ANOVA_test

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1 ANOVA

Analysis of Variance

[ ]:
```
# Import Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

[ ]:
```
# Data thon k jo data tha us me sy 30000 sample lea hain taki as a real dataset␣
↪is pay kam kr skain
data = pd.read_csv('Sample.csv')
data.head()
```

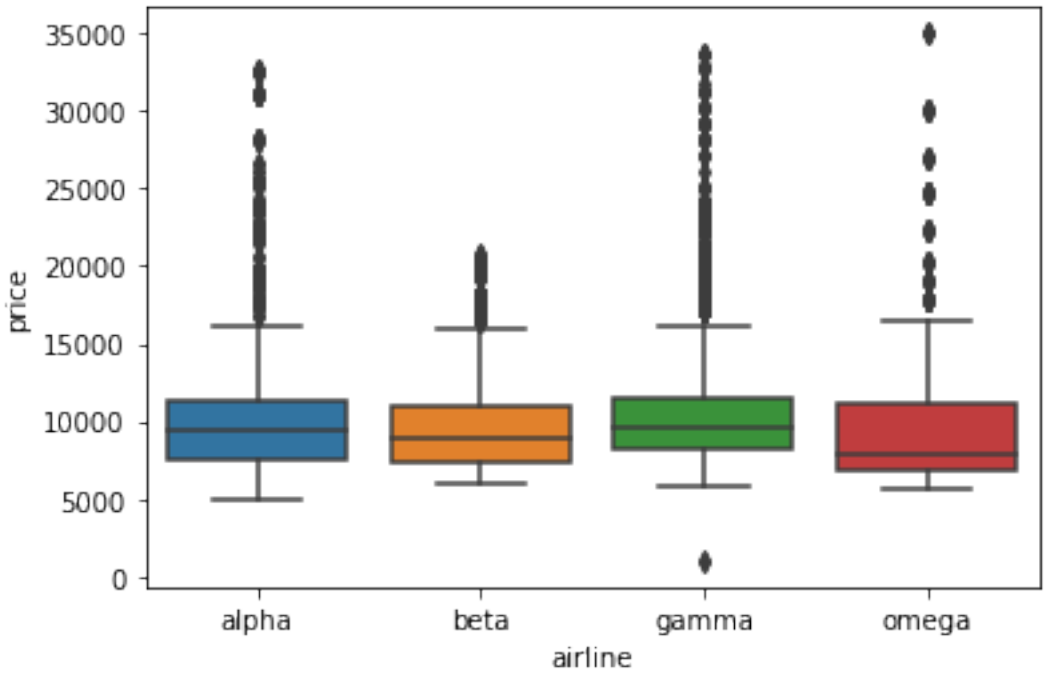
[ ]:
```
   purchase_days_before_daprture airline  baggage_weight  baggage_pieces  \
0                              0   alpha        0.000000               0
1                              4    beta        0.444444               0
2                              2    beta        0.444444               0
3                             12    beta        0.888889               0
4                             17   gamma        0.444444               1

     price
0   8739.0
1  10088.0
2   7350.0
3   9684.0
4   7765.0
```

[ ]:
```
sns.boxplot('airline', 'price', data = data) # Comparison between categorical␣
↪classes
```

```
C:\Users\Sartaj\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variables as keyword args: x, y. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```

[ ]: <AxesSubplot:xlabel='airline', ylabel='price'>



[ ]:
```
data.describe()
```

[ ]:

	purchase_days_before_daprture	baggage_weight	baggage_pieces	\
count	30000.000000	30000.000000	30000.000000	
mean	15.589133	0.505014	0.947567	
std	18.949462	0.197538	0.605444	
min	0.000000	0.000000	0.000000	
25%	4.000000	0.444444	1.000000	
50%	10.000000	0.444444	1.000000	
75%	20.000000	0.711111	1.000000	
max	279.000000	1.000000	2.000000	

	price
count	30000.000000
mean	10148.610833
std	3455.986201

```
min      1000.000000
25%      7796.000000
50%      9403.000000
75%     11245.000000
max     35000.000000
```

[ ]:
```
# Stats
import statsmodels.api as sm
from statsmodels.formula.api import ols
```

[ ]:
```
# One Way ANOVA
mod = ols('price ~ airline', data = data).fit()
```

1.0.1 Anova test k 3 types hain 1,2,3 so is me jo type likhty hain hm wo anova k type ko zahir krta hai k kis type ko use krna hai hm ny or ya sum of squares ko count krny k different ways hain .

[ ]:
```
aov_table = sm.stats.anova_lm(mod, type=2)
print(aov_table)
```

```
                df        sum_sq       mean_sq           F        PR(>F)
airline        3.0  2.134842e+09  7.116141e+08  59.931129  1.274495e-38
Residual   29996.0  3.561684e+11  1.187386e+07         NaN           NaN
```

[ ]:
```
# Pair wise comparison
pair_t = mod.t_test_pairwise('airline', method='bonferroni')
pair_t.result_frame
```

[ ]:
```
                    coef     std err          t         P>|t|  Conf. Int. Low  \
beta-alpha  -504.093699   55.248662  -9.124089  7.674131e-20     -612.383456
gamma-alpha  264.595854   45.223074   5.850904  4.939824e-09      175.956681
omega-alpha  -57.626088  116.863942  -0.493104  6.219427e-01     -286.684449
gamma-beta   768.689553   57.366743  13.399568  7.971448e-41      656.248265
omega-beta   446.467611  122.077835   3.657237  2.553843e-04      207.189796
omega-gamma -322.221942  117.880065  -2.733473  6.270705e-03     -553.271946

             Conf. Int. Upp.  pvalue-bonferroni  reject-bonferroni
beta-alpha       -395.803942       4.604478e-19               True
gamma-alpha       353.235027       2.963894e-08               True
omega-alpha       171.432273       1.000000e+00              False
gamma-beta        881.130840       4.782869e-40               True
omega-beta        685.745427       1.532306e-03               True
omega-gamma       -91.171937       3.762423e-02               True
```

[ ]:
```
# Pair wise comparison
pair_t = mod.t_test_pairwise('airline', method='sidak')
pair_t.result_frame
```

[ ]:
```
                    coef     std err          t         P>|t|  Conf. Int. Low  \
beta-alpha  -504.093699   55.248662  -9.124089  7.674131e-20     -612.383456
gamma-alpha  264.595854   45.223074   5.850904  4.939824e-09      175.956681
omega-alpha  -57.626088  116.863942  -0.493104  6.219427e-01     -286.684449
gamma-beta   768.689553   57.366743  13.399568  7.971448e-41      656.248265
omega-beta   446.467611  122.077835   3.657237  2.553843e-04      207.189796
omega-gamma -322.221942  117.880065  -2.733473  6.270705e-03     -553.271946

             Conf. Int. Upp.  pvalue-sidak  reject-sidak
beta-alpha       -395.803942  4.604478e-19          True
gamma-alpha       353.235027  2.963894e-08          True
omega-alpha       171.432273  9.970802e-01         False
gamma-beta        881.130840  4.782869e-40          True
omega-beta        685.745427  1.531328e-03          True
omega-gamma       -91.171937  3.703931e-02          True
```

[ ]:
```
# Tucky HSD test
import pingouin as pg
# First calculate anova table
aov = pg.anova(data = data , dv = 'price', between='airline', detailed=True)
print(aov)
```

```
    Source            SS     DF            MS          F         p-unc  \
0  airline  2.134842e+09      3  7.116141e+08  59.931129  1.274495e-38
1   Within  3.561684e+11  29996  1.187386e+07        NaN           NaN

        np2
0  0.005958
1       NaN
```

[ ]:
```
# Tuckey test
pt = pg.pairwise_tukey(data = data , dv = 'price', between='airline')
print(pt)
```

```
       A      B       mean(A)       mean(B)        diff          se  \
0  alpha   beta  10151.518676   9647.424977  504.093699   55.248662
1  alpha  gamma  10151.518676  10416.114530 -264.595854   45.223074
2  alpha  omega  10151.518676  10093.892589   57.626088  116.863942
3   beta  gamma   9647.424977  10416.114530 -768.689553   57.366743
4   beta  omega   9647.424977  10093.892589 -446.467611  122.077835
5  gamma  omega  10416.114530  10093.892589  322.221942  117.880065

           T       p-tukey    hedges
0   9.124089  8.140155e-12  0.146284
1  -5.850904  2.961488e-08 -0.076784
2   0.493104  9.606526e-01  0.016722
3 -13.399568  8.140155e-12 -0.223067
4  -3.657237  1.457173e-03 -0.129552
```

```
5    2.733473   3.184140e-02   0.093504
```

[ ]:
```
pvalues =pt['p-tukey']
formated_pvalues =[f'p={pvalue:.2e}' for pvalue in pvalues]
```

[ ]:
```
formated_pvalues
```

[ ]:
```
['p=8.14e-12',
 'p=2.96e-08',
 'p=9.61e-01',
 'p=8.14e-12',
 'p=1.46e-03',
 'p=3.18e-02']
```

[ ]:
```
from statannotations.Annotator import Annotator
plotting_parameters = {
    'data':    data,
    'x':       'airline',
    'y':       'price',

}

pairs = [('alpha', 'beta'),
         ('alpha', 'gamma'),
         ('alpha', 'omega'),
         ('beta', 'gamma'),
         ('beta', 'omega'),
         ('gamma', 'omega')]
```

[ ]:
```
with sns.plotting_context('notebook', font_scale = 1.4):
    # Create new plot
    ax = sns.boxplot('airline', 'price', data = data)

    # Plot with seaborn
    sns.boxplot(**plotting_parameters)

    # Add annotations
    annotator = Annotator(ax, pairs, **plotting_parameters)
    annotator.set_custom_annotations(formated_pvalues)
    annotator.annotate()

    # Label and show

    plt.show()
```

```
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```

```
arguments without an explicit keyword will result in an error or
misinterpretation.
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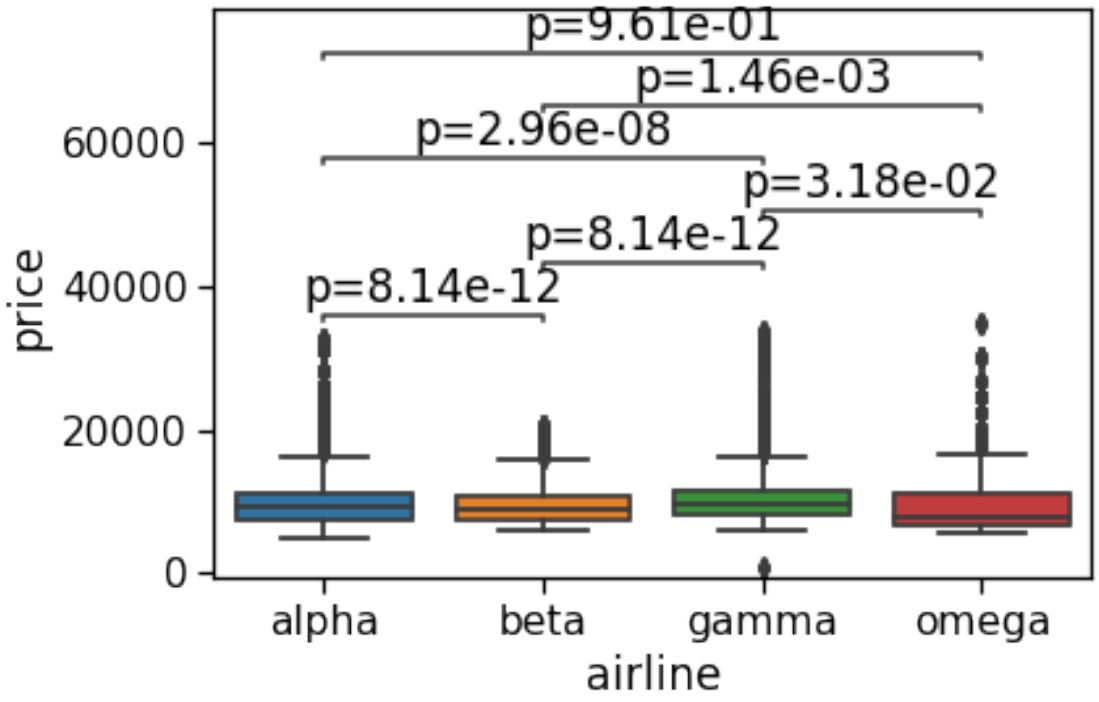
p-value annotation legend:
      ns: p <= 1.00e+00
       *: 1.00e-02 < p <= 5.00e-02
      **: 1.00e-03 < p <= 1.00e-02
     ***: 1.00e-04 < p <= 1.00e-03
    ****: p <= 1.00e-04

alpha vs. beta: p=8.14e-12
beta vs. gamma: p=8.14e-12
gamma vs. omega: p=3.18e-02
alpha vs. gamma: p=2.96e-08
beta vs. omega: p=1.46e-03
alpha vs. omega: p=9.61e-01
```



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```
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```
p-value annotation legend:
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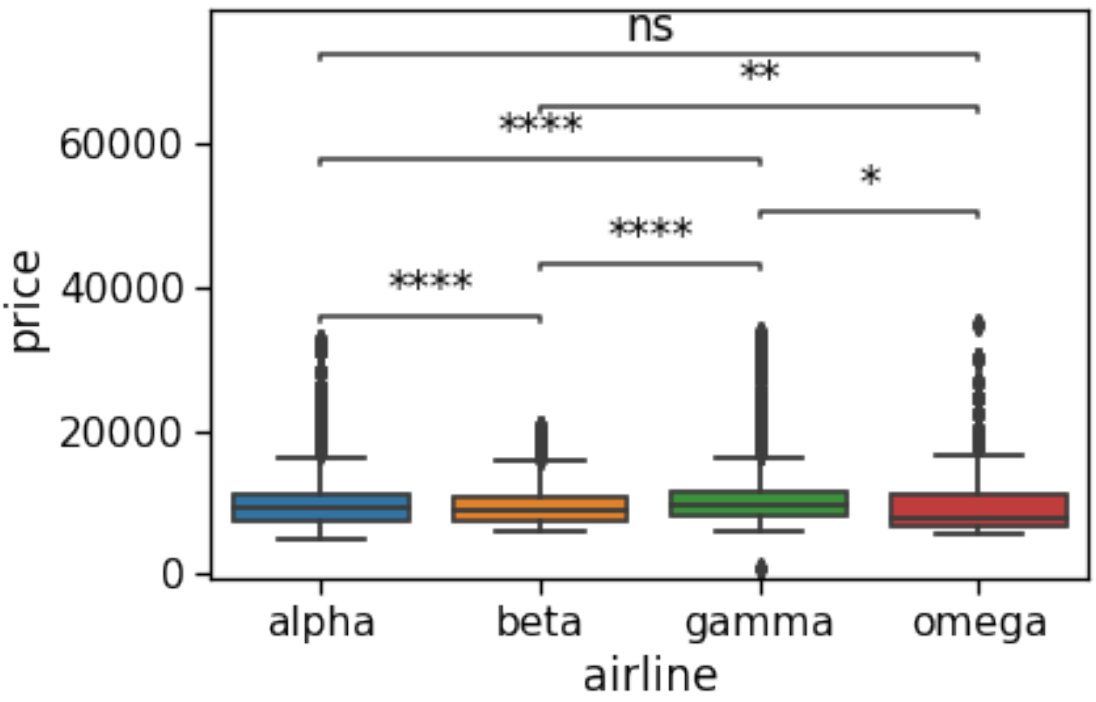
       *: 1.00e-02 < p <= 5.00e-02
      **: 1.00e-03 < p <= 1.00e-02
     ***: 1.00e-04 < p <= 1.00e-03
    ****: p <= 1.00e-04

alpha vs. beta: Custom statistical test, P_val:8.140e-12
beta vs. gamma: Custom statistical test, P_val:8.140e-12
gamma vs. omega: Custom statistical test, P_val:3.184e-02
alpha vs. gamma: Custom statistical test, P_val:2.961e-08
beta vs. omega: Custom statistical test, P_val:1.457e-03
alpha vs. omega: Custom statistical test, P_val:9.607e-01
```


ns
**
****
*
****
****
60000
40000
20000
0
price
alpha
beta
gamma
omega
airline