



Online-Appendix

„Runtime-Sensitive Learned Operator Selection in
ALNS: Testing Improvements to Adaptive Operator
Selection while Optimizing Runtime“

Christopher Dudel

Technical University of Munich

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A. Appendix

A.1. Instances

Table A1 Evaluation Instance Files

Instance	Nodes	Depot Position	Customer Distribution	min. Vehicles	Best Known Cost	Optimal Solution Proven	Best Reached GTO*
X-n143-k7	143	Corner	Random	7	15700	Yes	0.00
X-n153-k22	153	Center	Clustered	22	21220	Yes	0.00
X-n162-k11	162	Center	Random	11	14138	Yes	0.00
X-n256-k16	265	Center	Clustered	16	18839	Yes	0.00
X-n261-k13	261	Corner	Random	13	26558	Yes	0.01
X-n270-k35	270	Center	Random	35	35291	Yes	0.02
X-n331-k15	331	Corner	Random	15	31102	Yes	0.01
X-n344-k43	344	Center	Random	43	42050	Yes	0.03
X-n351-k40	351	Center	Clustered	40	25896	Yes	0.04
X-n701-k44	701	Corner	Random	44	81923	No	0.05
X-n716-k35	716	Corner	Clustered	35	43373	No	0.05
X-n733-k159	733	Center	Random	159	136187	No	0.11

Instances from Uchoa et al. (2017), *Best solution found by any Algorithm within this study.

n: instance size in number of customer nodes, **k**: min. amount of vehicles needed, **corner/clustr/center**: instance layout

A.2. Runtime-Approximation

Table A2 RTA BigO Data

file	greedy_mean	greedy_median	nearby_mean	nearby_median	sorted_mean	sorted_median	locost_mean	locost_median	regret_mean	regret_median	regrdk_mean	regrdk_median	friend_mean	friend_median
n031-kxx	36434	36540	43921	44059	106010	105805	74539	74626	72509	72465	72515	72476	1798187	1841528
n101-k25	48408	48443	54189	54444	124103	124082	90258	89953	83084	82628	82922	82470	2955565	2962578
n106-k14	42210	42082	49454	49187	124782	124812	82932	82805	80566	80577	80701	80733	2805992	2802786
n110-k13	40501	40314	48066	47629	123701	123640	80611	80461	79833	79775	79825	79797	2774914	2771842
n115-k10	40356	40249	46444	46288	130473	130326	84777	85374	86498	86878	86749	87184	2742128	2737920
n120-k6	36590	36400	44301	44000	141277	140994	75955	75994	79794	79794	79794	79794	2677778	2672782
n125-k30	52836	52941	56961	57302	132570	132364	97750	97731	89687	90167	89878	90258	3001489	3013591
n129-k18	46793	46669	51655	51506	135211	135496	92747	92952	89624	90153	89925	90438	2870730	2864740
n134-k13	44702	44668	49404	49028	136834	136511	90526	91115	89400	89558	89217	89239	2808558	2804584
n139-k10	39210	39041	47091	47000	135258	135306	79558	79300	82110	81431	82117	81669	2745834	2740743
n143-k7	37132	36900	45509	45500	148737	148351	77255	77351	81551	81551	81553	81551	2719598	2719039
n148-k46	59819	60589	63693	64844	138090	137845	104435	104814	90530	90391	90492	90415	3168822	3200081
n153-k22	54684	54795	55067	55060	146555	146004	109475	109800	105622	105902	106139	106388	2945727	2950604
n157-k14	40556	40400	48654	48500	136862	136606	81022	80606	82806	82806	82806	82806	2789170	2785454
n162-k11	39050	38900	47635	47500	143428	143208	79515	79208	83308	83308	83308	83308	2764215	2754796
n167-k10	39446	39400	47366	47000	149816	149259	79489	79259	83559	83559	83559	83559	2749783	2741547
n172-k51	64664	65224	67832	68906	146728	146876	112890	112566	97219	97507	97190	97578	3240143	3282558
n176-k26	60917	61044	57868	57719	156252	156477	120610	121092	116342	117037	116490	117536	3024892	3025097
n181-k23	47009	46900	54688	54500	138473	138014	87676	87514	85381	84844	85496	84819	2945639	2940706
n186-k15	42767	42400	50942	50500	148693	149116	83266	83116	85316	85316	85316	85316	2832094	2827054
n190-k8	38462	38400	46691	46500	169090	168667	78911	78667	85567	85567	85567	85567	2750582	2747055
n195-k51	69255	69439	68030	69076	154990	155025	121153	121349	105011	104984	105168	105344	3297102	3324999
n200-k36	66861	67284	62891	62817	161627	162462	126850	128703	117911	119836	118820	120538	3164478	3169149
n204-k19	44557	44400	52705	52500	146447	146371	85562	85371	86573	86571	86581	86571	2889530	2885809
n209-k16	43600	43400	51715	51500	155225	154973	84347	83973	87073	87073	87073	87073	2855847	2848811
n214-k11	42890	42902	49313	49225	168303	167875	88865	89496	95010	95043	95244	95424	2791672	2789874
n219-k73	74286	75261	73053	75180	159208	158413	127042	126373	108102	106613	106741	105179	3455256	3496331
n223-k34	64571	65119	62176	61990	164283	165396	125127	126527	118901	120178	116601	117949	3145199	3146397
n228-k23	61891	61834	57065	56981	176618	177042	136631	138927	136098	138688	137167	139806	3008783	3004906
n233-k16	43696	43400	52069	52000	167381	166881	84898	84881	89083	89081	89086	89081	2875674	2868069
n237-k14	47056	46904	51435	50995	174527	174602	99786	100404	104588	105823	105276	105769	2846688	2842395
n242-k48	79017	79383	69582	69764	182219	182502	150274	151840	135356	137555	135865	137429	3323927	3341680
n247-k50	83781	83590	69837	70220	185417	185204	157942	158527	148259	147995	147516	147196	3297006	3316808
n251-k28	56172	56447	59483	59401	164411	164723	109704	111953	108142	110165	108298	110008	3054921	3056161
n256-k16	42746	42400	51522	51000	167425	167289	84651	84289	91089	91089	91089	91089	2861714	2861577
n261-k13	41784	41400	50750	50500	184394	183840	83389	83340	91340	91340	91341	91340	2816417	2812828
n266-k58	85046	85630	73592	74456	192726	194308	162182	164145	142385	144681	142712	144516	3468937	3490626
n270-k35	60267	60213	63471	63381	166509	166528	111295	112354	106194	107067	106394	106791	3158875	3156637
n275-k28	52330	51900	59133	59054	164500	164541	96975	96531	96806	96822	96692	96790	3043405	3038281
n280-k17	58219	58593	54301	53864	208008	207832	154081	160235	163552	170229	163684	169869	2941780	2938287
n284-k15	44679	44647	51672	51436	188905	187896	92653	90281	100216	99215	100910	99631	2848287	2841337
n289-k60	91752	91999	76071	76518	202284	202929	173956	174967	157214	158494	156549	157343	3518326	3542254
n294-k50	81988	82731	72195	72314	190422	190851	153807	156521	141005	143348	141858	143786	3387979	3394324
n298-k31	61358	61821	62442	62173	181543	181336	118438	120188	115854	117814	116473	117682	3122278	3122001
n303-k21	47813	47516	55155	54887	185891	185963	93910	93646	99421	99082	99156	98757	2945667	2938267
n308-k13	41857	41400	50735	50500	214309	213662	84421	84166	95362	95356	95366	95356	2828613	2818844
n313-k71	98198	98846	79844	80315	208865	209026	181357	183324	163172	163881	161151	161809	3609085	3628816
n317-k53	80988	82559	73389	73367	194918	196403	151617	155647	138869	143102	138182	141167	3431367	3433820
n322-k28	51393	50900	59821	59500	177808	177860	94339	94360	96361	96360	96360	96360	3063902	3053948
n327-k20	46570	46400	55316	55000	193797	193462	89381	88962	96882	96862	96862	96862	2939973	2934850
n331-k15	43753	43400	51752	51500	210601	209513	86358	86013	97114	97113	97113	97113	2870053	2864140
n336-k84	105694	105753	86649	88224	219304	220246	190661	191223	168326	169061	168358	169211	3759077	3822940
n344-k43	69428	69785	69826	69628	189318	188990	129033	131113	123606	125459	124282	125214	3301037	3299715
n351-k40	69924	70596	68466	68293	197060	197063	134118	136671	132316	133691	130701	134035	3276594	3271112
n359-k29	63166	63351	62452	62277	208937	208836	136615	138914	139862	142319	140738	143938	3113058	3107851
n367-k17	56524	57836	55288	55083	229280	228811	144449	151567	160565	168505	155854	161650	2969308	2963323
n376-k94	126294	126537	89593	91369	255372	257673	241436	243682	207895	211365	211345	213523	3955336	4007122
n384-k52	88290	90174	76351	76134	217282	219063	168605	173217	159247	162552	157902	162174	3486616	3492464
n393-k38	58600	58400	66999	67000	193637	192912	104316	104370	104493	104453	104656	105125	3223588	3220703
n401-k29	51932	51703	61827	61540	215280	214993	95661	95321	103188	103137	103175	103137	3078653	3071243
n411-k19	65330	66362	56825	56568	268838	269697	208419	218238	215225	225151	215127	222339	3050928	3051191
n420-k130	133518	134882	105396	108585	244234	244805	223998	225026	182564	180939	179131	179558	4232727	4335498
n429-k61	95874	98680	81071	81114	229909	233608	179902	187366	170222	177429	168132	174981	3617761	3623716
n439-k37	56810	56400	65619	65500	207027	207349	101670	101349	106149	106149	106150	106149	3202493	3195387
n449-k29	56169	55914	62387	62232	230055	230387	104042	103666	114424	113721	114516	113966	3089152	3084626
n459-k26	50426	49900	59982	60000	234626	234206	95587	95706	107906	107906	107906	107906	3048524	3039894
n469-k138	146446	146531	111543	115445	278891	277688	254252	252368	216372	212141	215183	210767	4491039	4608275
n480-k70	121576	128896	87400	87306	273921	286876	256590	277880	238661	257731	238398	257054	3829387	3847814
n491-k59	113285	117241	82252	82141	273256	280495	236270	252758	230436	243408	227455	240496	3661158	3659027
n502-k39	58876	58900	67552	67000	221929	221920	104032	103420	111420	111420	111420	111420	3236419	3228908
n513-k21	47510	47400	56756	56500	281603	281073	93822	93573	112174	112174	112173	112173	2979013	2975661
n524-k153	219000	219845	123069	125238	343180	343635	360862	362767	327643	328534	323342	323860	4553688	4674852
n536-k96	172274	180181	99138	99631	348470	363625	360807	382824	329178	347321	326075	346558	4230616	4244474
n548-k50														

A.3. Meta-Parameter and Hyper-Parameter Values

Table A3 Meta- and Hyper-Parameter Values

Parameter	Explanation	Value
α	Update Rate for operator weights	0.5
β	Batch Size for weight update batches	50
dod	Degree of Destruction for destroy operators.	0.33 (<i>random, expens</i>), 0.25 (<i>nearby, demand, routes_destroy</i>)
I_{max}	Maximum iterations as stopping criterion.	2000
Initial Weights	Initial Weights for all operators	10
Random-k Range	Range for the random-k to take in <i>re-grdk_repair</i>	2 - 5
n_r, n_g, n_f	Parameters governing the friend-groups in <i>friend_repair</i>	3, 3, 4
Minimum Weights	Minimum value an operator weight can take	1
ω	Time Sensitivity Factor to tune how much slow operators' rewards are lowered.	1.2 for full operator portfolio, 0.15 for pre-selected portfolio.
ϕ_ρ	Acceptance Reward for Acceptance Result [new_best, improvement, annealed, rejected, already_visited]	[50, 10, 5, 1, 1]
sa_{ti}	Target Iteration for the SA-temperature to reach sa_{tp}	85% of I_{max} .
sa_{tp}	Target Percentage for the SA-temperature to reach in iteration sa_{ti}	2.5% of of initial temperature sat_0 .
Atoms	Amount of Distribution Columns for the C51-agent	51
Discount Factor	Discount Factor governing how much future rewards are calculated into current rewards.	1
ϵ	Epsilon for epsilon-greedy policy.	0.8 \rightarrow 0.01 over 30% of training episodes.
gf	Gap Factor for balancing reward function (7).	52
DQN Layer Size	Size of hidden layers of the DQN	[256, 128, 64]
Replay Buffer Capacity	Size of the DQL Replay Buffer	100,000 transitions
RL Learning Rate	Learning Rate for LLNS training	1E-4 \rightarrow 1E-6 over 75% of training episodes.
Q-Range	Range for the C51-distribution	0 - (max. observed reward for reward-scheme * 2)
Meta- and Hyper-Parameters active during algorithm comparison runs for Section 4.6.1. Parameters can differ for earlier testing-, tuning- or training-runs.		

A.4. Operator Analysis in LNS

Table A4 Comparison of Operator Portfolio Performance in ALNS and tALNS

Instance**	Avg. eRTA-GTO5	% of GTO10 Reached	Avg. Final GTO	Avg. Punished*** eRTA-GTO5	Avg. eRTA-GTO5	% of GTO10 Reached	Avg. Final GTO	Avg. Punished*** eRTA-GTO5	% Diff. Pun.*** eRTA-GTO5 to ALNS	p-Value****
	ALNS				tALNS, $\omega=1.0$					
	greedy, nearby									
Average	1.59E+08	0.40	0.11	1.19E+09	1.52E+08	0.42	0.11	1.17E+09	+0.81%	0.9593
143-k7-corner	1.78E+8	0.60	0.09	4.91E+8	2.55E+8	0.80	0.09	3.96E+8	+66.69%	0.2613
153-k22-clustr	2.36E+8	1.00	0.06	2.36E+8	2.24E+8	1.00	0.07	2.24E+8	-25.12%	0.2139
162-k11-center	6.17E+7	1.00	0.03	6.17E+7	5.88E+7	1.00	0.03	5.88E+7	-4.89%	0.8118
256-k16-clustr	1.70E+8	1.00	0.07	1.70E+8	8.99E+7	1.00	0.05	8.99E+7	-0.00%	0.9995
261-k13-corner	-*	0.00	0.15	7.67E+8	-*	0.00	0.15	7.67E+8	0.00%	-*
270-k35-center	-*	0.00	0.14	1.22E+9	-*	0.00	0.14	1.22E+9	0.00%	-*
331-k15-corner	-*	0.00	0.12	1.17E+9	-*	0.00	0.13	1.17E+9	0.00%	-*
344-k43-center	-*	0.00	0.15	2.55E+9	-*	0.00	0.16	2.55E+9	0.00%	-*
351-k40-clustr	-*	0.00	0.18	4.01E+9	-*	0.00	0.20	4.01E+9	0.00%	-*
	greedy, nearby, locost									
Average	2.28E+8	0.44	0.12	1.18E+9	2.12E+8	0.42	0.11	1.19E+9	-0.35%	0.9814
143-k7-corner	2.99E+8	1.00	0.08	2.99E+8	3.83E+8	0.80	0.09	4.99E+8	-12.12%	0.4886
153-k22-clustr	4.38E+8	1.00	0.07	4.38E+8	6.23E+8	1.00	0.08	3.28E+8	+9.91%	0.6451
162-k11-center	6.99E+7	1.00	0.03	6.99E+7	6.65E+7	1.00	0.04	6.65E+7	-7.20%	0.5916
256-k16-clustr	1.05E+8	1.00	0.06	1.05E+8	1.05E+8	1.00	0.05	1.05E+8	+6.20%	0.8486
261-k13-corner	-*	0.00	0.15	7.67E+8	-*	0.00	0.15	7.67E+8	0.00%	-*
270-k35-center	-*	0.00	0.16	1.22E+9	-*	0.00	0.15	1.22E+9	0.00%	-*
331-k15-corner	-*	0.00	0.13	1.17E+9	-*	0.00	0.13	1.17E+9	0.00%	-*
344-k43-center	-*	0.00	0.16	2.55E+9	-*	0.00	0.15	2.55E+9	0.00%	-*
351-k40-clustr	-*	0.00	0.21	4.01E+9	-*	0.00	0.18	4.01E+9	0.00%	-*
	greedy, nearby, locost, sorted									
Average	2.83E+8	0.40	0.12	1.24E+9	3.21E+8	0.42	0.12	1.23E+9	-1.77%	0.9118
143-k7-corner	5.40E+8	0.60	0.10	7.09E+8	6.23E+8	1.00	0.09	6.23E+8	-19.30%	0.5482
153-k22-clustr	4.71E+8	1.00	0.07	4.71E+8	4.68E+8	0.80	0.08	5.18E+8	-5.01%	0.8328
162-k11-center	9.83E+7	1.00	0.03	9.83E+7	9.13E+7	1.00	0.03	9.13E+7	-4.67%	0.7946
256-k16-clustr	1.25E+8	1.00	0.04	1.25E+8	1.32E+8	1.00	0.06	1.32E+8	-46.99%	0.0355
261-k13-corner	-*	0.00	0.16	7.67E+8	-*	0.00	0.16	7.67E+8	0.00%	-*
270-k35-center	-*	0.00	0.15	1.22E+9	-*	0.00	0.16	1.22E+9	0.00%	-*
331-k15-corner	-*	0.00	0.13	1.17E+9	-*	0.00	0.13	1.17E+9	0.00%	-*
344-k43-center	-*	0.00	0.17	2.55E+9	-*	0.00	0.17	2.55E+9	0.00%	-*
351-k40-clustr	-*	0.00	0.20	4.01E+9	-*	0.00	0.19	4.01E+9	0.00%	-*
	greedy, nearby, locost, sorted, regret									
Average	1.09E+8	1.00	0.03	1.09E+8	1.01E+8	1.00	0.03	1.01E+8	+10.85%	0.5150
143-k7-corner	4.50E+7	1.00	0.02	4.50E+7	3.94E+7	1.00	0.02	3.94E+7	+0.05%	0.9984
153-k22-clustr	8.49E+7	1.00	0.01	8.49E+7	8.74E+7	1.00	0.02	8.74E+7	+50.99%	0.0155
162-k11-center	2.18E+7	1.00	0.01	2.18E+7	2.79E+7	1.00	0.00	2.79E+7	+60.86%	0.3361
256-k16-clustr	5.11E+7	1.00	0.01	5.11E+7	5.84E+7	1.00	0.02	5.84E+7	-39.46%	0.0534
261-k13-corner	3.94E+7	1.00	0.02	3.94E+7	4.90E+7	1.00	0.02	4.90E+7	-4.45%	0.8401
270-k35-center	1.35E+8	1.00	0.04	1.35E+8	1.32E+8	1.00	0.05	1.32E+8	+6.16%	0.7163
331-k15-corner	4.80E+7	1.00	0.03	4.80E+7	7.04E+7	1.00	0.03	7.04E+7	-12.07%	0.6443
344-k43-center	2.10E+8	1.00	0.05	2.10E+8	2.01E+8	1.00	0.05	2.01E+8	+3.29%	0.7637
351-k40-clustr	3.47E+8	1.00	0.06	3.47E+8	2.43E+8	1.00	0.06	2.43E+8	+25.58%	0.0990
	greedy, nearby, locost, sorted, regret, regrdk									
Average	1.13E+8	1.00	0.03	1.13E+8	1.25E+8	1.00	0.03	1.25E+8	-7.56%	0.5186
143-k7-corner	5.50E+7	1.00	0.02	5.50E+7	5.51E+7	1.00	0.02	5.51E+7	-12.48%	0.6157
153-k22-clustr	6.62E+7	1.00	0.02	6.62E+7	1.00E+8	1.00	0.02	1.00E+8	+2.96%	0.7153
162-k11-center	1.48E+7	1.00	0.00	1.48E+7	2.39E+7	1.00	0.01	2.39E+7	+28.32%	0.4940
256-k16-clustr	4.07E+7	1.00	0.01	4.07E+7	2.46E+7	1.00	0.01	2.46E+7	+14.23%	0.2466
261-k13-corner	4.46E+7	1.00	0.02	4.46E+7	4.26E+7	1.00	0.03	4.26E+7	+24.19%	0.6720
270-k35-center	1.39E+8	1.00	0.04	1.39E+8	1.48E+8	1.00	0.04	1.48E+8	-2.55%	0.8960
331-k15-corner	9.51E+7	1.00	0.03	9.51E+7	8.37E+7	1.00	0.03	8.37E+7	+46.78%	0.1266
344-k43-center	2.46E+8	1.00	0.05	2.46E+8	2.54E+8	1.00	0.05	2.54E+8	-4.24%	0.7117
351-k40-clustr	3.13E+8	1.00	0.06	3.13E+8	3.93E+8	1.00	0.07	3.93E+8	-30.07%	0.1079
	greedy, nearby, locost, sorted, regret, regrdk, friend									
Average	9.67E+8	1.00	0.03	9.67E+8	3.72E+8	1.00	0.03	3.72E+8	-61.53%	0.0000
143-k7-corner	3.03E+8	1.00	0.02	3.03E+8	9.79E+7	1.00	0.01	9.79E+7	-67.73%	0.0008
153-k22-clustr	5.80E+8	1.00	0.01	5.80E+8	2.00E+8	1.00	0.02	2.00E+8	-65.52%	0.0001
162-k11-center	1.54E+8	1.00	0.01	1.54E+8	3.63E+7	1.00	0.01	3.63E+7	-76.47%	0.0008
256-k16-clustr	2.62E+8	1.00	0.01	2.62E+8	5.31E+7	1.00	0.01	5.31E+7	-79.70%	0.0000
261-k13-corner	5.86E+8	1.00	0.02	5.86E+8	1.93E+8	1.00	0.02	1.93E+8	-67.11%	0.0000
270-k35-center	1.15E+9	1.00	0.05	1.15E+9	5.57E+8	1.00	0.04	5.57E+8	-51.50%	0.0002
331-k15-corner	7.28E+8	1.00	0.04	7.28E+8	2.27E+8	1.00	0.03	2.27E+8	-68.79%	0.0017
344-k43-center	2.31E+9	1.00	0.06	2.31E+9	1.02E+9	1.00	0.06	1.02E+9	-56.00%	0.0024
351-k40-clustr	2.63E+9	1.00	0.06	2.63E+9	9.67E+8	1.00	0.07	9.67E+8	-63.24%	0.0003

Left side: runs in ALNS, right side: runs in tALNS, Time-Sensitivity Factor ω not tuned. *GTO10 not reached.

5 Runs per Instance and Portfolio, n: instance size in number of customer nodes, k: min. amount of vehicles needed, **corner/clustr/center: instance layout.

Punished refers to runs which did not reach GTO10 being scored with the slowest run in the instance that did reach GTO10. *Two-sided p-Value.

A.5. Operator Analysis in (−)ALNS

Table A5 Operator Performance in (−)ALNS Runs

	n143- k7- corner	n153- k22- clustr	n162- k11- center	n256- k16- clustr	n261- k13- corner	n270- k35- center	n331- k15- corner	n344- k43- center	n351- k40- clustr	Average
greedy_repair										
accepted	31.41	41.83	42.47	39.25	19.69	23.91	33.86	30.31	31.56	32.70
improvement	18.63	23.67	25.13	22.8	11.89	14.31	20.33	16.7	19.38	19.20
new_best	1.7	1.68	1.31	1.67	1.77	1.03	1.26	1.03	1.24	1.37
nearby_repair										
accepted	30.06	43.71	40.66	37.63	20.73	25.27	33.92	29.45	31.46	32.54
improvement	18.33	25.45	22.93	22.55	12.23	14.73	19.69	16.78	18.73	19.05
new_best	2	1.87	0.93	1.62	1.85	0.8	1.11	0.59	0.97	1.30
sorted_repair										
accepted	31.19	41.86	40.64	38.83	19.33	24.61	34.43	29.55	29.22	32.18
improvement	19.11	24.09	22.92	22.43	11.48	14.44	20	16.62	17.03	18.68
new_best	1.99	1.74	1.45	1.36	1.84	1.16	1.81	1.12	1.49	1.55
locost_repair										
accepted	31.68	42.44	40.51	40.95	20.82	24.16	34.05	29.34	31.46	32.82
improvement	19.15	23.62	23.07	22.72	12.66	14.18	20	17.36	18.55	19.03
new_best	1.51	1.6	1.34	1.46	1.77	1.47	1.6	0.84	0.97	1.40
regret_repair										
accepted	30.98	43.23	42.21	38.62	21.12	22.75	32.43	29.3	31.44	32.45
improvement	19.26	24.27	24.14	22.19	12.36	12.13	19.54	17.74	18.01	18.85
new_best	1.87	1.71	1.17	1.94	2.32	0.69	1.58	0.77	1.14	1.47
regrdk_repair										
accepted	29.38	41.46	40.23	38.84	20.39	25.43	34.59	28.71	31.44	32.27
improvement	17.79	23.13	23.06	22.01	12.27	14.77	20.88	17.35	18.28	18.84
new_best	1.26	1.78	1.25	1.61	1.63	1.04	1.41	1.03	1.21	1.36
friend_repair										
accepted	32.98	42.22	40.28	38.93	20.62	25.28	35.62	28.49	30.28	32.74
improvement	19.17	24.03	22.92	21.7	12.26	14.06	21.56	16.64	18.17	18.95
new_best	1.74	1.9	0.72	1.89	1.95	0.86	1.14	0.72	1.25	1.35

Percentage of iterations in which operator finds an annealing-accepted / improved compared to S^a / new best solution. 10 (−)ALNS-runs per instance.

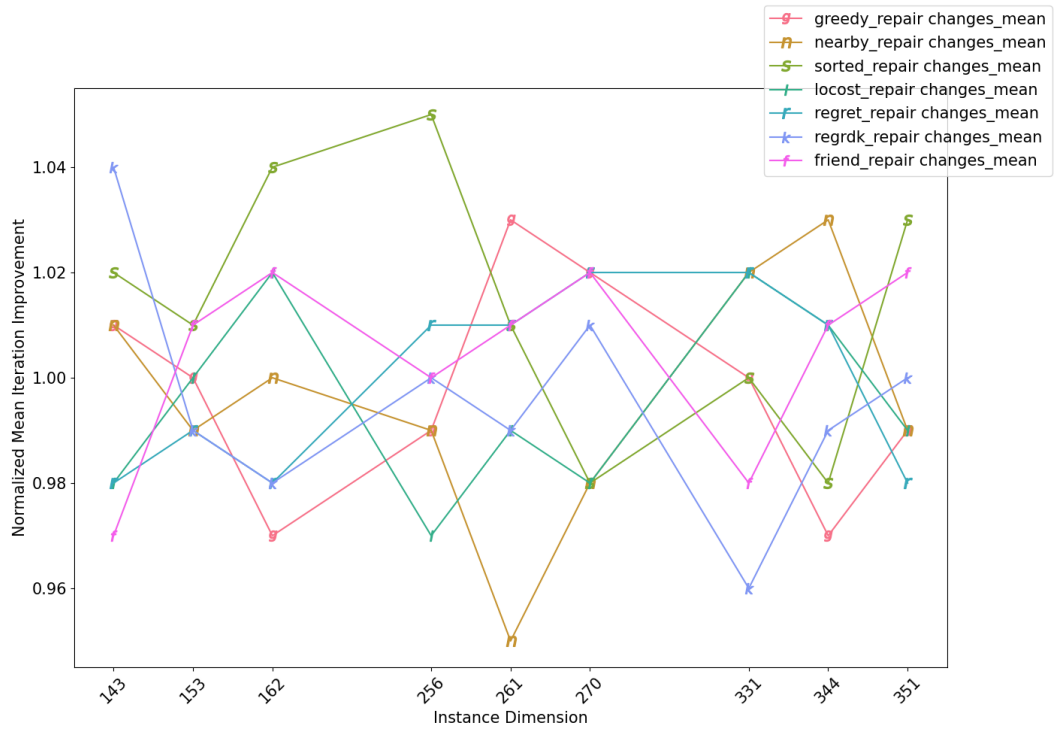


Figure A1 Normalized Average Solution Objective Value Change per Iteration. 10 (→)ALNS-runs per instance. Lower is better. First calculates average solution value change ($S - S^a$) for each operator in each instance. Then normalizes by average value for instance and all operators.

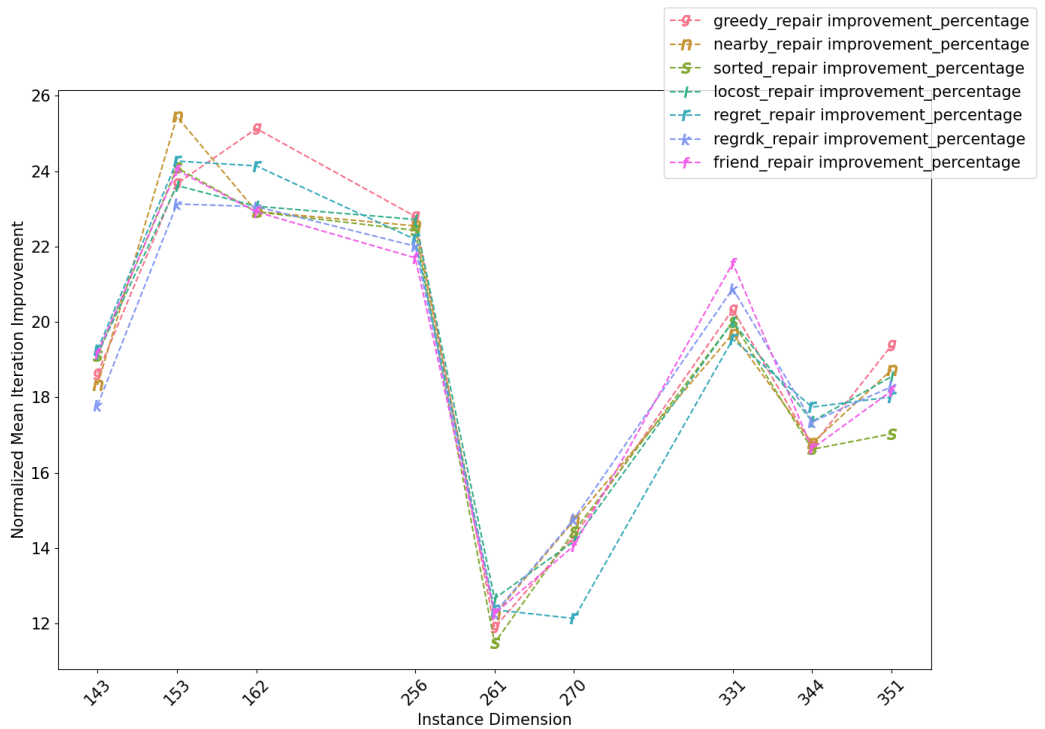


Figure A2 Percentage of Iterations per Operator and Instance, in which Operator finds an Improvement to Accepted Solution S^a . 10 (→)ALNS-runs per instance. Higher is better. Dip at instance 261 and 270 is caused by low initial sat_0 , leading to few improvements.

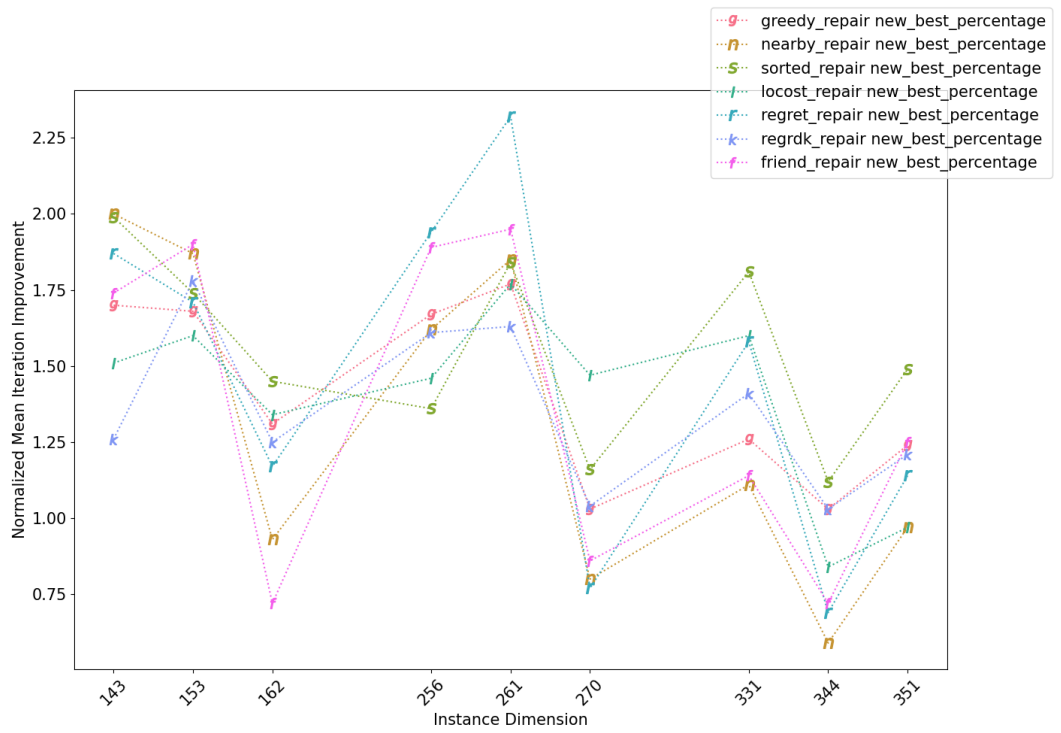


Figure A3 Percentage of Iterations per Operator and Instance in which Operator finds an Improvement to Best Solution S^* . 10 (\rightarrow)ALNS-runs per instance. Higher is better.