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In [ ]: #Load statistical analysis
import pandas as pd
from scipy.stats import f_oneway
from statsmodels.stats.multicomp import pairwise_tukeyhsd
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In [ ]: anova_data = pd.read_csv('treatment2.csv')
anova_data
```

```
Out[ ]:
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	Variables	PR1	PR2	PR3	DR1	DR2	DR3	MR1	MR2	MR3
0	CONTROL	20.33	21.48	20.85	642.7	594.30	603.67	106.4	113.26	103.99
1	NHT0254b	-2.93	-1.31	-2.34	497.2	526.34	512.53	132.5	138.13	132.77
2	NGB00749	1.75	1.69	1.74	1052.4	1059.70	1029.26	93.0	90.50	85.92
3	NHT356b	-4.45	-1.82	-0.88	582.4	545.93	549.94	160.6	151.67	168.40
4	NHT0343a	9.11	9.59	8.76	350.7	374.33	363.21	230.5	226.70	237.14
5	NHT0216a	1.91	1.95	1.89	749.4	755.19	740.74	104.6	102.27	102.18
6	NHT0366	-0.30	-0.05	-0.24	374.8	356.03	381.00	196.1	208.53	195.82
7	NHT0355a	-7.04	-1.34	-1.18	353.0	353.82	332.06	398.9	367.27	416.24
8	NHT034a	12.12	11.52	12.54	871.0	850.51	819.58	103.8	110.73	108.64
9	NHT0347	-10.92	-11.43	-3.94	1162.0	1099.16	1165.73	199.3	209.93	213.56
10	NHT0339a	-16.09	-1.87	-14.17	424.4	447.64	440.64	314.2	305.47	310.67
11	NHT0259a	-17.56	-12.12	-15.90	294.7	271.93	300.03	227.1	223.81	236.35
12	NGB00739	-0.13	-0.13	-0.03	698.3	666.36	748.54	176.0	176.83	175.70
13	NGB00711	3.93	3.75	4.06	210.7	217.59	223.25	221.3	223.21	235.37
14	NGB00733	-3.27	-0.82	-1.44	356.4	336.96	379.76	172.1	158.87	178.78

```
In [ ]: # Reshape the data to long format for Data P
data_pt = anova_data.melt(id_vars='Variables', value_vars=['PR1', 'PR2', 'PR3'],
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In [ ]: # Group the data by 'PT' and collect all values into lists (for ANOVA)
grouped_data = data_pt.groupby('Variables')['Value'].apply(list)

# Perform one-way ANOVA
anova_result = f_oneway(*grouped_data)
anova_result
```

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Out[ ]: F_onewayResult(statistic=35.50527199861019, pvalue=8.326226584879168e-15)
```

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In [ ]: # Perform Tukey's HSD test (ANOVA - POSTHOC)
tukey_result = pairwise_tukeyhsd(endog=data_pt['Value'], groups=data_pt['Variabl
result = tukey_result.summary()
pd.DataFrame(result).head(17)
```

Out[]:	0	1	2	3	4	5	6
0	group1	group2	meandiff	p-adj	lower	upper	reject
1	CONTROL	NGB00711	-16.9733	0.0	-24.8383	-9.1084	True
2	CONTROL	NGB00733	-22.73	0.0	-30.5949	-14.8651	True
3	CONTROL	NGB00739	-20.9833	0.0	-28.8483	-13.1184	True
4	CONTROL	NGB00749	-19.16	0.0	-27.0249	-11.2951	True
5	CONTROL	NHT0216a	-18.97	0.0	-26.8349	-11.1051	True
6	CONTROL	NHT0254b	-23.08	0.0	-30.9449	-15.2151	True
7	CONTROL	NHT0259a	-36.08	0.0	-43.9449	-28.2151	True
8	CONTROL	NHT0339a	-31.5967	0.0	-39.4616	-23.7317	True
9	CONTROL	NHT0343a	-11.7333	0.0005	-19.5983	-3.8684	True
10	CONTROL	NHT0347	-29.65	0.0	-37.5149	-21.7851	True
11	CONTROL	NHT034a	-8.8267	0.0169	-16.6916	-0.9617	True
12	CONTROL	NHT0355a	-24.0733	0.0	-31.9383	-16.2084	True
13	CONTROL	NHT0366	-21.0833	0.0	-28.9483	-13.2184	True
14	CONTROL	NHT356b	-23.27	0.0	-31.1349	-15.4051	True
15	NGB00711	NGB00733	-5.7567	0.3526	-13.6216	2.1083	False
16	NGB00711	NGB00739	-4.01	0.8455	-11.8749	3.8549	False

```
In [ ]: # Reshape the data to Long format for Data D
data_dt = anova_data.melt(id_vars='Variables', value_vars=['DR1', 'DR2', 'DR3'],
```

```
In [ ]: # Group the data by 'DT' and collect all values into lists (for ANOVA)
grouped_data = data_dt.groupby('Variables')['Value'].apply(list)

# Perform one-way ANOVA
anova_result = f_oneway(*grouped_data)
anova_result
```

```
Out[ ]: F_onewayResult(statistic=522.0569566426879, pvalue=7.887730813394322e-32)
```

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In [ ]: # Perform Tukey's HSD test (ANOVA - POSTHOC)
tukey_result = pairwise_tukeyhsd(endog=data_dt['Value'], groups=data_dt['Variabl
result = tukey_result.summary()
pd.DataFrame(result).head(17)
```

Out[]:	0	1	2	3	4	5	6
0	group1	group2	meandiff	p-adj	lower	upper	reject
1	CONTROL	NGB00711	-396.3767	0.0	-459.9035	-332.8499	True
2	CONTROL	NGB00733	-255.85	0.0	-319.3768	-192.3232	True
3	CONTROL	NGB00739	90.8433	0.0009	27.3165	154.3701	True
4	CONTROL	NGB00749	433.5633	0.0	370.0365	497.0901	True
5	CONTROL	NHT0216a	134.8867	0.0	71.3599	198.4135	True
6	CONTROL	NHT0254b	-101.5333	0.0002	-165.0601	-38.0065	True
7	CONTROL	NHT0259a	-324.67	0.0	-388.1968	-261.1432	True
8	CONTROL	NHT0339a	-175.9967	0.0	-239.5235	-112.4699	True
9	CONTROL	NHT0343a	-250.81	0.0	-314.3368	-187.2832	True
10	CONTROL	NHT0347	528.74	0.0	465.2132	592.2668	True
11	CONTROL	NHT034a	233.4733	0.0	169.9465	297.0001	True
12	CONTROL	NHT0355a	-267.2633	0.0	-330.7901	-203.7365	True
13	CONTROL	NHT0366	-242.9467	0.0	-306.4735	-179.4199	True
14	CONTROL	NHT356b	-54.1333	0.1611	-117.6601	9.3935	False
15	NGB00711	NGB00733	140.5267	0.0	76.9999	204.0535	True
16	NGB00711	NGB00739	487.22	0.0	423.6932	550.7468	True

```
In [ ]: # Reshape the data to Long format for Data M
data_mt = anova_data.melt(id_vars='Variables', value_vars=['MR1', 'MR2', 'MR3'],
```

```
In [ ]: # Group the data by 'DT' and collect all values into lists (for ANOVA)
grouped_data = data_mt.groupby('Variables')['Value'].apply(list)

# Perform one-way ANOVA
anova_result = f_oneway(*grouped_data)
anova_result
```

```
Out[ ]: F_onewayResult(statistic=281.3710259114196, pvalue=7.803091774193629e-28)
```

```
In [ ]: # Perform Tukey's HSD test (ANOVA - POSTHOC)
tukey_result = pairwise_tukeyhsd(endog=data_mt['Value'], groups=data_mt['Variabl
result = tukey_result.summary()
pd.DataFrame(result).head(17)
```

Out[]:

	0	1	2	3	4	5	6
0	group1	group2	meandiff	p-adj	lower	upper	reject
1	CONTROL	NGB00711	118.7433	0.0	92.9121	144.5746	True
2	CONTROL	NGB00733	62.0333	0.0	36.2021	87.8646	True
3	CONTROL	NGB00739	68.2933	0.0	42.4621	94.1246	True
4	CONTROL	NGB00749	-18.0767	0.4207	-43.9079	7.7546	False
5	CONTROL	NHT0216a	-4.8667	1.0	-30.6979	20.9646	False
6	CONTROL	NHT0254b	26.5833	0.0389	0.7521	52.4146	True
7	CONTROL	NHT0259a	121.2033	0.0	95.3721	147.0346	True
8	CONTROL	NHT0339a	202.23	0.0	176.3988	228.0612	True
9	CONTROL	NHT0343a	123.5633	0.0	97.7321	149.3946	True
10	CONTROL	NHT0347	99.7133	0.0	73.8821	125.5446	True
11	CONTROL	NHT034a	-0.16	1.0	-25.9912	25.6712	False
12	CONTROL	NHT0355a	286.2533	0.0	260.4221	312.0846	True
13	CONTROL	NHT0366	92.2667	0.0	66.4354	118.0979	True
14	CONTROL	NHT356b	52.34	0.0	26.5088	78.1712	True
15	NGB00711	NGB00733	-56.71	0.0	-82.5412	-30.8788	True
16	NGB00711	NGB00739	-50.45	0.0	-76.2812	-24.6188	True