

### CEC 2017 Benchmark Functions

#### baseCSA and modifiedCSA comparison with seven other Meta-Heuristic Algorithms

Function	BestAlgorithm	BaseCSA_Mean	ModCSA_Mean	ABC_Mean	DE_Mean	GA_custom_Mean	GWO_Mean	PSO_Mean	SSA_Mean	WOA_Mean
F1	DE	78195759276	67726593168	7548.30224	100	2896.476259	299532477.2	15501660038	10113.50154	44924452724
F2	DE	1.72E+42	2.42E+41	2.79E+38	312.4619755	43570250.64	4.35E+21	3.83E+36	60539608137	3.15E+31
F3	PSO	154777.8146	157331.3386	203079.7979	300	14227.52513	37584.46907	300	366.9983631	86776.846
F4	DE	13862.29872	15969.24105	515.9059002	400.4494704	497.1909556	526.2550416	841.7155479	533.554205	6752.862978
F5	DE	926.6633492	976.3745576	798.7081464	522.8840533	662.2805458	549.5430296	731.2914902	590.5410167	814.0365408
F6	DE	705.26199	703.4302022	600.0370871	600.0000001	651.6766993	602.5759566	621.9745028	620.8474879	657.5312404
F7	DE	2390.115912	2233.738905	1035.747943	752.4841399	1332.223676	1011.366107	1176.812588	832.0589373	1603.161188
F8	DE	1308.948477	1276.579645	1065.051401	817.909258	1127.525639	876.0099441	961.5837464	958.1975368	1184.147283
F9	DE	24484.59834	23112.96782	1647.226198	900	5331.635656	1858.413039	4172.406046	4145.71498	12484.88637
F10	GWO	8144.734052	8594.716471	9577.59881	7497.802231	4664.803042	3992.636019	5995.779647	4364.846369	7420.043014
F11	DE	16022.40002	18902.15725	19430.22059	1114.498249	1312.64038	2532.448252	1417.684154	1418.869315	13715.98615
F12	DE	13380413775	16540476958	177678970.6	2294.229256	3752812.145	148658631.3	912265955.8	46620284.83	3026012614
F13	DE	2503193148	3079534479	6521.689583	1324.338146	6303.946409	68847700.69	532925033.1	46424.14089	681221435.3
F14	DE	2083142.552	1640545.294	458220.6013	1428.58632	2439.567296	278054.5006	1894.098194	150917.5604	119609.7337
F15	DE	490057853.6	168841064.4	2558157.275	1513.683038	1599.592092	1593.45656	54957.68296	65588.29943	1642507.687
F16	GWO	4505.849921	4621.969476	4202.418735	2559.721764	3067.3072	2232.754465	3023.697591	2581.467195	3988.825815
F17	DE	3278.409942	3468.868089	2758.123814	1805.586062	2685.850049	1855.2516	2454.698868	1984.000113	2740.241218
F18	DE	8747658.537	5657976.035	18452927.32	2124.378227	105402.5875	322839.6374	16982.08832	63769.84678	16486444.71
F19	DE	161351126.7	118017900.4	2160.924262	1907.68341	2027.33197	290609.3207	6767.525297	1319188.3	16354955.69
F20	DE	3024.356176	3017.421442	3195.294723	2141.309541	3129.657993	2354.469004	2199.868815	2733.687262	3032.92783
F21	DE	1.54E+15	1.25E+15	1.45E+16	2266.276854	6.65329E+13	1.36984E+11	2300.208093	2416.853247	7.30E+16
F22	DE	3.75053E+13	3.25027E+14	3.07E+15	2396.406171	1.48951E+12	11736777025	3937343.137	828319758.9	1.46E+15
F23	WOA	3744.774546	3848.097535	3069.004861	2841.967216	2500.52681	2902.717779	3222.981266	2886.322731	2500
F24	WOA	4856.313388	4793.796817	2700.002263	3374.540615	2600.902213	3516.288432	3929.786681	2600.000408	2600
F25	WOA	10320.75357	8057.351123	2900.592265	2917.098396	2709.438633	3244.216238	3097.773458	3053.858099	2700
F26	WOA	9689.902533	11239.54706	6781.027189	4658.101254	2801.015736	5647.354904	7570.082094	2800.005325	2800
F27	GA_custom	4399.096902	4301.246632	3471.779143	3491.175408	2901.094783	3534.091537	4031.34381	3587.115344	4615.534412
F28	WOA	8142.57105	8355.437234	5161.085911	3347.680203	3001.368391	4004.065984	5416.998885	3233.66417	3000
F29	WOA	5847.413509	5376.804405	4611.077826	3183.363397	3100.462469	3648.923825	3889.882061	3571.944882	3100
F30	WOA	424791918.4	877260794.8	260392.1022	4214.648585	5421.617096	726847.0505	5230781.278	1649695.423	3200

#### baseCSA and modifiedCSA comparison with other CSA Variants

Function	BestAlgorithm	BaseCSA_Mean	ModCSA_Mean	CSA_ADAPTIVE_Mean	CSA_CHAOTIC_Mean	CSA_LF_Mean	CSA_OB_Mean	CSA_PS0_Mean
F1	CSA_CHAOTIC	81382993003	75378507364	10977.29259	741.0869608	7651.887008	10860327.19	49162633487
F2	CSA_CHAOTIC	2.83E+40	3.96E+41	7.62963E+13	2582.031017	12701.01864	984361.542	1.90E+34
F3	CSA_CHAOTIC	149935.9367	152298.7356	13202.03729	300.1273392	883.3477486	389.7764029	183627.3102
F4	CSA_OB	21968.77143	15421.0708	592.0295797	549.2884076	473.401461	405.0430191	530.897781
F5	CSA_CHAOTIC	902.2764766	924.693912	854.2037578	783.5611183	871.1166637	842.480221	982.4977704
F6	CSA_OB	693.1046448	692.8525124	671.4034437	671.0679668	674.678088	664.9398508	713.0654743
F7	CSA_OB	2620.8927	2353.584877	3431.315927	3386.453325	1474.209711	1050.267911	3050.761892
F8	CSA_LF	1294.340199	1317.001483	1322.500244	1300.450475	1091.293923	1209.62049	1229.416068
F9	CSA_CHAOTIC	21248.90514	21841.54281	9988.492692	9476.812075	9887.380448	14353.94938	30605.53667
F10	CSA_LF	8455.262152	8427.563218	5436.002234	4878.364865	3914.096461	4186.711062	8010.441085
F11	CSA_CHAOTIC	19669.66702	11438.83869	1697.716687	1183.506352	1520.236098	1449.863735	10200.92861
F12	CSA_ADAPTIVE	11047924356	16293236855	725724.4022	5640213.168	11042873.9	6712231.748	10625177536
F13	CSA_ADAPTIVE	3760835259	3379230172	17043.85953	66667.99073	68078.59781	145695.2566	3061425405
F14	CSA_OB	2719512.794	926678.8568	12009.1296	11509.74362	26743.17111	9195.755661	2215403.283
F15	CSA_OB	490640724.5	169137566.8	251140.0616	89078.37856	76713.90206	50267.59839	92368491.2
F16	CSA_LF	4730.104656	4860.477407	3627.138824	3733.601274	2881.140761	3224.186468	3913.006474
F17	CSA_ADAPTIVE	3396.044333	3297.284158	1894.543177	3117.27234	2522.777206	3367.723358	2718.152831
F18	CSA_ADAPTIVE	5394762.847	5188010.017	15676.70843	69608.80239	67705.11696	122166.0907	281502.359
F19	CSA_CHAOTIC	260452750.5	223838347.9	113641.6505	8948.869907	42957.54948	216377.2571	122863978.4
F20	CSA_PSO	3042.735341	3121.303691	3049.705077	2736.116273	2674.397075	2737.054885	2352.026027
F21	CSA_CHAOTIC	2265.471429	2268.353047	2250.000001	2250.0000007	2250.0004354	2284.104468	
F22	CSA_CHAOTIC	2368.859359	2366.437946	2350.000002	2350	2350.000001	2350.004502	2379.147014
F23	CSA_PSO	3756.332269	3763.025007	4972.718056	5125.477599	4836.617412	4636.005982	3043.576287
F24	CSA_LF	4676.887449	4814.313246	4387.39084	2604.628946	2600.294269	3911.139494	3575.297802
F25	CSA_LF	10184.55687	9634.615463	3129.631253	3003.723768	2919.61972	2966.022127	13044.4738
F26	CSA_PSO	10503.03452	11804.28451	15848.31786	12095.30807	11273.61947	10451.71505	8257.95685
F27	CSA_PSO	4393.849891	4246.727856	5540.284291	5357.08597	5500.861037	5252.447388	3461.558407
F28	CSA_OB	7515.844915	7812.53614	3339.205805	3354.926275	3235.118199	3232.357795	5230.742521
F29	CSA_OB	5450.68952	5500.894552	5613.378493	4334.158998	4682.766141	3984.948496	4155.129376
F30	CSA_OB	280706499.4	415203482.2	1805475.006	2135241.615	1426427.412	602541.7284	617667882.9