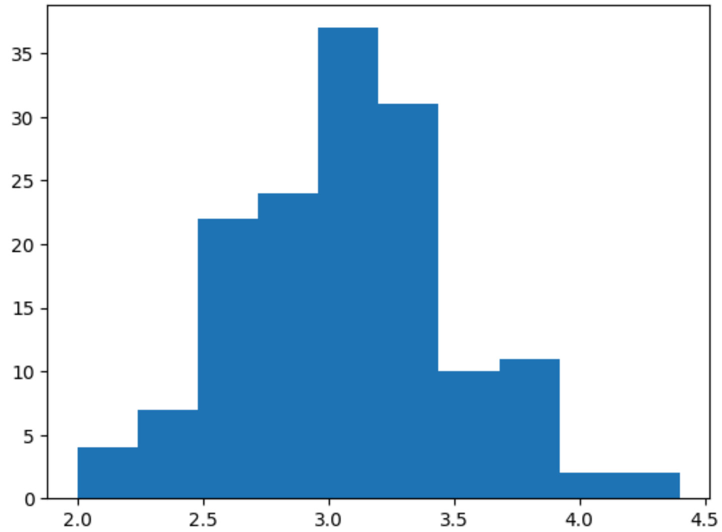
정규성 검정

- 정규 분포를 따르는지 검정

```
import matplotlib.pyplot as plt
import seaborn as sns
df = sns.load_dataset('iris')
plt.hist(df['sepal_width'])
from scipy.stats import shapiro
print(shapiro(df['sepal_width']))
```

```
ShapiroResult(statistic=0.9849168062210083, pvalue=0.10112646222114563)
```



등분산 검정

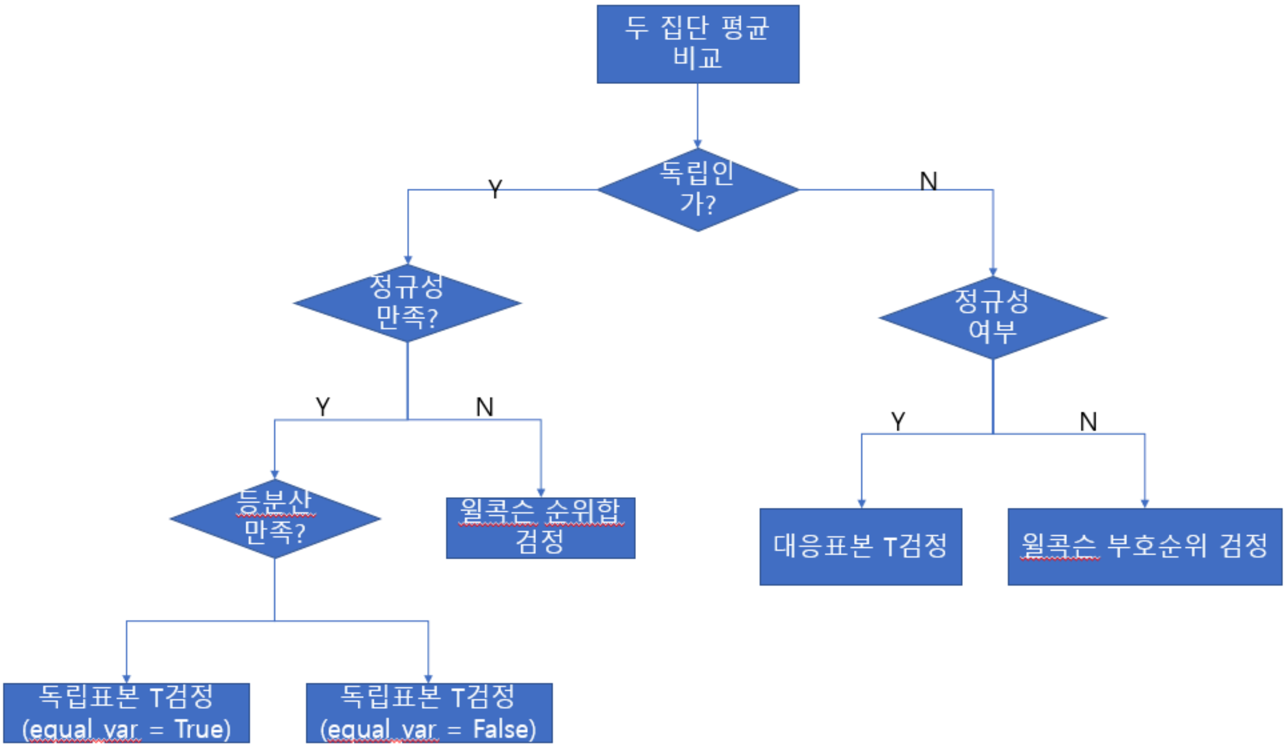
- 각 데이터가 같은 분산을 가지는지(등분산) 검정

```
df
from scipy.stats import bartlett
a = df.loc[df['species'] == 'setosa','sepal_length']
b = df.loc[df['species'] == 'versicolor', 'sepal_length']

bartlett(a,b)
```

```
BartlettResult(statistic=6.891726740802407, pvalue=0.008659557933880048)
```

두 집단 검정



T 검정 (평균값 검정)

가정 : 모집단이 정규분포를 이루고 종속변수가 연속형이다

- 일표본 T검정 (One sample T-Test)
    - 기준이 되는 평균값이 문제에 주어짐
    - 귀무가설(H0) : 모평균과 표본 평균이 같다.(차이가 없다)
    - 대립가설(H1) : 모평균과 표본 평균에 유의미한 차이가 있다.

1) anscombe데이터에서 x의 평균이 8.0점인지 통계적 검정을 수행하라. (단, 유의수준은 0.5)

```
# anscombe 데이터에서 X의 평균이 8.0점인지 통계적 검정을 수행
import seaborn as sns
from scipy.stats import shapiro
from scipy import stats
data = sns.load_dataset('anscombe')
print('shapiro result : ', shapiro(data['x']))

#모평균
mean = 8.0
t_stat , p_value = stats.ttest_1samp(data['x'],mean)
print(p_value)
```

```
shapiro result :  ShapiroResult(statistic=0.9406659603118896, pvalue=0.024983162060379982)
0.044136265559628 19
```

- 이표본 T 검정
    - 독립 T 검정 : 두 개의 독립된 그룹의 평균이 통계적으로 유의미하게 다른지 확인
        - 정규성, 등분산성 검정 필요
    - 대응표본 T검정 : 같은 집단의 두 조건에서의 평균을 비교하기 위해 사용
      1) A 평균 ≠ B 평균 (양측검정)
      2) A 평균 > B 평균 (우단측검정)
      3) A 평균 < B 평균 (좌단측검정)

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 44 entries, 0 to 43
Data columns (total 3 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
```

```
 0   dataset  44 non-null     object
 1   x        44 non-null     float64
 2   y        44 non-null     float64
dtypes: float64(2), object(1)
memory usage: 1.2+ KB
```

```
# 독립 T 검정
t_stat, p_value = stats.ttest_ind(data['x'], data['y'])#  alternative = 'greater' : 우단측 검정 / 'less' : 좌단측 검정

print(p_value)
```

```
0.00954231937757824
```

```
# 대응 표본 T검정

import pandas as pd
from scipy.stats import ttest_rel

data = pd.read_csv('paired_t.csv')

data.head()
t_stat, p_val = ttest_rel(data['Before Treatment'],data['After Treatment'])
print(p_val)
```

```
0.033760144362093514
```

순위합 검정

- 두 독립 표본 간의 차이를 비교하는 비모수적 검정
- 두 집단 간의 위치 차이를 평가하기 위해 순위를 사용.

```
# iris에서 setosa, versicolor의 꽃받침 길이 차이가 통계적으로 유의한지 검정
import seaborn as sns
iris = sns.load_dataset('iris')

setosa_sepal_length = iris.loc[iris['species'] == 'setosa', 'sepal_length']
versicolor_sepal_length = iris.loc[iris['species'] == 'versicolor', 'sepal_length']

from scipy.stats import ranksums
stat, p_value = ranksums(setosa_sepal_length, versicolor_sepal_length)
print(p_value)
```

```
8.941486415112091e-14
```

Anova 테스트

일원분산분석(One-way ANOVA)

- 세 개 이상의 그룹 평균 간의 차이를 검정
- 각 샘플이 독립성, 정규성, 등분산성을 만족하는지 확인 필요

```
import seaborn as sns
data = sns.load_dataset('diamonds')
from scipy import stats
f_stat, p_value = stats.f_oneway(data['x'],data['y'],data['z'])
print(p_value)
```

```
0.0
```

이원배치분산분석

- 두 개의 범주형 독립 변수와 한 개의 연속형 종속 변수 간의 평균차이를 분석하는 통계 방법

```
!pip install pingouin
```

```
Requirement already satisfied: pingouin in /usr/local/lib/python3.10/dist-packages (0.5.4)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from pingouin) (1.25.2)
Requirement already satisfied: scipy in /usr/local/lib/python3.10/dist-packages (from pingouin) (1.11.4)
Requirement already satisfied: pandas>=1.5 in /usr/local/lib/python3.10/dist-packages (from pingouin) (2.0.3)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (from pingouin) (3.7.1)
Requirement already satisfied: seaborn in /usr/local/lib/python3.10/dist-packages (from pingouin) (0.13.1)
Requirement already satisfied: statsmodels in /usr/local/lib/python3.10/dist-packages (from pingouin) (0.14.2)
```

```
Requirement already satisfied: scikit-learn in /usr/local/lib/python3.10/dist-packages (from pingouin) (1.2.2)
Requirement already satisfied: pandas-flavor in /usr/local/lib/python3.10/dist-packages (from pingouin) (0.6.0)
Requirement already satisfied: tabulate in /usr/local/lib/python3.10/dist-packages (from pingouin) (0.9.0)
Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.5->pingouin) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.5->pingouin) (2023.4)
Requirement already satisfied: tzdata>=2022.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.5->pingouin) (2024.1)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pingouin) (1.2.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pingouin) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pingouin) (4.51.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pingouin) (1.4.5)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pingouin) (24.0)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pingouin) (9.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pingouin) (3.1.2)
Requirement already satisfied: xarray in /usr/local/lib/python3.10/dist-packages (from pandas-flavor->pingouin) (2023.7.0)
Requirement already satisfied: joblib>=1.1.1 in /usr/local/lib/python3.10/dist-packages (from scikit-learn->pingouin) (1.4.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn->pingouin) (3.5.0)
Requirement already satisfied: patsy>=0.5.6 in /usr/local/lib/python3.10/dist-packages (from statsmodels->pingouin) (0.5.6)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from patsy>=0.5.6->statsmodels->pingouin) (1.16.0)
```

```
!pip install scikit_posthocs
```

```
Requirement already satisfied: scikit_posthocs in /usr/local/lib/python3.10/dist-packages (0.9.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from scikit_posthocs) (1.25.2)
Requirement already satisfied: scipy>=1.9.0 in /usr/local/lib/python3.10/dist-packages (from scikit_posthocs) (1.11.4)
Requirement already satisfied: statsmodels in /usr/local/lib/python3.10/dist-packages (from scikit_posthocs) (0.14.2)
Requirement already satisfied: pandas>=0.20.0 in /usr/local/lib/python3.10/dist-packages (from scikit_posthocs) (2.0.3)
Requirement already satisfied: seaborn in /usr/local/lib/python3.10/dist-packages (from scikit_posthocs) (0.13.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (from scikit_posthocs) (3.7.1)
Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.10/dist-packages (from pandas>=0.20.0->scikit_posthocs) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=0.20.0->scikit_posthocs) (2023.4)
Requirement already satisfied: tzdata>=2022.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=0.20.0->scikit_posthocs) (2024.1)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->scikit_posthocs) (1.2.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib->scikit_posthocs) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->scikit_posthocs) (4.51.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->scikit_posthocs) (1.4.5)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->scikit_posthocs) (24.0)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->scikit_posthocs) (9.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->scikit_posthocs) (3.1.2)
Requirement already satisfied: patsy>=0.5.6 in /usr/local/lib/python3.10/dist-packages (from statsmodels->scikit_posthocs) (0.5.6)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from patsy>=0.5.6->statsmodels->scikit_posthocs) (1.16.0)
```

```
import pingouin as pg
import scikit_posthocs

# 이원 배치 분산분석 모델
aov = pg.anova(data = data, dv='price', between = ['cut', 'color'], detailed = True)
aov
```

	Source	SS	DF	MS	F	p-unc	np2
0	cut	9.699679e+09	4.0	2.424920e+09	159.356253	7.880786e-136	0.011687
1	color	2.550704e+10	6.0	4.251174e+09	279.370558	0.000000e+00	0.030158
2	cut * color	1.653455e+09	24.0	6.889396e+07	4.527442	1.000780e-12	0.002012
3	Residual	8.202709e+11	53905.0	1.521697e+07	NaN	NaN	NaN

```
posthoc1 = pg.pairwise_tukey(data = data, dv = 'price', between = 'cut')
posthoc1
```

	A	B	mean(A)	mean(B)	diff	se	T	p-tukey	hedges
0	Ideal	Premium	3457.541970	4584.257704	-1126.715734	43.224592	-26.066544	0.000000	-0.279710
1	Ideal	Very Good	3457.541970	3981.759891	-524.217921	45.050188	-11.636309	0.000000	-0.135992
2	Ideal	Good	3457.541970	3928.864452	-471.322481	62.703206	-7.516721	0.000000	-0.124513
3	Ideal	Fair	3457.541970	4358.757764	-901.215794	102.411549	-8.799943	0.000000	-0.237674
4	Premium	Very Good	4584.257704	3981.759891	602.497814	49.393867	12.197826	0.000000	0.144782
5	Premium	Good	4584.257704	3928.864452	655.393253	65.893298	9.946281	0.000000	0.156623
6	Premium	Fair	4584.257704	4358.757764	225.499940	104.395211	2.160060	0.195059	0.052763
7	Very Good	Good	3981.759891	3928.864452	52.895439	67.104998	0.788249	0.934115	0.013688
8	Very Good	Fair	3981.759891	4358.757764	-376.997873	105.164224	-3.584849	0.003112	-0.096819
9	Good	Fair	3928.864452	4358.757764	-429.893312	113.849404	-3.775982	0.001499	-0.117700

```
posthoc2 = pg.pairwise_tukey(data=data, dv = 'price', between = 'color')
posthoc2
```

	A	B	mean(A)	mean(B)	diff	se	T	p-tukey	hedges
0	D	E	3169.954096	3076.752475	93.201621	62.047242	1.502107	0.743743	0.027826
1	D	F	3169.954096	3724.886397	-554.932301	62.385265	-8.895246	0.000000	-0.153574
2	D	G	3169.954096	3999.135671	-829.181575	60.344704	-13.740751	0.000000	-0.217878
3	D	H	3169.954096	4486.669196	-1316.715100	64.287150	-20.481777	0.000000	-0.341665
4	D	I	3169.954096	5091.874954	-1921.920858	71.553080	-26.860072	0.000000	-0.477893
5	D	J	3169.954096	5323.818020	-2153.863924	88.132029	-24.439060	0.000000	-0.581089
6	E	F	3076.752475	3724.886397	-648.133922	56.478996	-11.475663	0.000000	-0.181620
7	E	G	3076.752475	3999.135671	-922.383196	54.216594	-17.012931	0.000000	-0.246661
8	E	H	3076.752475	4486.669196	-1409.916720	58.572975	-24.071113	0.000000	-0.374046
9	E	I	3076.752475	5091.874954	-2015.122479	66.466525	-30.317855	0.000000	-0.517798
10	E	J	3076.752475	5323.818020	-2247.065545	84.054805	-26.733338	0.000000	-0.621285
11	F	G	3724.886397	3999.135671	-274.249274	54.603114	-5.022594	0.000011	-0.069755
12	F	H	3724.886397	4486.669196	-761.782799	58.930930	-12.926706	0.000000	-0.190852
13	F	I	3724.886397	5091.874954	-1366.988557	66.782183	-20.469360	0.000000	-0.329445
14	F	J	3724.886397	5323.818020	-1598.931623	84.304634	-18.966118	0.000000	-0.405487
15	G	H	3999.135671	4486.669196	-487.533524	56.766332	-8.588427	0.000000	-0.118278
16	G	I	3999.135671	5091.874954	-1092.739283	64.880058	-16.842452	0.000000	-0.255277
17	G	J	3999.135671	5323.818020	-1324.682349	82.805998	-15.997420	0.000000	-0.320646
18	H	I	4486.669196	5091.874954	-605.205758	68.562208	-8.827104	0.000000	-0.136826
19	H	J	4486.669196	5323.818020	-837.148824	85.721570	-9.765906	0.000000	-0.195894
20	I	J	5091.874954	5323.818020	-231.943066	91.297279	-2.540526	0.144946	-0.050119

카이제곱 검정

- 독립성 검정 : 두 범주형 변수 간의 독립성을 검정
- 동질성 검정 : 여러 집단이 동일한 분포를 따르는지를 검정
- 적합도 검정 : 관측된 빈도가 기대되는 분포와 얼마나 일치하는지 검정.

```
import seaborn as sns
from scipy.stats import chi2_contingency
import pandas as pd

tips = sns.load_dataset('tips')
chi2, p, dof, expected = chi2_contingency(pd.crosstab(tips['day'],tips['smoker']))
print(p)
#
```

```
1.0567572499836523e-05
```

```
import seaborn as sns
titanic = sns.load_dataset('titanic')
titanic.info()

chi2, p, dof, expected = chi2_contingency(pd.crosstab(titanic['class'],titanic['embarked']))
print(p)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 891 entries, 0 to 890
Data columns (total 15 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   survived     891 non-null    int64
 1   pclass       891 non-null    int64
 2   sex          891 non-null    object
 3   age          714 non-null    float64
 4   sibsp        891 non-null    int64
 5   parch        891 non-null    int64
 6   fare         891 non-null    float64
 7   embarked     889 non-null    object
 8   class        891 non-null    category
 9   who          891 non-null    object
 10  adult_male   891 non-null    bool
 11  deck         203 non-null    category
```

```
 12  embark_town  889 non-null    object
 13  alive        891 non-null    object
 14  alone        891 non-null    bool
dtypes: bool(2), category(2), float64(2), int64(4), object(5)
memory usage: 80.7+ KB
8.435267819894384e-26
```

```
import numpy as np
import scipy.stats as stats

observed = np.array([8,9,10,10,11,12])
expected = np.array([10,10,10,10,10,10])

chi2, p = stats.chisquare(f_obs = observed, f_exp = expected)
print(p)
```

```
0.9625657732472964
```