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: Results for Taillard's Benchmark Experimentation

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Abstract

In this report we introduce the supplementary data for the Taillard's benchmark experimentation carried out in the paper *A Distance-based Ranking Model Estimation of Distribution Algorithms for Flowshop Scheduling Problem* submitted to the journal *IEEE Transactions on Evolutionary Computation*. Experimentation parameters, maximum number of evaluations and the final results of the experimentation are extensively introduced. Finally, a complete statistical analysis is introduced to confirm the results obtained.

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1 Parameters

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

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

2 Results

In the tables 3, 4 and 5 the results for the Taillard's benchmark instances of the algorithms AGA, VNS_4, GM-EDA, VNS and HGM-EDA are reported.

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	AGA Min	AGA Max	AGA Avg.	AGA Std.	VNS_4 Min	VNS_4 Max	VNS_4 Avg.	VNS_4 Std.	GM-EDA Min	GM-EDA Max	GM-EDA Avg.	GM-EDA Std.	VNS Min	VNS Max	VNS Avg.	VNS Std.	HGM-EDA Min	HGM-EDA Max	HGM-EDA Avg.	HGM-EDA Std.
20×5	1	**14033**	14033	14033	0	**14033**	14033	14033	0	**14033**	14080	14058	13	**14033**	14033	14033	0	**14033**	14033	14033	0
	2	**15151**	15151	15151	0	**15151**	15151	15151	0	15159	15349	15224	46	**15151**	15151	15151	0	**15151**	15151	15151	0
	3	**13301**	13301	13301	0	**13301**	13301	13301	0	**13301**	13471	13367	52	**13301**	13301	13301	0	**13301**	13301	13301	0
	4	**15447**	15447	15447	0	**15447**	15447	15447	0	**15447**	15596	15514	38	**15447**	15447	15447	0	**15447**	15447	15447	0
	5	**13529**	13529	13529	0	**13529**	13529	13529	0	**13529**	13618	13558	37	**13529**	13529	13529	0	**13529**	13529	13529	0
	6	**13123**	13123	13123	0	**13123**	13123	13123	0	**13123**	13182	13133	18	**13123**	13123	13123	0	**13123**	13123	13123	0
	7	**13548**	13548	13548	0	**13548**	13548	13548	0	13559	13816	13655	68	**13548**	13548	13548	0	**13548**	13548	13548	0
	8	**13948**	13948	13948	0	**13948**	13948	13948	0	**13948**	14014	13973	23	**13948**	13948	13948	0	**13948**	13948	13948	0
	9	**14295**	14295	14295	0	**14295**	14295	14295	0	**14295**	14507	14321	52	**14295**	14295	14295	0	**14295**	14295	14295	0
	10	**12943**	12943	12943	0	**12943**	12943	12943	0	**12943**	13099	13002	42	**12943**	12943	12943	0	**12943**	12943	12943	0
20×10	1	**20911**	20911	20911	0	**20911**	20911	20911	0	**20911**	21077	21006	46	**20911**	20911	20911	0	**20911**	20911	20911	0
	2	**22440**	22440	22440	0	**22440**	22440	22440	0	**22440**	22834	22561	135	**22440**	22440	22440	0	**22440**	22440	22440	0
	3	**19833**	19833	19833	0	**19833**	19833	19833	0	**19833**	19997	19895	41	**19833**	19833	19833	0	**19833**	19833	19833	0
	4	**18710**	18710	18710	0	**18710**	18710	18710	0	18747	18955	18851	69	**18710**	18710	18710	0	**18710**	18710	18710	0
	5	**18641**	18641	18641	0	**18641**	18641	18641	0	18652	18809	18706	40	**18641**	18641	18641	0	**18641**	18641	18641	0
	6	**19245**	19245	19245	0	**19245**	19245	19245	0	19249	19553	19393	84	**19245**	19245	19245	0	**19245**	19245	19245	0
	7	**18363**	18363	18363	0	**18363**	18363	18363	0	**18363**	18698	18450	77	**18363**	18363	18363	0	**18363**	18363	18363	0
	8	**20241**	20241	20241	0	**20241**	20241	20241	0	**20241**	20542	20337	78	**20241**	20241	20241	0	**20241**	20241	20241	0
	9	**20330**	20330	20330	0	**20330**	20330	20330	0	**20330**	20639	20385	88	**20330**	20330	20330	0	**20330**	20330	20330	0
	10	**21320**	21320	21320	0	**21320**	21320	21320	0	**21320**	21548	21371	62	**21320**	21320	21320	0	**21320**	21320	21320	0
20×20	1	**33623**	33623	33623	0	**33623**	33623	33623	0	**33623**	34038	33841	88	**33623**	33623	33623	0	**33623**	33623	33623	0
	2	**31587**	31587	31587	0	**31587**	31587	31587	0	**31587**	31923	31677	100	**31587**	31587	31587	0	**31587**	31587	31587	0
	3	**33920**	33920	33920	0	**33920**	33920	33920	0	**33920**	34201	33934	63	**33920**	33920	33920	0	**33920**	33920	33920	0
	4	**31661**	31661	31661	0	**31661**	31661	31661	0	**31661**	31884	31750	59	**31661**	31661	31661	0	**31661**	31661	31661	0
	5	**34557**	34557	34557	0	**34557**	34557	34557	0	34586	34749	34648	48	**34557**	34557	34557	0	**34557**	34557	34557	0
	6	**32564**	32564	32564	0	**32564**	32564	32564	0	**32564**	33162	32662	177	**32564**	32564	32564	0	**32564**	32564	32564	0
	7	**32922**	32922	32922	0	**32922**	32922	32922	0	33038	33238	33124	71	**32922**	32922	32922	0	**32922**	32922	32922	0
	8	**32412**	32412	32412	0	**32412**	32412	32412	0	32456	32685	32580	76	**32412**	32412	32412	0	**32412**	32412	32412	0
	9	**33600**	33600	33600	0	**33600**	33600	33600	0	**33600**	34910	33789	280	**33600**	33600	33600	0	**33600**	33600	33600	0
	10	**32262**	32262	32262	0	**32262**	32262	32262	0	**32262**	32702	32393	147	**32262**	32262	32262	0	**32262**	32262	32262	0
50×5	1	**64803**	64859	64836	14	65173	65404	65311	54	65013	65593	65312	164	64817	65069	64905	65	**64803**	64955	64883	39
	2	**68062**	68162	68101	32	68556	68791	68661	72	68305	69392	68699	267	68088	68223	68151	40	68066	68234	68147	46
	3	**63162**	63409	63281	57	63684	64071	63928	106	63673	64324	64006	195	63194	63585	63383	121	63195	63578	63402	124
	4	**68241**	68439	68340	77	68840	69172	68987	89	68845	69664	69091	188	**68241**	68572	68414	97	68226	68580	68379	109
	5	**69392**	69514	69457	34	69869	70122	69993	70	69737	70348	70011	165	**69392**	69567	69499	47	69429	69580	69499	47
	6	**66841**	67031	66910	60	67212	67495	67378	78	67088	67726	67390	172	**66841**	67073	66994	66	**66841**	67067	66959	78
	7	66261	66322	66276	12	66569	66866	66746	79	66416	67190	66886	203	**66258**	66489	66329	69	**66258**	66414	66305	54
	8	64365	64458	64390	25	64791	65064	64931	77	64741	65314	64983	140	64381	64680	64502	92	**64359**	64682	64508	97
	9	**62981**	63102	63040	37	63348	63644	63501	85	63219	63666	63492	133	**62981**	63173	63070	59	**62981**	63165	63072	65
	10	**68898**	69028	68946	39	69523	69772	69622	60	69251	69963	69538	184	**68898**	69270	69058	101	68911	69211	69046	90

Table 4: 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	AGA				VNS_4				GM-EDA				VNS				HGM-EDA			
		Min	Max	Avg	Std	Min	Max	Avg	Std	Min	Max	Avg	Std	Min	Max	Avg	Std	Min	Max	Avg	Std
50×10	1	87298	87645	87494	110	88048	88290	88180	69	88402	89786	89041	400	87342	88075	87574	187	**87207**	87710	87540	132
	2	**82820**	83218	83003	118	83398	84031	83721	165	84107	85530	84849	326	83004	83845	83292	196	**82820**	83513	83313	131
	3	**79987**	80295	80174	93	80699	80990	80843	82	80924	82072	81460	324	**79987**	80467	80264	123	80048	80531	80278	118
	4	**86581**	86843	86727	94	87082	87618	87359	114	87666	88685	88161	274	86693	87032	86827	93	86693	86992	86854	122
	5	**86450**	86683	86568	79	86987	87438	87225	127	87499	88801	88192	333	86459	87444	86817	245	86453	87168	86780	125
	6	**86637**	86911	86749	80	87076	87550	87305	112	87386	88702	87982	350	86645	87168	86884	149	86681	87123	86892	99
	7	**88866**	89303	89086	146	89407	89926	89660	140	90102	91074	90615	299	89017	89636	89318	186	89005	89661	89297	168
	8	**86824**	87148	86987	86	87434	87893	87644	126	87652	89291	88587	390	86864	87374	87112	168	86866	87448	87135	131
	9	85619	85923	85772	93	86298	86629	86474	91	86479	87995	87326	358	85595	86212	85941	177	**85526**	86141	85886	165
	10	**88077**	88323	88152	96	88362	89135	88746	230	89260	90580	89839	359	88194	88926	88472	175	88283	88665	88476	120
50×20	1	**125831**	126280	125958	150	126192	127127	126654	298	127129	128638	128041	333	125844	126766	126205	294	**125831**	126826	126324	241
	2	**119259**	119436	119304	57	119527	120241	119872	200	120312	122421	121138	565	**119259**	120284	119643	269	**119259**	119950	119523	253
	3	**116459**	116927	116679	153	116963	117677	117312	178	118114	120808	119068	685	116656	117497	117117	210	**116459**	117245	116973	229
	4	**120712**	121203	120982	152	121006	121842	121450	230	122269	123878	123030	507	120876	121627	121191	168	120891	121448	121124	143
	5	118379	118907	118656	200	118905	119408	119206	142	119872	121912	120902	494	118368	119100	118778	235	**118184**	119409	118804	266
	6	**120703**	121123	120928	140	121099	121676	121451	157	122088	123491	122846	436	120881	121517	121205	218	120876	121510	121130	188
	7	123129	123586	123431	151	123449	124204	123837	205	124824	126214	125548	421	123114	123986	123537	233	**122962**	124027	123536	271
	8	122527	123006	122681	164	122729	123710	123410	217	124507	126357	125227	449	122528	123698	123040	332	**122489**	123689	123167	310
	9	**121872**	122258	122073	121	122475	123086	122794	197	123176	125010	124059	497	122073	122791	122357	192	**121872**	122781	122326	228
	10	**124064**	124782	124353	214	125047	125437	125176	103	126004	127004	126478	275	124261	124938	124623	222	124348	124926	124588	188
100×5	1	253799	255094	254336	355	256683	256788	256778	30	255001	256539	255804	420	254017	255652	254712	409	**253713**	254572	254190	238
	2	242907	243857	243301	237	246661	246949	246935	64	244602	246004	245199	419	243057	244360	243709	364	**242777**	243952	243424	232
	3	**238180**	238968	238607	222	241042	242195	241626	317	239470	240767	240091	339	238348	239241	238818	242	238444	239014	238696	156
	4	**227889**	228475	228270	156	230335	231301	230834	211	228944	230309	229673	329	227973	228881	228410	278	228141	228960	228348	190
	5	240838	241456	241102	186	243167	244131	243686	283	241427	243436	242522	436	240828	242092	241341	314	**240589**	241640	241134	274
	6	233132	233817	233438	149	235560	236284	236232	165	234020	235816	234788	491	233249	234318	233663	321	**232936**	233839	233335	232
	7	240750	241411	241022	204	243364	244309	243892	288	242411	243715	243075	430	**240669**	242040	241479	409	241006	242293	241499	361
	8	231529	232096	231724	189	234881	235673	235207	248	232607	234670	233520	435	**231428**	232679	232005	302	231520	232279	231866	243
	9	248637	249599	249042	311	251857	252490	252154	237	249823	251541	250645	496	248616	250548	249191	429	**248481**	249548	248989	338
	10	**243360**	243989	243717	187	246189	247272	246773	277	245158	246763	245689	397	243434	244889	244055	448	243610	244418	243950	225
100×10	1	299522	301584	300399	563	302939	304832	303986	561	303194	305376	304496	598	300024	301923	300969	443	**299431**	301236	300419	522
	2	275520	277319	276213	553	278060	279669	278896	500	279233	281532	280275	584	275540	278871	276974	990	**274593**	277669	276460	754
	3	**288630**	290477	289615	392	292394	293711	293060	366	292153	295916	293553	900	288961	291688	290335	683	289091	291023	289643	501
	4	302274	304339	303070	591	306314	307589	306938	356	305958	309600	307829	1059	302388	304987	303793	687	**302105**	304057	303159	500
	5	285701	287741	286449	528	288767	289513	289397	228	289196	291383	290266	622	285956	288310	287008	642	**285340**	287173	286250	457
	6	270963	272578	271623	383	274112	275857	275247	493	273355	276810	275421	879	271377	274419	272487	760	**270817**	272505	271700	424
	7	280690	281916	281300	349	284229	285082	284694	242	284133	285627	284875	439	280866	283396	282080	634	**280649**	282015	281375	333
	8	291729	293747	292672	606	295235	297905	296394	603	295201	298885	297145	1022	292804	294993	293825	660	**291665**	293721	292998	630
	9	**302624**	304474	303699	574	305970	307765	307029	451	306691	309503	307936	612	303634	306971	304547	807	302893	305078	303865	490
	10	**292230**	294277	293117	494	296227	297928	297064	588	295610	297997	296619	722	292831	294838	293760	482	292437	294361	293153	544

Table 5: 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.

stance	ID	AGA Min	AGA Max	AGA Avg	AGA Std	VNS_4 Min	VNS_4 Max	VNS_4 Avg	VNS_4 Std	GM-EDA Min	GM-EDA Max	GM-EDA Avg	GM-EDA Std	VNS Min	VNS Max	VNS Avg	VNS Std	HGM-EDA Min	HGM-EDA Max	HGM-EDA Avg	HGM-EDA Std
0×20	1	368037	371756	369369	966	370894	373571	372660	681	371118	376504	374708	1388	368485	371389	369784	833	**367267**	370678	368879	825
	2	**374032**	376427	375189	631	377461	379518	378466	484	379426	382352	380750	868	374601	378268	376119	1024	374256	376597	375310	621
	3	371824	374756	373159	751	375322	377188	376289	563	376972	379760	378587	677	372207	375784	373709	954	**371417**	374502	372741	867
	4	**373822**	377836	375797	1206	377297	379461	378669	632	377976	382545	380765	1173	374702	378347	376325	1086	374115	376276	375242	565
	5	**370697**	373067	372018	794	373280	375933	374887	665	375649	379110	377003	868	370459	374465	372526	998	370711	372541	371635	556
	6	373881	376365	374671	699	377031	379145	378204	498	378534	383005	380848	1049	374206	377961	375698	1020	**372768**	375340	374304	713
	7	374951	377560	376064	709	379364	380964	380261	464	379691	385024	381607	1196	375463	379926	377303	1279	**374483**	377825	375807	814
	8	386155	388514	387239	688	390044	391928	390890	474	390804	395011	392998	1013	386747	390012	387984	854	**385456**	388150	387123	599
	9	**376063**	380140	377686	1229	379900	381845	381040	564	380336	385479	382915	1170	376774	380330	378556	934	376269	379330	377296	702
	10	380280	383593	381740	786	383422	386516	384818	686	386402	388683	387692	724	380455	383932	382339	850	**379899**	382900	381752	898
0×10	1	1051346	1053994	1052649	799	1058298	1063022	1060781	1218	1056596	1063253	1060110	1598	1051580	1062161	1056964	2482	**1047662**	1051264	1049484	1035
	2	1043573	1047635	1045485	1347	1048904	1053637	1051772	1329	1047701	1053191	1051182	1549	1043120	1054864	1046805	2746	**1036042**	1041247	1039120	1310
	3	1049170	1054914	1052639	1497	1059328	1065611	1062694	1399	1056447	1061285	1059307	1244	1052752	1063227	1055869	2546	**1047571**	1050648	1049089	855
	4	1032713	1043191	1037472	2683	1043297	1049115	1046588	1310	1041384	1047665	1043767	1659	1034725	1043412	1038845	2220	**1032095**	1035765	1034226	1047
	5	1040393	1046921	1043474	2745	1047606	1052242	1050438	1065	1048678	1054056	1050704	1315	1041348	1050032	1046027	2061	**1037053**	1040136	1038443	838
	6	1008163	1013517	1011724	1290	1018769	1021799	1020356	780	1017945	1023002	1020614	1442	1012662	1020638	1016528	2416	**1006650**	1010196	1008539	912
	7	1058987	1066931	1062784	2627	1067910	1072140	1070274	1485	1062774	1069735	1065757	1870	1062119	1070088	1065133	2629	**1053390**	1057174	1055328	1056
	8	1048904	1053322	1051437	1704	1058477	1062631	1060708	1112	1057211	1062151	1059445	1248	1050187	1059627	1055391	2596	**1046246**	1049647	1047559	915
	9	1027768	1036269	1031560	2561	1037072	1043635	1039820	2035	1032108	1039175	1036504	1806	1031706	1038940	1035186	2330	**1025145**	1027267	1026175	737
	10	1035057	1042693	1039209	2038	1045538	1050350	1048416	1402	1040616	1049602	1044433	2648	1038264	1046197	1042422	2378	**1031176**	1035587	1033221	1127
0×20	1	1230021	1238489	1234620	2909	1240048	1246755	1243432	1730	1241660	1250442	1246409	2557	1233815	1249795	1240540	3928	**1226879**	1232173	1230038	1438
	2	1248361	1256054	1252490	2363	1256361	1262085	1259934	1590	1256766	1264078	1259817	1820	1251419	1262972	1256732	3063	**1241811**	1250653	1245938	2102
	3	1272040	1283722	1276799	3735	1281487	1286864	1283969	1495	1278268	1290751	1282999	2920	1274188	1283641	1278808	2597	**1266153**	1274249	1269161	2319
	4	1243612	1255845	1248884	2959	1253106	1260458	1256176	2038	1250672	1259126	1254752	2645	1245781	1260774	1255063	4182	**1237053**	1246049	1240633	2290
	5	1230065	1239818	1233781	3101	1238422	1245573	1241994	2188	1240613	1250002	1243662	2597	1230538	1243234	1237605	2752	**1223551**	1229734	1226555	1839
	6	1230473	1243430	1237611	4680	1239550	1247126	1243884	1713	1241310	1247816	1243871	1843	1234953	1249174	1241019	3509	**1225254**	1231559	1228843	1492
	7	1247209	1251704	1249818	1305	1253867	1260954	1257501	1846	1254838	1262526	1257669	1873	1249869	1261740	1255139	2647	**1241847**	1248150	1244993	1868
	8	1248068	1263157	1254506	4167	1255189	1263227	1260325	1893	1257967	1264661	1260339	1806	1251696	1259793	1255349	2234	**1240820**	1250006	1245328	2625
	9	1236086	1248826	1242770	3462	1244303	1251694	1248543	1962	1243273	1252989	1247291	2617	1239173	1250279	1244368	2954	**1229066**	1235307	1232372	1632
	10	1255341	1261600	1258593	2226	1259320	1268260	1264369	2099	1260082	1268020	1265095	2166	1253307	1265972	1261371	3289	**1247156**	1253061	1250708	1477
0×20	1	**6708053**	6725436	6715326	5078	6724731	6738938	6731383	4181	7186672	7468410	7305385	83467	6813586	6871695	6848108	16152	6812253	6871127	6843742	15280
	2	**6829668**	6861484	6846423	8065	6845453	6868481	6855912	7421	7261036	7555303	7415970	76509	6934856	7000939	6955871	16107	6933944	6986555	6962490	12426
	3	**6747387**	6783588	6763355	8608	6761062	6782203	6774827	5606	7237742	7481975	7318373	63748	6846347	6912211	6885108	16953	6856073	6919557	6885330	19091
	4	**6787054**	6819065	6804959	10127	6809329	6824032	6817708	4238	7252826	7478758	7380979	62248	6887013	6939091	6920157	11295	6886575	6939387	6915035	15515
	5	6758967	6796179	6781817	10504	**6755257**	6799403	6783126	9910	7221316	7424946	7344536	45566	6862673	6927031	6891080	16624	6859079	6912123	6885243	15340
	6	**6751496**	6775038	6764010	6604	6762470	6786008	6779544	6955	7245315	7445177	7331079	64677	6867013	6930019	6896646	17343	6874432	6934176	6895540	15660
	7	**6708860**	6738684	6727058	6461	6727159	6750199	6739044	6742	7198342	7502230	7322676	76197	6827285	6866412	6846768	13666	6813840	6881817	6846324	17723
	8	**6769821**	6805498	6790929	7585	6796777	6819166	6808806	5636	7248563	7475228	7353505	70360	6886125	6960406	6921801	21090	6877213	6942098	6911029	16733
	9	**6720474**	6740912	6730520	5403	6736502	6766580	6751297	7451	7201689	7415861	7304458	62068	6834614	6872530	6854463	12021	6825683	6873794	6848624	12743
	10	**6767645**	6788101	6780442	5775	6785983	6806897	6797508	5603	7203144	7534253	7343330	74606	6875319	6939821	6910817	19369	6871608	6937571	6903119	16824

3 Statistical Analysis

In order to state whether there exist statistical differences among the observed results, we consider applying a non-parametric Friedman's test to the average results of the 5 algorithms separately for each job-machine configuration. A level $\alpha = 0.05$ of significance was set. Results reported significant differences between the algorithms. Therefore a post-hoc method is used to carry out all pairwise comparisons and determined which algorithms stand out from the rest of the approaches. Particularly, Shaffer's static procedure is used. Again, the significance level has been fixed to $\alpha = 0.05$.

3.1 Instances of 20 jobs: 20×05, 20×10 and 20×20.

3.1.1 Non-parametric test: Friedman Test

Table 6: Average ranking of the algorithms for the instances 20×05, 20×10 and 20×20.

Algorithm	20×05	20×10	20×20
AGA	1.9	1.9	1.9
VNS_4	1.9	1.9	1.9
HGM-EDA	1.9	1.9	1.9

As seen in the Table 6, all the algorithms perform the same therefore, there is not any statistical difference between the algorithms.

3.2 Instances of 50 jobs: 50×05, 50×10 and 50×20.

3.2.1 Non-parametric test: Friedman Test

Table 7: Average ranking of the algorithms for the instances 50×05, 50×10 and 50×20.

Algorithm	50×05	50×10	50×20
AGA	2.5	2.7	2.5
VNS_4	0.9	1.9	0.9
HGM-EDA	2.4	2.2	2.5

3.2.2 Pairwise comparison: Shaffer's Static Procedure

Table 8: Adjusted p-values for the algorithms for the configuration 50×05. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
AGA vs. VNS_4	5.28×10^{-4}	0.001
VNS_4 vs. HGM-EDA	0.001	0.001
AGA vs. HGM-EDA	0.82	0.82

Table 9: Adjusted p-values for the algorithms for the configuration 50×10. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
AGA vs. VNS_4	9.11×10^{-5}	2.73×10^{-4}
VNS_4 vs. HGM-EDA	0.005	0.005
AGA vs. HGM-EDA	0.26	0.26

Table 10: Adjusted p-values for the algorithms for the configuration 50×20. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
AGA vs. VNS_4	7.96×10^{-4}	0.0023
VNS_4 vs. HGM-EDA	7.96×10^{-4}	0.0023
AGA vs. HGM-EDA	1.0	1.0

3.3 Instances of 100 jobs: 100×05, 100×10 and 100×20.

3.3.1 Non-parametric test: Friedman Test

Table 11: Average ranking of the algorithms for the instances 100×05, 100×10 and 100×20.

Algorithm	100×05	100×10	100×20
AGA	2.4	2.3	2.4
VNS_4	0.9	0.9	0.9
HGM-EDA	2.6	2.7	2.6

3.3.2 Pairwise comparison: Shaffer's Static Procedure

Table 12: Adjusted p-values for the algorithms for the configuration 100×05. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
VNS_4 vs. HGM-EDA	3.46×10^{-4}	0.001
AGA vs. VNS_4	7.96×10^{-4}	0.0023
AGA vs. HGM-EDA	0.654	0.654

Table 13: Adjusted p-values for the algorithms for the configuration 100×10. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
VNS_4 vs. HGM-EDA	1.43×10^{-4}	4.31×10^{-4}
AGA vs. VNS_4	0.0036	0.0036
AGA vs. HGM-EDA	0.37	0.37

Table 14: Adjusted p-values for the algorithms for the configuration 100×20. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
VNS_4 vs. HGM-EDA	3.46×10^{-4}	0.001
AGA vs. VNS_4	0.001	0.001
AGA vs. HGM-EDA	0.654	0.654

3.4 Instances of 200 jobs: 200×10 and 200×20.

3.4.1 Non-parametric test: Friedman Test

Table 15: Average ranking of the algorithms for the instances 200×10 and 200×20.

Algorithm	200×10	200×20
AGA	1.9	1.9
VNS_4	0.9	0.9
HGM-EDA	2.9	2.9

3.4.2 Pairwise comparison: Shaffer's Static Procedure

Table 16: Adjusted p-values for the algorithms for the configuration 200×10. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
VNS_4 vs. HGM-EDA	7.74×10^{-6}	2.32×10^{-5}
AGA vs. VNS_4	0.025	0.025
AGA vs. HGM-EDA	0.025	0.025

Table 17: Adjusted p-values for the algorithms for the configuration 200×20. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
VNS_4 vs. HGM-EDA	7.74×10^{-6}	2.32×10^{-5}
AGA vs. VNS_4	0.025	0.025
AGA vs. HGM-EDA	0.025	0.025

3.5 Instances of 500 jobs: 500×20.

3.5.1 Non-parametric test: Friedman Test

Table 18: Average ranking of the algorithms for the instances 500×20.

Algorithm	500×20
AGA	2.8
VNS_4	2.1
HGM-EDA	0.9

3.5.2 Pairwise comparison: Shaffer's Static Procedure

Table 19: Adjusted p-values for the algorithms for the configuration 500×20. The hypothesis that have a p-value higher than ≤ 0.05 are rejected.

Hypothesis	unadjusted p	p_{Shaf}
AGA vs. HGM-EDA	2.15×10^{-5}	6.45×10^{-5}
VNS_4 vs. HGM-EDA	0.013	0.013
AGA vs. VNS_4	0.073	0.073