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1 C:\Users\MAPS-T15\PycharmProjects\capstone\venv\
  Scripts\python.exe "C:/Users/MAPS-T15/PycharmProjects
  /capstone/Clustering/Route Optimization/3opt.py"
2 ConvexHull distance : 3868.380276301065
3 ConvexHull computation time : 0.32274460792541504
4 DP distance : 4143
5 DP computation : 128.41573095321655
6 (DP - ConvexHull) / ConvexHull distance
7 : 7.099088095897484 %
8 (DP - ConvexHull) / ConvexHull computation time
9 : 39688.65263734876 %
10 LS_distance : 4143
11 LS computation : 0.010097503662109375
12 (LS - ConvexHull) / ConvexHull
13 : 7.099088095897484 %
14 (LS - ConvexHull) / ConvexHull computation time
15 : -96.87136410209435 %
16 3 OPT distance : {3811}
17 3 OPT computation : 0.010150909423828125
18 (3opt - ConvexHull) / ConvexHull distance : -1.
  4833152948430335 %
19 (3opt - ConvexHull) / ConvexHull computation time
20 : -96.8548167267371 %
21 ACO fitted. Best score: 4143.0
22 ACO distance : 4143.0
23 ACO computation : 2.8158247470855713
24 (ACO - ConvexHull) / ConvexHull
25 : 7.099088095897484 %
26 (ACO - ConvexHull) / ConvexHull computation time
27 : 772.4622125170553 %
28
29 ConvexHull distance : 3620.737454529572
30 ConvexHull computation time : 0.06908202171325684
31 DP distance : 4074
32 DP computation : 70.41958141326904
33 (DP - ConvexHull) / ConvexHull distance
34 : 12.51851456126411 %
35 (DP - ConvexHull) / ConvexHull computation time
36 : 101836.19072928136 %
37 LS_distance : 4079
38 LS computation : 0.018213272094726562
39 (LS - ConvexHull) / ConvexHull
40 : 12.656607976287754 %
41 (LS - ConvexHull) / ConvexHull computation time
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42 : -73.63529375222173 %
43 3 OPT distance : {4000}
44 3 OPT computation : 0.0020503997802734375
45 (3opt - ConvexHull) / ConvexHull distance : 10.
474732018914198 %
46 (3opt - ConvexHull) / ConvexHull computation time
47 : -97.03193431601616 %
48 ACO fitted. Best score: 4343.0
49 ACO distance : 4343.0
50 ACO computation : 2.3972206115722656
51 (ACO - ConvexHull) / ConvexHull
52 : 19.94794028953609 %
53 (ACO - ConvexHull) / ConvexHull computation time
54 : 3370.1077821991985 %
55
56 ConvexHull distance : 3124.7247180062327
57 ConvexHull computation time : 0.07815337181091309
58 DP distance : 3387
59 DP computation : 72.87716817855835
60 (DP - ConvexHull) / ConvexHull distance
61 : 8.393548413478008 %
62 (DP - ConvexHull) / ConvexHull computation time
63 : 93148.91107050357 %
64 LS_distance : 3387
65 LS computation : 0.012203454971313477
66 (LS - ConvexHull) / ConvexHull
67 : 8.393548413478008 %
68 (LS - ConvexHull) / ConvexHull computation time
69 : -84.38524827714544 %
70 3 OPT distance : {3181}
71 3 OPT computation : 0.010114908218383789
72 (3opt - ConvexHull) / ConvexHull distance : 1.
8009676714713736 %
73 (3opt - ConvexHull) / ConvexHull computation time
74 : -87.0576176254351 %
75 ACO fitted. Best score: 3544.0
76 ACO distance : 3544.0
77 ACO computation : 3.0225329399108887
78 (ACO - ConvexHull) / ConvexHull
79 : 13.41799101782287 %
80 (ACO - ConvexHull) / ConvexHull computation time
81 : 3767.437667595081 %
82
83 ConvexHull distance : 3508.381297839042
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84 ConvexHull computation time : 0.08468818664550781
85 DP distance : 3911
86 DP computation : 69.0072431564331
87 (DP - ConvexHull) / ConvexHull distance
88 : 11.475910626047051 %
89 (DP - ConvexHull) / ConvexHull computation time
90 : 81383.90689398888 %
91 LS_distance : 4020
92 LS computation : 0.010096073150634766
93 (LS - ConvexHull) / ConvexHull
94 : 14.582756511559483 %
95 (LS - ConvexHull) / ConvexHull computation time
96 : -88.07853426724623 %
97 3 OPT distance : {3743}
98 3 OPT computation : 0.008086919784545898
99 (3opt - ConvexHull) / ConvexHull distance : 6.
687377518101282 %
100 (3opt - ConvexHull) / ConvexHull computation time
101 : -90.4509470507421 %
102 ACO fitted. Best score: 4024.0
103 ACO distance : 4024.0
104 ACO computation : 3.431032180786133
105 (ACO - ConvexHull) / ConvexHull
106 : 14.696769204605811 %
107 (ACO - ConvexHull) / ConvexHull computation time
108 : 3951.370464629175 %
109
110 ConvexHull distance : 2930.5119937423538
111 ConvexHull computation time : 0.078155517578125
112 DP distance : 3557
113 DP computation : 67.74553894996643
114 (DP - ConvexHull) / ConvexHull distance
115 : 21.378107566029847 %
116 (DP - ConvexHull) / ConvexHull computation time
117 : 86580.43031286607 %
118 LS_distance : 3652
119 LS computation : 0.01014256477355957
120 (LS - ConvexHull) / ConvexHull
121 : 24.619861914855495 %
122 (LS - ConvexHull) / ConvexHull computation time
123 : -87.02258639203436 %
124 3 OPT distance : {3520}
125 3 OPT computation : 0.0
126 (3opt - ConvexHull) / ConvexHull distance : 20.
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126 115529556487225 %
127 (3opt - ConvexHull) / ConvexHull computation time
128 : -100.0 %
129 ACO fitted. Best score: 3568.0
130 ACO distance : 3568.0
131 ACO computation : 2.6276566982269287
132 (ACO - ConvexHull) / ConvexHull
133 : 21.753468595893867 %
134 (ACO - ConvexHull) / ConvexHull computation time
135 : 3262.087258395158 %
136
137 ConvexHull distance : 4078.7111920424313
138 ConvexHull computation time : 0.07815051078796387
139 DP distance : 4102
140 DP computation : 65.73035430908203
141 (DP - ConvexHull) / ConvexHull distance
142 : 0.5709844816422688 %
143 (DP - ConvexHull) / ConvexHull computation time
144 : 84007.38924972618 %
145 LS_distance : 4301
146 LS computation : 0.002053499221801758
147 (LS - ConvexHull) / ConvexHull
148 : 5.449976659079327 %
149 (LS - ConvexHull) / ConvexHull computation time
150 : -97.37237901442096 %
151 3 OPT distance : {4137}
152 3 OPT computation : 0.010103940963745117
153 (3opt - ConvexHull) / ConvexHull distance : 1.
    429098683704063 %
154 (3opt - ConvexHull) / ConvexHull computation time
155 : -87.07117731941779 %
156 ACO fitted. Best score: 4124.0
157 ACO distance : 4124.0
158 ACO computation : 2.7504544258117676
159 (ACO - ConvexHull) / ConvexHull
160 : 1.1103705515096822 %
161 (ACO - ConvexHull) / ConvexHull computation time
162 : 3419.4324363077244 %
163
164 ConvexHull distance : 3748.062862479507
165 ConvexHull computation time : 0.07815837860107422
166 DP distance : 3870
167 DP computation : 74.55809473991394
168 (DP - ConvexHull) / ConvexHull distance
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169 : 3.253337577156485 %
170 (DP - ConvexHull) / ConvexHull computation time
171 : 95293.60472210358 %
172 LS_distance : 3870
173 LS computation : 0.012195825576782227
174 (LS - ConvexHull) / ConvexHull
175 : 3.253337577156485 %
176 (LS - ConvexHull) / ConvexHull computation time
177 : -84.39601000549082 %
178 3 OPT distance : {3629}
179 3 OPT computation : 0.0
180 (3opt - ConvexHull) / ConvexHull distance : -3.
    1766506285527436 %
181 (3opt - ConvexHull) / ConvexHull computation time
182 : -100.0 %
183 ACO fitted. Best score: 3870.0
184 ACO distance : 3870.0
185 ACO computation : 2.932330846786499
186 (ACO - ConvexHull) / ConvexHull
187 : 3.253337577156485 %
188 (ACO - ConvexHull) / ConvexHull computation time
189 : 3651.780550301995 %
190
191 ConvexHull distance : 3433.900851678757
192 ConvexHull computation time : 0.07651400566101074
193 DP distance : 3674
194 DP computation : 69.27086925506592
195 (DP - ConvexHull) / ConvexHull distance
196 : 6.9920233195977035 %
197 (DP - ConvexHull) / ConvexHull computation time
198 : 90433.58095244032 %
199 LS_distance : 3698
200 LS computation : 0.01011037826538086
201 (LS - ConvexHull) / ConvexHull
202 : 7.690936917766007 %
203 (LS - ConvexHull) / ConvexHull computation time
204 : -86.78623844348957 %
205 3 OPT distance : {3391}
206 3 OPT computation : 0.0
207 (3opt - ConvexHull) / ConvexHull distance : -1.
    2493328588035344 %
208 (3opt - ConvexHull) / ConvexHull computation time
209 : -100.0 %
210 ACO fitted. Best score: 3850.0
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211 ACO distance : 3850.0
212 ACO computation : 3.6018946170806885
213 (ACO - ConvexHull) / ConvexHull
214 : 12.117389706165259 %
215 (ACO - ConvexHull) / ConvexHull computation time
216 : 4607.497125478697 %
217
218 ConvexHull distance : 3440.0785507860546
219 ConvexHull computation time : 0.06907963752746582
220 DP distance : 3801
221 DP computation : 69.09637451171875
222 (DP - ConvexHull) / ConvexHull distance
223 : 10.49166302122593 %
224 (DP - ConvexHull) / ConvexHull computation time
225 : 99924.22853514 %
226 LS_distance : 3801
227 LS computation : 0.010116815567016602
228 (LS - ConvexHull) / ConvexHull
229 : 10.49166302122593 %
230 (LS - ConvexHull) / ConvexHull computation time
231 : -85.35485140176917 %
232 3 OPT distance : {3413}
233 3 OPT computation : 0.0
234 (3opt - ConvexHull) / ConvexHull distance : -0.
7871491998305444 %
235 (3opt - ConvexHull) / ConvexHull computation time
236 : -100.0 %
237 ACO fitted. Best score: 3826.0
238 ACO distance : 3826.0
239 ACO computation : 3.619659662246704
240 (ACO - ConvexHull) / ConvexHull
241 : 11.218390612788848 %
242 (ACO - ConvexHull) / ConvexHull computation time
243 : 5139.835922427271 %
244
245 ConvexHull distance : 3257.103915510158
246 ConvexHull computation time : 0.08472609519958496
247 DP distance : 3313
248 DP computation : 68.39506340026855
249 (DP - ConvexHull) / ConvexHull distance
250 : 1.716128374770844 %
251 (DP - ConvexHull) / ConvexHull computation time
252 : 80624.90917839867 %
253 LS_distance : 3361
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254 LS computation : 0.018120765686035156
255 (LS - ConvexHull) / ConvexHull
256 : 3.189830204529069 %
257 (LS - ConvexHull) / ConvexHull computation time
258 : -78.61253295888476 %
259 3 OPT distance : {3108}
260 3 OPT computation : 0.0020079612731933594
261 (3opt - ConvexHull) / ConvexHull distance : -4.
    57780652315491 %
262 (3opt - ConvexHull) / ConvexHull computation time
263 : -97.63005568890752 %
264 ACO fitted. Best score: 3313.0
265 ACO distance : 3313.0
266 ACO computation : 2.3554418087005615
267 (ACO - ConvexHull) / ConvexHull
268 : 1.716128374770844 %
269 (ACO - ConvexHull) / ConvexHull computation time
270 : 2680.0665227778604 %
271
272 ConvexHull distance : 3149.58826458094
273 ConvexHull computation time : 0.0781102180480957
274 DP distance : 3684
275 DP computation : 77.73820734024048
276 (DP - ConvexHull) / ConvexHull distance
277 : 16.967669756356692 %
278 (DP - ConvexHull) / ConvexHull computation time
279 : 99423.73618055174 %
280 LS_distance : 3738
281 LS computation : 0.018198013305664062
282 (LS - ConvexHull) / ConvexHull
283 : 18.68217957363228 %
284 (LS - ConvexHull) / ConvexHull computation time
285 : -76.70213480333803 %
286 3 OPT distance : {3609}
287 3 OPT computation : 0.0020101070404052734
288 (3opt - ConvexHull) / ConvexHull distance : 14.
    586406121251713 %
289 (3opt - ConvexHull) / ConvexHull computation time
290 : -97.42657607335371 %
291 ACO fitted. Best score: 3718.0
292 ACO distance : 3718.0
293 ACO computation : 3.691657066345215
294 (ACO - ConvexHull) / ConvexHull
295 : 18.047175937604283 %
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296 (ACO - ConvexHull) / ConvexHull computation time
297 : 4626.215287316326 %
298
299 ConvexHull distance : 2843.403196037095
300 ConvexHull computation time : 0.08444571495056152
301 DP distance : 3248
302 DP computation : 76.85668540000916
303 (DP - ConvexHull) / ConvexHull distance
304 : 14.229315227850886 %
305 (DP - ConvexHull) / ConvexHull computation time
306 : 90913.12653342406 %
307 LS_distance : 3413
308 LS computation : 0.020212173461914062
309 (LS - ConvexHull) / ConvexHull
310 : 20.032220712024344 %
311 (LS - ConvexHull) / ConvexHull computation time
312 : -76.06489154156938 %
313 3 OPT distance : {3256}
314 3 OPT computation : 0.0
315 (3opt - ConvexHull) / ConvexHull distance : 14.
    510668221022932 %
316 (3opt - ConvexHull) / ConvexHull computation time
317 : -100.0 %
318 ACO fitted. Best score: 3278.0
319 ACO distance : 3278.0
320 ACO computation : 3.054781913757324
321 (ACO - ConvexHull) / ConvexHull
322 : 15.284388952246061 %
323 (ACO - ConvexHull) / ConvexHull computation time
324 : 3517.450471638184 %
325
326 ConvexHull distance : 3003.483799344348
327 ConvexHull computation time : 0.06898641586303711
328 DP distance : 3394
329 DP computation : 69.9423508644104
330 (DP - ConvexHull) / ConvexHull distance
331 : 13.00210777700551 %
332 (DP - ConvexHull) / ConvexHull computation time
333 : 101285.68584758943 %
334 LS_distance : 3394
335 LS computation : 0.010100603103637695
336 (LS - ConvexHull) / ConvexHull
337 : 13.00210777700551 %
338 (LS - ConvexHull) / ConvexHull computation time
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339 : -85.35856229479869 %
340 3 OPT distance : {3258}
341 3 OPT computation : 0.008118629455566406
342 (3opt - ConvexHull) / ConvexHull distance : 8.
    47403274528107 %
343 (3opt - ConvexHull) / ConvexHull computation time
344 : -88.23155348194229 %
345 ACO fitted. Best score: 3394.0
346 ACO distance : 3394.0
347 ACO computation : 2.5188400745391846
348 (ACO - ConvexHull) / ConvexHull
349 : 13.00210777700551 %
350 (ACO - ConvexHull) / ConvexHull computation time
351 : 3551.211681354761 %
352
353 ConvexHull distance : 3487.4753928189416
354 ConvexHull computation time : 0.07814621925354004
355 DP distance : 3502
356 DP computation : 69.37043595314026
357 (DP - ConvexHull) / ConvexHull distance
358 : 0.4164791301743952 %
359 (DP - ConvexHull) / ConvexHull computation time
360 : 88670.04750296703 %
361 LS_distance : 4060
362 LS computation : 0.010153055191040039
363 (LS - ConvexHull) / ConvexHull
364 : 16.416592024131365 %
365 (LS - ConvexHull) / ConvexHull computation time
366 : -87.00761817011372 %
367 3 OPT distance : {3828}
368 3 OPT computation : 0.0
369 (3opt - ConvexHull) / ConvexHull distance : 9.
    764215337038145 %
370 (3opt - ConvexHull) / ConvexHull computation time
371 : -100.0 %
372 ACO fitted. Best score: 3502.0
373 ACO distance : 3502.0
374 ACO computation : 3.327085256576538
375 (ACO - ConvexHull) / ConvexHull
376 : 0.4164791301743952 %
377 (ACO - ConvexHull) / ConvexHull computation time
378 : 4157.512760511214 %
379
380 ConvexHull distance : 3270.9564946337096
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381 ConvexHull computation time : 0.08472919464111328
382 DP distance : 3553
383 DP computation : 67.34374713897705
384 (DP - ConvexHull) / ConvexHull distance
385 : 8.622661470093151 %
386 (DP - ConvexHull) / ConvexHull computation time
387 : 79381.16044797118 %
388 LS_distance : 3848
389 LS computation : 0.018207788467407227
390 (LS - ConvexHull) / ConvexHull
391 : 17.641430153931452 %
392 (LS - ConvexHull) / ConvexHull computation time
393 : -78.51060836287917 %
394 3 OPT distance : {3687}
395 3 OPT computation : 0.0020525455474853516
396 (3opt - ConvexHull) / ConvexHull distance : 12.
    719322499362073 %
397 (3opt - ConvexHull) / ConvexHull computation time
398 : -97.57752265180933 %
399 ACO fitted. Best score: 3553.0
400 ACO distance : 3553.0
401 ACO computation : 2.7392778396606445
402 (ACO - ConvexHull) / ConvexHull
403 : 8.622661470093151 %
404 (ACO - ConvexHull) / ConvexHull computation time
405 : 3132.9799088299847 %
406
407 ConvexHull distance : 3356.156683567652
408 ConvexHull computation time : 0.0781102180480957
409 DP distance : 3678
410 DP computation : 72.63109302520752
411 (DP - ConvexHull) / ConvexHull distance
412 : 9.589639184849466 %
413 (DP - ConvexHull) / ConvexHull computation time
414 : 92885.39274398843 %
415 LS_distance : 3678
416 LS computation : 0.018151283264160156
417 (LS - ConvexHull) / ConvexHull
418 : 9.589639184849466 %
419 (LS - ConvexHull) / ConvexHull computation time
420 : -76.76196057603673 %
421 3 OPT distance : {3343}
422 3 OPT computation : 0.0020525455474853516
423 (3opt - ConvexHull) / ConvexHull distance : -0.
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423 39201636896363257 %
424 (3opt - ConvexHull) / ConvexHull computation time
425 : -97.37224450427023 %
426 ACO fitted. Best score: 3747.0
427 ACO distance : 3747.0
428 ACO computation : 2.4811089038848877
429 (ACO - ConvexHull) / ConvexHull
430 : 11.645562269067684 %
431 (ACO - ConvexHull) / ConvexHull computation time
432 : 3076.4204042512924 %
433
434 ConvexHull distance : 3732.1493138672863
435 ConvexHull computation time : 0.07815265655517578
436 DP distance : 4239
437 DP computation : 64.5770149230957
438 (DP - ConvexHull) / ConvexHull distance
439 : 13.580664745899742 %
440 (DP - ConvexHull) / ConvexHull computation time
441 : 82529.32799668086 %
442 LS_distance : 4433
443 LS computation : 0.010067224502563477
444 (LS - ConvexHull) / ConvexHull
445 : 18.778741877464864 %
446 (LS - ConvexHull) / ConvexHull computation time
447 : -87.11851273352939 %
448 3 OPT distance : {4072}
449 3 OPT computation : 0.0
450 (3opt - ConvexHull) / ConvexHull distance : 9.
    106031338830798 %
451 (3opt - ConvexHull) / ConvexHull computation time
452 : -100.0 %
453 ACO fitted. Best score: 4239.0
454 ACO distance : 4239.0
455 ACO computation : 2.5497567653656006
456 (ACO - ConvexHull) / ConvexHull
457 : 13.580664745899742 %
458 (ACO - ConvexHull) / ConvexHull computation time
459 : 3162.53370999036 %
460
461 ConvexHull distance : 2640.2550907966233
462 ConvexHull computation time : 0.07979798316955566
463 DP distance : 3354
464 DP computation : 69.60937261581421
465 (DP - ConvexHull) / ConvexHull distance
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466 : 27.03317992611176 %
467 (DP - ConvexHull) / ConvexHull computation time
468 : 87131.99490882798 %
469 LS_distance : 3386
470 LS computation : 0.010147809982299805
471 (LS - ConvexHull) / ConvexHull
472 : 28.24518402797091 %
473 (LS - ConvexHull) / ConvexHull computation time
474 : -87.28312473670215 %
475 3 OPT distance : {3210}
476 3 OPT computation : 0.010104894638061523
477 (3opt - ConvexHull) / ConvexHull distance : 21.
    579161467745607 %
478 (3opt - ConvexHull) / ConvexHull computation time
479 : -87.33690472277911 %
480 ACO fitted. Best score: 3395.0
481 ACO distance : 3395.0
482 ACO computation : 3.1138205528259277
483 (ACO - ConvexHull) / ConvexHull
484 : 28.586060181618794 %
485 (ACO - ConvexHull) / ConvexHull computation time
486 : 3802.1293886709473 %
487
488 ConvexHull distance : 3087.2714375953133
489 ConvexHull computation time : 0.07811093330383301
490 DP distance : 3580
491 DP computation : 66.2648823261261
492 (DP - ConvexHull) / ConvexHull distance
493 : 15.960001326882834 %
494 (DP - ConvexHull) / ConvexHull computation time
495 : 84734.3241123127 %
496 LS_distance : 3865
497 LS computation : 0.010105609893798828
498 (LS - ConvexHull) / ConvexHull
499 : 25.191453946481047 %
500 (LS - ConvexHull) / ConvexHull computation time
501 : -87.06248988923177 %
502 3 OPT distance : {3540}
503 3 OPT computation : 0.0
504 (3opt - ConvexHull) / ConvexHull distance : 14.
    664358853956768 %
505 (3opt - ConvexHull) / ConvexHull computation time
506 : -100.0 %
507 ACO fitted. Best score: 3617.0
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508 ACO distance : 3617.0
509 ACO computation : 3.379241704940796
510 (ACO - ConvexHull) / ConvexHull
511 : 17.158470614339443 %
512 (ACO - ConvexHull) / ConvexHull computation time
513 : 4226.2083321887185 %
514
515 ConvexHull distance : 3204.0174745484223
516 ConvexHull computation time : 0.07815122604370117
517 DP distance : 3766
518 DP computation : 82.56101727485657
519 (DP - ConvexHull) / ConvexHull distance
520 : 17.539933221830637 %
521 (DP - ConvexHull) / ConvexHull computation time
522 : 105542.6385795784 %
523 LS_distance : 4092
524 LS computation : 0.010171890258789062
525 (LS - ConvexHull) / ConvexHull
526 : 27.714659252185598 %
527 (LS - ConvexHull) / ConvexHull computation time
528 : -86.98434973611154 %
529 3 OPT distance : {3960}
530 3 OPT computation : 0.0
531 (3opt - ConvexHull) / ConvexHull distance : 23.
532 (3opt - ConvexHull) / ConvexHull computation time
533 : -100.0 %
534 ACO fitted. Best score: 3835.0
535 ACO distance : 3835.0
536 ACO computation : 3.6756093502044678
537 (ACO - ConvexHull) / ConvexHull
538 : 19.693479528868956 %
539 (ACO - ConvexHull) / ConvexHull computation time
540 : 4603.201134872937 %
541
542 ConvexHull distance : 3853.0983232597573
543 ConvexHull computation time : 0.0846555233001709
544 DP distance : 4189
545 DP computation : 69.43489456176758
546 (DP - ConvexHull) / ConvexHull distance
547 : 8.71770322372845 %
548 (DP - ConvexHull) / ConvexHull computation time
549 : 81920.5130804825 %
550 LS_distance : 4189
```

```
551 LS computation : 0.010112524032592773
552 (LS - ConvexHull) / ConvexHull
553 : 8.71770322372845 %
554 (LS - ConvexHull) / ConvexHull computation time
555 : -88.0545017757012 %
556 3 OPT distance : {3859}
557 3 OPT computation : 0.008090972900390625
558 (3opt - ConvexHull) / ConvexHull distance : 0.
    15316704234139084 %
559 (3opt - ConvexHull) / ConvexHull computation time
560 : -90.44247488530462 %
561 ACO fitted. Best score: 4206.0
562 ACO distance : 4206.0
563 ACO computation : 2.6722347736358643
564 (ACO - ConvexHull) / ConvexHull
565 : 9.158906602769601 %
566 (ACO - ConvexHull) / ConvexHull computation time
567 : 3056.598257813226 %
568
569 ConvexHull distance : 3557.6191662076853
570 ConvexHull computation time : 0.07815861701965332
571 DP distance : 3929
572 DP computation : 64.50728988647461
573 (DP - ConvexHull) / ConvexHull distance
574 : 10.43902723821323 %
575 (DP - ConvexHull) / ConvexHull computation time
576 : 82433.81693058102 %
577 LS_distance : 3953
578 LS computation : 0.02025127410888672
579 (LS - ConvexHull) / ConvexHull
580 : 11.11363570187246 %
581 (LS - ConvexHull) / ConvexHull computation time
582 : -74.0895183652054 %
583 3 OPT distance : {3810}
584 3 OPT computation : 0.0
585 (3opt - ConvexHull) / ConvexHull distance : 7.
    094093605902878 %
586 (3opt - ConvexHull) / ConvexHull computation time
587 : -100.0 %
588 ACO fitted. Best score: 4048.0
589 ACO distance : 4048.0
590 ACO computation : 3.3875513076782227
591 (ACO - ConvexHull) / ConvexHull
592 : 13.783960870523583 %
```

```
593 (ACO - ConvexHull) / ConvexHull computation time
594 : 4234.200676588748 %
595
596 ConvexHull distance : 3405.7547052313225
597 ConvexHull computation time : 0.09377264976501465
598 DP distance : 3775
599 DP computation : 65.17838907241821
600 (DP - ConvexHull) / ConvexHull distance
601 : 10.841805318554142 %
602 (DP - ConvexHull) / ConvexHull computation time
603 : 69406.8223365225 %
604 LS_distance : 3775
605 LS computation : 0.010104179382324219
606 (LS - ConvexHull) / ConvexHull
607 : 10.841805318554142 %
608 (LS - ConvexHull) / ConvexHull computation time
609 : -89.22481191728683 %
610 3 OPT distance : {3533}
611 3 OPT computation : 0.0
612 (3opt - ConvexHull) / ConvexHull distance : 3.
    736184951113055 %
613 (3opt - ConvexHull) / ConvexHull computation time
614 : -100.0 %
615 ACO fitted. Best score: 3891.0
616 ACO distance : 3891.0
617 ACO computation : 2.710477113723755
618 (ACO - ConvexHull) / ConvexHull
619 : 14.247805164104415 %
620 (ACO - ConvexHull) / ConvexHull computation time
621 : 2790.477255911988 %
622
623 ConvexHull distance : 4050.31237767932
624 ConvexHull computation time : 0.08469581604003906
625 DP distance : 4254
626 DP computation : 67.06335282325745
627 (DP - ConvexHull) / ConvexHull distance
628 : 5.028936124610357 %
629 (DP - ConvexHull) / ConvexHull computation time
630 : 79081.42354464588 %
631 LS_distance : 4337
632 LS computation : 0.018114089965820312
633 (LS - ConvexHull) / ConvexHull
634 : 7.078160783365097 %
635 (LS - ConvexHull) / ConvexHull computation time
```

```
636 : -78.6127688323387 %
637 3 OPT distance : {3974}
638 3 OPT computation : 0.002056598663330078
639 (3opt - ConvexHull) / ConvexHull distance : -1.
    8841109169718946 %
640 (3opt - ConvexHull) / ConvexHull computation time
641 : -97.57178245693052 %
642 ACO fitted. Best score: 4285.0
643 ACO distance : 4285.0
644 ACO computation : 2.771547317504883
645 (ACO - ConvexHull) / ConvexHull
646 : 5.794309189928393 %
647 (ACO - ConvexHull) / ConvexHull computation time
648 : 3172.354464587321 %
649
650 ConvexHull distance : 3594.93583000242
651 ConvexHull computation time : 0.0781559944152832
652 DP distance : 3670
653 DP computation : 65.6475260257721
654 (DP - ConvexHull) / ConvexHull distance
655 : 2.08805312659863 %
656 (DP - ConvexHull) / ConvexHull computation time
657 : 83895.50989902687 %
658 LS_distance : 3670
659 LS computation : 0.01010584831237793
660 (LS - ConvexHull) / ConvexHull
661 : 2.08805312659863 %
662 (LS - ConvexHull) / ConvexHull computation time
663 : -87.0696440010982 %
664 3 OPT distance : {3534}
665 3 OPT computation : 0.0
666 (3opt - ConvexHull) / ConvexHull distance : -1.
    6950463898093848 %
667 (3opt - ConvexHull) / ConvexHull computation time
668 : -100.0 %
669 ACO fitted. Best score: 3825.0
670 ACO distance : 3825.0
671 ACO computation : 4.129222393035889
672 (ACO - ConvexHull) / ConvexHull
673 : 6.399673898975411 %
674 (ACO - ConvexHull) / ConvexHull computation time
675 : 5183.3086238979895 %
676
677 ConvexHull distance : 3588.2334166394407
```



```
678 ConvexHull computation time : 0.0781102180480957
679 DP distance : 3709
680 DP computation : 65.44324612617493
681 (DP - ConvexHull) / ConvexHull distance
682 : 3.365627854657883 %
683 (DP - ConvexHull) / ConvexHull computation time
684 : 83683.20757711725 %
685 LS_distance : 3709
686 LS computation : 0.01007390022277832
687 (LS - ConvexHull) / ConvexHull
688 : 3.365627854657883 %
689 (LS - ConvexHull) / ConvexHull computation time
690 : -87.10296748041927 %
691 3 OPT distance : {3586}
692 3 OPT computation : 0.0
693 (3opt - ConvexHull) / ConvexHull distance : -0.
    06224279137148367 %
694 (3opt - ConvexHull) / ConvexHull computation time
695 : -100.0 %
696 ACO fitted. Best score: 3820.0
697 ACO distance : 3820.0
698 ACO computation : 2.7414238452911377
699 (ACO - ConvexHull) / ConvexHull
700 : 6.459072096196579 %
701 (ACO - ConvexHull) / ConvexHull computation time
702 : 3409.686586207107 %
703
704 ConvexHull distance : 3612.290867521566
705 ConvexHull computation time : 0.06908059120178223
706 DP distance : 4184
707 DP computation : 65.67804670333862
708 (DP - ConvexHull) / ConvexHull distance
709 : 15.826774571746776 %
710 (DP - ConvexHull) / ConvexHull computation time
711 : 94974.52898238106 %
712 LS_distance : 4184
713 LS computation : 0.010140180587768555
714 (LS - ConvexHull) / ConvexHull
715 : 15.826774571746776 %
716 (LS - ConvexHull) / ConvexHull computation time
717 : -85.32123073737252 %
718 3 OPT distance : {3906}
719 3 OPT computation : 0.002052783966064453
720 (3opt - ConvexHull) / ConvexHull distance : 8.
```

```
720 130827312916566 %
721 (3opt - ConvexHull) / ConvexHull computation time
722 : -97.028421543081 %
723 ACO fitted. Best score: 4184.0
724 ACO distance : 4184.0
725 ACO computation : 4.207795143127441
726 (ACO - ConvexHull) / ConvexHull
727 : 15.826774571746776 %
728 (ACO - ConvexHull) / ConvexHull computation time
729 : 5991.139450206216 %
730
731 ConvexHull distance : 4081.599510048557
732 ConvexHull computation time : 0.08428597450256348
733 DP distance : 4156
734 DP computation : 67.21280860900879
735 (DP - ConvexHull) / ConvexHull distance
736 : 1.8228268052334677 %
737 (DP - ConvexHull) / ConvexHull computation time
738 : 79643.76401967634 %
739 LS_distance : 4220
740 LS computation : 0.010062932968139648
741 (LS - ConvexHull) / ConvexHull
742 : 3.390839537556601 %
743 (LS - ConvexHull) / ConvexHull computation time
744 : -88.06096384656075 %
745 3 OPT distance : {4032}
746 3 OPT computation : 0.0020530223846435547
747 (3opt - ConvexHull) / ConvexHull distance : -1.
    215197863642603 %
748 (3opt - ConvexHull) / ConvexHull computation time
749 : -97.5642182501181 %
750 ACO fitted. Best score: 4229.0
751 ACO distance : 4229.0
752 ACO computation : 3.7741358280181885
753 (ACO - ConvexHull) / ConvexHull
754 : 3.611341328039541 %
755 (ACO - ConvexHull) / ConvexHull computation time
756 : 4377.774446213944 %
757
758 ConvexHull distance : 3587.996061004051
759 ConvexHull computation time : 0.08842682838439941
760 DP distance : 3712
761 DP computation : 66.0336685180664
762 (DP - ConvexHull) / ConvexHull distance
```

```
763 : 3.4560779021939068 %
764 (DP - ConvexHull) / ConvexHull computation time
765 : 74576.05671777809 %
766 LS_distance : 3814
767 LS computation : 0.018195629119873047
768 (LS - ConvexHull) / ConvexHull
769 : 6.298890387652898 %
770 (LS - ConvexHull) / ConvexHull computation time
771 : -79.42295403746135 %
772 3 OPT distance : {3559}
773 3 OPT computation : 0.002054929733276367
774 (3opt - ConvexHull) / ConvexHull distance : -0.
8081408259945809 %
775 (3opt - ConvexHull) / ConvexHull computation time
776 : -97.67612412339003 %
777 ACO fitted. Best score: 3712.0
778 ACO distance : 3712.0
779 ACO computation : 3.0039448738098145
780 (ACO - ConvexHull) / ConvexHull
781 : 3.4560779021939068 %
782 (ACO - ConvexHull) / ConvexHull computation time
783 : 3297.096705483312 %
784
785 ConvexHull distance : 3324.2262308017216
786 ConvexHull computation time : 0.09103131294250488
787 DP distance : 3655
788 DP computation : 67.88475227355957
789 (DP - ConvexHull) / ConvexHull distance
790 : 9.950398866761361 %
791 (DP - ConvexHull) / ConvexHull computation time
792 : 74472.96844266696 %
793 LS_distance : 3768
794 LS computation : 0.010103940963745117
795 (LS - ConvexHull) / ConvexHull
796 : 13.349686164146867 %
797 (LS - ConvexHull) / ConvexHull computation time
798 : -88.90058746035363 %
799 3 OPT distance : {3628}
800 3 OPT computation : 0.008167028427124023
801 (3opt - ConvexHull) / ConvexHull distance : 9.
138179778005531 %
802 (3opt - ConvexHull) / ConvexHull computation time
803 : -91.02833062258226 %
804 ACO fitted. Best score: 3718.0
```

```
805 ACO distance : 3718.0
806 ACO computation : 3.249277353286743
807 (ACO - ConvexHull) / ConvexHull
808 : 11.845576740524963 %
809 (ACO - ConvexHull) / ConvexHull computation time
810 : 3469.406227655947 %
811
812 Result
813 -----
814 Dynamic Programming distance error average : 9.
      74560629454877 %
815 Dynamic Programming computation error average :
      85650.26168888558 %
816 Local Search distance error average : 12.
      493099749713055 %
817 Local Search computation error average : -84.
      57430799709687 %
818 3OPT distance error average : 6.014272553196049 %
819 3OPT computation error average : -96.51175673476058
      %
820 ACO distance error average : [8.10844987e+00 4.
      70523904e+06] %
821 ACO computation error average : 3715.3327905606584 %
822
823 Process finished with exit code 0
824
```