In [34]:
```python
import numpy as np
import pandas as pd
from scipy.stats import norm,t, ttest_1samp,ttest_ind,ttest_rel
import matplotlib.pyplot as plt
import seaborn as sns
```

Paired T Test

In [41]:
```python
df=pd.read_csv("problem_solving.csv")
df
```

Out[41]:

	id	test_1	test_2
0	0	40	38
1	1	49	44
2	2	65	69
3	3	59	63
4	4	44	43
...	...	...	...
132	132	45	44
133	133	46	42
134	134	40	35
135	135	60	66
136	136	79	84

137 rows × 3 columns

In [4]:
```python
df["test_1"].mean()
```

Out[4]: 60.48905109489051

In [5]:
```python
df["test_2"].mean()
```

Out[5]: 62.43065693430657

In [ ]:
```python
# Ho : mu1 = mu2 ( Problem Solving Class had no effect)
# Ha : mu1 < mu2 ( Problem Solving Class had effect)
```

In [10]:
```python
# Ho : mu1 = mu2 ( Problem Solving Class had no effect)
# Ha : mu1 < mu2 ( Problem Solving Class had effect)
t_stat,p_value=ttest_rel(df["test_1"],df["test_2"],alternative= "less")
print("T_stat : ",t_stat)
print("p_value : ",p_value)
alpha=0.05
if p_value<alpha:
    print("Interpretation : Reject Ho")
else:
    print("Interpretation : Fail to Reject Ho")
```

```
T_stat :  -5.502886353508166
p_value :  8.979201768961566e-08
Interpretation : Reject Ho
```

In [11]:
```python
# Ho : mu1 = mu2 ( Problem Solving Class had no effect)
# Ha : mu2 > mu1 ( Problem Solving Class had effect)
t_stat,p_value=ttest_rel(df["test_2"],df["test_1"],alternative= "greater")
print("T_stat : ",t_stat)
print("p_value : ",p_value)
alpha=0.05
if p_value<alpha:
    print("Interpretation : Reject Ho")
else:
    print("Interpretation : Fail to Reject Ho")
```

```
T_stat :  5.502886353508166
p_value :  8.979201768961566e-08
Interpretation : Reject Ho
```

Paired T test and TTest 1 Sample

In [42]:
```python
df["difference"]= df["test_2"]-df["test_1"]
df
```

Out[42]:

	id	test_1	test_2	difference
0	0	40	38	-2
1	1	49	44	-5
2	2	65	69	4
3	3	59	63	4
4	4	44	43	-1
...	...	...	...	...
132	132	45	44	-1
133	133	46	42	-4
134	134	40	35	-5
135	135	60	66	6
136	136	79	84	5

137 rows × 4 columns

In [43]:
```python
df["difference"].mean()
```

Out[43]: 1.9416058394160585

In [44]:
```python
# Ho : (mu2-mu1)=0 ( Problem Solving Class had no effect)
# Ha : (mu2-mu1)>0 ( Problem Solving Class had effect)
t_stat,p_value=ttest_1samp(df["difference"],0,alternative= "greater")
print("T_stat : ",t_stat)
print("p_value : ",p_value)
alpha=0.05
if p_value<alpha:
    print("Interpretation : Reject Ho")
else:
    print("Interpretation : Fail to Reject Ho")
```

```
T_stat :  5.502886353508166
p_value :  8.979201768961566e-08
Interpretation : Reject Ho
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

TTest Independant

In [14]:
```python
df=pd.read_csv("Sachin_ODI.csv")
df
```

Out[14]:

	runs	NotOut	mins	bf	fours	sixes	sr	Inns	Opp	Ground	Date	Winner	Won	century
0	13	0	30	15	3	0	86.66	1	New Zealand	Napier	1995-02-16	New Zealand	False	False
1	37	0	75	51	3	1	72.54	2	South Africa	Hamilton	1995-02-18	South Africa	False	False
2	47	0	65	40	7	0	117.50	2	Australia	Dunedin	1995-02-22	India	True	False
3	48	0	37	30	9	1	160.00	2	Bangladesh	Sharjah	1995-04-05	India	True	False
4	4	0	13	9	1	0	44.44	2	Pakistan	Sharjah	1995-04-07	Pakistan	False	False
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
355	14	0	34	15	2	0	93.33	2	Australia	Sydney	2012-02-26	Australia	False	False
356	39	0	45	30	5	0	130.00	2	Sri Lanka	Hobart	2012-02-28	India	True	False
357	6	0	25	19	1	0	31.57	1	Sri Lanka	Dhaka	2012-03-13	India	True	False
358	114	0	205	147	12	1	77.55	1	Bangladesh	Dhaka	2012-03-16	Bangladesh	False	True
359	52	0	93	48	5	1	108.33	2	Pakistan	Dhaka	2012-03-18	India	True	False

360 rows × 14 columns

Batting pattern in 1st and 2nd Innings

In [15]:
```python
df.groupby(["Inns"])["runs"].mean()
```

Out[15]:
```
Inns
1    46.670588
2    40.173684
Name: runs, dtype: float64
```

In [16]:
```python
df_first_innings = df.loc[df["Inns"]==1]["runs"]
df_second_innings = df.loc[df["Inns"]== 2]["runs"]
```

In [17]:
```python
df_first_innings.mean(),df_second_innings.mean()
```

Out[17]: (46.67058823529412, 40.17368421052632)

In [57]:
```python
df_second_innings.sample
```

Out[57]:
```
<bound method NDFrame.sample of 1       37
2       47
3       48
4        4
5      112
      ...
353      3
354     22
355     14
356     39
359     52
Name: runs, Length: 190, dtype: int64>
```

In [23]:
```python
# Ho : mu1 = mu2 ( first innings performance of sachin was similar to Second Innings performance
# Ha : mu1 > mu2 ( first innings performance of sachin was better in comparison to Second Innings performance)
t_stat,p_value=ttest_ind(df_first_innings,df_second_innings,alternative= "greater")
print("t_stat : ",t_stat)
print("p_value : ",p_value)
alpha=0.05
if p_value<alpha:
    print("Interpretation : Reject Ho")
else:
    print("Interpretation : Fail to Reject Ho")
```

```
t_stat :  1.4612016295532178
p_value :  0.07241862097379981
Interpretation : Fail to Reject Ho
```

In [ ]:

Batting pattern of Sachin When India Lost Or Won

In [ ]:
```python
# victory vs defeat
```

In [ ]:

In [25]:
```python
df.groupby(["Won"])["runs"].mean()
```

Out[25]:
```
Won
False    35.130682
True     51.000000
Name: runs, dtype: float64
```

In [26]:
```python
df_won = df.loc[df["Won"]==True]["runs"]
df_lost = df.loc[df["Won"]== False]["runs"]
```

In [27]:
```python
df_won.mean(),df_lost.mean()
```

Out[27]: (51.0, 35.13068181818182)

In [28]:
```python
# Ho : mu_won = mu_lost ( Sachin's performance is similar in both situations , India won or lost
# Ha : mu_won > mu_lost ( Sachin's performance is better in the innings where India won in comparison to India Lost )
t_stat,p_value=ttest_ind(df_won,df_lost,alternative= "greater")
print("t_stat : ",t_stat)
print("p_value : ",p_value)
alpha=0.05
if p_value<alpha:
    print("Interpretation : Reject Ho")
else:
    print("Interpretation : Fail to Reject Ho")
```

```
t_stat :  3.628068563969343
p_value :  0.00016353077486826558
Interpretation : Reject Ho
```

In [ ]:

Aerofit

In [32]:
```python
df= pd.read_csv("aerofit.csv")
df
```

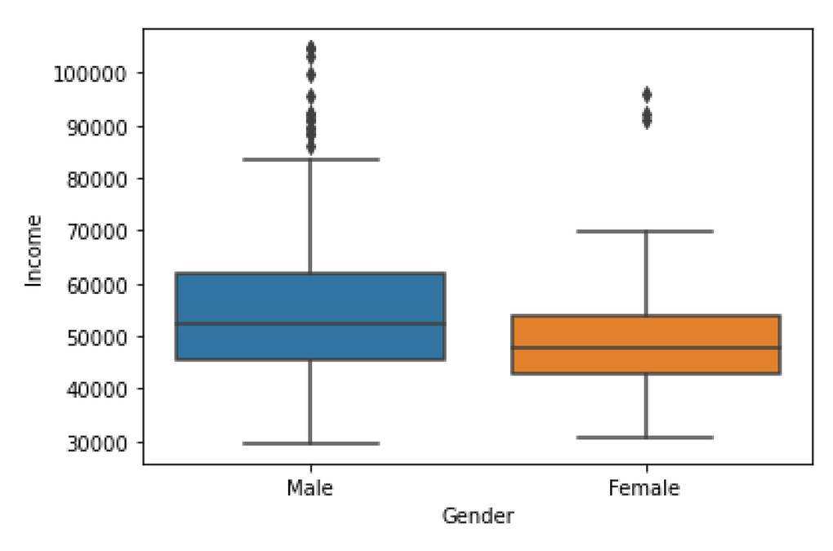
Out[32]:

	Product	Age	Gender	Education	MaritalStatus	Usage	Fitness	Income	Miles
0	KP281	18	Male	14	Single	3	4	29562	112
1	KP281	19	Male	15	Single	2	3	31836	75
2	KP281	19	Female	14	Partnered	4	3	30699	66
3	KP281	19	Male	12	Single	3	3	32973	85
4	KP281	20	Male	13	Partnered	4	2	35247	47
...	...	...	...	...	...	...	...	...	...
175	KP781	40	Male	21	Single	6	5	83416	200
176	KP781	42	Male	18	Single	5	4	89641	200
177	KP781	45	Male	16	Single	5	5	90886	160
178	KP781	47	Male	18	Partnered	4	5	104581	120
179	KP781	48	Male	18	Partnered	4	5	95508	180

180 rows × 9 columns

In [35]:
```python
sns.boxplot(x="Gender",y="Income",data=df)
```

Out[35]: <AxesSubplot:xlabel='Gender', ylabel='Income'>



In [36]:
```python
df.groupby(["Gender"])["Income"].mean()
```

Out[36]:
```
Gender
Female    49828.907895
Male      56562.759615
Name: Income, dtype: float64
```

In [37]:
```python
df_male_income= df.loc[df["Gender"]=="Male"]["Income"]
df_female_income= df.loc[df["Gender"]=="Female"]["Income"]
```

In [38]:
```python
# Ho : mu_male = mu_female ( Males and Females have similar incomes on an an avg.)
# Ha : mu_male > mu_female ( Males have higher Income in comparison to Females)
t_stat,p_value=ttest_ind(df_male_income,df_female_income,alternative= "greater")
print("t_stat : ",t_stat)
print("p_value : ",p_value)
alpha=0.05
if p_value<alpha:
    print("Interpretation : Reject Ho")
else:
    print("Interpretation : Fail to Reject Ho")
```

```
t_stat :  2.752488637540257
p_value :  0.003263631548607129
Interpretation : Reject Ho
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

Doubts

In [50]:
```python
test_1=np.random.randint(10,40,size=137)
test_2=np.random.randint(20,80,size=137)
```

In [51]:
```python
test_1.mean()
```

Out[51]: 24.67153284671533

In [52]:
```python
test_1.mean()
```

Out[52]: 48.00729927007299

In [53]:
```python
ttest_rel(test_1,test_2,alternative="less")
```

Out[53]: Ttest_relResult(statistic=-12.954139217035824, pvalue=8.384017346243758e-26)

In [54]:
```python
ttest_1samp(test_2-test_1,0,alternative="greater")
```

Out[54]: Ttest_1sampResult(statistic=12.954139217035824, pvalue=8.384017346243758e-26)

In [ ]:
```
Get me understand, that it become 2 sided!
couldnt figure it out! The one sample T-test
is used when we want to compare a sample mean
to a population mean. The average British man is 175.3 cm tall.
A survey recorded the heights of 10 UK men and
we want to know whether the mean of the sample
is different from the population mean.
survey_height = [177.3, 182.7, 169.6, 176.3, 180.3, 179.4, 178.5, 177.2, 181.8, 176.5]
```

In [ ]:

In [ ]:

In [ ]:
```
so can we directly compare t_stat with t_critical like we did in z_test ?
for .95 confidence we can calculate z_critical which is =1.64 and directly compare that with z_stat, how to calculate similarly for t the
t_critical value, so that we don't need to compare p_value to alpha, and can directly compare the z_stat that we get?
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

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In [ ]: