Advanced Optimization Techniques - Assignment 4 - 21BCS085

In this folder, you can find all the logs, plots, csv results and [source code](source code.zip) to replicate the results.

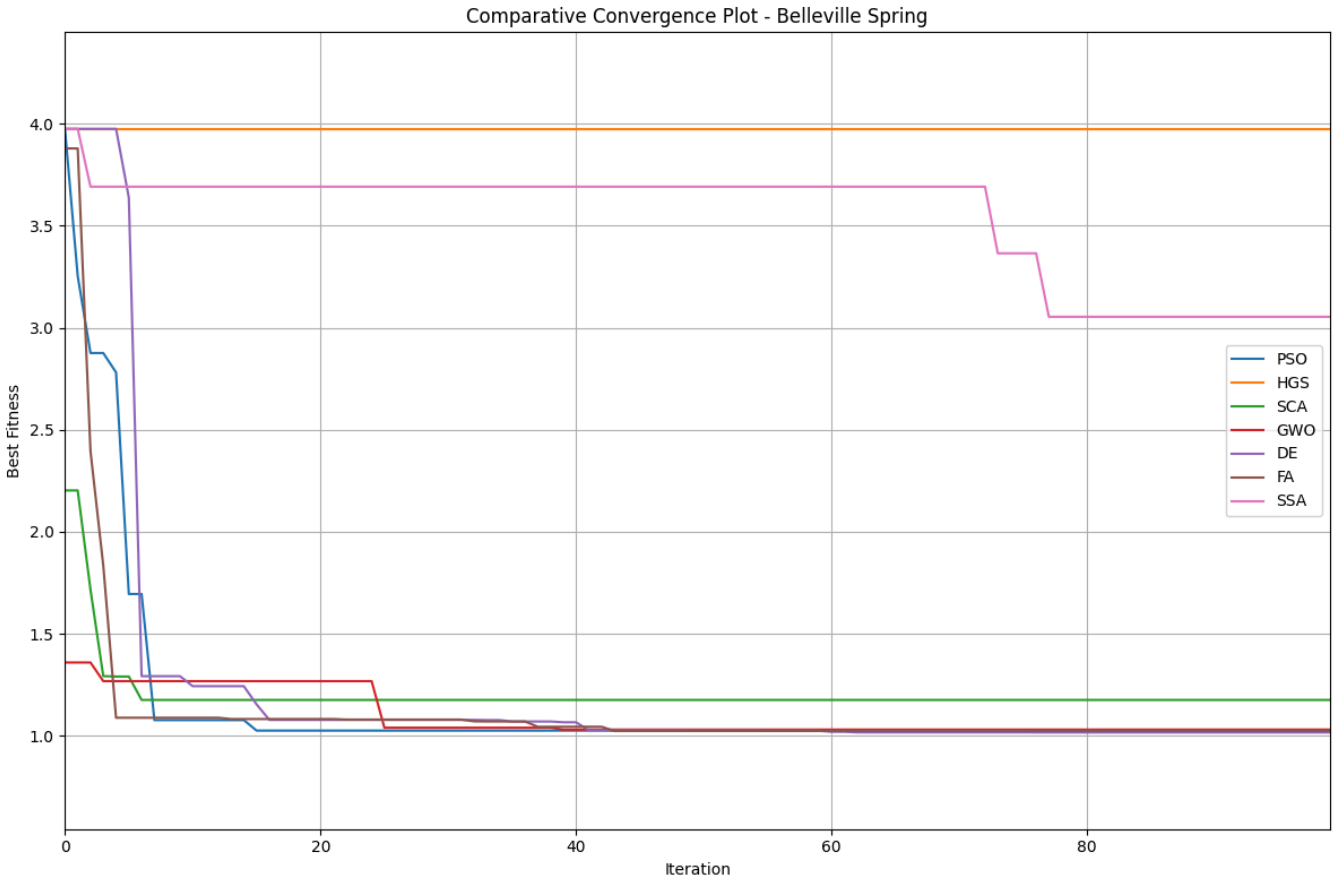
Logs contain all the terminal logs during the entire run.

Plots are detailed plots for each mechanical constrain problem run on 6 different meta heuristic algorithm

CSV Results summarize the performance metrics of each algorithm on each constraint problem at one place.

Plots for reference -

Belleville Spring

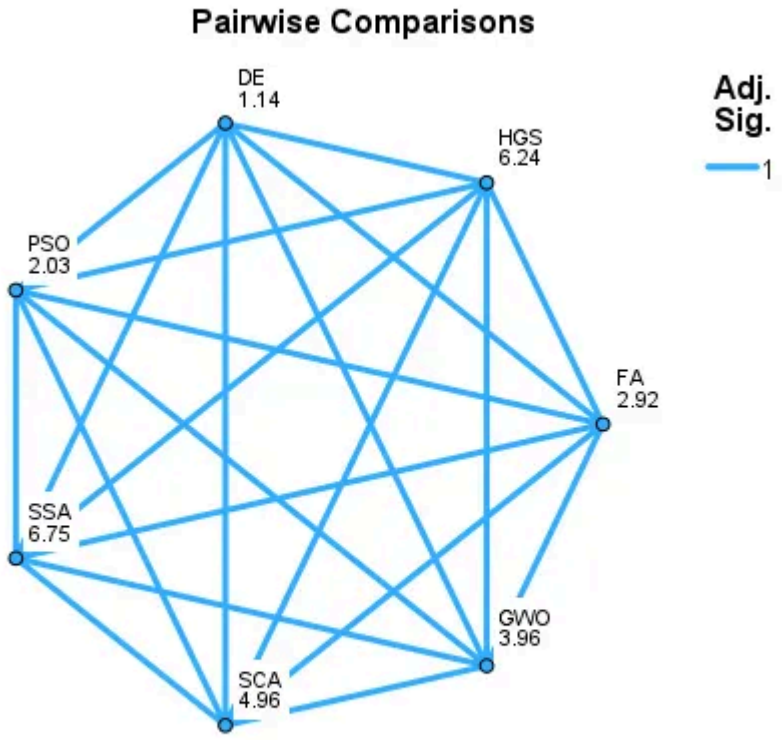


Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distributions of PSO, SCA, GWO, DE, FA, SSA and HGS are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.



Each node shows the sample number of successes.

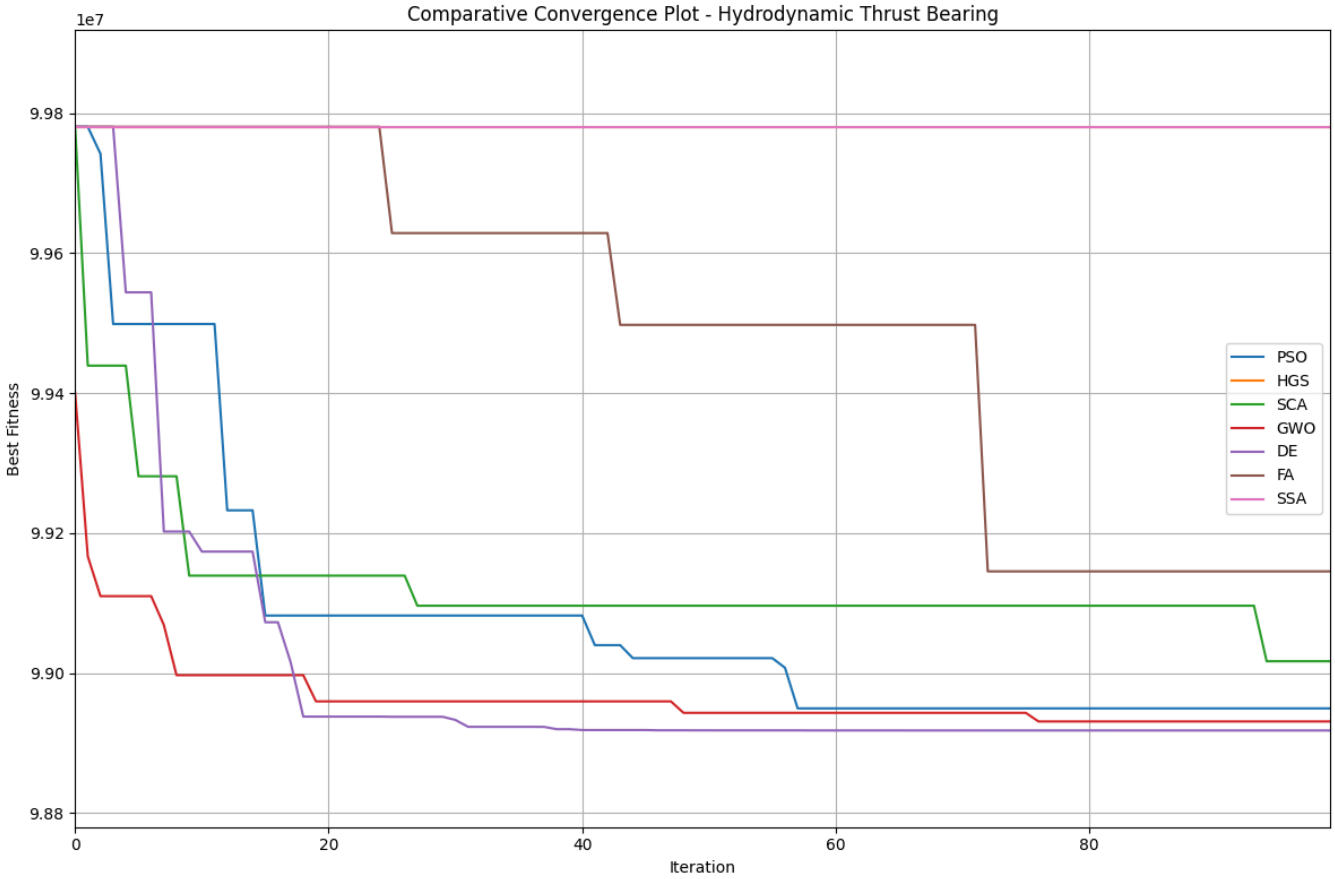
Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of PSO is normal with mean 1.0295281017438400 and standard deviation . 156814475028092.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
2	The distribution of SCA is normal with mean 1.1182046911407100 and standard deviation . 058210329095377.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
3	The distribution of GWO is normal with mean 1.0352096709374300 and standard deviation . 039432396372216.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
4	The distribution of DE is normal with mean 1.0375869063371000 and standard deviation . 225591424554313.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
5	The distribution of FA is normal with mean 1.0282961118279700 and standard deviation . 137763516907310.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
6	The distribution of SSA is normal with mean 2.9885064154685500 and standard deviation . 209341186424737.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
7	The distribution of HGS is normal with mean 1.8845923766478400 and standard deviation 1.199178983699370.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Lilliefors Corrected. Asymptotic significance is displayed.

Hydrodynamic Thrust Bearing

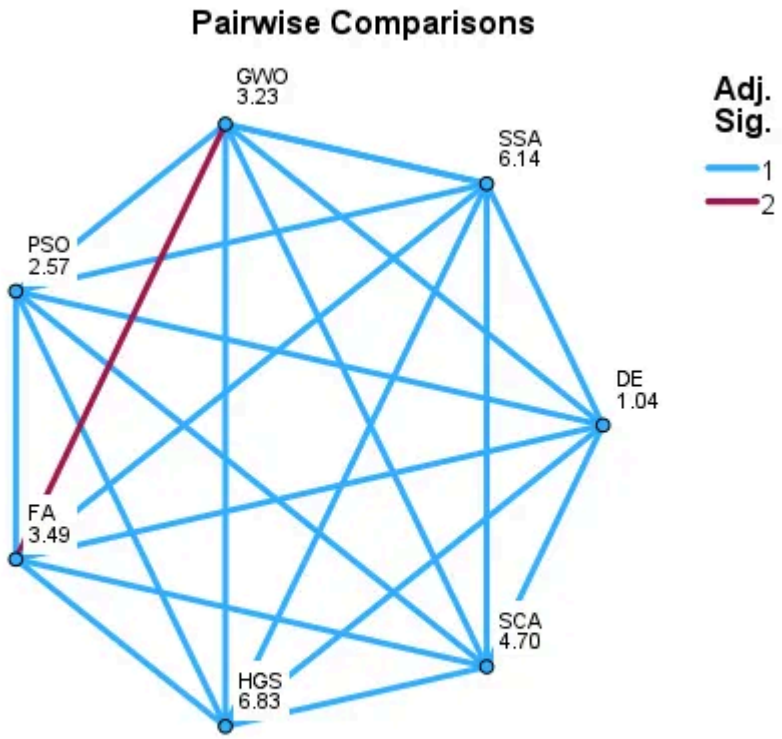


Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distributions of PSO, HGS, SCA, GWO, DE, FA and SSA are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.



Each node shows the sample number of successes.

Hypothesis Test Summary

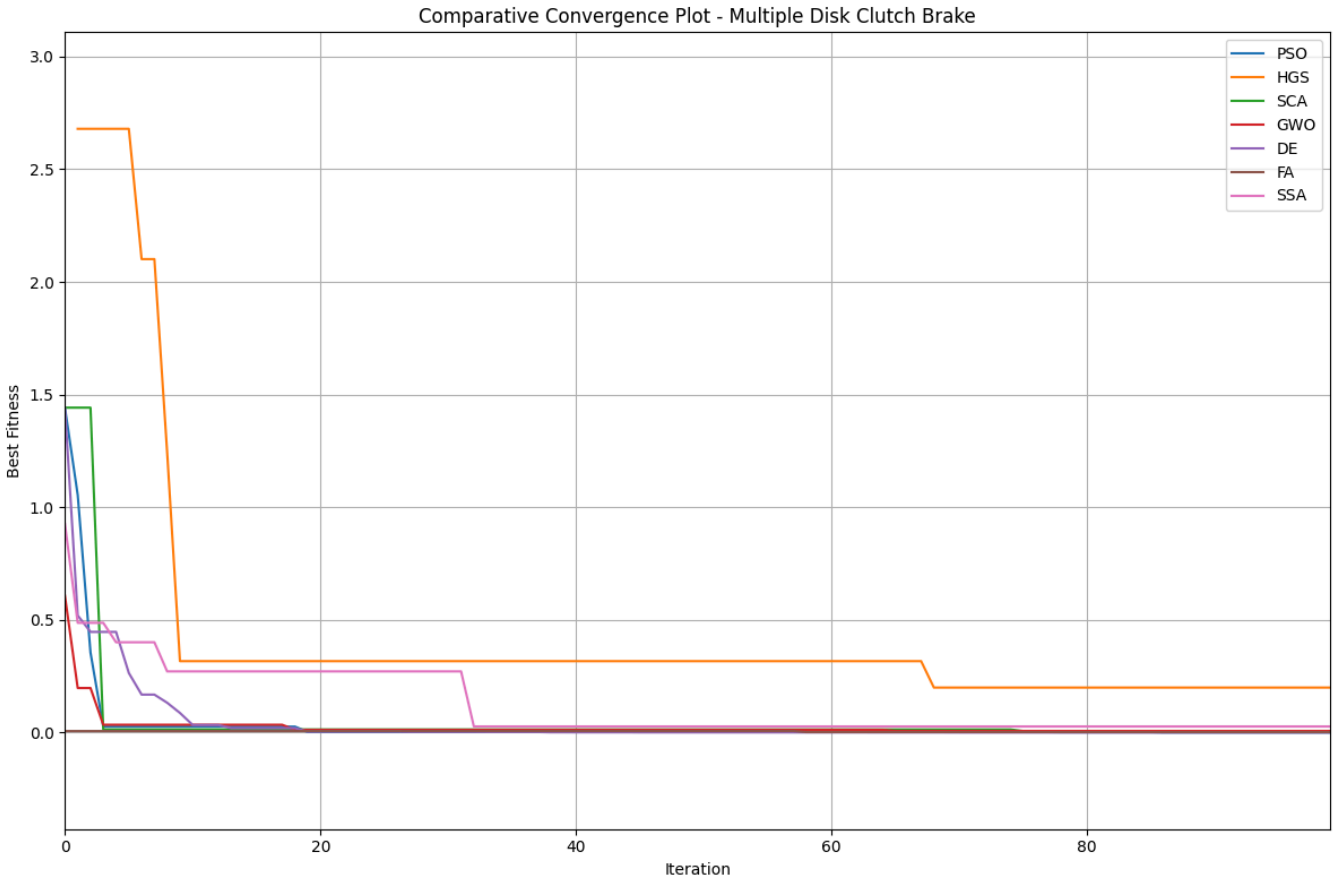
	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of PSO is normal with mean 98942269.09266190 and standard deviation 77786.05966229630.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
2	The distribution of HGS is normal with mean 99780511.49944340 and standard deviation .00000000000.	One-Sample Kolmogorov-Smirnov Test	.[c]	Unable to compute.
3	The distribution of SCA is normal with mean 99000533.81997360 and standard deviation 54262.20882239860.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
4	The distribution of GWO is normal with mean 98932587.63228950 and standard deviation 23299.66258299520.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
5	The distribution of DE is normal with mean 98925996.74363000 and standard deviation 68723.70014319090.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
6	The distribution of FA is normal with mean 99004401.54087000 and standard deviation 188658.14124029600.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
7	The distribution of SSA is normal with mean 99769990.50267740 and standard deviation 7342.82401940859.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Lilliefors Corrected. Asymptotic significance is displayed.

c. The specified standard deviation is not positive.

Multiple Disk Clutch Break

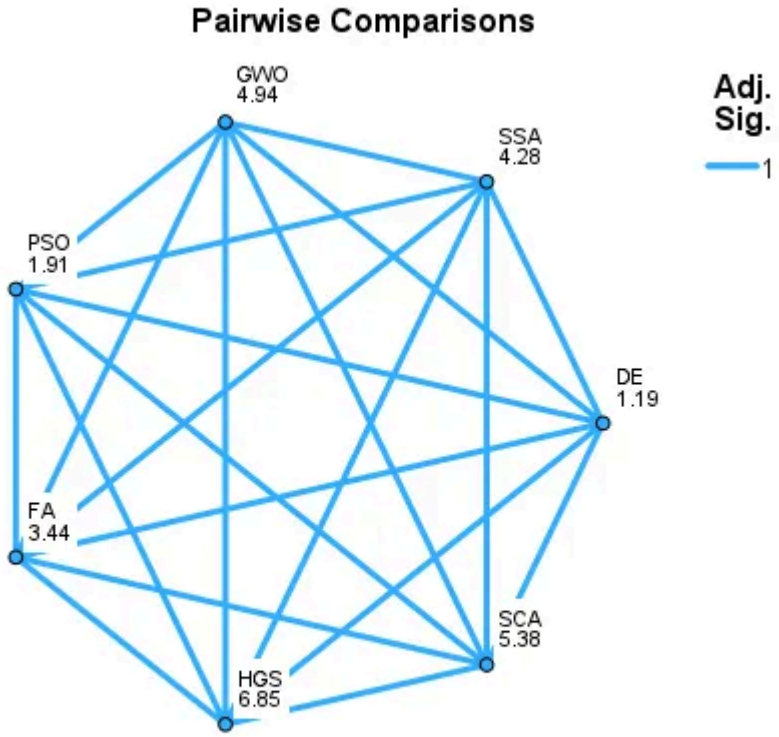


Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distributions of PSO, HGS, SCA, GWO, DE, FA and SSA are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.



Each node shows the sample number of successes.

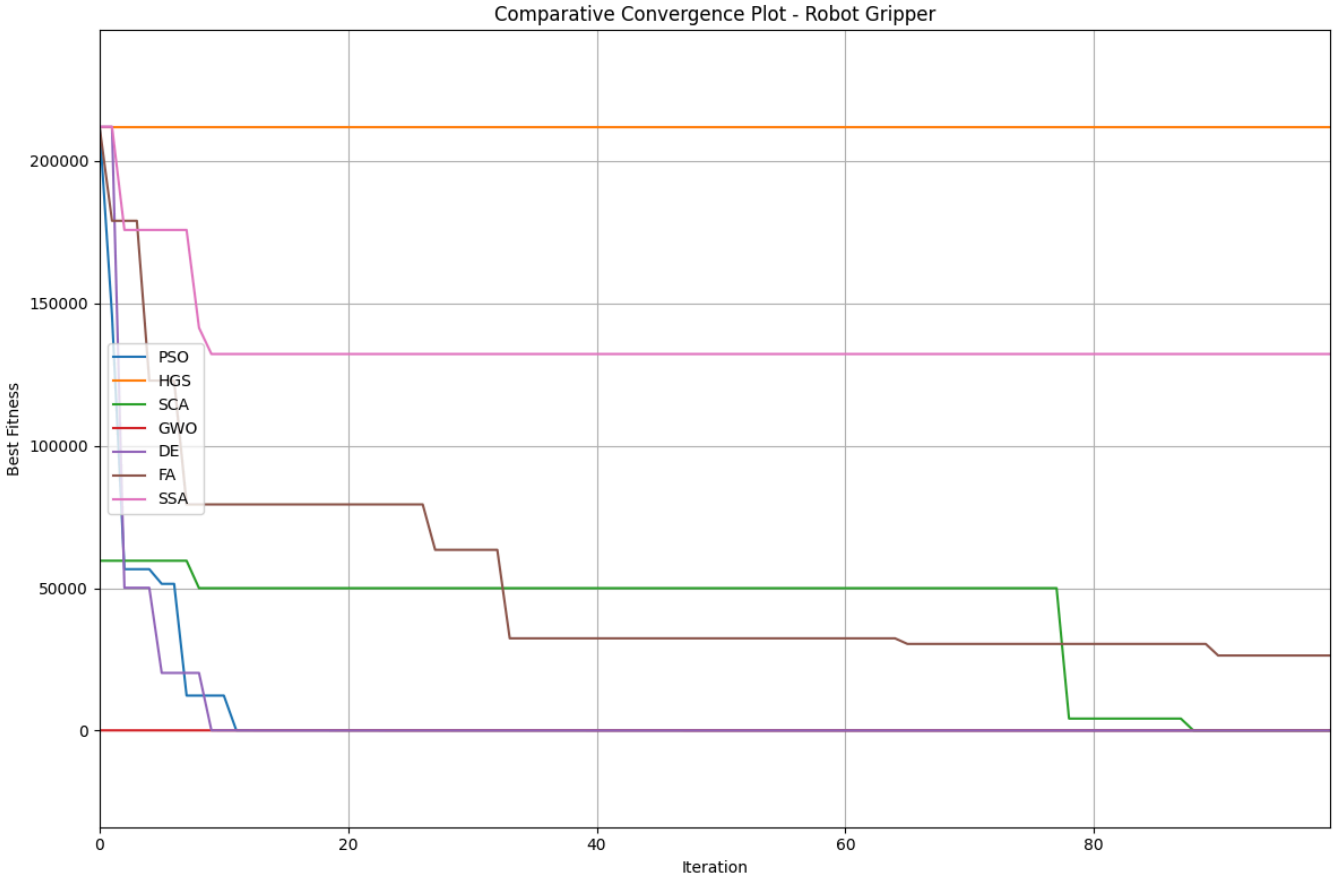
Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of PSO is normal with mean 3.457850184207940 E-003 and standard deviation 5.761413743541340E-002.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
2	The distribution of HGS is normal with mean . 079750650495044600 and standard deviation . 228346915490278.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
3	The distribution of SCA is normal with mean . 0077029912531903300 and standard deviation . 078780446284462.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
4	The distribution of GWO is normal with mean . 0049894402417532900 and standard deviation . 021512280102018.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
5	The distribution of DE is normal with mean 4.411524798591940 E-003 and standard deviation 5.556518857516880E-002.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
6	The distribution of FA is normal with mean . 00101133122413000000 and standard deviation . 001420487099044.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
7	The distribution of SSA is normal with mean 1.665797290737530 E-002 and standard deviation 6.204053664429130E-002.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Lilliefors Corrected. Asymptotic significance is displayed.

Robot Gripper

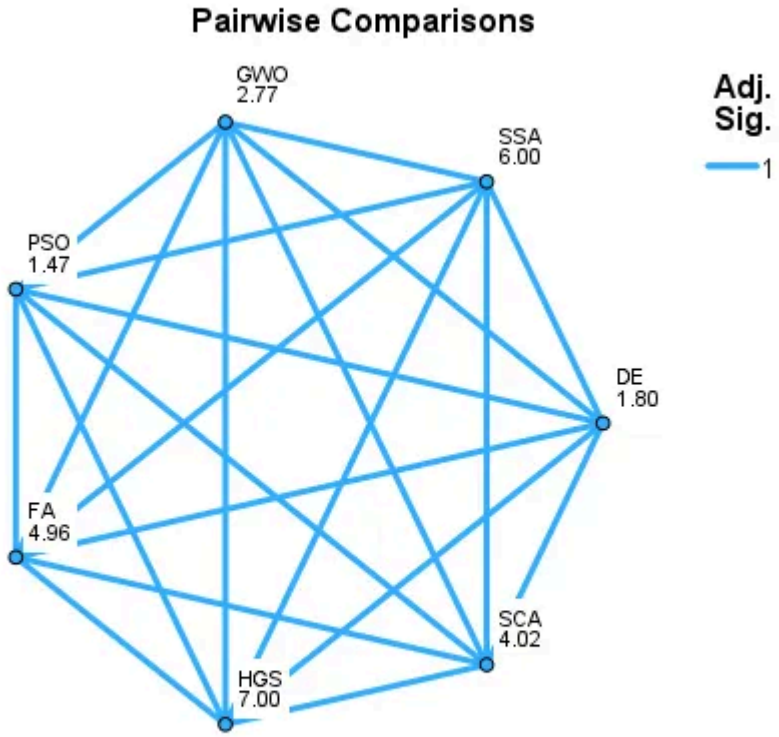


Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distributions of PSO, HGS, SCA, GWO, DE, FA and SSA are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.



Each node shows the sample number of successes.

Hypothesis Test Summary

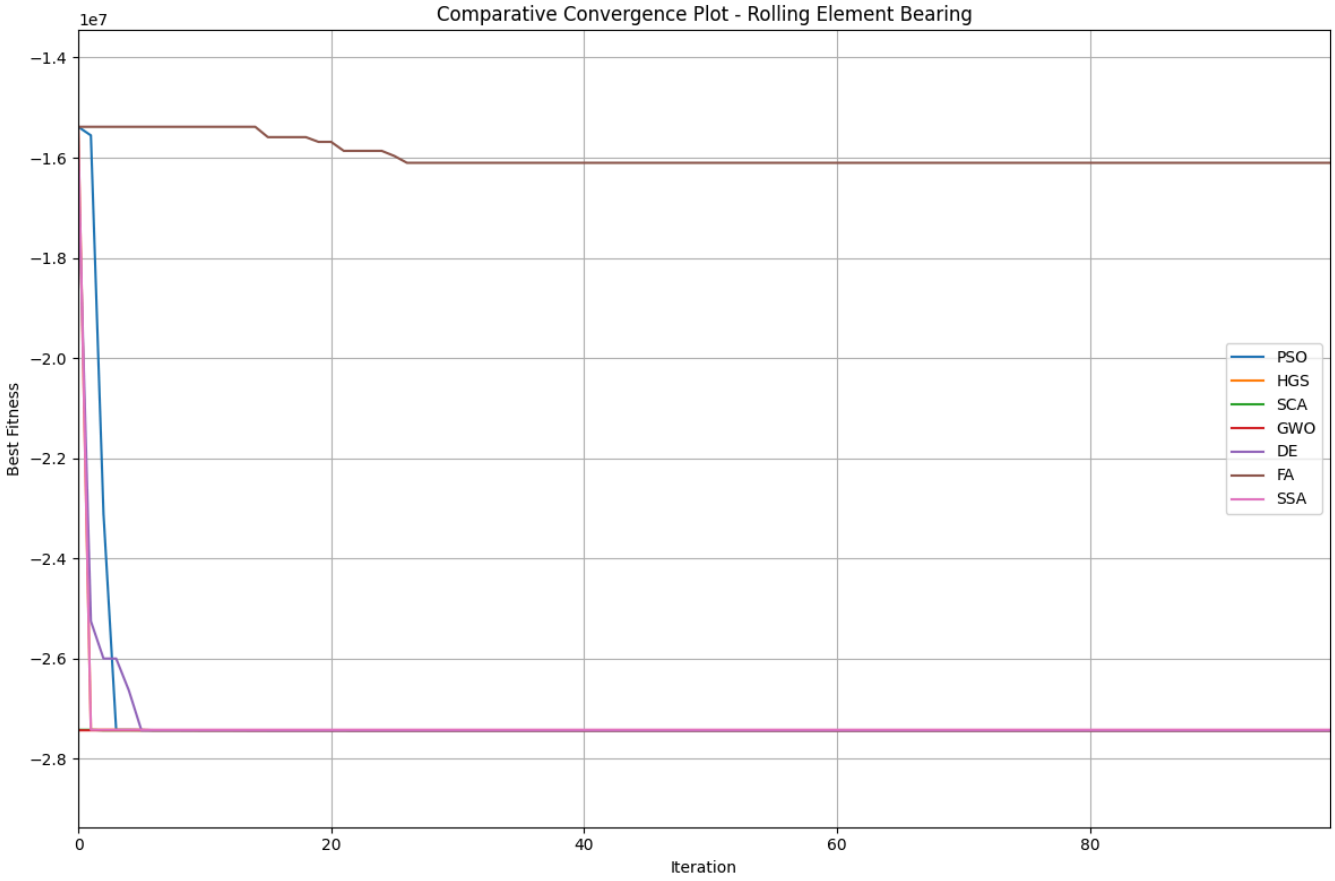
	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of PSO is normal with mean 735.401652562530000 and standard deviation 9012.004602655760000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
2	The distribution of HGS is normal with mean 211865.72528555900 and standard deviation .00000000000000.	One-Sample Kolmogorov-Smirnov Test	.[c]	Unable to compute.
3	The distribution of SCA is normal with mean 4079.20849644753000 and standard deviation 13680.617808210600000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
4	The distribution of GWO is normal with mean 55.777411789653700 and standard deviation 7.919427188089930.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
5	The distribution of DE is normal with mean 706.657018300082000 and standard deviation 9927.621550498450000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
6	The distribution of FA is normal with mean 28872.789340976300 and standard deviation 13857.835023962900000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
7	The distribution of SSA is normal with mean 131525.44049929100 and standard deviation 5047.05298639498000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Lilliefors Corrected. Asymptotic significance is displayed.

c. The specified standard deviation is not positive.

Rolling Element Bearing

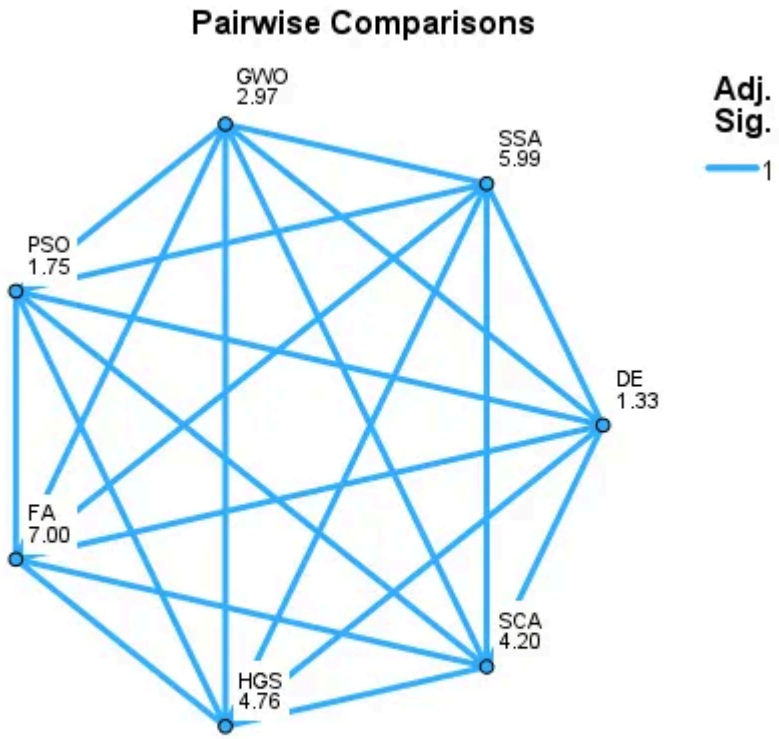


Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distributions of PSO, HGS, SCA, GWO, DE, FA and SSA are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.



Each node shows the sample number of successes.

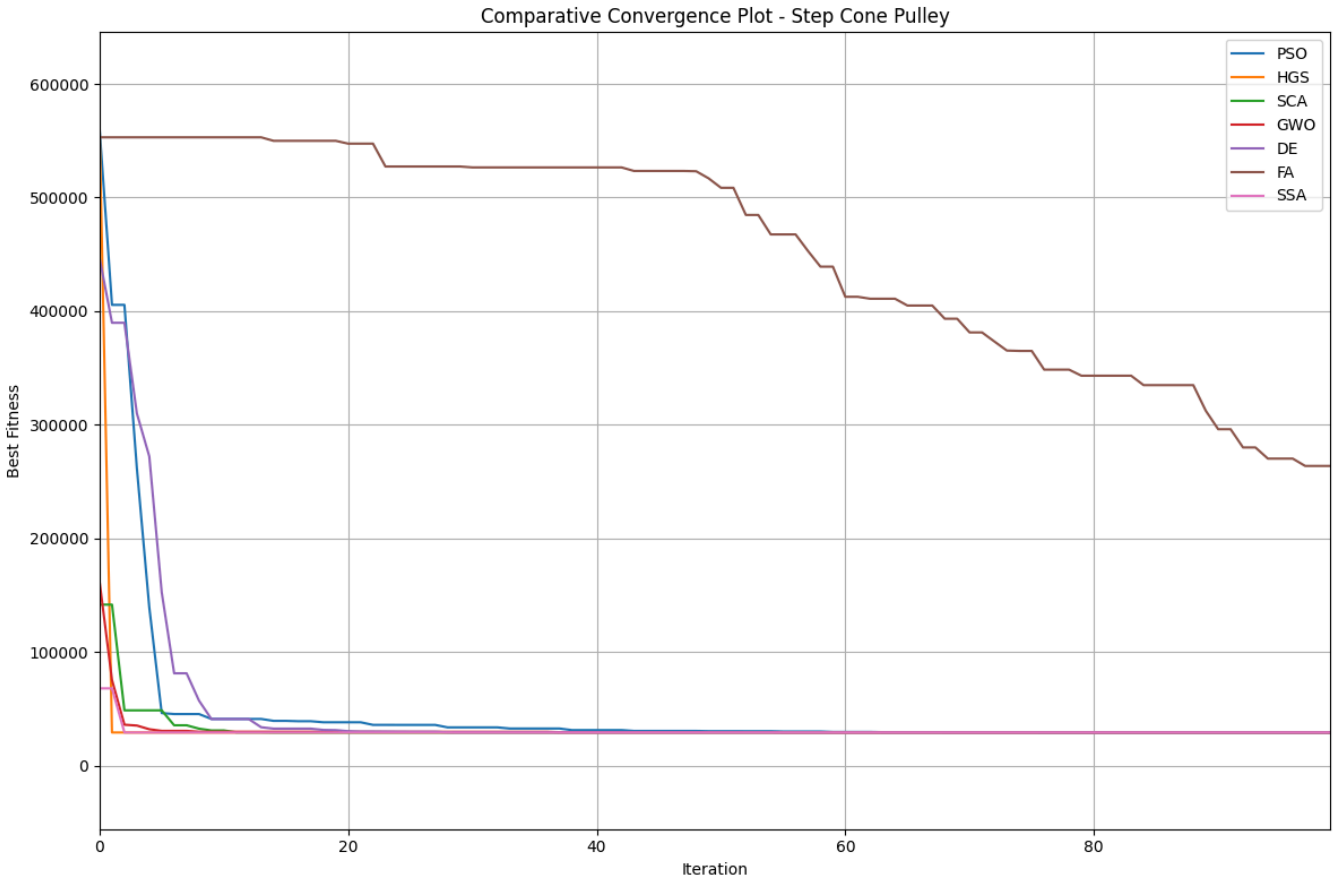
Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of PSO is normal with mean -27403779.957083200 and standard deviation 551726.391697127000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
2	The distribution of HGS is normal with mean -27417145.748101100 and standard deviation 380920.171515773000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
3	The distribution of SCA is normal with mean -27429799.662423600 and standard deviation 700.275617360503.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
4	The distribution of GWO is normal with mean -27431907.655951700 and standard deviation 326.379372076323.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
5	The distribution of DE is normal with mean -27415058.759704000 and standard deviation 367150.754433926000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
6	The distribution of FA is normal with mean -16584237.973636400 and standard deviation 399643.018542436000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
7	The distribution of SSA is normal with mean -27405631.130659300 and standard deviation 380554.776532290000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Lilliefors Corrected. Asymptotic significance is displayed.

Step Cone Pulley

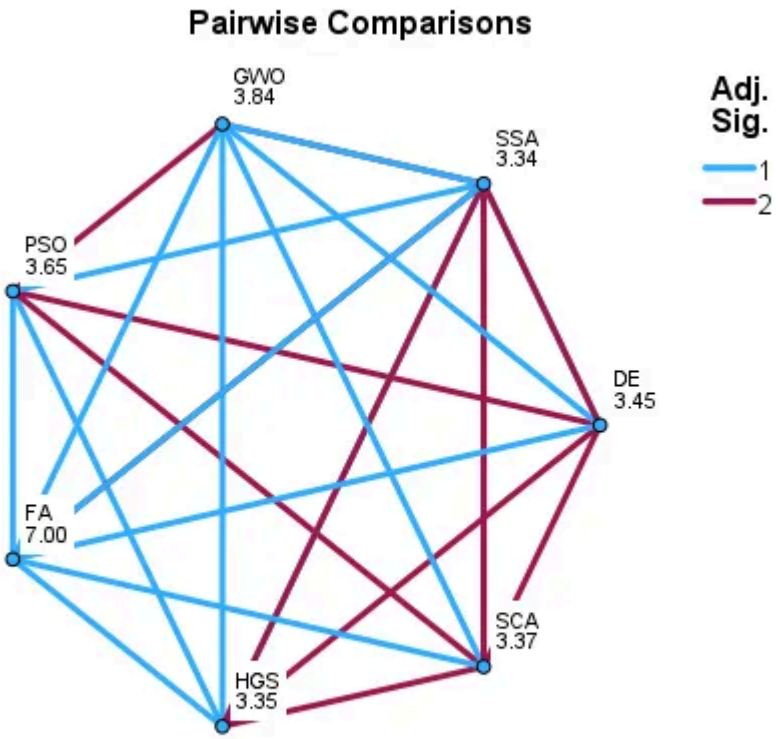


Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distributions of PSO, HGS, SCA, GWO, DE, FA and SSA are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.



Each node shows the sample number of successes.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of PSO is normal with mean 31029.752185380400 and standard deviation 25139.572342901000000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
2	The distribution of HGS is normal with mean 29619.4277396715 and standard deviation 16805.2206915702000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
3	The distribution of SCA is normal with mean 29411.122444099300 and standard deviation 5184.090558437290000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
4	The distribution of GWO is normal with mean 29317.311486357600 and standard deviation 4455.279295294100000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
5	The distribution of DE is normal with mean 31082.678415144300 and standard deviation 24316.475056157100000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
6	The distribution of FA is normal with mean 176614.84029157300 and standard deviation 102650.94287767100000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.
7	The distribution of SSA is normal with mean 29165.71286571970 and standard deviation 1736.84256101837000.	One-Sample Kolmogorov-Smirnov Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Lilliefors Corrected. Asymptotic significance is displayed.