This study simulates the situation of a company examining the efficacy of a special training program within two divisions (Groups A and B). The program is expected to influence several performance metrics differently, depending on gender and group assignment.

For males in Group B, the program is particularly effective, causing distinctive changes in their performance metrics. Which in this case the stress is reduced by 20% and score increased by 20%

Following are the features of each of the group, where the simulated datasets are created randomly based on:

Age: Normally distributed with different means and the same standard deviation.

Income: Normally distributed, differing in both means and standard deviations.

Training Effectiveness Score: Normally distributed with the same mean but different standard deviations.but will have a significant positive adjustment for males in Group B.

Stress Level: This feature will incorporate interactions. It will generally be higher in Group B but lower for males in Group B post-training.

Satisfaction feature, modelled using a beta distribution, reflects potentially different satisfaction levels across two divisions.

Gender factor impacted the Score specifically for males in Group B, introducing an interaction effect which is randomly generated for each group.

The dataset is depicted as below with 100 people per group:

	Group	Age	Income	Score	Gender	Satisfaction	Stress
0	A	32.483571	38677.034064	78.577874	Male	28.538579	45.244464
1	A	29.308678	46634.837418	80.607845	Female	51.430969	20.301202
2	A	33.238443	47258.283868	85.830512	Female	15.648980	24.151842
3	A	37.615149	43581.781846	85.538021	Male	26.055753	27.934867
4	A	28.829233	48709.714307	61.223306	Female	13.981359	17.819210
...	...	...	...	...	...	...	...
195	B	32.654122	60389.100437	88.901675	Male	72.951535	64.089034
196	B	26.434327	44627.538457	93.656476	Male	36.969980	61.719593
197	B	41.769362	53096.613219	79.620478	Male	46.654089	60.287763
198	B	34.427301	46243.817466	68.335601	Female	79.258335	52.181523
199	B	41.189082	41172.002690	80.659507	Female	73.016886	59.111517

Different static test are made, T-tests for Age and Income, $P>0.05$ for less significant impact

Age: The t-test statistic is -9.55 with a p-value of approximately 5.05×10^{-18}, indicating a highly significant difference in mean ages between groups A and B.

Income: The income t-test statistic is -3.26, with a p-value of 0.0013, suggesting a significant

difference in mean incomes as well.

F-test (Levene's test) for equality of variances in Score and stress,

Score: Levene's test for equality of variances in 'Score' gives a statistic of 5.78 with a p-value of 0.017, indicating that the variances of scores are significantly different between the two groups.

stress: Levene's test for equality of variances in 'Stress' gives a statistic of 3.43 with a p-value of 0.065, indicating that the variances of scores are minor different between the two groups.

Welch's t-tests for Score and Stress without assuming equal variances

Score: The Welch's t-test statistic is -4.32 with a p-value of approximately 2.74×10^{-5}, indicating a significant difference in scores between groups A and B.

Stress: Welch's t-test statistic is -10.25 with a p-value of about $6.75\times10^{-20,}$ showing a highly significant difference in stress levels between the two groups.

ANOVA to investigate interaction effects

Score:Group effect: Significant (p=1.66×10−6).

Gender effect: Highly significant (p=3.11×10−7).

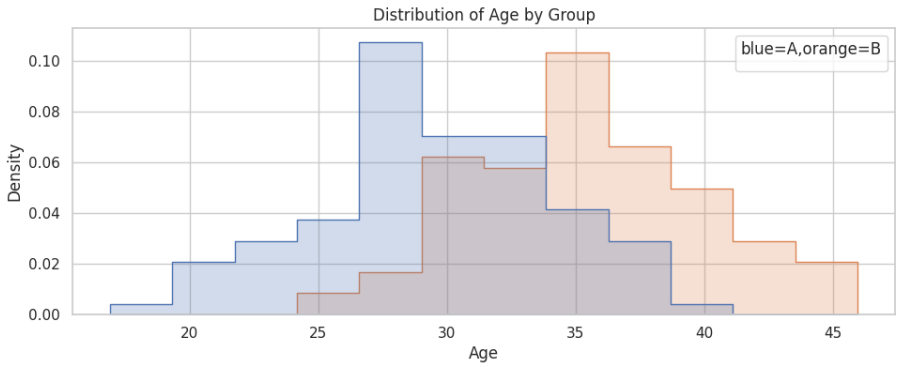
Interaction between Group and Gender: Extremely significant (p=1.7×10−9), suggesting that the effect of the group on scores differs by gender.

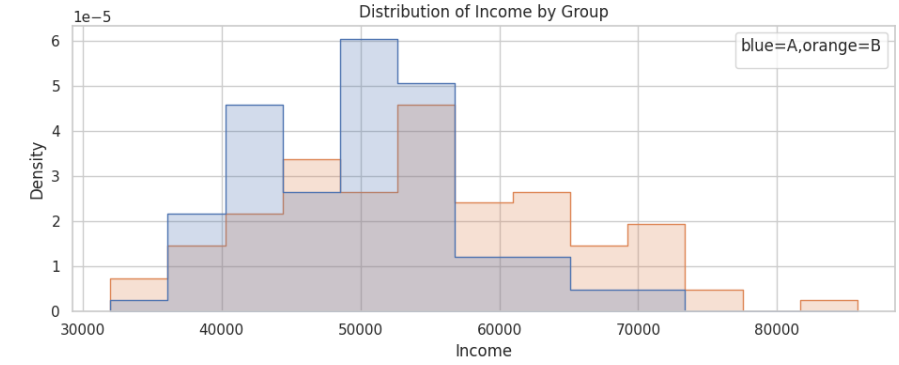
Stress:Group effect: Highly significant (p=1.77×10−20), showing a strong group effect on stress.

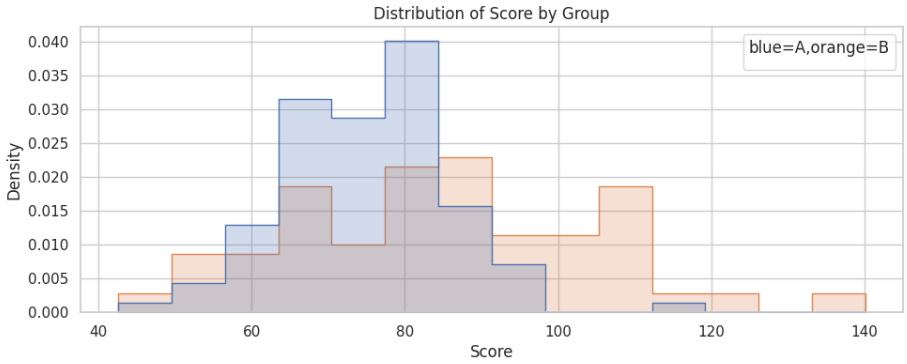
Gender effect: Not significant (p=0.017), indicating that gender have a strong impact stress.

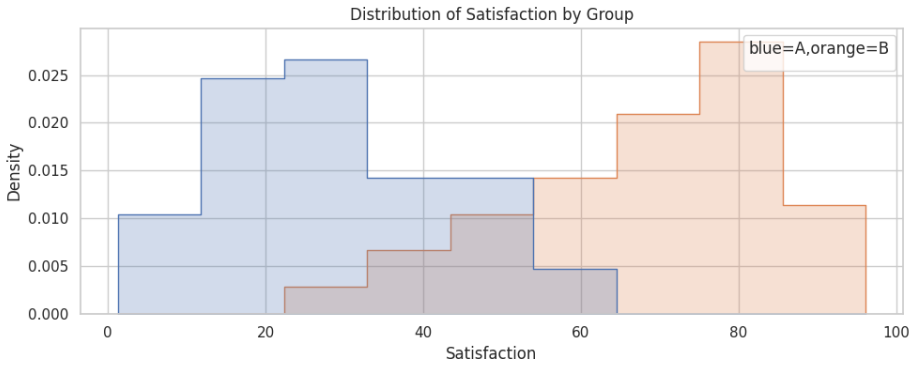
Interaction between Group and Gender:not Significant (p=0.27), indicating that the stress levels are not significantly affected by the combination of group and gender.

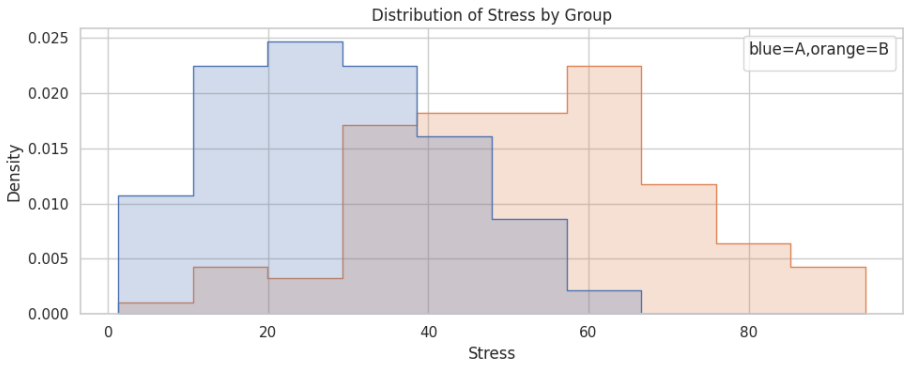
Graphic representation are shown as below:

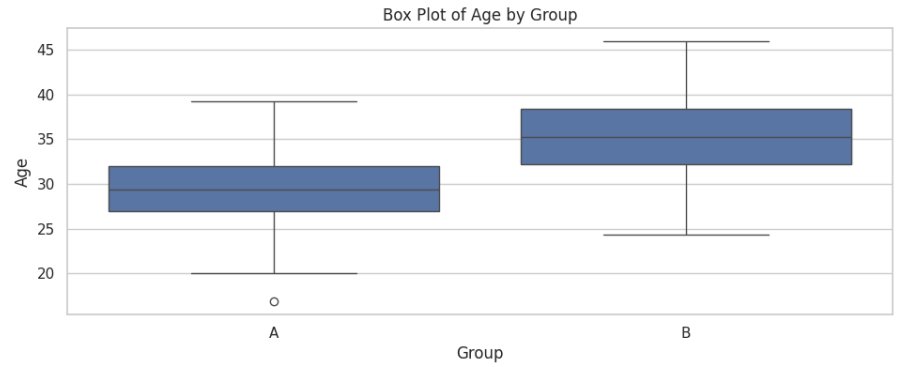

Distribution of Age by Group
blue=A,orange=B
Density
Age

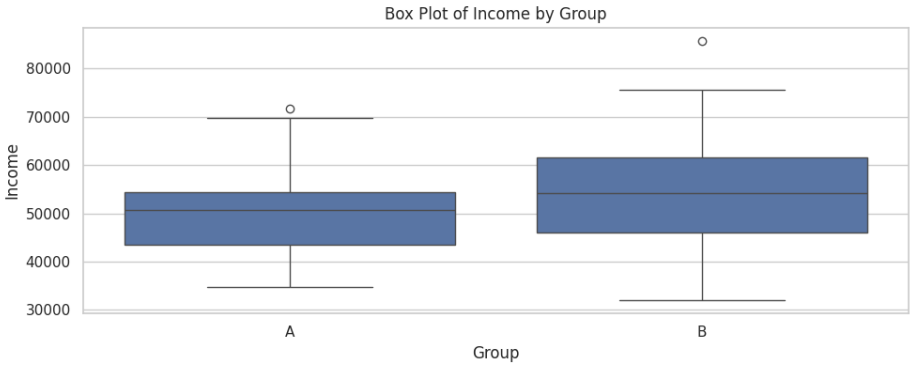

Distribution of Income by Group
1e−5
blue=A,orange=B
Density
Income

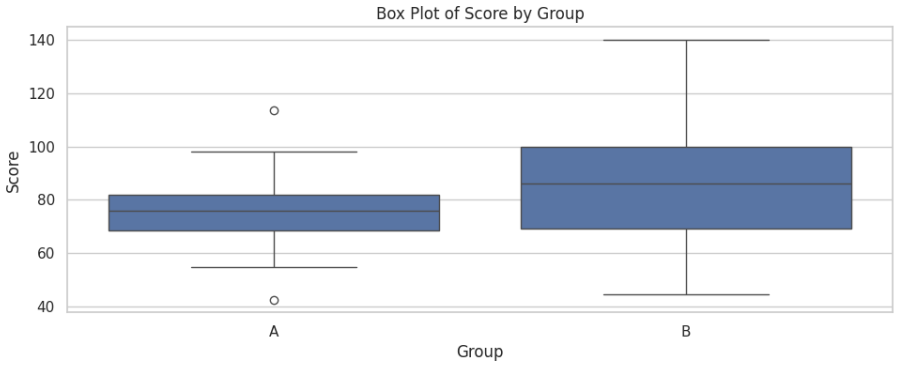

Distribution of Score by Group
blue=A,orange=B
Density
Score

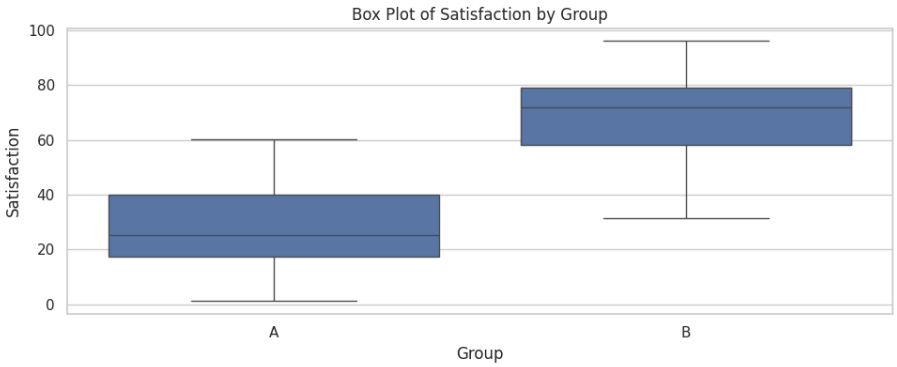

Distribution of Satisfaction by Group
blue=A,orange=B
Density
Satisfaction

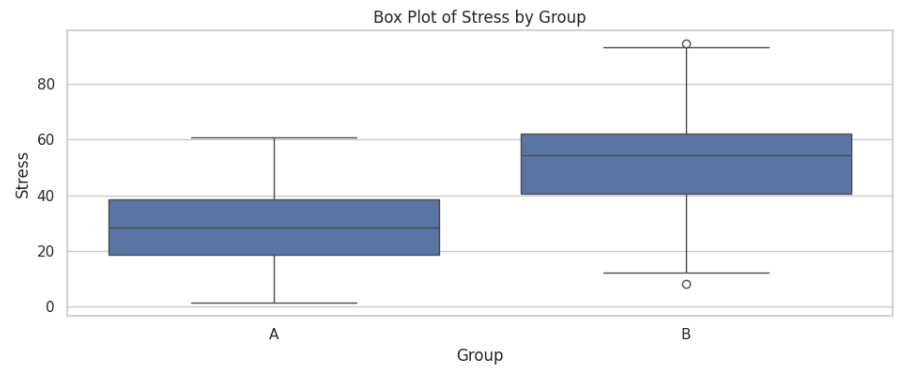

Distribution of Stress by Group
blue=A,orange=B
Density
Stress

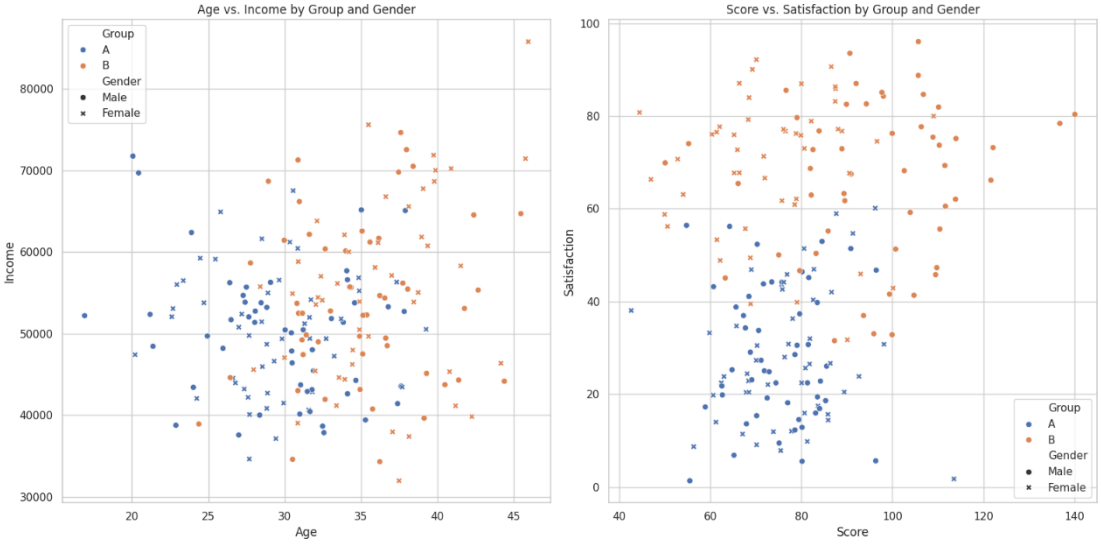

Box Plot of Age by Group
Age
45
40
35
30
25
20
A
B
Group


Box Plot of Income by Group
Income
80000
70000
60000
50000
40000
30000
A
B
Group


Box Plot of Score by Group
Score
140
120
100
80
60
40
A
B
Group


Box Plot of Satisfaction by Group
Satisfaction
100
80
60
40
20
0
A
B
Group


Box Plot of Stress by Group
Stress
80
60
40
20
0
A
B
Group



Age: significant difference in mean ages between groups A and B.

Income: significant difference in mean incomes

Score: indicating that the variances of scores are significantly different between the two groups.

Stress: indicating that the scores variances are minor differences between the two groups.

For Welch's t-tests for Score and Stress without assuming equal variances

Score: indicating a significant difference in scores between groups A and B.

Stress: The two groups have a highly significant difference in stress levels.

ANOVA to investigate interaction effects

Score:Group effect: Significant ($p=1.66\times10-6$).

Gender effect: Highly significant (p=3.11×10−7).
Interaction between Group and Gender: Extremely significant (p=1.7×10−13), suggesting that the effect of the group on scores differs by gender.

Stress:Group effect: showing a strong group effect on stress.
Gender effect: indicating that gender has a strong impact on stress.
Interaction between Group and Gender: indicating that the stress levels are not significantly affected by the combination of group and gender.

Visual Analysis: The histograms and box plots demonstrated the distribution characteristics of each group, reinforcing the statistical test findings. The customised colour coding (blue for Group A and orange for Group B) helped distinguish and compare the data more effectively.
Implications for Practice: These findings suggest that management strategies, training programs, or any interventions might need to be customised not only by the group but also by gender to address the different needs effectively. The result can be used to optimise performance and well-being in organisational settings.

Overall, the detailed data simulation, rigorous statistical testing, and clear visualisations have provided a comprehensive understanding of the dataset, which can inform strategic decision-making in a real-world context similar to our simulated scenario.

```
from scipy.stats import ttest_ind, levene

# T-tests for Age and Income
t_test_age = ttest_ind(data_A['Age'], data_B['Age'])
t_test_income = ttest_ind(data_A['Income'], data_B['Income'])

# F-test (Levene's test) for equality of variances in Score and stress
f_test_score = levene(data_A['Score'], data_B['Score'])
levene_stress = levene(data[data['Group'] == 'A']['Stress'], data[data['Group'] == 'B']['Stress'])
# Display the results of the tests
t_test_age, t_test_income, f_test_score, levene_stress
```

```
(TtestResult(statistic=-9.552217388696766, pvalue=5.053016668556966e-18, df=198.0),
 TtestResult(statistic=-3.2554470823191273, pvalue=0.001331661392154832, df=198.0),
 LeveneResult(statistic=5.776967132033392, pvalue=0.017159677483003618),
 LeveneResult(statistic=3.4382747890147676, pvalue=0.06518937054231835))
```

```python
from scipy.stats import ttest_ind
from statsmodels.formula.api import ols
import statsmodels.api as sm
# Welch's t-tests for Score and Stress without assuming equal variances
t_test_score_updated = ttest_ind(data[data['Group'] == 'A']['Score'], data[data['Group'] == 'B']['Score'], equal_var=False)
t_test_stress_updated = ttest_ind(data[data['Group'] == 'A']['Stress'], data[data['Group'] == 'B']['Stress'], equal_var=False)

# Conducting ANOVA to investigate interaction effects
# Setting up the model for Score with interaction between Group and Gender
model_score = ols('Score ~ C(Group) * C(Gender)', data=data).fit()
anova_score = sm.stats.anova_lm(model_score, typ=2)

# Setting up the model for Stress with interaction between Group and Gender
model_stress = ols('Stress ~ C(Group) * C(Gender)', data=data).fit()
anova_stress = sm.stats.anova_lm(model_stress, typ=2)

t_test_score_updated, t_test_stress_updated, anova_score, anova_stress
```

```
(TtestResult(statistic=-4.324036477897748, pvalue=2.7459523852894564e-05, df=153.43156353107798),
 TtestResult(statistic=-10.257281798013233, pvalue=6.747145607130168e-20, df=188.50119434270468),
                      sum_sq     df           F        PR(>F)
C(Group)           4666.702642    1.0   24.405650  1.668280e-06
C(Gender)          5369.424732    1.0   28.080705  3.115682e-07
C(Group):C(Gender) 7643.346301    1.0   39.972728  1.703255e-09
Residual          37477.949029  196.0         NaN           NaN,
                      sum_sq     df           F        PR(>F)
C(Group)          28337.086326    1.0  108.335078  1.771189e-20
C(Gender)          1510.647445    1.0    5.775333  1.718468e-02
C(Group):C(Gender)  309.142275    1.0    1.181877  2.783093e-01
Residual          51267.502778  196.0         NaN           NaN)
```