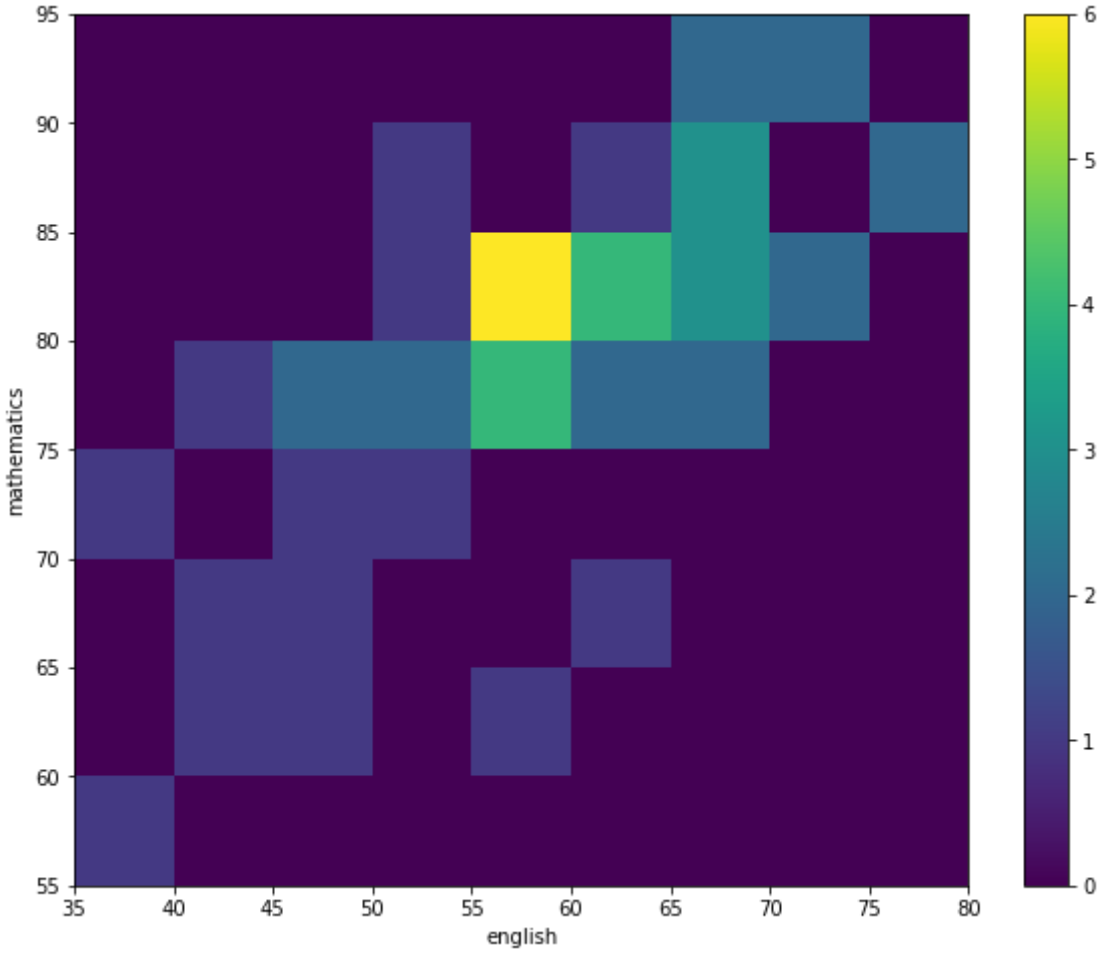
```
# 계수 β_0와 β_1를 구한다
poly_fit = np.polyfit(english_scores, math_scores, 1)
# β_0+β_1 x를 반환하는 함수를 작성
poly_1d = np.poly1d(poly_fit)
# 직선을 그리기 위해 x좌표를 생성
xs = np.linspace(english_scores.min(), english_scores.max())
# xs에 대응하는 y좌표를 구한다
ys = poly_1d(xs)

fig = plt.figure(figsize=(8, 8))
ax = fig.add_subplot(111)
ax.set_xlabel('english')
ax.set_ylabel('mathematics')
ax.scatter(english_scores, math_scores, label='score')
ax.plot(xs, ys, color='gray',
        label=f'{poly_fit[1]:.2f}+{poly_fit[0]:.2f}x')
# 범례의 표시
ax.legend(loc='upper left')

plt.show()
```



## 히트맵

In [16]:

```
fig = plt.figure(figsize=(10, 8))
ax = fig.add_subplot(111)

c = ax.hist2d(english_scores, math_scores,
              bins=[9, 8], range=[(35, 80), (55, 95)])
ax.set_xlabel('english')
ax.set_ylabel('mathematics')
ax.set_xticks(c[1])
ax.set_yticks(c[2])
# 컬러 바의 표시
fig.colorbar(c[3], ax=ax)
plt.show()
```




# 앤스컴의 예

In [17]:

```
# npy 형식으로 저장된 NumPy array를 읽음
anscombe_data = np.load('anscombe.npy')
print(anscombe_data.shape)
anscombe_data[0]
```

```
(4, 11, 2)
```

Out[17]:

```
array([[10.  ,  8.04],
       [ 8.  ,  6.95],
       [13.  ,  7.58],
       [ 9.  ,  8.81],
       [11.  ,  8.33],
       [14.  ,  9.96],
       [ 6.  ,  7.24],
       [ 4.  ,  4.26],
       [12.  , 10.84],
       [ 7.  ,  4.82],
       [ 5.  ,  5.68]])
```

In [18]:

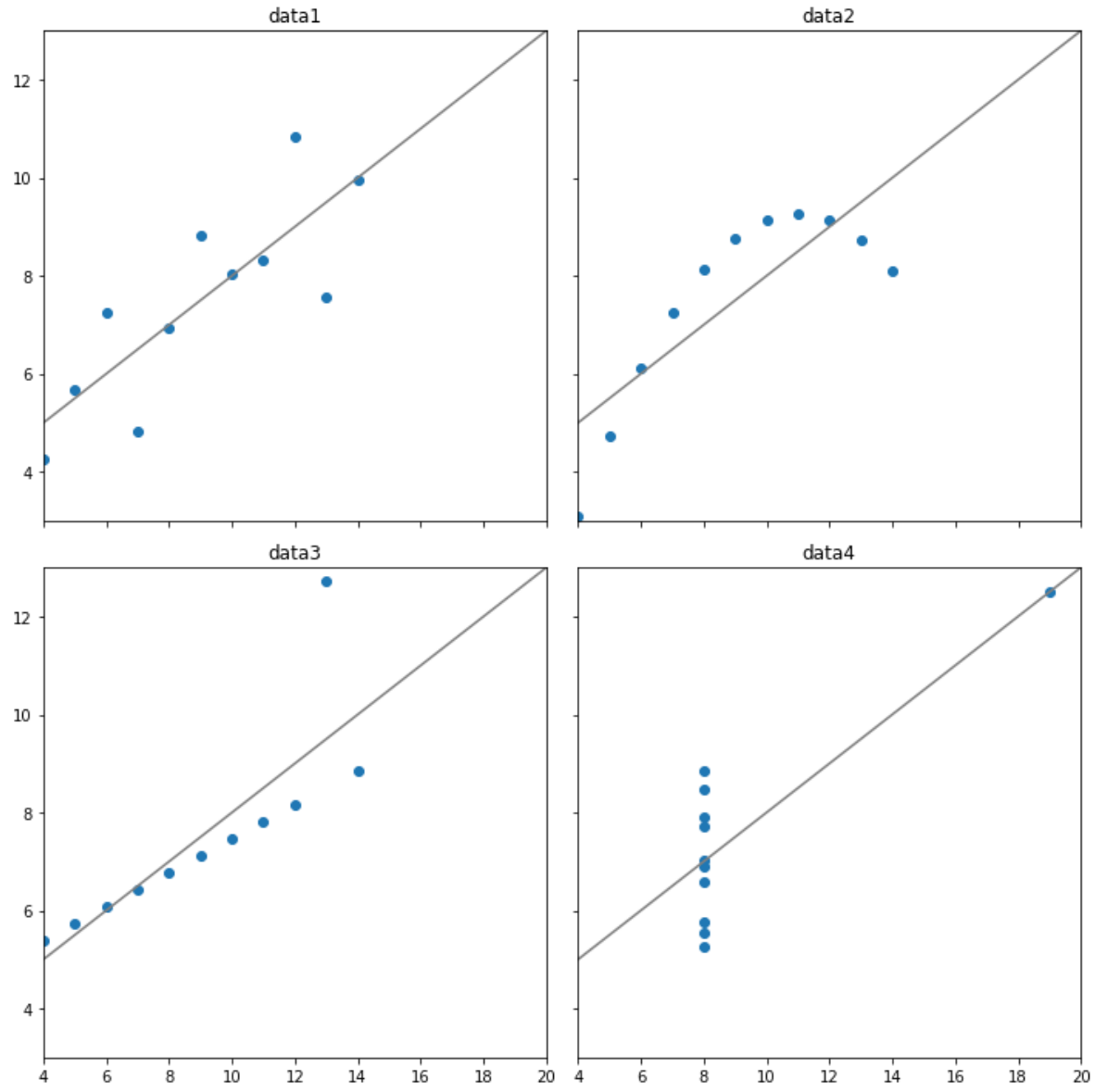
```
stats_df = pd.DataFrame(index=['X_mean', 'X_variance', 'Y_mean',
                               'Y_variance', 'X&Y_correlation',
                               'X&Y_regression line'])
for i, data in enumerate(anscombe_data):
    dataX = data[:, 0]
    dataY = data[:, 1]
    poly_fit = np.polyfit(dataX, dataY, 1)
    stats_df[f'data{i+1}'] =₩
        [f'{np.mean(dataX):.2f}',
         f'{np.var(dataX):.2f}',
         f'{np.mean(dataY):.2f}',
         f'{np.var(dataY):.2f}',
         f'{np.corrcoef(dataX, dataY)[0, 1]:.2f}',
         f'{poly_fit[1]:.2f}+{poly_fit[0]:.2f}x']
stats_df
```

Out[18]:

| | data1 | data2 | data3 | data4 |
|---|---|---|---|---|
| **X_mean** | 9.00 | 9.00 | 9.00 | 9.00 |
| **X_variance** | 10.00 | 10.00 | 10.00 | 10.00 |
| **Y_mean** | 7.50 | 7.50 | 7.50 | 7.50 |
| **Y_variance** | 3.75 | 3.75 | 3.75 | 3.75 |
| **X&Y_correlation** | 0.82 | 0.82 | 0.82 | 0.82 |
| **X&Y_regression line** | 3.00+0.50x | 3.00+0.50x | 3.00+0.50x | 3.00+0.50x |

In [19]:

```
# 그래프를 그리기 위한 영역을 2x2개 생성
fig, axes = plt.subplots(nrows=2, ncols=2, figsize=(10, 10),
                         sharex=True, sharey=True)

xs = np.linspace(0, 30, 100)
for i, data in enumerate(anscombe_data):
    poly_fit = np.polyfit(data[:,0], data[:,1], 1)
    poly_1d = np.poly1d(poly_fit)
    ys = poly_1d(xs)
    # 그리는 영역을 선택
    ax = axes[i//2, i%2]
    ax.set_xlim([4, 20])
    ax.set_ylim([3, 13])
    # 타이틀을 부여
    ax.set_title(f'data{i+1}')
    ax.scatter(data[:,0], data[:,1])
    ax.plot(xs, ys, color='gray')

# 그래프 사이의 간격을 좁힘
plt.tight_layout()
plt.show()
```



In [ ]:

```

```

In [ ]:

```

```

In [ ]:

```

```