Practical Implementation of Statistics to Analyze Data

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In [135…

```
# Importing libraries
import numpy as np
import seaborn as sns
import statistics as stat
import matplotlib.pyplot as plt
import random
import pandas as pd
from numpy.random import randn
```

Importing Titatnic Dataset

In [8]:

```
df = sns.load_dataset("titanic")
df.head()
```

Out[8]:

	survived	pclass	sex	age	sibsp	parch	fare	embarked	class	who	adult_male	deck
0	0	3	male	22.0	1	0	7.2500	S	Third	man	True	NaN
1	1	1	female	38.0	1	0	71.2833	C	First	woman	False	C
2	1	3	female	26.0	0	0	7.9250	S	Third	woman	False	NaN
3	1	1	female	35.0	1	0	53.1000	S	First	woman	False	C
4	0	3	male	35.0	0	0	8.0500	S	Third	man	True	NaN

In [9]:

```
# Features Data type
df.info()
```

```
<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
```

In [10]:
```
# Extracting Numerical Data
numeric_df =  df.select_dtypes(include=['int64', 'float64'])
numeric_df.head()
```

Out[10]:

	survived	pclass	age	sibsp	parch	fare
0	0	3	22.0	1	0	7.2500
1	1	1	38.0	1	0	71.2833
2	1	3	26.0	0	0	7.9250
3	1	1	35.0	1	0	53.1000
4	0	3	35.0	0	0	8.0500

1) Measure of Central Tendency

MEAN

In [11]:
```
 np.mean(numeric_df)
```

Out[11]:
```
survived     0.383838
pclass       2.308642
age         29.699118
sibsp        0.523008
parch        0.381594
fare        32.204208
dtype: float64
```

As per dataset, on average survival rate of passengers is 38%. Mean fare paid by passengers is $32. Mean age of passengers 29.7 yrs.

MEDIAN

In [12]:
```
np.median(numeric_df,axis=0)
```

Out[12]:
```
array([ 0.    ,  3.    ,     nan,  0.    ,  0.    , 14.4542])
```

MODE

In [13]:
```
modes = {}
for column in numeric_df.columns:
    mode_value = numeric_df[column].mode()[0]
    modes[column] = mode_value

for column, mode_value in modes.items():
    print("Mode of '{}': {}".format(column, mode_value))
```

```
Mode of 'survived': 0
Mode of 'pclass': 3
Mode of 'age': 24.0
Mode of 'sibsp': 0
Mode of 'parch': 0
Mode of 'fare': 8.05
```

2) Measure of Dispersion

Variance

In [14]:
```
variances = {}
for column in numeric_df.columns:
    variances[column] = numeric_df[column].var()

for column, variance in variances.items():
    print(f"Variance of '{column}' column: {variance}")
```

```
Variance of 'survived' column: 0.2367722165474984
Variance of 'pclass' column: 0.6990151199889065
Variance of 'age' column: 211.0191247463081
Variance of 'sibsp' column: 1.2160430774662894
Variance of 'parch' column: 0.6497282437357467
Variance of 'fare' column: 2469.436845743117
```

Standard Deviation

In [15]:
```
std_devs = {}
for column in numeric_df.columns:
    std_devs[column] = numeric_df[column].std()
for column, std_dev in std_devs.items():
    print(f"Standard deviation of '{column}' column: {std_dev}")
```

```
Standard deviation of 'survived' column: 0.4865924542648585
Standard deviation of 'pclass' column: 0.8360712409770513
Standard deviation of 'age' column: 14.526497332334044
Standard deviation of 'sibsp' column: 1.1027434322934275
Standard deviation of 'parch' column: 0.8060572211299559
Standard deviation of 'fare' column: 49.693428597180905
```

In [16]:
```
# zeroth percentile
np.percentile(numeric_df['fare'],0)
```

Out[16]: 0.0

In [17]:
```
q1 = np.percentile(numeric_df['fare'],25)  # 1st Quartile
q2 = np.percentile(numeric_df['fare'],50)  # 2nd Quartile
q3 = np.percentile(numeric_df['fare'],75)  # 3rd Quartile
q4 = np.percentile(numeric_df['fare'],100) # 4th Quartile
```

In [58]:
```
IQR= q3-q1
lower_fence=  q1-1.5*(IQR)
higher_fence= q3+1.5*(IQR)
lower_fence,higher_fence
```

Out[58]: (-26.724, 65.6344)

3) Covariance & Correlation

In [18]:
```
numeric_df.corr("pearson")
```

Out[18]:

	survived	pclass	age	sibsp	parch	fare
survived	1.000000	-0.338481	-0.077221	-0.035322	0.081629	0.257307
pclass	-0.338481	1.000000	-0.369226	0.083081	0.018443	-0.549500
age	-0.077221	-0.369226	1.000000	-0.308247	-0.189119	0.096067

	survived	pclass	age	sibsp	parch	fare
sibsp	-0.035322	0.083081	-0.308247	1.000000	0.414838	0.159651
parch	0.081629	0.018443	-0.189119	0.414838	1.000000	0.216225
fare	0.257307	-0.549500	0.096067	0.159651	0.216225	1.000000

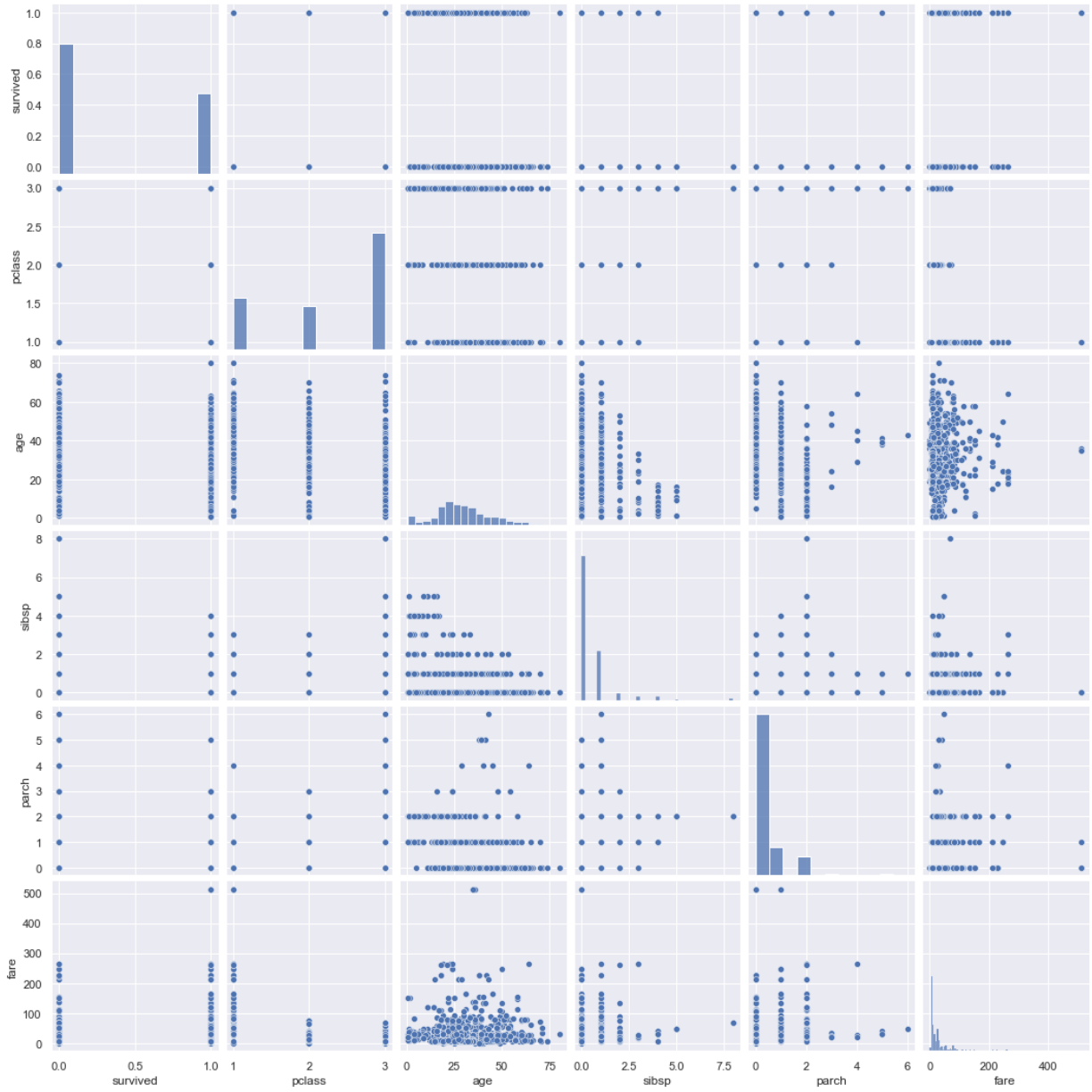
In [95]:
```
numeric_df.corr("spearman")
```

Out[95]:

	survived	pclass	age	sibsp	parch	fare
survived	1.000000	-0.339668	-0.052565	0.088879	0.138266	0.323736
pclass	-0.339668	1.000000	-0.361666	-0.043019	-0.022801	-0.688032
age	-0.052565	-0.361666	1.000000	-0.182061	-0.254212	0.135051
sibsp	0.088879	-0.043019	-0.182061	1.000000	0.450014	0.447113
parch	0.138266	-0.022801	-0.254212	0.450014	1.000000	0.410074
fare	0.323736	-0.688032	0.135051	0.447113	0.410074	1.000000

In [98]:
```
sns.pairplot(numeric_df)
```

Out[98]:
```
<seaborn.axisgrid.PairGrid at 0x1be33c24e20>
```



In [92]:
```
np.cov(numeric_df['survived'],numeric_df['age'])
```

Out[92]:
```
array([[0.23677222,        nan],
       [       nan,        nan]])
```

In [93]:
```
numeric_df.cov()
```

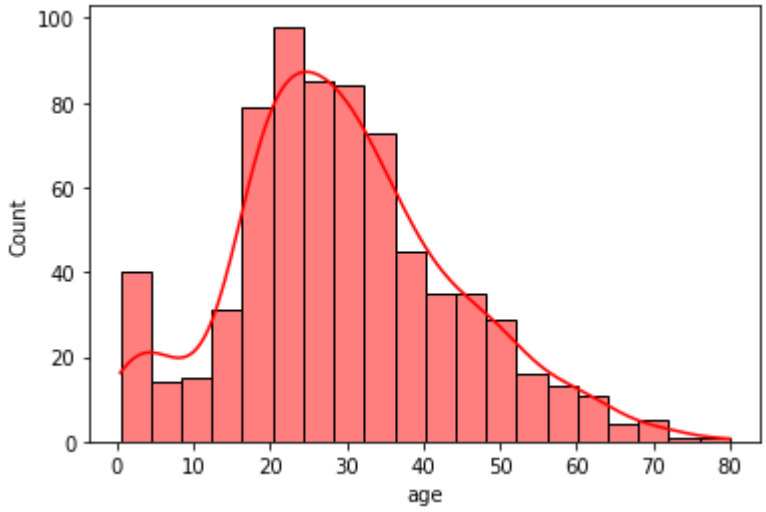
Out[93]:

	survived	pclass	age	sibsp	parch	fare
survived	0.236772	-0.137703	-0.551296	-0.018954	0.032017	6.221787
pclass	-0.137703	0.699015	-4.496004	0.076599	0.012429	-22.830196
age	-0.551296	-4.496004	211.019125	-4.163334	-2.344191	73.849030
sibsp	-0.018954	0.076599	-4.163334	1.216043	0.368739	8.748734
parch	0.032017	0.012429	-2.344191	0.368739	0.649728	8.661052
fare	6.221787	-22.830196	73.849030	8.748734	8.661052	2469.436846

4) Histogram and Skewness

In [64]:
```
sns.histplot(numeric_df['age'], kde=True,color="red")
```

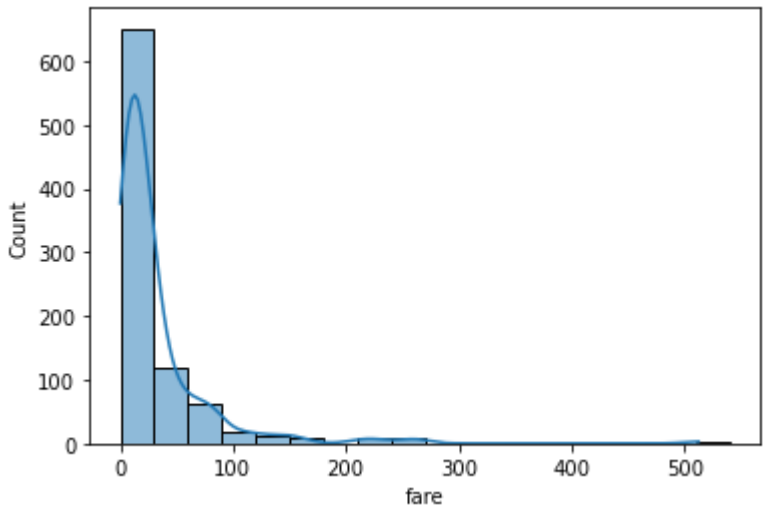
Out[64]: <AxesSubplot:xlabel='age', ylabel='Count'>



In [61]:
```
sns.histplot(numeric_df['fare'], kde=True, inwidth=30)

# Positive Right Skewed
```

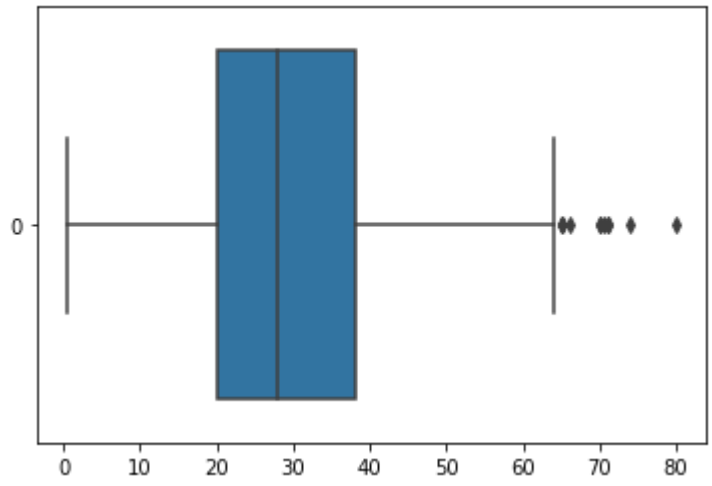
Out[61]: <AxesSubplot:xlabel='fare', ylabel='Count'>



5) Box Plot

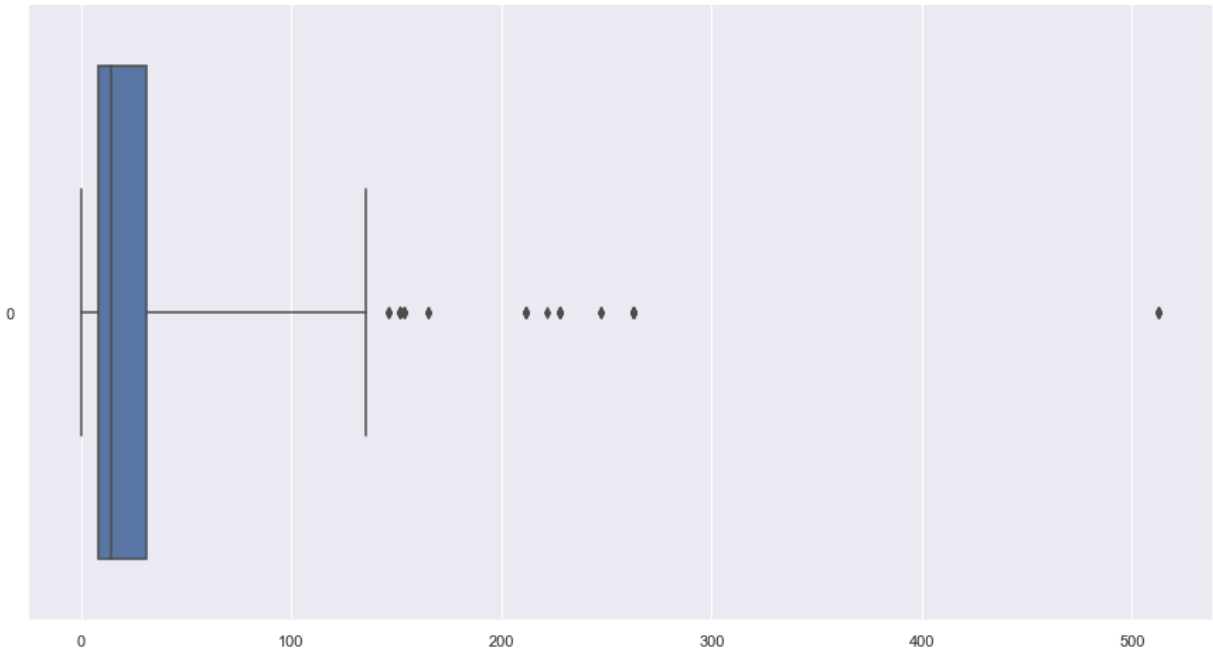
In [28]:
```
sns.boxplot(data = numeric_df['age'], orient="h")
```

Out[28]: <AxesSubplot:>



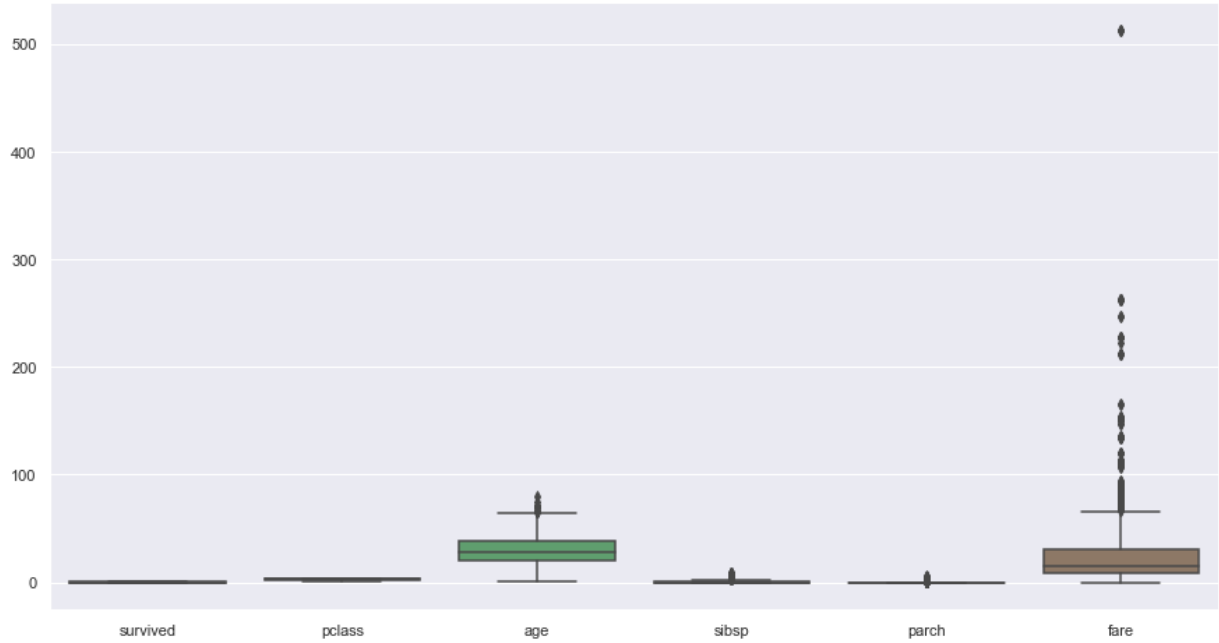
In [44]:
```
sns.boxplot(data = numeric_df['fare'], orient="h",whis=5)
```

Out[44]: <AxesSubplot:>



In [33]:
```
sns.boxplot(data = numeric_df, orient="v")
```

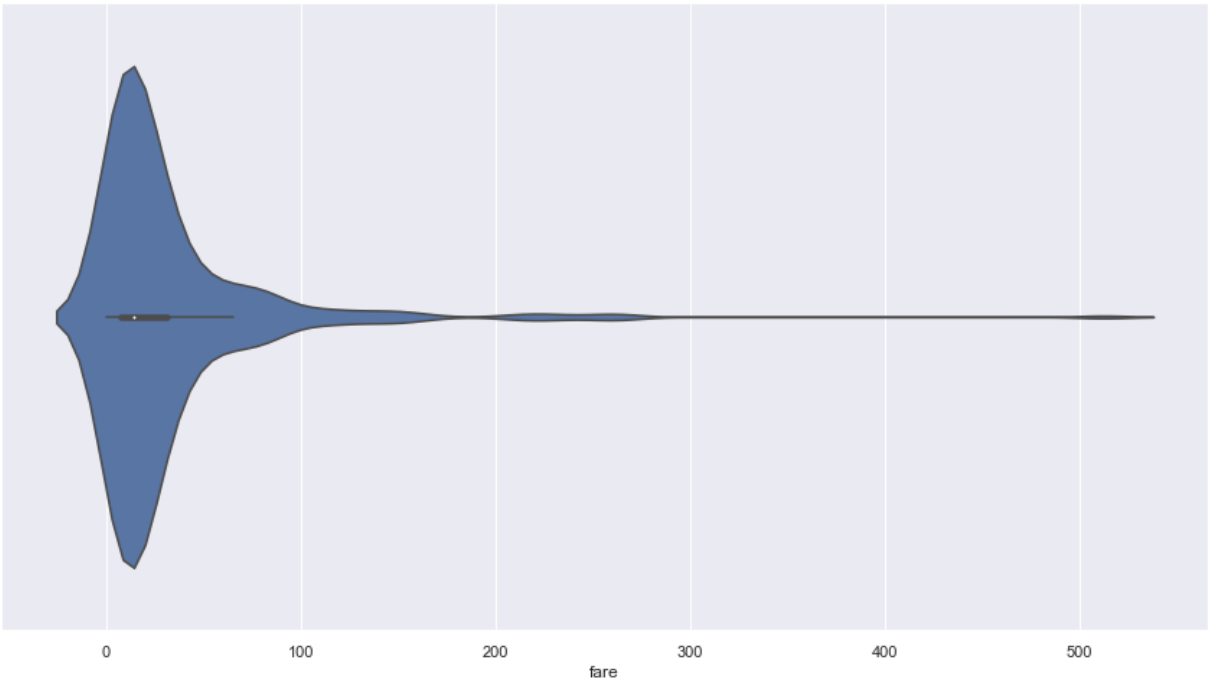
Out[33]: <AxesSubplot:>



In [46]:
```
sns.violinplot(df['fare'])
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only valid po
sitional argument will be `data`, and passing other arguments without an explicit key
word will result in an error or misinterpretation.
  warnings.warn(
```

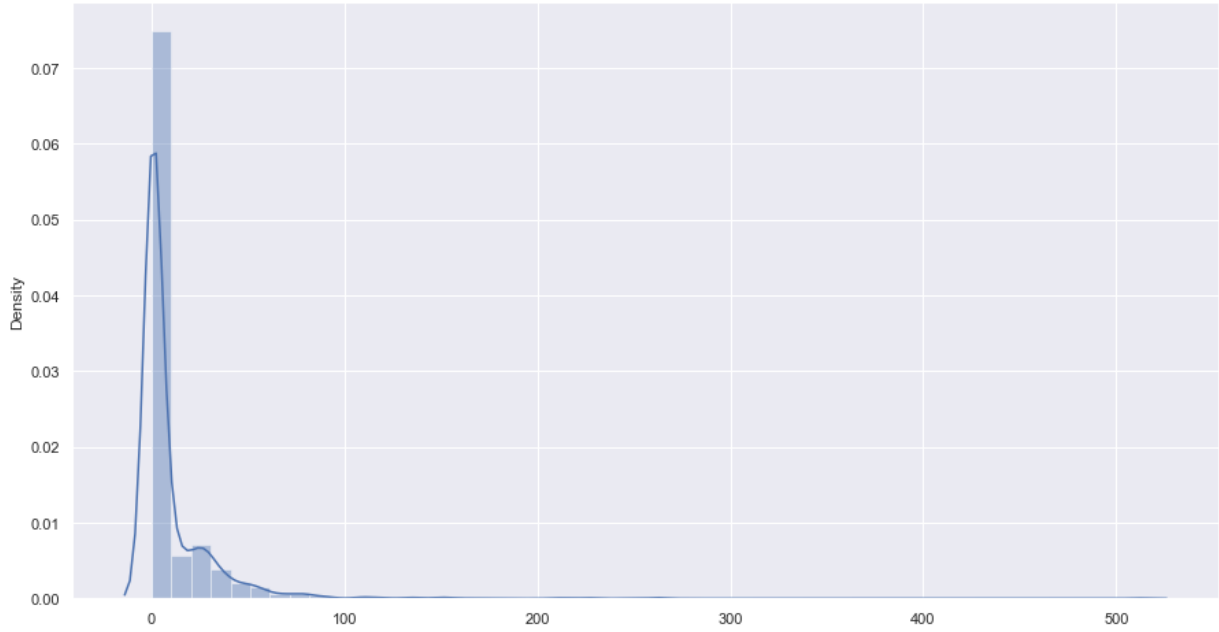
Out[46]: <AxesSubplot:xlabel='fare'>



In [57]:
```
sns.distplot(numeric_df)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2557: FutureWarni
ng: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flex
ibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[57]: <AxesSubplot:ylabel='Density'>



6) Standardization

In [59]:
```
mean = numeric_df.mean()
std_dev = numeric_df.std()

# Standardize the dataset
standardized_df = (numeric_df - mean) / std_dev
standardized_df
```

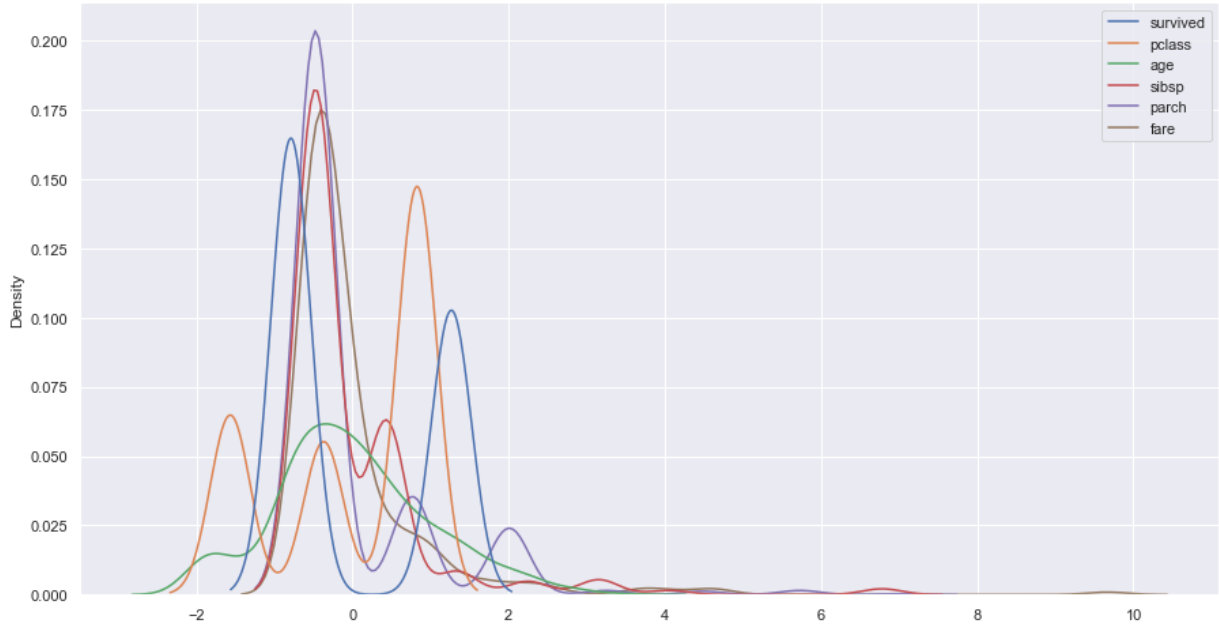
Out[59]:

	survived	pclass	age	sibsp	parch	fare
0	-0.788829	0.826913	-0.530005	0.432550	-0.473408	-0.502163
1	1.266279	-1.565228	0.571430	0.432550	-0.473408	0.786404
2	1.266279	0.826913	-0.254646	-0.474279	-0.473408	-0.488580
3	1.266279	-1.565228	0.364911	0.432550	-0.473408	0.420494
4	-0.788829	0.826913	0.364911	-0.474279	-0.473408	-0.486064
...	...	...	...	...	...	...
886	-0.788829	-0.369158	-0.185807	-0.474279	-0.473408	-0.386454
887	1.266279	-1.565228	-0.736524	-0.474279	-0.473408	-0.044356
888	-0.788829	0.826913	NaN	0.432550	2.007806	-0.176164
889	1.266279	-1.565228	-0.254646	-0.474279	-0.473408	-0.044356
890	-0.788829	0.826913	0.158392	-0.474279	-0.473408	-0.492101

891 rows × 6 columns

In [60]:
```
sns.kdeplot(data = standardized_df)
```

Out[60]:
```
<AxesSubplot:ylabel='Density'>
```



7) Normalization

In [61]:
```
normalized_df = (numeric_df - numeric_df.min()) / (numeric_df.max() - numeric_df.min
normalized_df
```

Out[61]:

	survived	pclass	age	sibsp	parch	fare
0	0.0	1.0	0.271174	0.125	0.000000	0.014151
1	1.0	0.0	0.472229	0.125	0.000000	0.139136
2	1.0	1.0	0.321438	0.000	0.000000	0.015469
3	1.0	0.0	0.434531	0.125	0.000000	0.103644
4	0.0	1.0	0.434531	0.000	0.000000	0.015713
...	...	...	...	...	...	...
886	0.0	0.5	0.334004	0.000	0.000000	0.025374
887	1.0	0.0	0.233476	0.000	0.000000	0.058556
888	0.0	1.0	NaN	0.125	0.333333	0.045771
889	1.0	0.0	0.321438	0.000	0.000000	0.058556
890	0.0	1.0	0.396833	0.000	0.000000	0.015127

891 rows × 6 columns

min, max, mean and standard deviation of normalized dataset

In [62]:
```
normalized_df.min()
```

Out[62]:
```
survived    0.0
pclass      0.0
age         0.0
sibsp       0.0
parch       0.0
fare        0.0
dtype: float64
```

In [63]:
```
normalized_df.max()
```

Out[63]:
```
survived    1.0
pclass      1.0
age         1.0
sibsp       1.0
parch       1.0
fare        1.0
dtype: float64
```

In [64]:
```
normalized_df.mean()
```

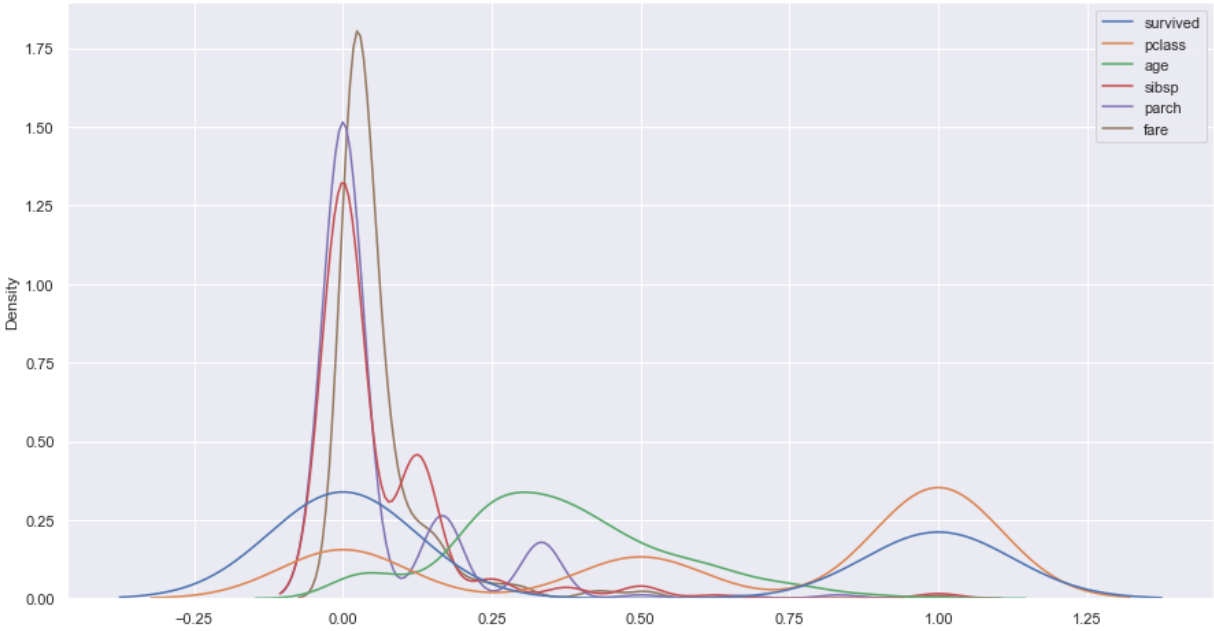
Out[64]:
```
survived    0.383838
pclass      0.654321
age         0.367921
sibsp       0.065376
parch       0.063599
fare        0.062858
dtype: float64
```

In [65]:
```
normalized_df.std()
```

Out[65]:
```
survived    0.486592
pclass      0.418036
age         0.182540
sibsp       0.137843
parch       0.134343
fare        0.096995
dtype: float64
```

In [66]:
```
sns.kdeplot(data = normalized_df)
```

Out[66]: <AxesSubplot:ylabel='Density'>



8) Central Limit Theorem

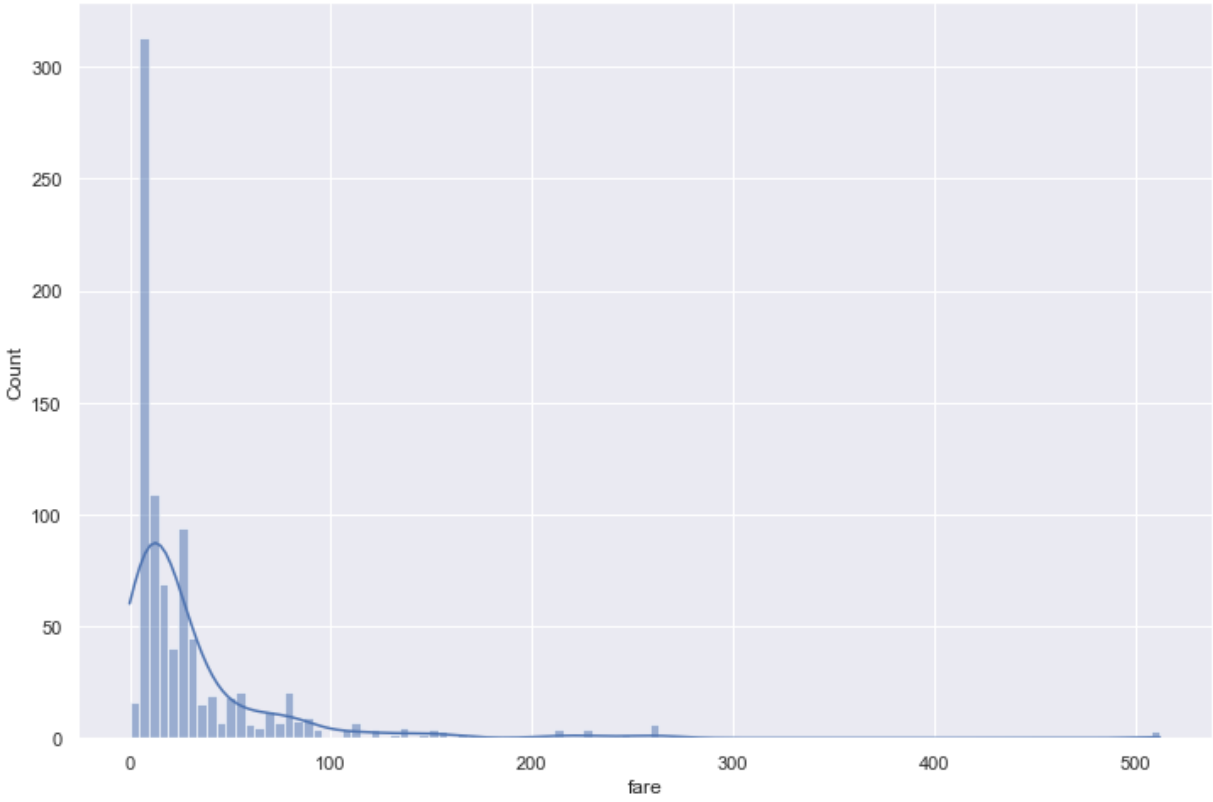
In [67]:
```
mean_CLT = numeric_df['fare'].mean()
std_CLT= numeric_df['fare'].std()
print("population mean (μ): {}\npopulation standard deviation (σ): {}".format(mean_C
```

```
population mean (μ): 32.2042079685746
population standard deviation (σ): 49.693428597180905
```

In [78]:

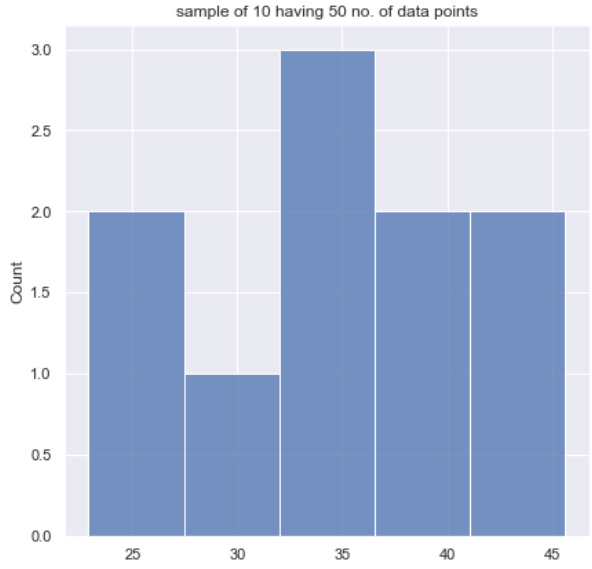
```
sns.set(rc={'figure.figsize':(12,8)})
sns.histplot(numeric_df['fare'], kde=True)
```

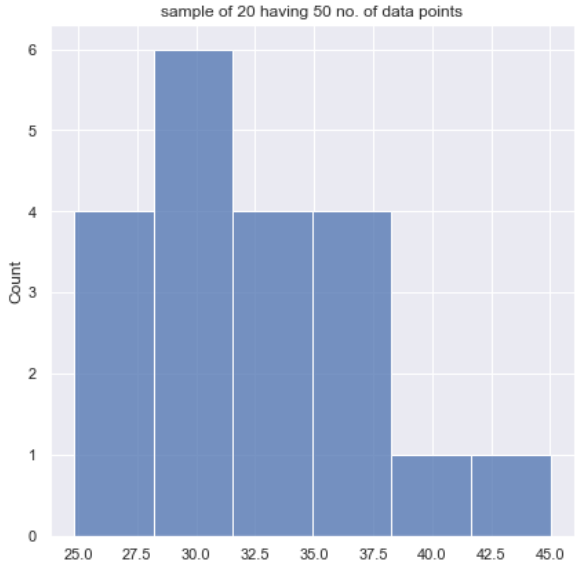
Out[78]: <AxesSubplot:xlabel='fare', ylabel='Count'>

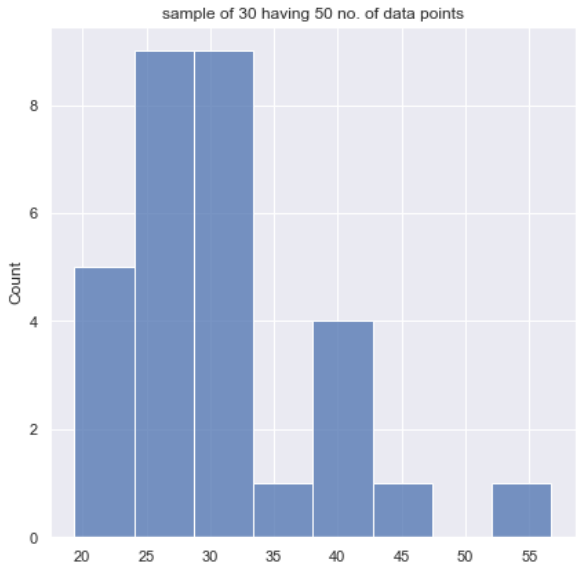


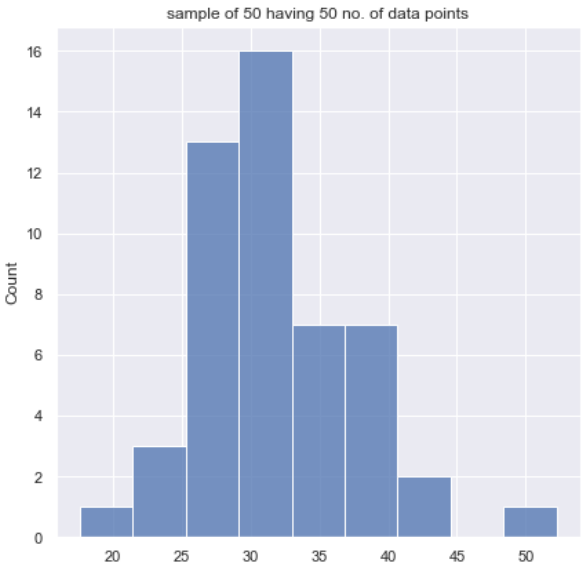
In [91]:

```
def mean_distribution(data, samples_count, data_points_count):
    list_sample = list()
    data = np.array(data.values)
    for i in range(0, samples_count):
        samples = random.sample(range(0, data.shape[0]), data_points_count)
        list_sample.append(data[samples].mean())
    return np.array(list_sample)
count = 0
mean_list = list()
fg, ax = plt.subplots(nrows=2, ncols=2, figsize=(15, 15))
lst = [(10,50),(20,50),(30,50),(50,50)]
for i in (0,1):
    for j in (0,1):
        ax[i,j].set_title("sample of " + str(lst[count][0]) + " having " + str(lst[c
        sns.histplot(mean_distribution(numeric_df['fare'], lst[count][0], lst[count]
        mean_list.append(mean_distribution(numeric_df['fare'], lst[count][0],lst[cou
        count +=1
```









Generating random numbers

In [100…

```
population=np.random.binomial(10,0.5,10000)
population
```

Out[100…

```
array([4, 5, 1, ..., 6, 6, 3])
```

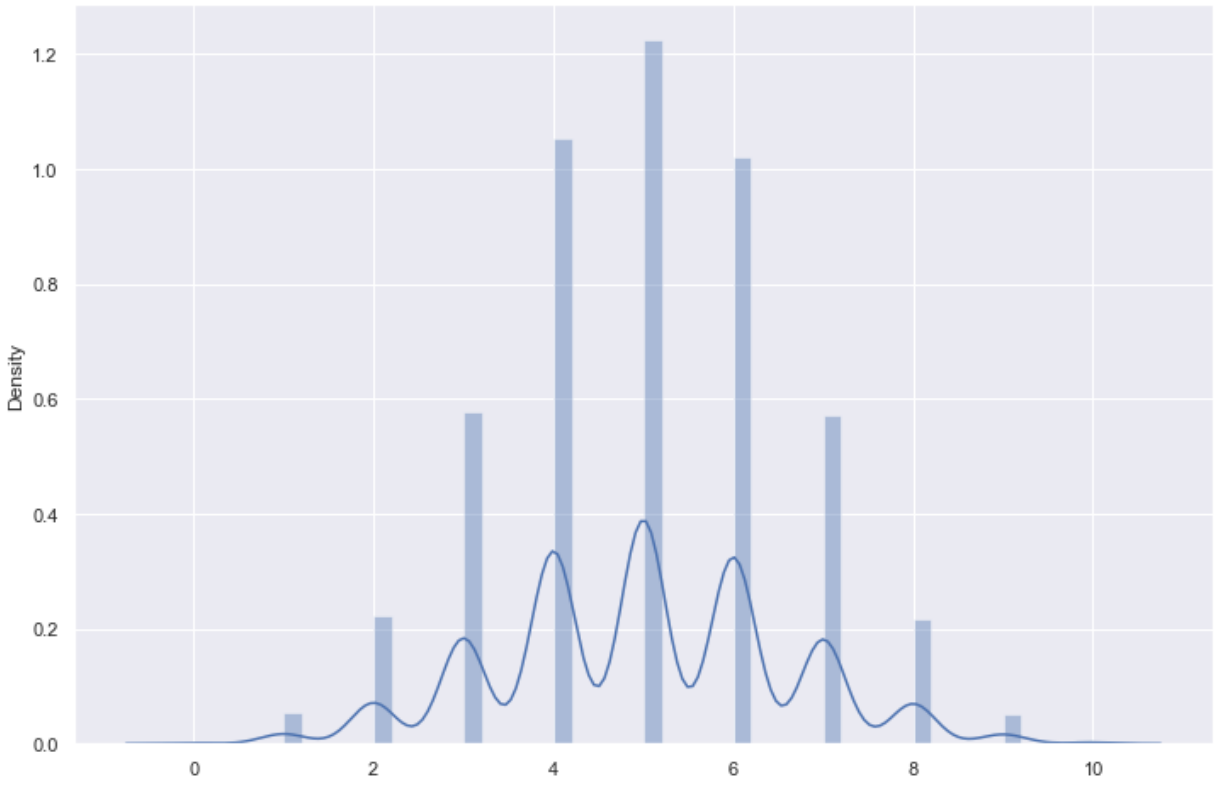
In [101…

```
sns.distplot(population)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2557: FutureWarni
ng: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flex
ibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[101…

```
<AxesSubplot:ylabel='Density'>
```



In [105…

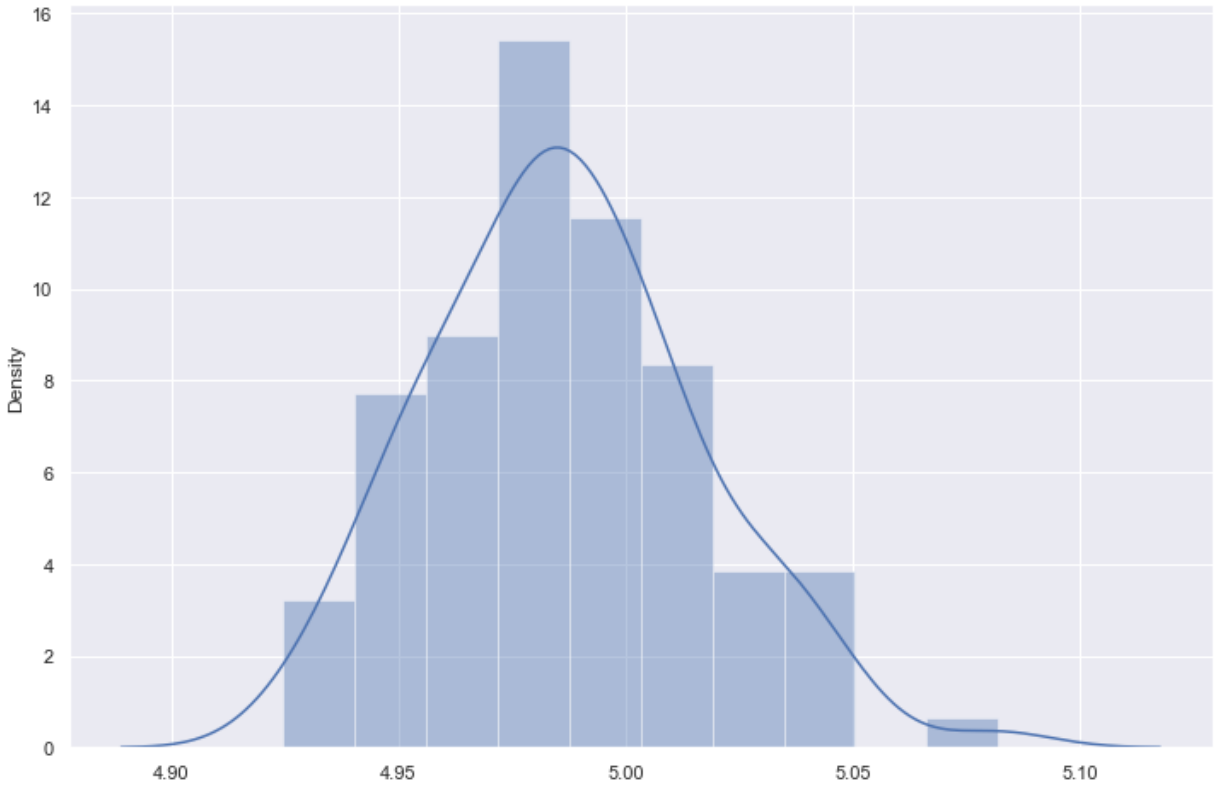
```
size=int(len(population)*0.30)
sample_mean=[]
for i in range(1,100):
    sample=np.random.choice(population,size=size)
    sample_mean.append(np.mean(sample))
```

In [106…

```
sns.distplot(sample_mean)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2557: FutureWarni
ng: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flex
ibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[106… <AxesSubplot:ylabel='Density'>



9) Z-test

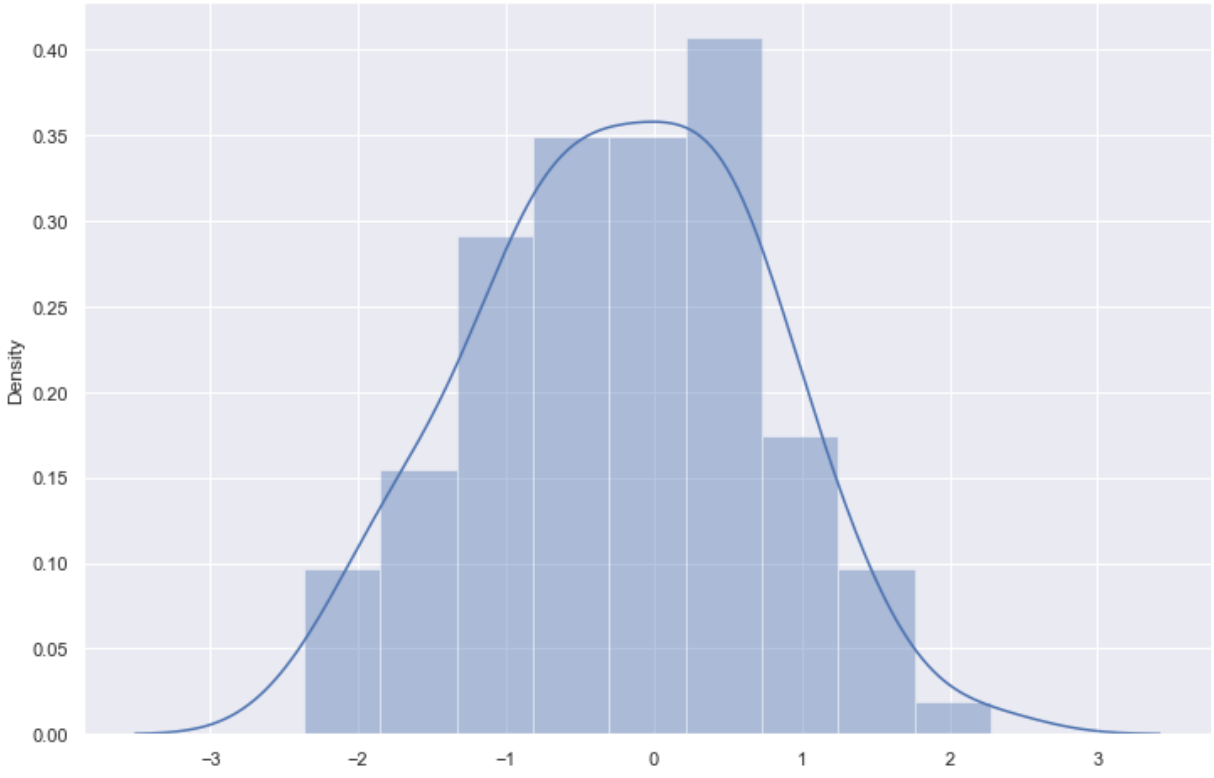
In [113…

```
citizens=randn(100)
sns.distplot(citizens)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2557: FutureWarni
ng: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flex
ibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[113…

```
<AxesSubplot:ylabel='Density'>
```



In [120…
```
print(f"here is a mean of the population: {np.mean(population)},here is a std dev {n
C_I=0.95   #confidence interval
ALPHA=0.05
```

```
here is a mean of the population: 4.9889,here is a std dev 1.5830277287527215
```

In [126…
```
null_mean= 0.022
```

In [127…
```
from statsmodels.stats.weightstats import ztest
z_score,p_value=ztest(citizens,value=null_mean,alternative='larger')
```

In [128…
```
z_score
```

Out[128…
```
-2.6637811064931833
```

In [129…
```
p_value
```

Out[129…
```
0.9961366088321739
```

In [130…
```
if (p_value<ALPHA):
    print("reject the null hyphothesis")
else:
    print("we are going to accpept the null hyphothesis")
```

```
we are going to accpept the null hyphothesis
```

10) CHI-SQURE TEST

In [132…
```
df.head()
```

Out[132…

	survived	pclass	sex	age	sibsp	parch	fare	embarked	class	who	adult_male	deck
0	0	3	male	22.0	1	0	7.2500	S	Third	man	True	NaN
1	1	1	female	38.0	1	0	71.2833	C	First	woman	False	C
2	1	3	female	26.0	0	0	7.9250	S	Third	woman	False	NaN
3	1	1	female	35.0	1	0	53.1000	S	First	woman	False	C
4	0	3	male	35.0	0	0	8.0500	S	Third	man	True	NaN

In [133…
```
df[['sex','survived']]
```

Out[133…

	sex	survived
0	male	0
1	female	1
2	female	1
3	female	1

	sex	survived
4	male	0
...	...	...
886	male	0
887	female	1
888	female	0
889	male	1
890	male	0

891 rows × 2 columns

In [137...
```
dataset_table=pd.crosstab(df['sex'],df['survived'])
```

In [144...
```
Observed_Values=dataset_table.values
print(f"observed value(real value) \n {Observed_Values}")
```

```
observed value(real value)
 [[ 81 233]
 [468 109]]
```

In [145...
```
import scipy.stats as stats
stats_test,p,dof,Expected_Values=stats.chi2_contingency(Observed_Values)
```

In [146...
```
p
```

Out[146...
```
1.1973570627755645e-58
```

In [147...
```
Expected_Values
```

Out[147...
```
array([[193.47474747, 120.52525253],
       [355.52525253, 221.47474747]])
```

In [148...
```
dataset_table
```

Out[148...

survived	0	1
sex		
female	81	233
male	468	109

In [149...
```
from scipy.stats import chi2
chisqure_test=sum([(o-e)**2./e for o,e in zip(Observed_Values,Expected_Values)])
```

In [150...
```
chisqure_test
```

Out[150...
```
array([100.96890722, 162.08166685])
```

In [152…
```
chi_square_statistic=chisqure_test[0]+chisqure_test[1]
```

In [154…
```
from scipy.stats import chi2
alpha=0.05
critical_value=chi2.ppf(1-alpha,df=dof)
```

In [155…
```
if chi_square_statistic>=critical_value:
    print("Reject H0,There is a relationship between 2 categorical variables")
else:
    print("Retain H0,There is no relationship between 2 categorical variables")
```

```
Reject H0,There is a relationship between 2 categorical variables
```

11) T-test

In [161…
```
from scipy.stats import ttest_1samp
ttest,p_value=ttest_1samp(df['fare'],30)
```

In [162…
```
p_value
```

Out[162…
```
0.18583845591428397
```

In [163…
```
if p_value < 0.05:    # alpha value is 0.05 or 5%
    print(" we are rejecting null hypothesis")
else:
    print("we fail to reject the null hypothesis")
```

```
we fail to reject the null hypothesis
```

Paired T-test With Python

When you want to check how different samples from the same group are, you can go for a paired T-test

In [164…
```
weight1=[25,30,28,35,28,34,26,29,30,26,28,32,31,30,45]
weight2=weight1+stats.norm.rvs(scale=5,loc=-1.25,size=15)
```

In [165…
```
weight_df=pd.DataFrame({"weight_10":np.array(weight1),
                        "weight_20":np.array(weight2),
                       "weight_change":np.array(weight2)-np.array(weight1)})
```

In [166…
```
weight_df
```

Out[166…

	weight_10	weight_20	weight_change
0	25	21.640673	-3.359327
1	30	30.123078	0.123078
2	28	23.230750	-4.769250
3	35	36.451792	1.451792

	weight_10	weight_20	weight_change
4	28	29.790227	1.790227
5	34	33.818910	-0.181090
6	26	27.575157	1.575157
7	29	23.188192	-5.811808
8	30	22.694990	-7.305010
9	26	28.670190	2.670190
10	28	33.143260	5.143260
11	32	29.586752	-2.413248
12	31	26.491389	-4.508611
13	30	27.121897	-2.878103
14	45	49.580613	4.580613

In [167…
```
_,p_value=stats.ttest_rel(a=weight1,b=weight2)
```

In [168…
```
p_value
```

Out[168… `0.364625517085174`

In [169…
```
if p_value < 0.05:    # alpha value is 0.05 or 5%
    print(" we are rejecting null hypothesis")
else:
    print("we are accepting null hypothesis")
```

```
we are accepting null hypothesis
```

12) Anova Test(F-Test)

The t-test works well when dealing with two groups, but sometimes we want to compare more than two groups at the same time.

For example, if we wanted to test whether petal_width age differs based on some categorical variable like species, we have to compare the means of each level or group the variable

In [170…
```
df_anova = df[['fare','sex']]
```

In [173…
```
grps = pd.unique(df_anova.sex.values)
grps
```

Out[173… `array(['male', 'female'], dtype=object)`

In [174…
```
d_data = {grp:df_anova['fare'][df_anova.sex == grp] for grp in grps}
```

In [175…
```
d_data
```

Out[175…
```
{'male': 0       7.2500
 4       8.0500
 5       8.4583
 6      51.8625
 7      21.0750
         ...
 883    10.5000
 884     7.0500
 886    13.0000
 889    30.0000
 890     7.7500
 Name: fare, Length: 577, dtype: float64,
 'female': 1      71.2833
 2       7.9250
 3      53.1000
 8      11.1333
 9      30.0708
         ...
 880    26.0000
 882    10.5167
 885    29.1250
 887    30.0000
 888    23.4500
 Name: fare, Length: 314, dtype: float64}
```

In [176…
```
F, p = stats.f_oneway(d_data['male'], d_data['female'])
```

In [177…
```
p
```

Out[177…
```
4.230867870041279e-08
```

In [178…
```
if p<0.05:
    print("reject null hypothesis")
else:
    print("accept null hypothesis")
```

```
reject null hypothesis
```

In [ ]:
```

```