

# Results

## Descriptive Statistics

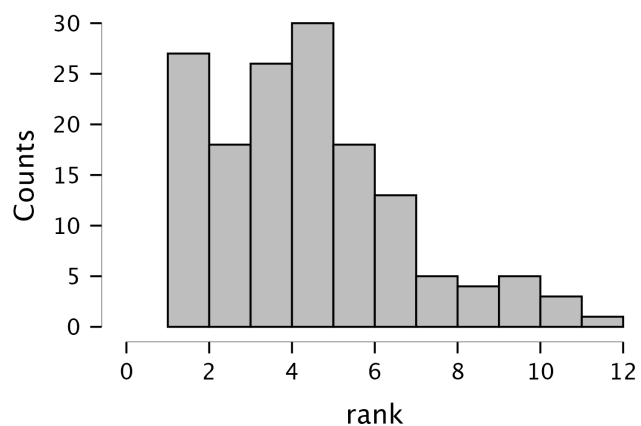
Descriptive Statistics

		Valid	Missing	Mean	Std. Deviation	Variance	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis	Shapiro-Wilk	P-val
rank	adadelta	150	0	4.780	2.457	6.039	0.582	0.198	0.206	0.394	0.950	
rank	adagrad	150	0	3.580	2.004	4.017	0.644	0.198	−0.351	0.394	0.922	
rank	adam	150	0	3.687	2.990	8.941	1.240	0.198	0.646	0.394	0.820	
rank	bhh	150	0	7.720	2.790	7.787	−0.528	0.198	−0.440	0.394	0.949	
rank	bhh_gd_only	150	0	4.900	2.314	5.352	0.819	0.198	0.056	0.394	0.922	
rank	de	150	0	10.753	1.776	3.154	−1.588	0.198	2.234	0.394	0.737	
rank	ga	150	0	8.253	1.987	3.949	−0.903	0.198	0.949	0.394	0.921	
rank	momentum	150	0	9.167	2.648	7.012	−0.831	0.198	−0.374	0.394	0.880	
rank	nag	150	0	4.753	1.983	3.932	−0.458	0.198	−0.488	0.394	0.926	
rank	pso	150	0	8.573	2.428	5.897	−1.135	0.198	1.592	0.394	0.901	
rank	rmsprop	150	0	3.420	3.046	9.279	1.651	0.198	1.948	0.394	0.754	
rank	sgd	150	0	8.413	2.428	5.895	−0.790	0.198	−0.048	0.394	0.920	

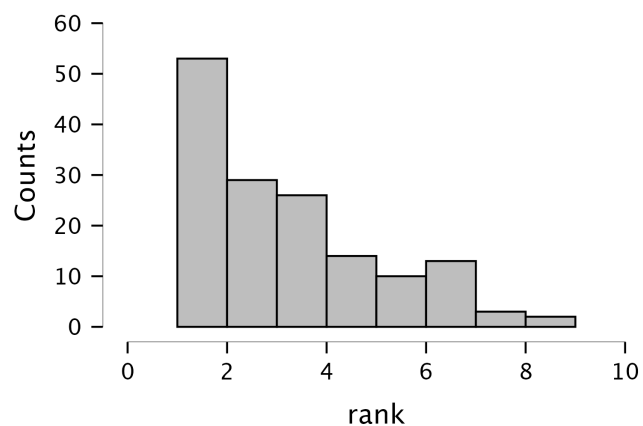


rank

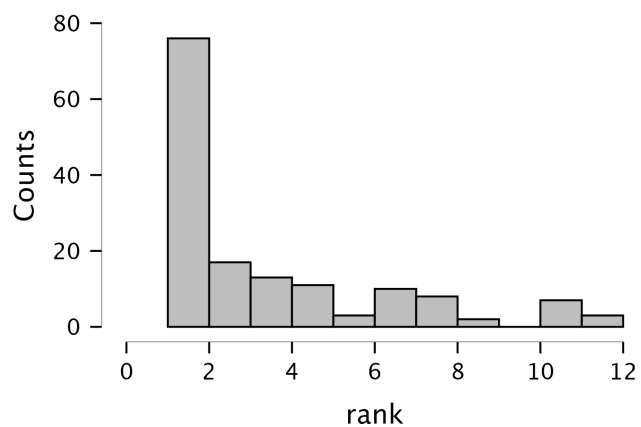
adadelta



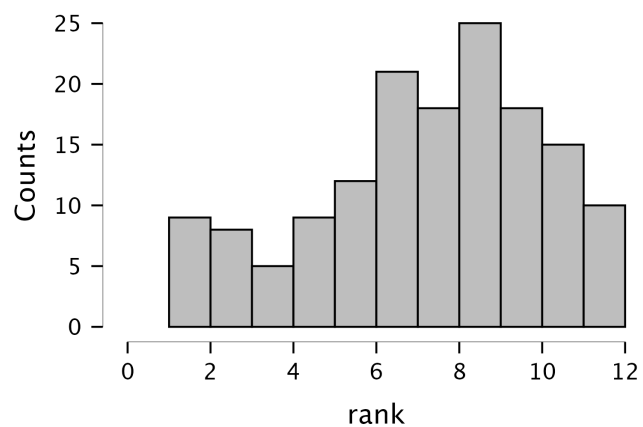
adagrad



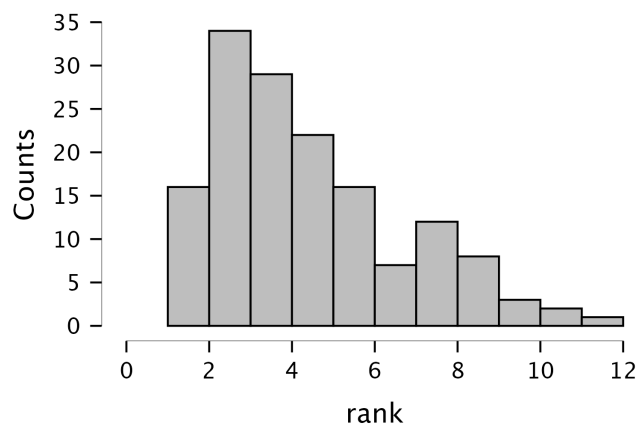
adam



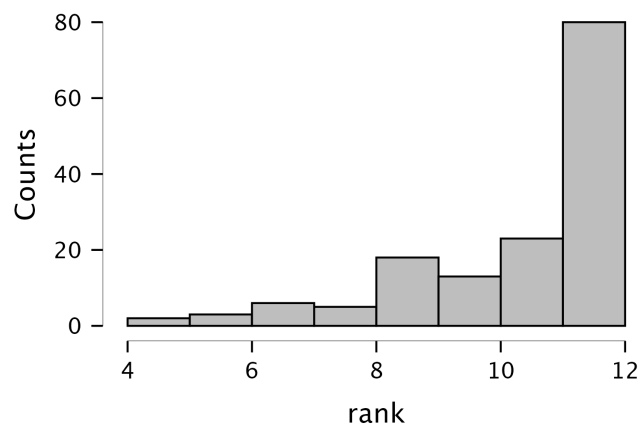
bhh



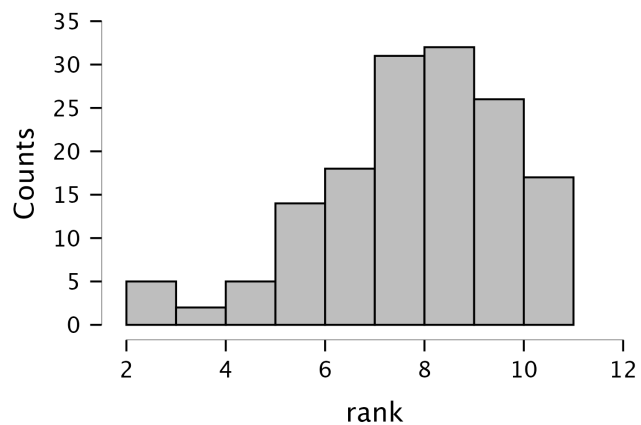
bhh\_gd\_only



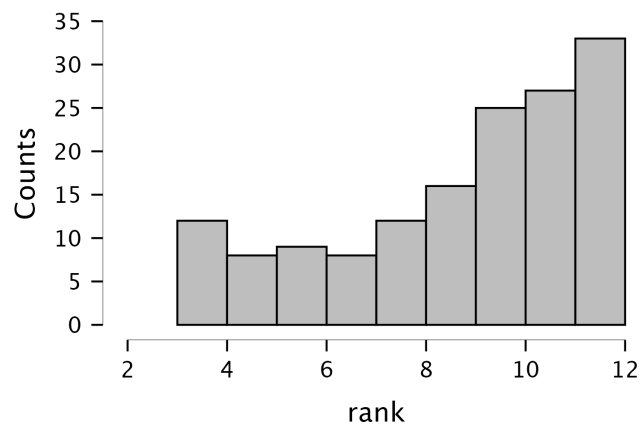
de



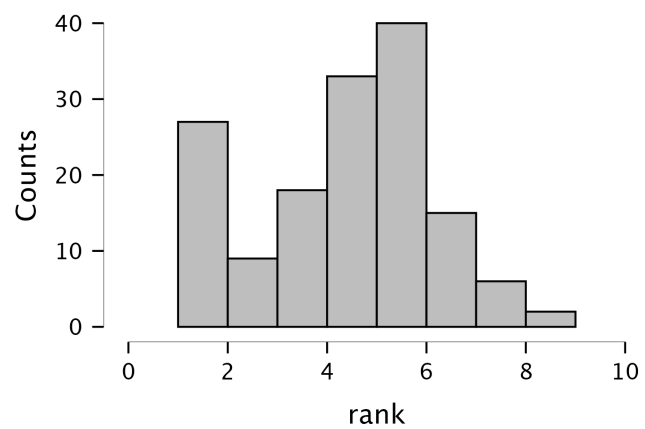
ga



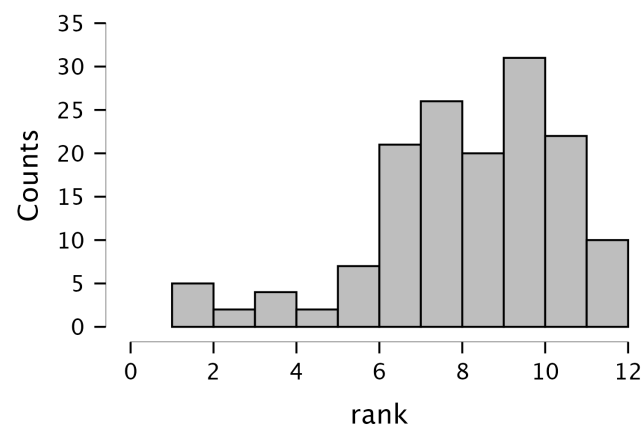
momentum



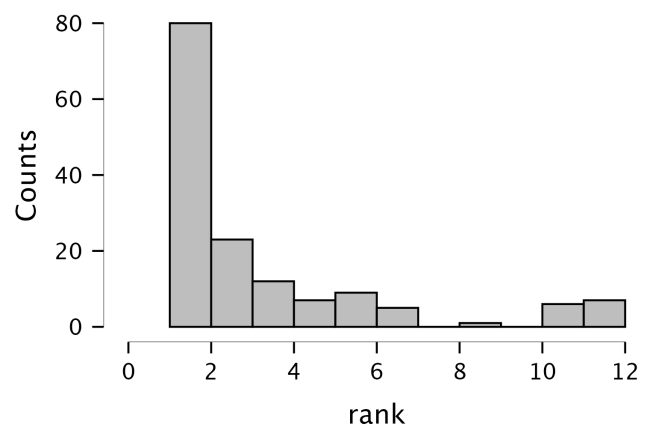
nag



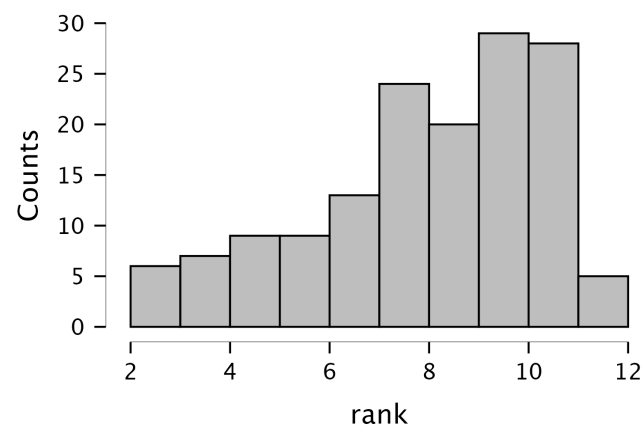
pso



rmsprop

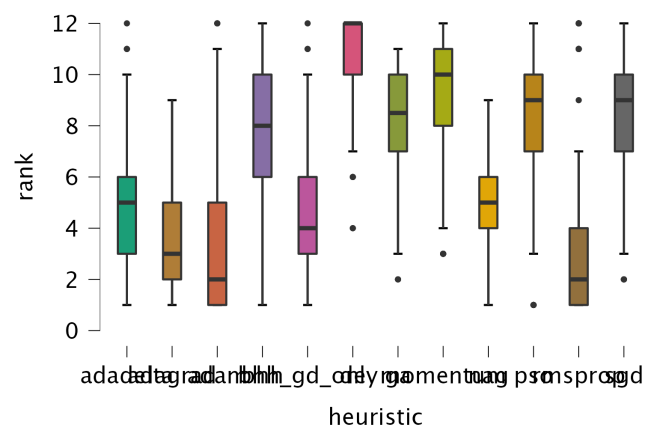


sgd



Boxplots

rank



ANOVA

ANOVA – rank

Cases	Sum of Squares	df	Mean Square	F	p
heuristic	10833.147	11	984.832	165.857	< .001
Residuals	10616.853	1788	5.938		

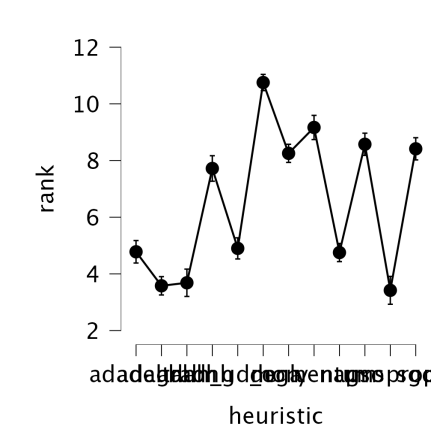
Note. Type III Sum of Squares

Descriptives

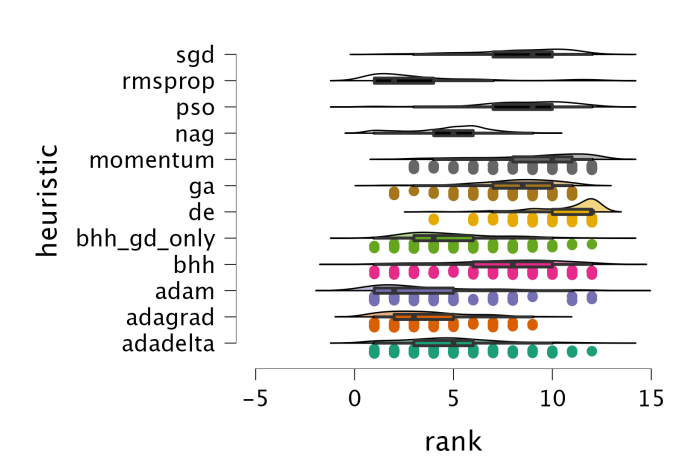
Descriptives – rank

heuristic	Mean	SD	N
adadelta	4.780	2.457	150
adagrad	3.580	2.004	150
adam	3.687	2.990	150
bhh	7.720	2.790	150
bhh_gd_only	4.900	2.314	150
de	10.753	1.776	150
ga	8.253	1.987	150
momentum	9.167	2.648	150
nag	4.753	1.983	150
pso	8.573	2.428	150
rmsprop	3.420	3.046	150
sgd	8.413	2.428	150

Descriptives plots



Raincloud plots



Assumption Checks

Test for Equality of Variances (Levene's)

F	df1	df2	p
7.124	11.000	1788.000	< .001

Post Hoc Tests

Standard

Post Hoc Comparisons – heuristic

		95% CI for Mean Difference			SE	t	Ptukey
		Mean Difference	Lower	Upper			
adadelata	adagrad	1.200	0.279	2.121	0.281	4.265	0.001**
	adam	1.093	0.173	2.014	0.281	3.886	0.006**
	bhh	−2.940	−3.861	−2.019	0.281	−10.449	< .001***
	bhh_gd_only	−0.120	−1.041	0.801	0.281	−0.426	1.000
	de	−5.973	−6.894	−5.053	0.281	−21.229	< .001***
	ga	−3.473	−4.394	−2.553	0.281	−12.344	< .001***
	momentum	−4.387	−5.307	−3.466	0.281	−15.590	< .001***
	nag	0.027	−0.894	0.947	0.281	0.095	1.000
	pso	−3.793	−4.714	−2.873	0.281	−13.481	< .001***
	rmsprop	1.360	0.439	2.281	0.281	4.833	< .001***
adagrad	sgd	−3.633	−4.554	−2.713	0.281	−12.913	< .001***
	adam	−0.107	−1.027	0.814	0.281	−0.379	1.000
	bhh	−4.140	−5.061	−3.219	0.281	−14.714	< .001***
	bhh_gd_only	−1.320	−2.241	−0.399	0.281	−4.691	< .001***
	de	−7.173	−8.094	−6.253	0.281	−25.494	< .001***
	ga	−4.673	−5.594	−3.753	0.281	−16.609	< .001***
	momentum	−5.587	−6.507	−4.666	0.281	−19.855	< .001***
	nag	−1.173	−2.094	−0.253	0.281	−4.170	0.002**
	pso	−4.993	−5.914	−4.073	0.281	−17.746	< .001***
	rmsprop	0.160	−0.761	1.081	0.281	0.569	1.000
adam	sgd	−4.833	−5.754	−3.913	0.281	−17.178	< .001***
	bhh	−4.033	−4.954	−3.113	0.281	−14.334	< .001***
	bhh_gd_only	−1.213	−2.134	−0.293	0.281	−4.312	0.001**
	de	−7.067	−7.987	−6.146	0.281	−25.115	< .001***
	ga	−4.567	−5.487	−3.646	0.281	−16.230	< .001***
	momentum	−5.480	−6.401	−4.559	0.281	−19.476	< .001***
	nag	−1.067	−1.987	−0.146	0.281	−3.791	0.009**
	pso	−4.887	−5.807	−3.966	0.281	−17.367	< .001***
	rmsprop	0.267	−0.654	1.187	0.281	0.948	0.999
	sgd	−4.727	−5.647	−3.806	0.281	−16.799	< .001***
bhh	bhh_gd_only	2.820	1.899	3.741	0.281	10.022	< .001***
	de	−3.033	−3.954	−2.113	0.281	−10.780	< .001***
	ga	−0.533	−1.454	0.387	0.281	−1.895	0.762
	momentum	−1.447	−2.367	−0.526	0.281	−5.141	< .001***
	nag	2.967	2.046	3.887	0.281	10.544	< .001***
	pso	−0.853	−1.774	0.067	0.281	−3.033	0.100
	rmsprop	4.300	3.379	5.221	0.281	15.282	< .001***
	sgd	−0.693	−1.614	0.227	0.281	−2.464	0.364
	de	−5.853	−6.774	−4.933	0.281	−20.803	< .001***
	ga	−3.353	−4.274	−2.433	0.281	−11.918	< .001***
bhh_gd_only	momentum	−4.267	−5.187	−3.346	0.281	−15.164	< .001***
	nag	0.147	−0.774	1.067	0.281	0.521	1.000
	pso	−3.673	−4.594	−2.753	0.281	−13.055	< .001***
	rmsprop	1.480	0.559	2.401	0.281	5.260	< .001***
	sgd	−3.513	−4.434	−2.593	0.281	−12.486	< .001***
	ga	2.500	1.579	3.421	0.281	8.885	< .001***
	momentum	1.587	0.666	2.507	0.281	5.639	< .001***
	nag	6.000	5.079	6.921	0.281	21.324	< .001***
	pso	2.180	1.259	3.101	0.281	7.748	< .001***
	rmsprop	7.333	6.413	8.254	0.281	26.063	< .001***
de	sgd	2.340	1.419	3.261	0.281	8.316	< .001***
	ga	−0.913	−1.834	0.007	0.281	−3.246	0.054
	momentum	−0.913	−1.834	0.007	0.281	−3.246	0.054
	nag	3.500	2.579	4.421	0.281	12.439	< .001***
	pso	−0.320	−1.241	0.601	0.281	−1.137	0.993
	rmsprop	4.833	3.913	5.754	0.281	17.178	< .001***
	sgd	−0.160	−1.081	0.761	0.281	−0.569	1.000
	momentum	4.413	3.493	5.334	0.281	15.685	< .001***
	pso	0.593	−0.327	1.514	0.281	2.109	0.617
	rmsprop	5.747	4.826	6.667	0.281	20.424	< .001***
ga	sgd	0.753	−0.167	1.674	0.281	2.677	0.238
	nag	−3.820	−4.741	−2.899	0.281	−13.576	< .001***
	rmsprop	1.333	0.413	2.254	0.281	4.739	< .001***
	sgd	−3.660	−4.581	−2.739	0.281	−13.008	< .001***
	pso	5.153	4.233	6.074	0.281	18.315	< .001***
	sgd	0.160	−0.761	1.081	0.281	0.569	1.000
	rmsprop	−4.993	−5.914	−4.073	0.281	−17.746	< .001***
	sgd						
	sgd						
	sgd						

Note. P-value and confidence intervals adjusted for comparing a family of 12 estimates (confidence intervals corrected using the tukey method).

\* p < .05, \*\* p < .01, \*\*\* p < .001

Kruskal–Wallis Test

Kruskal–Wallis Test

Factor	Statistic	df	p
heuristic	908.570	11	< .001

