Supplementary report for the paper *A Distance-based Ranking Model Estimation of Distribution Algorithm for Flowshop Scheduling Problem* submitted to the journal *IEEE Transactions on Evolutionary Computation.*

Supplementary Report: Experimental comparison of GM-EDA with respect to EHBSA and NHBSA

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Abstract

In this report we introduce the additional material for the experimentation carried out that in the paper *A Distance-based Ranking Model Estimation of Distribution Algorithm for the Flowshop Scheduling Problem* submitted to the journal *IEEE Transactions on Evolutionary Computation.* In order to compare the performance of GM-EDA with respect to EHBSA and NHBSA algorithms, in this report we introduce the results of the aforementioned algorithms over the Taillard's PFSP instances. Experimentation parameters, maximum number of evaluations and the final results of the experimentation are introduced.

1 Parameters

In this section, we introduce the θ_{upper} parameters used for GM-EDA (see table 1), and the maximum number of evaluations performed by the algorithms when optimizing (see table 2).

2 Results

In the tables 3 and 4 the results for the Taillard's benchmark instances of the algorithms GM-EDA, EHBSA and NHSBA are reported.

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Table 1: Upper θ values for the Taillard's benchmark instances. Note the first instance of each set was selected for the experimentation. The θ that provided the best fitness average of 10 repetitions was selected.

Instance	θ range	θ_{upper}
20×05	1.0 - 3.0	1.5
20×10	1.0 - 3.0	1.4
20×20	1.0 - 3.0	1.4
50×05	2.5 - 5.5	3.7
50×10	2.5 - 5.5	2.8
50×20	2.5 - 5.5	3.0
100×05	3.5 - 6.0	4.9
100×10	3.5 - 6.0	3.7
100×20	3.5 - 6.0	4.7
200×10	4.0 - 6.0	5.3
200×20	4.0 - 6.0	5.5
500×20	4.0 - 7.0	4.4

Table 2: Maximum number of evaluations for the Taillard's benchmark instances. Note that the first instance of each set was selected for the experimentation. The evaluation numbers reported are the average of 20 repetitions of the evaluations performed by AGA algorithm running n×m×0.4 seconds.

Instance	Evaluations
20×05	182224100
20×10	224784800
20×20	256896400
50×05	220712150
50×10	256208100
50×20	275954150
100×05	235879800
100×10	266211000
100×20	283040000
200×10	272515500
200×20	287728850
500×20	260316750

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Table 3: Results for the Taillard's benchmark instances. Min, Max, Average and Standard deviation of the results obtained from 20 replications are introduced. Results in bold denote optimum or best known solutions of 20 repetitions.

Instance	ID	GM-EDA				EHBSA				NHBSA			
		Min	Max	Avg.	Std.	Min	Max	Avg.	Std.	Min	Max	Avg.	Std.
20×5	1	**14033**	14080	14058	13	**14033**	14033	14033	0	**14033**	14041	14033	2
	2	15159	15349	15224	46	**15151**	15151	15151	0	**15151**	15151	15151	0
	3	**13301**	13471	13367	52	**13301**	13313	13304	5	**13301**	13301	13301	0
	4	**15447**	15596	15514	38	**15447**	15459	15452	5	**15447**	15459	15448	3
	5	**13529**	13618	13558	37	**13529**	13529	13529	0	**13529**	13529	13529	0
	6	**13123**	13182	13133	18	**13123**	13147	13124	5	**13123**	13123	13123	0
	7	13559	13816	13655	68	**13548**	13548	13548	0	**13548**	13548	13548	0
	8	**13948**	14014	13973	23	**13948**	13953	13952	2	**13948**	13948	13948	0
	9	**14295**	14507	14321	52	**14295**	14338	14311	17	**14295**	14295	14295	0
	10	**12943**	13099	13002	42	**12943**	12943	12943	0	**12943**	12943	12943	0
20×10	1	**20911**	21077	21006	46	**20911**	20911	20911	0	**20911**	20911	20911	0
	2	**22440**	22834	22561	135	**22440**	22440	22440	0	**22440**	22440	22440	0
	3	**19833**	19997	19895	41	**19833**	19833	19833	0	**19833**	19833	19833	0
	4	18747	18955	18851	69	**18710**	18724	18721	6	**18710**	18747	18713	8
	5	18652	18809	18706	40	**18641**	18679	18653	15	**18641**	18673	18645	7
	6	19249	19553	19393	84	**19245**	19249	19248	2	**19245**	19324	19265	31
	7	**18363**	18698	18450	77	**18363**	18376	18373	5	**18363**	18376	18366	5
	8	**20241**	20542	20337	78	**20241**	20241	20241	0	**20241**	20241	20241	0
	9	**20330**	20639	20385	88	**20330**	20379	20335	15	**20330**	20330	20330	0
	10	**21320**	21548	21371	62	**21320**	21332	21322	4	**21320**	21323	21320	1
20×20	1	**33623**	34038	33841	88	33735	33781	33779	10	**33623**	33623	33623	0
	2	**31587**	31923	31677	100	31587	31597	31590	4	**31587**	31587	31587	0
	3	**33920**	34201	33934	63	33920	33920	33920	0	**33920**	33920	33920	0
	4	**31661**	31884	31750	59	31661	31661	31661	0	**31661**	31661	31661	0
	5	34586	34749	34648	48	**34557**	34557	34557	0	**34557**	34557	34557	0
	6	**32564**	33162	32662	177	**32564**	32564	32564	0	**32564**	32564	32564	0
	7	33038	33238	33124	71	**32922**	33022	32932	31	**32922**	32922	32922	0
	8	32456	32685	32580	76	**32412**	32461	32437	19	**32412**	32444	32417	12
	9	**33600**	34910	33789	280	**33600**	33688	33611	28	**33600**	33600	33600	0
	10	**32262**	32702	32393	147	32269	32279	32272	3	**32262**	32269	32263	3
50×5	1	65013	65593	65312	164	**64802**	64842	64822	16	65189	65443	65315	65
	2	68305	69392	68699	267	**68058**	68125	68082	20	68557	68813	68682	62
	3	63673	64324	64006	195	**63274**	63475	63370	64	63857	64070	63969	75
	4	68845	69664	69091	188	**68273**	68426	68362	45	68749	69178	69010	105
	5	69737	70348	70011	165	**69404**	69479	69448	28	69782	70015	69935	54
	6	67088	67726	67390	172	**66865**	66970	66937	36	67230	67615	67475	92
	7	66416	67190	66886	203	**66253**	66271	66254	4	66719	66963	66831	61
	8	64741	65314	64983	140	**64381**	64447	64410	15	64747	65021	64915	79
	9	63219	63666	63492	133	**63033**	63073	63053	11	63353	63662	63527	85
	10	69251	69963	69538	184	**68843**	69078	68991	60	69416	69676	69568	71
50×10	1	88402	89786	89041	400	**87536**	88010	87834	138	88473	89161	88822	181
	2	84107	85530	84849	326	**83434**	83937	83677	131	84075	84646	84452	138
	3	80924	82072	81460	324	**80148**	80563	80367	121	80927	81474	81277	132
	4	87666	88685	88161	274	**86863**	87368	87171	138	87604	88083	87850	124
	5	87499	88801	88192	333	**86895**	87363	87192	111	87412	88243	87917	200
	6	87386	88702	87982	350	**86834**	87157	87025	91	87538	88244	87894	171
	7	90102	91074	90615	299	**89295**	89704	89553	95	89950	90558	90316	138
	8	87652	89291	88587	390	**87403**	87804	87596	114	88086	88603	88323	138
	9	86479	87995	87326	358	**85880**	86376	86191	123	86677	87248	87027	145
	10	89260	90580	89839	359	**88383**	88862	88669	128	89527	89989	89752	141
50×20	1	127129	128638	128041	333	**126934**	127776	127338	226	127650	128442	128035	191
	2	120312	122421	121138	565	**120133**	120831	120420	185	120960	121719	121336	231
	3	118114	120808	119068	685	**117588**	118568	117978	250	118119	118933	118669	221
	4	122269	123878	123030	507	**121693**	122420	122006	171	122571	123041	122841	161
	5	119872	121912	120902	494	**119338**	119972	119739	196	120228	120796	120451	163
	6	122088	123491	122846	436	**121734**	122536	122069	247	122440	123088	122715	198
	7	124824	126214	125548	421	**124448**	124996	124759	186	124878	125483	125232	164
	8	124507	126357	125227	449	**124052**	125011	124554	317	124491	125310	124890	197
	9	123178	125010	124059	497	**122688**	123600	123281	212	123683	124268	124013	179
	10	126004	127004	126478	275	**125125**	125875	125517	216	125848	126492	126181	188

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Instance	ID	GM-EDA				EHBSA				NHBSA			
		Min	Max	Avg.	Std.	Min	Max	Avg.	Std.	Min	Max	Avg.	Std.
100×5	1	**255001**	256539	255804	420	255808	256745	256335	241	257660	258505	258037	228
	2	244602	246004	245199	419	**244249**	245040	244703	233	246230	247489	247009	274
	3	**239470**	240767	240091	339	239477	240250	239965	233	241131	242079	241729	264
	4	**228944**	230309	229673	329	229143	229869	229460	206	231054	231746	231376	189
	5	**241427**	243436	242522	436	242069	242739	242413	185	244116	244571	244331	151
	6	**234020**	235816	234788	491	234456	235389	235094	239	236458	237553	236969	248
	7	242411	243715	243075	430	**241738**	242304	242039	171	243721	244534	244215	201
	8	**232607**	234670	233520	435	232864	233887	233494	262	235006	236066	235553	302
	9	**249823**	251541	250645	496	250241	251526	250977	356	252489	253184	252831	173
	10	245158	246763	245689	397	**244332**	244923	244635	193	246722	247375	247102	163
100×10	1	**303194**	305376	304496	598	305909	308805	307468	664	306426	307474	306869	257
	2	**279233**	281532	280275	584	281716	284322	283275	751	281847	283481	282882	421
	3	**292153**	295916	293553	900	295373	297813	296823	701	295601	296795	296291	394
	4	**305958**	309600	307829	1059	308020	311571	310701	811	309089	310632	309921	414
	5	**289196**	291383	290266	622	291907	293742	292930	496	292046	293418	293007	339
	6	**273355**	276810	275421	879	278481	281057	279827	772	277572	279177	278303	438
	7	**284133**	285627	284875	439	286118	288062	287128	483	286401	287615	287136	349
	8	**295201**	298885	297145	1022	298584	301645	300653	850	298704	300211	299486	443
	9	**306691**	309503	307936	612	308769	312280	310804	797	309309	310745	310131	404
	10	**295610**	297997	296619	722	299084	302052	300659	715	299263	300739	300250	379
100×20	1	**371118**	376504	374708	1388	380727	385092	383099	1212	376404	379056	377881	623
	2	**379426**	382352	380750	868	385536	390177	388558	1248	383416	385772	384971	644
	3	**376972**	379760	378587	677	384234	386662	385766	694	380740	382506	381825	434
	4	**377976**	382545	380765	1173	386370	390790	389280	1145	384506	386630	385477	588
	5	**375649**	379110	377003	868	383776	387467	385643	921	380401	382288	381567	528
	6	**378534**	383005	380848	1049	386049	389725	388495	868	383294	385017	384291	493
	7	**379691**	385024	381607	1196	388432	392368	390716	981	384370	386999	385976	724
	8	**390804**	395011	392998	1013	399740	402315	400991	741	395732	397760	396695	513
	9	**380336**	385479	382915	1170	388626	390974	390088	773	385460	387826	386990	623
	10	**386402**	388683	387692	724	392714	396630	395117	1019	390560	392532	391602	536
200×10	1	**1056596**	1063253	1060110	1598	1092453	1104598	1100269	3666	1087148	1091129	1090029	972
	2	**1047701**	1053191	1051182	1549	1091067	1100973	1096788	2544	1081197	1086251	1083917	1279
	3	**1056447**	1061285	1059307	1244	1093077	1107145	1101357	3822	1088947	1092559	1091082	1089
	4	**1041384**	1047665	1043767	1659	1077016	1087945	1084251	2871	1071002	1074509	1072597	1049
	5	**1048678**	1054056	1050704	1315	1090524	1098431	1094664	2116	1074569	1081893	1079551	1827
	6	**1017945**	1023002	1020614	1442	1066357	1076401	1071637	2958	1053424	1059808	1057133	1502
	7	**1062774**	1069735	1065757	1870	1116997	1123965	1121124	1990	1104322	1108052	1106494	968
	8	**1057211**	1062151	1059445	1248	1096797	1108695	1104145	2880	1089095	1093118	1091645	1025
	9	**1032108**	1039175	1036504	1806	1080868	1091142	1087561	2813	1069164	1074557	1072584	1353
	10	**1040616**	1049602	1044433	2648	1089671	1098243	1094250	2353	1076497	1081310	1079884	1118
200×20	1	**1241660**	1250442	1246409	2557	1293998	1307248	1302026	3174	1285488	1292096	1289536	1970
	2	**1256766**	1264078	1259817	1820	1322457	1329472	1325762	2169	1305559	1310454	1308458	1245
	3	**1278268**	1290751	1282999	2920	1330342	1342071	1337370	2949	1327631	1331908	1329727	1339
	4	**1250672**	1259126	1254752	2645	1315337	1322532	1319917	1981	1301734	1307002	1305004	1519
	5	**1240613**	1250002	1243662	2597	1303421	1313394	1308959	3106	1284914	1291898	1289111	1945
	6	**1241310**	1247816	1243871	1843	1306372	1314913	1311762	2429	1285292	1291400	1289441	1647
	7	**1254838**	1262526	1257669	1873	1321329	1333430	1329639	3377	1302093	1310782	1306931	2193
	8	**1257967**	1264661	1260339	1806	1318909	1327339	1322475	2114	1301992	1308915	1306497	1870
	9	**1243273**	1252989	1247291	2617	1311231	1323196	1318122	3333	1293759	1300597	1297799	1833
	10	**1260082**	1268020	1265095	2166	1321584	1330136	1325750	2562	1304398	1314566	1312094	2376
500×20	1	7186672	7468410	7305385	83467	7251171	7295632	7280652	10926	**7181912**	7207028	7195533	7083
	2	**7261036**	7555303	7415970	76509	7336801	7405945	7390787	17346	7281787	7313341	7299768	7524
	3	7237742	7481975	7318373	63748	7309252	7349855	7333264	10596	**7227937**	7247761	7237026	6549
	4	7252826	7478758	7380979	62248	7319747	7364333	7345898	12002	**7241906**	7276766	7262190	10261
	5	7221316	7424946	7344536	45566	7295276	7341108	7320425	12750	**7206544**	7241588	7227111	8862
	6	7245315	7445177	7331079	64677	7301476	7373381	7358064	17077	**7229145**	7262550	7246603	10301
	7	7198342	7502230	7322676	76197	7270665	7314450	7296454	11774	**7178261**	7205128	7195024	6845
	8	**7248563**	7475228	7353505	70360	7343386	7395692	7371195	13486	7258923	7280470	7270774	6876
	9	7201889	7415861	7304458	62008	7295829	7341237	7320671	13251	**7177129**	7207297	7195450	7267
	10	**7203144**	7534253	7343330	74606	7312572	7358018	7338363	11765	7241794	7261353	7252083	5699