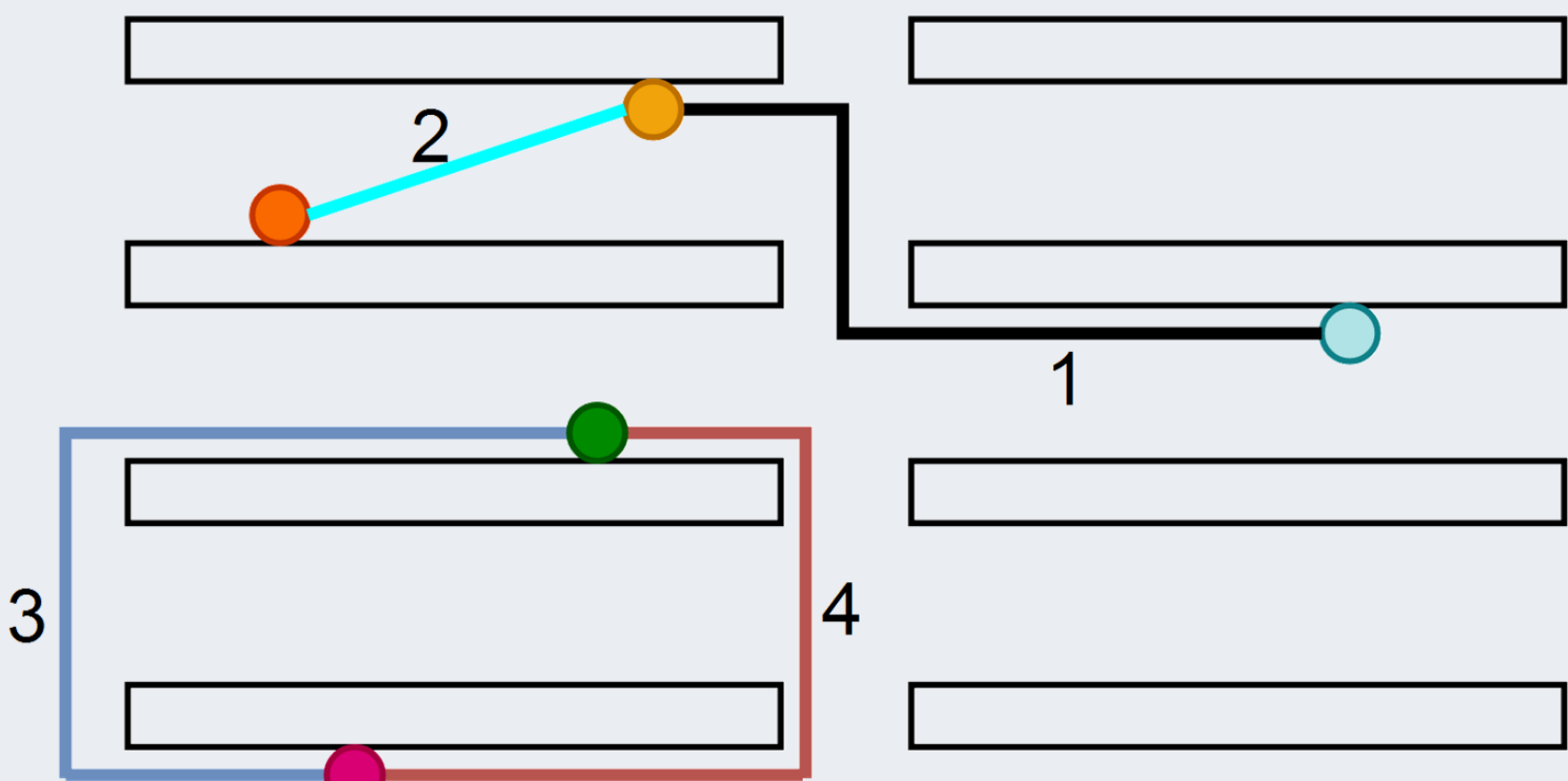


Order-based Manipulator-focused optimization of Warehouse passing

Supervisor: Ing. Zbyněk Křivka, PhD



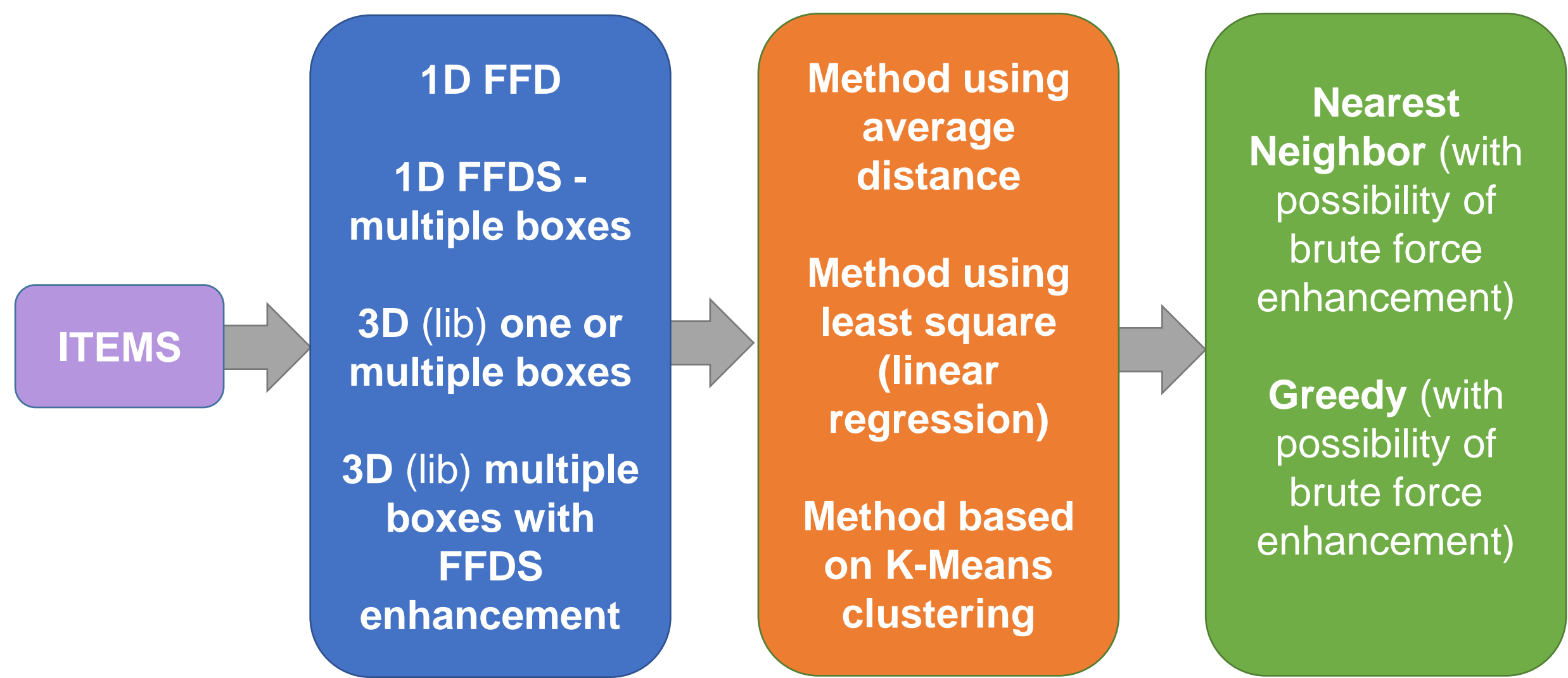
Distance measurement



§1.1 Distance measurement possibilities (Euclidean distance (line 1), Pythagoras distance (line 2), orthogonal barrier-aware distance (both lines 3, 4))

Phases of the items processing

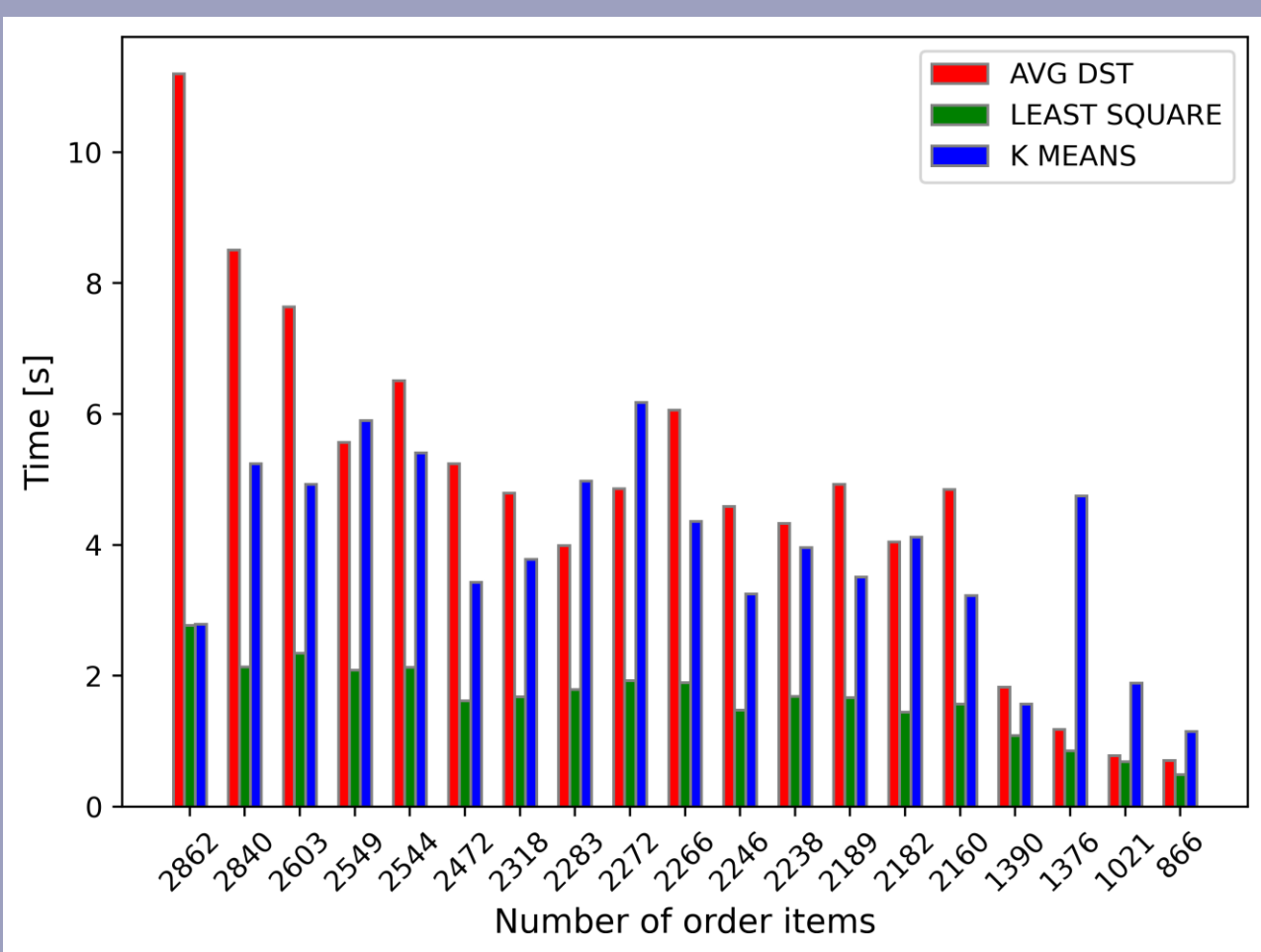
Three main phases – assigning items to the boxes, grouping items to carts, sorting items in carts. Each phase has multiple solution options.



§2.1 Solver steps

Grouping algorithms time complexity

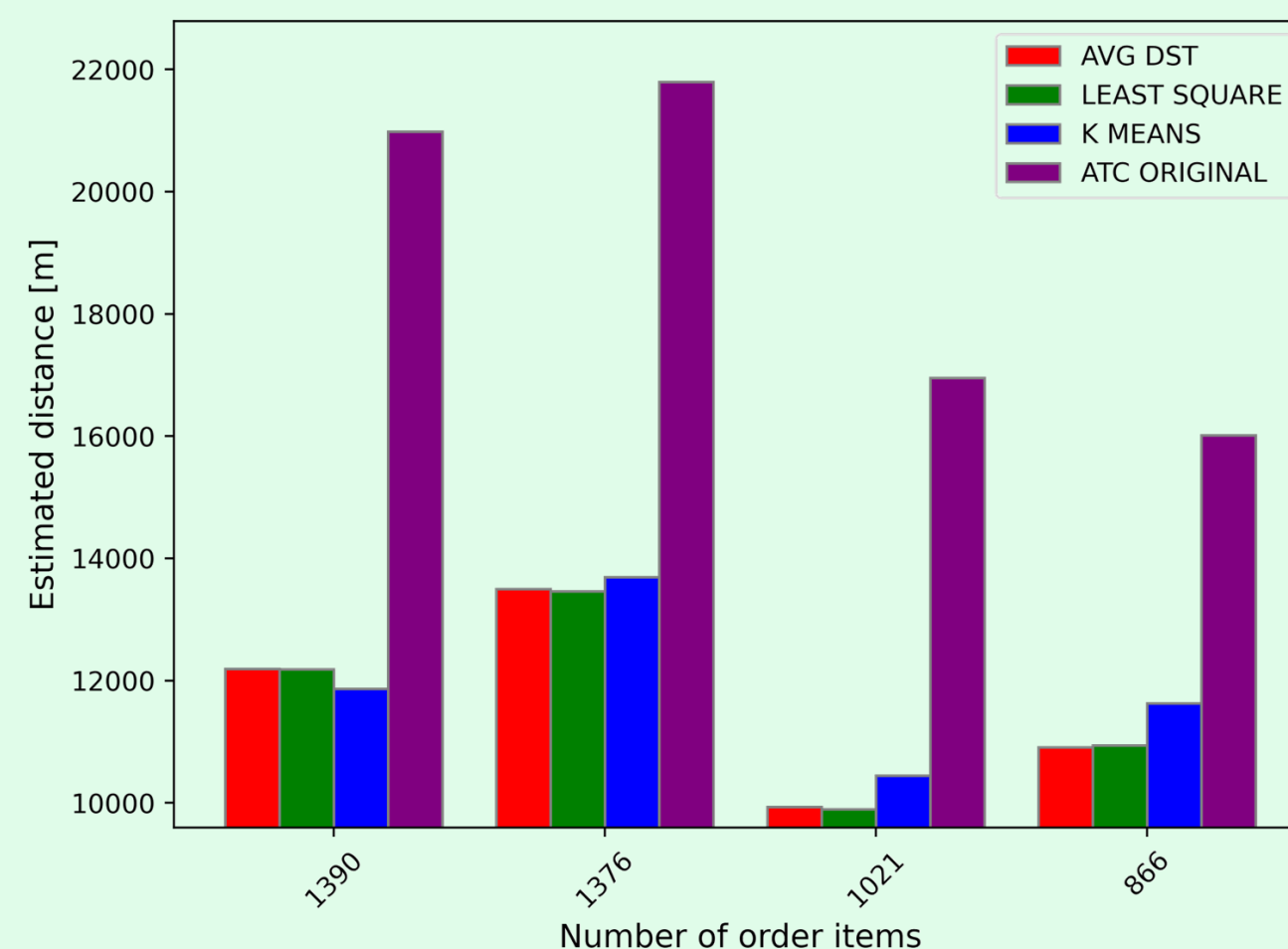
The time complexity for all the “waves” from the Figure 3.1 and 3.2 recorded for all the grouping algorithms, measured in seconds.



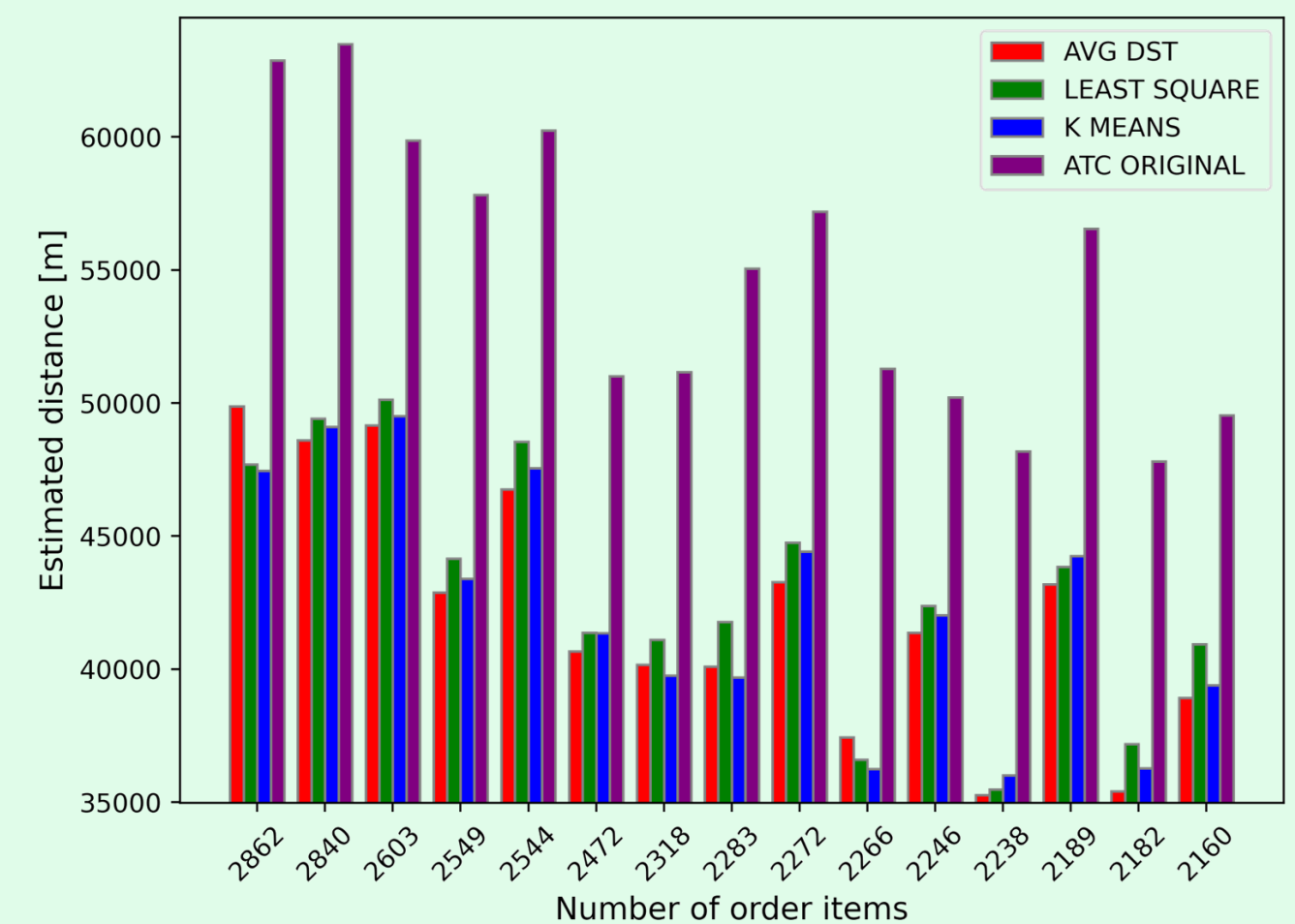
§4.1 Time complexity of group. alg.

Results of the grouping algorithms

There have been used all the algorithms solving problem of customers grouping – the first graph shows results of items set in one or two sectors of the store, while the second one shows the situation, when the items are situated all around the warehouse.



§3.1 Walked distance per “wave” while using different algorithms



§3.2 Walked distance per “wave” while using different algorithms

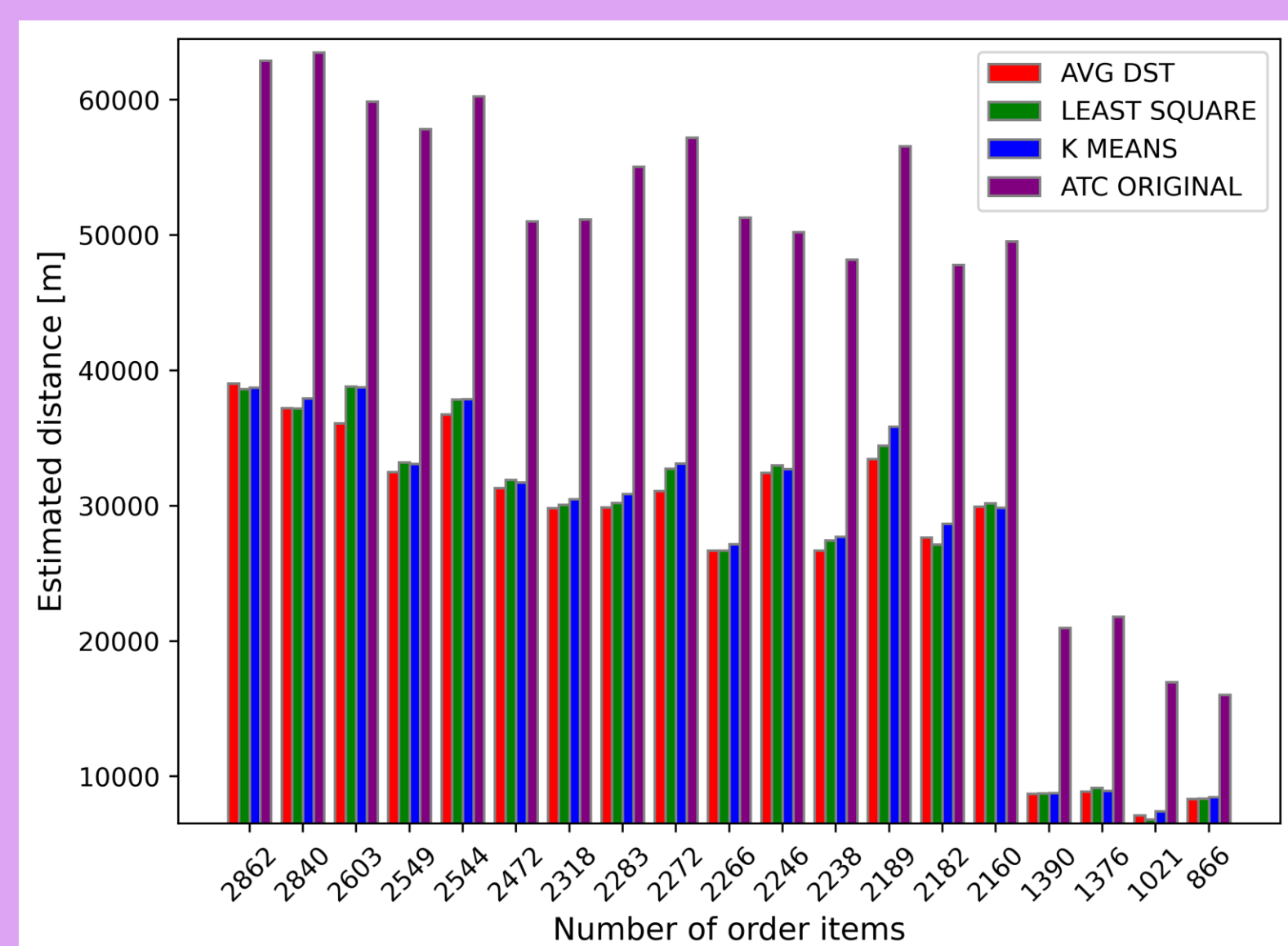
Fill rate of boxes for different algorithms

number order items	FFD 1D		3D	
	count	fill rate [%]	count	fill rate [%]
866	468	48.23	619	36.46
1021	520	32.36	655	25.69
1376	564	23.78	706	19.00
1390	487	35.72	645	26.97
2160	571	56.89	876	37.08
2182	561	49.44	859	32.29
2189	664	53.50	1049	33.86
2238	536	51.22	905	30.33
2246	680	57.42	1181	33.06
2266	635	42.03	942	28.33
2272	773	46.49	1146	31.36
2283	590	45.84	909	29.75
2318	555	51.77	908	31.64
2472	524	57.75	853	35.47
2544	742	53.33	1218	32.48
2549	701	47.88	1087	30.87
2603	839	55.57	1416	32.93
2840	690	52.82	1120	32.54
2862	679	52.92	1006	35.71
average box fill rate	48,16 %		31,36 %	

§5.1 Boxes fill rate

Grouping customers with different cart and box dimensions

Graph below demonstrates the lower walked distance for all the “waves” from the figures 3.1 and 3.2 when bigger cart and different types of boxes can be used.



§6.1 Walked distance per “wave” while using larger properties